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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER 7a APRIL 1983

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1. EDITORIAL

a. Future Directions

The aims of the Irrigation Management Network will remain the same as previously for as long as seems useful. The policy is to carry out research and to facilitate the exchange of information and ideas on

- planning, design and construction
- management, operation and maintenance

of both large and small scale systems, whether centrally organised or arising from informal, non-governmental or traditional initiatives. The item in section 3a, in regard to the proposed *International Irrigation Management Institute (IIMI)* will explain why I feel it necessary to add "as long as seems useful". If and when the IIMI is formed, it might be appropriate for this network to concentrate on planning and design questions, particularly for the rehabilitation of old systems. Another possibility would be to expand into management schemes for river basins and watersheds (which may include irrigation, particularly perhaps small-scale irrigation). Both rehabilitation and watershed management are concerned with resource conservation, likely to become increasingly important. At a meeting at ODI on March 2nd, 1983, Montague Yudelman, Director, Agriculture and Rural Development, World Bank, foresaw three main problem areas in the next decade: population growth, pressure on resources, and technology. The pressure on physical resources would lead, he said, to more concern with soil conservation, reafforestation, desilting rivers, and rehabilitating irrigation systems. The next Newsletter should have more definite information about the proposed IIMI; in the meantime I should be grateful for Networkers' opinions on research priorities.

Currently, we are also discussing possible Anglo-French co-operation in a comparative study of irrigation management structures and problems in Africa, in regard to both large and small scale systems, whether governmentally or privately managed. There is far too little knowledge in anglophone Africa of lessons to be learnt from experience gained in francophone Africa and vice-versa. If any African members of the Network would be interested in collaborating, particularly by co-operating in the research on the institutions and experience of their own country, could they let me know *immediately*. I will be sending out shortly more details and an outline research scheme for comment by those interested in participation. At present we envisage that the programme would include a conference in two years time to discuss the initial papers on country experience, and to define and debate the general issues arising. A period of further study of these general Africa-wide issues would culminate in publication of guidelines for selecting appropriate, or improving existing management structures, and recommendations on training and further research. 'Appropriate management structures' will take into account the socio-economic and political background of the irrigation schemes, and the manpower situation.

In the short term, in the next six months, I intend to work on land tenure issues, looking particularly at how these were investigated at feasibility stage, and whether the problems arising at detailed design or implementation were adequately foreseen. Case studies may well indicate the need for better guidelines for the investigation of land tenure and related issues in projects involving a degree of land distribution or resettlement. I should welcome suggestions on case-histories to investigate from networkers.

b. Network Papers

This Newsletter is accompanied by four papers. Paper 7b, with articles by *Martin Adams* and *David Seddon*, initiates the discussion on the necessity of taking existing land tenure into account in designing new or rehabilitating old systems, with examples from Indonesia and Morocco.

Paper 7c, by *Professor L. Horst*, is a suggestion from an engineer as to how systems can be designed with small reservoirs in the tertiary unit, making them less dependent on scarce resources of dedicated management and trained manpower, while giving groups of farmers more flexibility in the use of water. Paper 7d, by *Syed Hashim Ali*, on the Command Area Development Authority's problems, 1980-81, in Andhra Pradesh State, India in attempting to deliver a reliable discharge at every outlet, and to increase the area getting effective irrigation, illustrates some of the social and political pressures on irrigation staff to which Horst alludes. The paper supports Horst's contention that equitable distribution *within* the tertiary unit is facilitated by reliable distribution *to* each unit, so that main system operation must be corrected as a first step. Engineers and others may wish to consider whether Horst's preferred solution of reservoirs for each tertiary, combined with proportional division or open/shut structures on the main and secondary systems, are appropriate for the rehabilitation of elderly systems or the designs for new ones in Andhra Pradesh and similar areas.

Horst's reservoirs are also designed for fish culture. Paper 7e, by *Robert Yoder*, surveys the existing, limited knowledge on non-agricultural uses of irrigation systems, and makes suggestions for further research, which our university members might find a stimulating source of ideas for their post-graduate candidates.

c. Future Newsletters

This Newsletter is the seventh to be issued, hence its number, 7a. The change in reference style brings it more into line with other AAU Networks. Newsletter 8a is planned for October 1983; please get news items to me by September 1st. Drafts/suggestions for new papers should ideally arrive earlier, say by July 1st. This will enable me to get one or two reactions, and comments or companion pieces to go out with it.

About half the people who sent in comments on the format of the Newsletter in 1980 said it should not be too long. The longest section consists of material received by Anthony Bottrall or myself which we have considered worth filing in the AAU Library (Section 7). As this listing does take up time and space could those of you who actually a) read and b) use it, please let me know. Otherwise, it may be dropped in favour of brief notes on the one or two outstanding books/articles/reports received - for example, the recently published FAO Irrigation and Drainage Paper 40, J.S. Sargadoy with A.F. Bottrall and G.O. Uittenbogaard, Organisation, Operation and Maintenance of Irrigation Schemes, FAO, Rome, 1982.

Could anyone who still wishes to receive the Newsletter, but who has not yet filled in the attached form, please do so. We are happy to send it free to all who find it useful, but let me know if your interests (or address) have changed. Fiona Harris has taken over responsibility for Network membership from Gill Hopcraft (who is now a Farm Secretary in Devon).

d. ODI and AAU Libraries

Networkers are free to come and use both the AAU documentation room and the main ODI library whenever they are in London. The AAU entries, around 3,000, consist largely of unpublished or not easily available material. The hours are 9.30 to 5.30, week days.

The ODI Librarian has recently unearthed a large number of copies of very interesting but now somewhat dated papers given at the *ODI Workshop on Choices in Irrigation Management*, at the University of Kent, Canterbury, UK, in 1976. If you would like a set please write, enclosing £2 for p. and p. if your circumstances permit, before they are regretfully thrown out.

Mary Tiffen

2. AAU WORK ON IRRIGATION MANAGEMENT IN 1982

In January/February *Anthony Bottrall* visited Bangladesh to carry out a study of the organisation and management of community-operated lift irrigation devices (low-lift pumps, deep tubewells and shallow tubewells) on behalf of the Bangladesh Agricultural Research Council. The study was financed by the Ford Foundation. This was the first in a series of projected studies of community-managed systems, in which particular attention will be paid to the effectiveness of government (or other external agencies') support services.

In February he attended a workshop on tank irrigation held at the College of Engineering, Perarignar Anna University of Technology in Madras; and contributed to the first training course on irrigation development to be organised by the World Bank's Economic Development Institute in Washington D.C. And in April he presented two papers at a workshop on water management at the farm level, held at the University of Agriculture, Faisalabad, and sponsored by FAO and the Government of Pakistan.

At the end of September he left ODI to join the Ford Foundation, at Dhaka, Bangladesh. *Ian Carruthers*, Wye College, University of London, has expressed a thank you to him, in which he is probably speaking for most Network members:

> Anthony Bottrall's move to Bangladesh will be a loss to ODI but a gain to an important region. It was no real surprise that he has chosen to make this move at this time. In his recent writings he stressed action research - learning by doing. Clearly he will be closer to action in Bangladesh than London and hopefully, as he is working with the Ford Foundation, he will be with a group which is radical enough, and with sufficient resources, to enable him to test some of his most promising ideas. We all received recently the register of 550 members of the Irrigation Management Network. It reads like a comprehensive Who's Who of the representatives of the academic and various private and public agencies concerned with irrigation development. The success, over several years, of this informal grouping of professional interests from a wide range of disciplines is entirely due to Anthony's initiatives and enthusiasms. He not only recognised, before most, the crucial importance of improved irrigation management but by his own painstaking field research he clarified the precise nature of the problems and then verified many of his contentions. He was not afraid to advise where research and investment emphasis should be placed. His coverage was always extensive and by his writing he identified important research areas that I and many colleagues were pleased to try to develop. Members of the Network will miss him but we welcome his successor, Dr Mary Tiffen, who has a fine example to emulate.

3. NEWS FROM NETWORKERS

a. International Programmes

At a meeting in Paris in May 1982 the Consultation Group for International Agricultural Research (CGIAR) gave high priority for an *International Irrigation Management Institute* (IIMI) but, for financial reasons, was unable itself to undertake its implementation. At an informal meeting of interested parties, the Ford Foundation was asked to co-ordinate efforts to establish such an Institute. Dr R W Cummings was engaged to carry out soundings. These culminated in a meeting of 15 donor organisations and other interested parties in Washington in November 1982 at which it was decided to establish, outside the CGIAR framework, an IIMI Support Group to provide financial support to the proposed Institute. The implementing agency for its establishment is the Ford Foundation and the Interim Fund Custodian is the World Bank. Discussions are now under way with prospective host countries. The plan is for a headquarters staff of 10-12 professionals, with additional outposted staff at IIMI co-operating units, and an annual budget of $3 million. It is envisaged that one of the co-operating units will be at the *Center for Irrigation System Management for ASEAN* (CISMA) which is already being discussed between the Asean countries and the Asian Development Bank.

The IIMI is envisaged as supporting national activities in three fields:

Research on the development and testing of methodologies for improving irrigation management and performance

Training in these methodologies

Dissemination of selective information

In regard to the last, it is proposed that IIMI should keep in close touch with ODI's network, and with other research institutes. The Support Group plans further meetings in Paris during May 23-25 1983, after which the time-table of events may become clearer.

FAO's *International Support Programme for Farm Water Management* reports involvement in a water management pilot project in Besut, Malaysia; in an irrigation project in Panama; in the training of field technicians to improve tubewell command area development in N.W. Bangladesh; and the training of irrigation technicians in South Yemen. It also reports that institutions in a number of Latin American countries have established a network for the exchange of information about the improvement of lowlands subject to floods and droughts. (For more information, write to Pieter Dieleman, International Support Programme for Water Management, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy).

USAID's worldwide *Water Management Synthesis Program* is now going into stage 2. They would appreciate information on small-scale systems in Africa. Please contact Prof. Walter Coward, Cornell University Irrigation Studies Group, Ithaca, NY 14853, USA.

b. Recent Meetings

A workshop on *Water Resources Planning and Management* was held at the Water and Land Management Institute, Aurangabad, India from 22-24 January 1982. Requests for copies of the presented papers and proceedings should be addressed to the Administrative Officer, WALMI, P.B. No. 81, Aurangabad-431001, Maharashtra, India

A workshop on *Modernisation of Tank Irrigation: Problems and Issues* was held at the Centre for Water Resources, Perarignar Anna University of Technology, Madras from 10-12 February 1982. Recommendations arising out of workshop discussions are presented in Wamana, 2, 2, April 1982, pp. 16-17. The proceedings are now printed; for information please write to Dr R Sakthivadivel, Director, Centre of Water Resources, PAUT, Madras 600025, India.

Recent meetings of the British Section of the International Commission on Irrigation and Drainage include 26 April 1982 *Planning Irrigation Projects for Developing Projects: Health Considerations* and 2 February 1983 *Application of Remote Sensing in Land and Water Resources Development.* For more information write to Norman Tyler, Secretary, British Section, ICID, at the Institute of Civil Engineers, Great George Street, London SW1P 3AA, UK.

A national workshop on water management and control at the farm level was held at Faisalabad, Pakistan, from 18-22 April 1982, under the auspices of the Ministry of Food, Agriculture and Cooperatives, Government of Pakistan, and FAO. For information on papers and proceedings, write to Mr A Kango, Ministry of Food, Agriculture and Cooperatives, (Water Management Wing) House No. 27, Street No. 17 F-7/2, Islamabad, Pakistan.

An All-India Workshop on *Water Distribution Practices* was held at the Water Resources Development Training Centre, Roorkee, U.P. from 2-3 July 1982. The papers, general report and findings are available for US$ 12 from the Indian Water Resources Society, University of Roorkee, Roorkee 247672, U.P.India.

A workshop on *Asian Water Resources Management* was held at the Environment and Policy Institute of the East-West Center, Honolulu, Hawaii, from 13 - 17 September 1982.

For the report and other material, contact Dr Maynard M Hufschmidt, The East-West Environment and Policy Institute, 1777 East-West Road, Honolulu, Hawaii 96848, USA.

A workshop on *Productivity and Equity in Irrigation Development Systems* in India was held at the Giri Institute of Development Studies, B-42 Nirala Nagar, Lucknow 226 007, India, in September 1982. The January 1983 issue of Wamana contains a summary of papers and discussions, and the recommendations arrived at. It is hoped to edit the papers and bring them out as a book. Amongst the recommendations were data collection on the actual area irrigated as compared to the anticipated area, since it was felt that the Command Area Development proposals should be an integral part of project proposals, to avoid long delays in utilising new irrigation potential. Other recommendations were on better provision for farmer participation, reallocation of land especially to small farmers who lose land during construction, and conjunctive use of ground water. Seven case studies were considered, mainly in India, but including one from Sri Lanka. Further details from Dr Niranjan Pant, at the Giri Institute, address above.

The *IV World Congress on Water Resources* was held 3-11 September 1982. Details from the President of the International Water Resources Association, Arenales 2040-78, 1124 Buenos Aires, Argentina.

A *National Symposium on Planning and Design of Water Resource Systems* was held at the Bihar College of Engineering, Patna, India, 10-12 February 1983. Recommendations were made for planning water resource use on a river basin or sub-basin basis, conjunctively with ground water resources. Copies of the Proceedings are available from Dr T Prasad, Director, Water Resources Study Programme, for Rs 100 plus postage.

A workshop on small scale irrigation was held in Kenya, in February 1983. (More information from Mr L F Kortenhorst, ILRI, PO Box 45, 6700 AA Wageningen, The Netherlands).

A workshop on *Irrigation in Africa* was held at the University of Cambridge, African Studies Centre, Free School Lane, Cambridge CB2 3RQ on 24-25 March 1983. Write there to A T Grove or W M Adams for further information.

c. Forthcoming Meetings

The Centre d'Etudes Juridiques Comparatives is holding a colloquium 14-15 October 1983 on *Agricultural Development and Peasant Participation - the Politics of Water*. For details, write to Professor Gérard Conac, Sorbonne, 14 Rue Cujas, 75231 Paris, France.

The Indian Society for Agricultural Engineers, Andhra Pradesh chapter, is planning a workshop on *Contingency Irrigation Planning for Command Areas during Deficit Rainfall Years*, at Hyderabad, 2-5 August, 1983. Details from Professor G Ramana Reddi, Department of Agricultural Engineering, College of Agriculture, Rajendranagar, Hyderabad 500 030, India. He would be interested to hear from Network members who might be visiting

India at the time, and who would like to participate. Offers of papers should preferably reach him by mid-May.

This is one of several workshops in India being sponsored by the Ford Foundation. Others are: Institute of Social and Economic Change, Bangalore, *National Seminar on Command Area Development*, June 1983, Punjab Agricultural University, Ludliana, *Management of Groundwater Resources in Irrigated Areas*, October 1983, and Water and Land Management Institute, Aurangabad, *Scheduling of Irrigation*, November 1983.

d. Other Newsletters and Journals

A new, multidisciplinary *International Journal for Water Resources Development* will be published from 1983. It will publish state-of-the-art reviews, articles, case studies, and reports on water developments in developed and developing countries, and on the application of research results to solve real life problems. Manuscripts should be sent to Dr A K Biswas, The Editor, 76 Woodstock Close, Oxford, OX2 8DD, England. Complementary specimen copies of the journal and subscription information can be obtained from Tycooly International Publishing Ltd, 6 Crofton Terrace, Dun Laoghaire, Co. Dublin, Ireland.

A quarterly newsletter on *Water Management* is issued by the Water Management Wing of the Ministry of Food, Agriculture and Cooperatives, Government of Pakistan, Islamabad.

The *Indian Water Resources Society* produces a quarterly journal - but for members only. For information on terms of membership, write to Indian Water Resources Society, c/o Water Resources Development Training Centre, University of Roorkee, U.P. 247672, India.

Irrinews, No. 26 of 1982 contains an article on irrigation in sub-Saharan Africa (IIIC, PO Box 8500, Ottawa, Canada K1G 3H9; or IIIC, Volcani Centre, PO Box 49, Bet Dagan, Israel).

Land and Water, Technical Newsletter of the Land and Water Development Division, FAO, Rome has contained in 1982 items on a hydro-economic model for the Gefara Plain, Libya, the testing of hand pumps and solar powered pumps, and health issues in water management of rice.

e. Training Programmes

A short course on *Computer-Aided Irrigation Management in the Tropics* at the University of Edinburgh is being held from 3-15 April 1983. Details from the course organiser, Dr M E Parkes, Centre for Industrial Consultancy and Liaison, (Irrigation Management Course), University of Edinburgh, 16 George Square, Edinburgh EH8 9LD, UK.

NCAE, Silsoe, Bedford MK45 4DT, UK continue their short course programme. Forthcoming courses connected with irrigation are *Air Photo Interpretation* 12-14 April; *Irrigation and Dams, their effect on Public Health* 21-24 June. Further information from Mrs P Cook at the above address.

NCAE are introducing in October 1983 new MSc and PG 1-year courses in *Irrigation Water Management*, intended principally for civil engineers, agriculturalists and soil scientists.

The Overseas Development Group. University of East Anglia, Norwich NR4 7TJ, UK, has a course on *Irrigation Development Planning*, 18 May-29 June. Write to the Course Directors, Tony Barnett and Linden Vincent, address as above, for further details.

f. Reports from the Field

The Water Technology Centre and IIC-Delhi are collaborating with the Andhra Pradesh government on a pilot project to improve the management of the 43-L Palagudu Major canal, part of the Nagarjunasagar Right Canal irrigation system. Though similar projects have been undertaken elsewhere, principally in the Philippines by NIA/IRRI, this is probably the first time such an effort has been systematically undertaken in India. More information from Dr A M Michael, Project Director, Water Technology Centre, Indian Agricultural Research Institute, New Delhi 110012, India; or Dr Roberto Lenton, Program Officer, The Ford Foundation, 55 Lodi Estate, New Delhi, India.

A study of the performance of the north Indian warabandi system of rotational irrigation is being undertaken by S P Malhotra and S K Raheja in conjunction with the Haryana Department of Irrigation. The object is to develop a statistical methodology for estimating the performance of large scale irrigation systems throughout India. Information from S P Malhotra, 194 Sector,11-A Chandigarh-16001, India. Copies of S P Malhotra's booklet *The Warabandi System and its Infrastructure* are shortly expected at ODI and can be sent to members on request to Fiona Harris.

A very large programme of watercourse rehabilitation is under way in Pakistan, under the name of the On-farm Water Management Programme. Information on the programme's aims and achievements can be obtained from Mr M S Cheema, Director General, OFWMP (Punjab), 21 Davis Road, Lahore, Pakistan.

New legislation concerning the formation of water users' associations was introduced into the four Provinces of Pakistan in 1981. Copies of the ordinances for Punjab and North West Frontier Province are available in the library of the AAU, ODI.

One component of the Water Management Research Programme at the University of Agriculture, Faisalabad, Pakistan, has been concerned with initiating and comparing different approaches to organising water users' associations in the field: some have been organised as multi-purpose co-operatives, others are associations under the Water Users' Association Ordinance of 1981, others informal groups (M M Bashir Kausar, Water Management Research Project, University of Agriculture, Faisalabad, Pakistan).

The Water Resources Development Training Centre at Roorkee have completed a series of studies of the Gomti-Kalyani Doab in UP and have started a new programme on the Salawa Distributory of the Upper Ganga Canal system. This will include studies of water distribution practices, conveyance losses and related issues. (The Director, WRDTC, University of Roorkee, Roorkee, UP 247672, India).

Ed Martin and Bob Yoder of Cornell University are studying the mobilisation of local community resources in construction and management or irrigation systems in the hills of Nepal. Preliminary findings have now been written up. For information write to Bob Yoder at c/o UMN, PO Box 126, Kathmandu, Nepal.

Harry Underhill, (who is responsible for the FAO programme on small scale irrigation in Africa), has initiated a series of studies of existing practices in East and West Africa. Several network members are collaborating. (Harry Underhill, Water Resources Development & Management Service, FAO Via delle Terme di Caracalla, 00100 Rome, Italy.)

Dr Sjofjan Asnawi of the Faculty of Agriculture at Andalas University, Padang, West Sumatra, is leading a study on farm water management for rice cultivation in West Sumatra: the decline of a traditional system (Fakultas Pertanian, Universitas Andalas, Air Tawar, Padang, West Sumatra, Indonesia).

Thomas Engelhardt, based at the University of Stuttgart-Hohenheim, is working on a Ph.D. thesis on the management of traditional irrigation sources. Working from the Departmart of Economics at ICRISAT, he is monitoring agricultural production under tank and well irrigation in a 2000 ha catchment with a view to developing an integrated watershed management model applicable to small source irrigation systems in the semi-arid tropics (c/o Dept of Economics, ICRISAT, Patancheru PO, Andhra Pradesh 502324, India).

Frances Korten's paper for the World Bank, *Building National Capacity to Develop Water Users' Associations: Experience from the Philippines* (Staff Working Paper No 528) can be obtained free from the Bank's Publications Department provided you write at least a sentence explaining why the paper would be useful to you.

A Water Technology Centre for research and dissemination is being established at Tamil Nadu Agricultural University, Coimbatore, India, with assistance from SIDA (Swedish International Development Authority).

D S Rickard has sent a note on the work of the Winchmore Irrigated Research Station, Private Bag, Ashburton, New Zealand. Particular research interests include intensively grazed irrigated pastures, lucerne production, and livestock studies. Write to him for further information.

The Annual Report 1981 of ILRI, PO Box 45, 6700 AA, Wageningen, The Netherlands, contains an interesting article and bibliography on windmills for irrigation, which in certain circumstances are an economical alternative to motor pumps. A comparative study by Vel and van Veldhuizen in Sri Lanka is described.

4. LUNCHTIME MEETINGS AT ODI

The following lunchtime meetings have been held at ODI during 1982:

2 March 1982: Tom Wickham *On-farm and project-level management for lowland rice* (c/o Wickham's Fruit Farm, Cuthogue, Long Island, New York 11935, USA).

26 May 1982: Mick Howes *Solar irrigation in Pakistan* (Institute of Development Studies, University of Sussex, Brighton BN1 9RE).

28 September 1982: Anthony Bottrall *The cost of participation: experience with community-managed lift irrigation in Bangladesh.*

The next lunchtime meeting will be at 12.30 on 18 May 1983. Ian Carruthers and Martin Burton will be speaking on *Management simulation and role playing exercises for training irrigation managers.*

5. OTHER AAU ACTIVITIES SINCE JANUARY 1982

a. Staff

Guy Hunter retired in December 1982 as part-time advisor to ODI but remains a member of the AAU Advisory Committee. The AAU originated in 1974 from the Reading/ODI programme on Agricultural Development of which he was joint Director. With Anthony Bottrall he set up the AAU Networks and was a contributor to, and stimulator of, many of the papers associated with them. Stephen Sandford also left in December, to join the International Livestock Centre for Africa in Ethiopia. He established the Pastoral Management Network, and ran it for six years. Dr Clare Oxby will take charge of the Pastoral Network. Dr Simon Commander, who has conducted substantial field work in India, and who until recently was working for ILO as a consultant, will be joining the AAU in April 1983, and will work initially on rural employment.

b. Publications

Pastoral Network Papers, No.13 and 14 were issued in 1982, and No. 15 in January 1983.

The Agricultural Administration Network issued three Newsletters, Nos. 8, 9 and 10. Irrigation Networkers may be interested in Discussion Paper 8, by John Howell, *Managing Agricultural Extension: the T and V System in Practice.* Network responses were incorporated in Discussion Paper 10, *Strategy and Practice in the T and V System of Agricultural Extension.* Network Paper No. 15, *Administrative Levels for Rural Development Functions: a Suggested Framework* is by B J J Stubbings. Drawing on experience in Pakistan and Nigeria, he places particular emphasis on the district tier and the local government council tier. Network Paper 16, *Identification of Priority Project Areas for Small Farm Development* by C D S Bartlett describes an approach, based on farming systems techniques, for determining investment priorities for small scale farmers. The case study is an irrigated area in Bihar, India. These papers are all available, free of charge, from Fiona Harris, AAU.

AAU Occasional Paper No. 4 *Enlisting the Small Farmers: The Range of Requirements*, edited by Guy Hunter, pp 63, is available from the Publications Officer, ODI, 10-11 Percy Street, London, W1P OJB, price £2.00. It arises from an earlier Discussion Paper on directing benefits to the poor, and participation, and the comments that ensued. It is divided into 4 parts: Central Economic and Political Policies; Requirements for Effective Service to Small Farmers; Administration; Conclusions. The Administration section touches on the respective roles of local elected authorities, and central government departments and special interest elected/ participatory bodies, such as water users' associations.

The relations between the three also appear in many papers in a special issue of Agricultural Administration, Providing Services to Small Farmers, guest editors, John Howell and Guy Hunter, December 1982, available from ODI, price £9.60 including p & p. Articles on irrigated areas include Martin E Adams, *Irrigation and Community Development in Indonesia and Sri Lanka* and Shoaib Sultan Khan *Organising Farmer Groups in Mahaweli Ganga.*

c. AAU Meetings 1983

The AAU is organising an international workshop on *Financing the Recurrent Costs of Agricultural Services*, 3-8 July 1983, with financial support from several international agencies, banks and research foundations. We anticipate forty participants including around twenty ldc officials representing Planning and Finance ministries, ministries of Agriculture, and public sector agricultural corporations. The main emphasis will be on sub-Saharan Africa. The papers and proceedings will be available to networkers in due course, but the precise form has yet to be decided. Correspondence about the workshop should be addressed to Mr James Leach, who has been engaged by ODI until July to organise the workshop.

6. COMPOSITION OF NETWORK MEMBERSHIP

A geographical breakdown of the Network's membership based on June 1982 figures, is given on page 14.

7. STUDY TOUR OF CHINA

Study China Travel Ltd, 7 Rose Crescent, Market Hill, Cambridge CB2 3LL, UK is arranging a *Professional Study Tour, Water in China,* 3-25 September 1983. Costs are £1,825 if the starting point is London, £1,375 if the joining point is Hong Kong. Planned visits include Commune Irrigation Projects, the Chengdu irrigation and flood control scheme (with a 2,000 year history), Shanghai water supplies, night soil projects and biogas installations, the Gezhouba Dam at Wuhan and Chiang Jiang pumping stations, the Tianjin project to divert River Luan, near Peking. Extra visits will be arranged to take in special interests of group participants. The Chinese authorities have asked that some participants should be willing to give short papers on their special interests and will, where possible, arrange matching papers. The Directors of Studies are D J Kinnersley, Senior Economic Advisor of the UK National Water Council, and B Appleton, editor, World Water. If you are interested, write for more details to Mr Roger Balson at the above address, *mentioning the Irrigation Management Newsletter.*

8. RECENT PUBLICATIONS, REPORTS, ETC

a. Books, Articles

Martin Adams, "Irrigation and Community Development in Indonesia and Sri Lanka", Agricultural Administration, December 1982, pp 285-294.

Anon, "Bogged down in Madhaya Pradesh", International Agricultural Development, April 1982, p 5.

Anon "Irrigation in Israel", Irrinews, No. 25 1982.

Anon "Untold Story of Srisailam project", Voluntary Action, October 1981, pp 185-186.

BREAKDOWN BY REGION AND COUNTRY OF MEMBERS

JUNE 1982

Europe

Denmark	1
France	5
Italy	14
Netherlands	18
Sweden	4
Switzerland	1
W. Germany	6
	47

Middle East

Cyprus	3
Egypt	5
Israel	6
Jordan	1
Kuwait	2
Oman	1
Turkey	5
	23

N. America

Canada	5
USA	94
	99

Latin America

Mexico	4
Argentina	1
Brazil	1
Chile	2
Ecuador	6
Guyana	2
Honduras	1
Peru	2
Venezuela	1
	20

E. & C. Africa

Ethiopia	3
Kenya	15
Somalia	1
Sudan	4
	23

W. Africa

Ghana	4
Mauritania	1
Nigeria	14
Senegal	2
Sierra Leone	1
Upper Volta	3
	25

S. Africa

Botswana	1
South Africa	2
Tanzania	1
Zimbabwe	3
	7

S.E. & E. Asia

Burma	2
China	2
Indonesia	28
Japan	3
Malaysia	7
Philippines	14
S. Korea	1
Taiwan	3
Thailand	19
	79

S. Asia

Bangladesh	36
India	136
Nepal	5
Pakistan	15
Sri Lanka	18
	210

Australasia

Australia	3
New Zealand	2
	5

TOTAL	538

Arun Bagri,"Sprinkler irrigation: rain when one needs it",Voluntary Action, October 1981, pp 178-179.

A K Biswas,"Applying systems analysis in developing countries",Ceres, November/December 1982, pp 40-42.

A K Biswas, "Impacts of hydroelectric development on the environment",Energy Policy, December 1982, pp 349-352.

A K Biswas, "Long distance water transfer: the Chinese plans", GeoJournal, 6.5, 1982.

A K Biswas, "Systems analysis applied to water management in developing countries: problems and prospects", Environmental Conservation, Vol 8 No 2, summer 1981, pp 107-112.

Anthony Bottrall, "Management - irrigation's soggy centre", International Agricultural Development, July/August 1982, pp 20-21.

Kanchan Chopra, "Alternative sources of irrigation and land use patterns in the Punjab" Indian Journal of Agricultural Economics, April/June 1982, pp 171-183.

Anthony Ellman, "Irrigation: overview - objectives and options", International Agricultural Development,July/August 1982, pp 10-11.

Hamid Faki, "Disparities in the management of resources between farm and national levels in irrigation projects, example of the Sudan Gezira scheme", Agricultural Administration 9,1, January 1982, pp 47-59.

Richard H Goldman and Lyn Squire, "Technical change, labour use and income distribution in the Muda Irrigation Project (Malaysia)", Economic Development and Cultural Change, July 1982, 30:4, pp 753-776.

Jerry Gosney, "What price solar-powered pumps?" International Agricultural Development, July/August 1982, pp 16-18.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 7b

APRIL 1983

LAND TENURE IN IRRIGATION PLANNING: TWO EXAMPLES

Page

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** David Seddon is a Lecturer at the School of Development Studies, University of East Anglia, Norwich, NOR 88C, UK.

In the first of these articles, Martin Adams describes a method of taking into account land tenure during a feasibility study, through mapping a pilot area in consultation with local authority and the farmers. This may be a reliable procedure replicable over the whole area at a later stage in cases where the government has a clear cut view of its policy in relation to land, and where individual ownership is not in dispute. However, as David Seddon points out, this is not always the case. Failures by governments to define their land tenure policy for newly irrigated land, and failures by consulting companies adequately to investigate the actual situation at feasibility stage, can have very adverse effects. Land tenure and inheritance customs have deep roots in law, religion, the psychology of parental emotions and the power structure of society. Any new irrigation scheme or rehabilitation programme which ignores existing rights will certainly lead either to active farmer opposition, or, to sullen hostility and emigration out of farming. Either reaction will frustrate attempts to set up active water user groups, and in extreme cases, will nullify or postpone realisation of planned benefits from substantial government investment. David Seddon describes how the complexity of land rights and the failure to have any policy on reallocation of land till after the elimination of landmarks held up utilisation of new water supplies in Morocco.

I feel land tenure issues require more investigation. As a consultant in the Ministry of Planning, Iraq, I saw feasibility studies being submitted which proposed a layout of neat, standard sized farms which totally ignored both legal realities and the diversity of existing family rights, capabilities and needs. This was despite the fact that, as Martin Adams hints, a large scheme near Baghdad was lying idle through failure to tackle the issues at a sufficiently early stage. As David Seddon says, the local people are, in contrast, very aware of the consequences for land values of a better water supply and move into action very quickly. On a feasibility study in which I was involved in a dessicated wadi in North Yemen farmers had made, in advance of the prefeasibility team's arrival, very substantial investments in barbed wire. The single strand self-evidently did not serve to keep animals or vehicles off the crops (in many cases there had been no crops for several years for lack of rain) but had been hastily erected to define ownership. Failure to investigate land tenure can lead to totally erroneous cost-benefit analysis; costs are underestimated, since they do not allow for the level of compensation political considerations may eventually dictate for land taken for dams or building sites, while benefits do not flow to time or to the extent planned. Rich townsmen may be able to take advantage of the situation to the detriment of *smaller land holders so that social inequality increases, as Tina Wallace 1) and Richard Palmer Jones 2) have shown in Nigeria.*

It seems it would be useful to try to establish guidelines for the analysis of land tenure both at the proposal stage and at the design stage of new irrigation schemes or rehabilitation programmes. Variables will include existing law and custom, existing farming systems, existing patterns of land distribution, political intentions in regard to land reform. I hope the two articles by Martin Adams and David Seddon will stimulate other networkers to send me their views on the subject, with examples. I should be particularly grateful for suggestions as to existing reports that could be examined, as well as to suggestions for areas where field studies might be made as the basis for a paper on the subject.

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1) Tina Wallace, "The Kano River Project: The impact of an irrigation scheme on productivity and welfare" in ed. Heyer, Roberts and Williams, Rural Development in Tropical Africa, Macmillan, London 1981.

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A. INCORPORATING EXISTING LAND TENURE IN TERTIARY DESIGN; EXPERIENCE FROM SUMATRA, INDONESIA

Martin E Adams

Network paper 2/81/1 contained two interesting contributions on the design of tertiary irrigation systems. The first advocated close cooperation with farmers, who know every inch of their land, the second emphasised the importance of a particular type of levelling survey. This emphasis on participation is understandable because tertiary design and construction call for a higher level of accuracy than in the main system. Errors of a few centimeters can seriously affect the distribution of water in farmers' fields. However, the complexity of the design process at tertiary level would be seriously underestimated without mention of the need to adapt the irrigation layout to existing land tenure. This applies both in the rehabilitation of ancient irrigation systems (e.g. Mesopotamia, Iraq) as well as in areas where water is being introduced for the first time, which is the case in the rainfed paddy areas on the flood plain of the Jambu Aye, Aceh Province, Sumatra. This note outlines a participatory approach to tertiary development in which both local variation in land tenure and topography receive detailed attention in the course of tertiary design.

Implementation Procedure

The procedure demands the cooperation of engineers, agricultural field staff, contractors, local government officials and farmers during each of three stages: site investigation, design and construction. The recommended steps for each tertiary unit are as follows:

Site Investigation

(a) Determine a realistic annual programme, prepare tertiary development schedule (investigation, survey, design, documentation, etc) for each unit and inform local government officials in the areas involved.

(b) With the assistance of each village head, mark out the village and holding boundaries on 1:5000 orthophoto maps.

Design

(c) Prepare outline drawings of the tertiary unit in the site office, wherever possible providing each village with its own quaternary canal and keeping canals and drains along existing field and village boundaries.

(d) Agree outline design with village head and hold a meeting with all those concerned with a future water users' association to discuss the proposed design.

Construction

(e) Subject to approval of outline proposals by the project engineer, proceed with preparation of detailed level survey and bill of quantities for construction of structures and boxes by contractors.

(f) Encourage contractors to employ farmers in the construction of canals and drains under contracts administered and supervised by project staff.

(g) Assist farmers to form channel-based water-users associations, which take on responsibility for O & M.

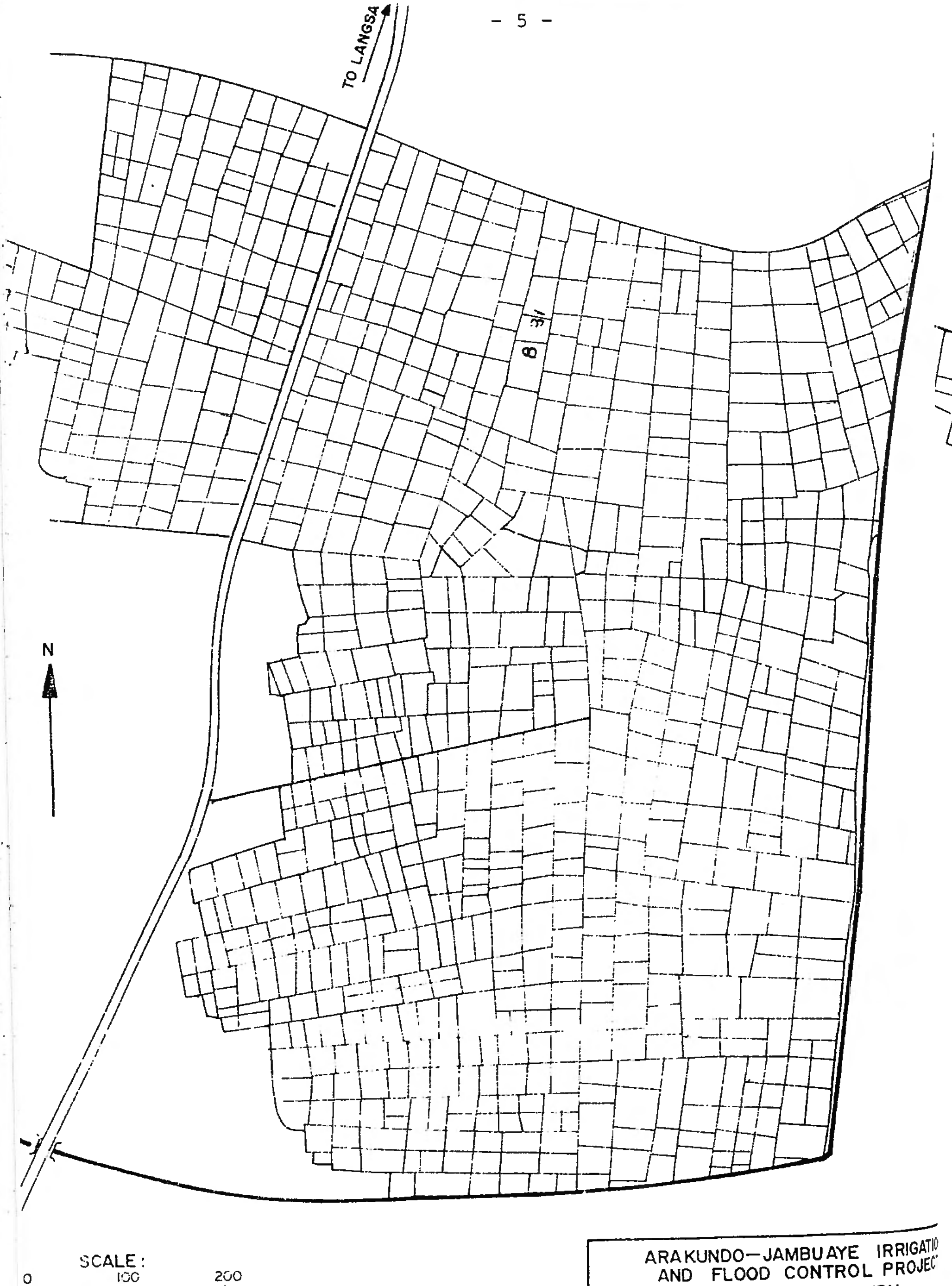
An Example

The procedure was tested at a pilot level on a representative 90 ha tertiary unit and the accompanying diagrams reveal the complexity of the process and demonstrate how a knowledge of land tenure is fundamental to both the design of the tertiary system and the organisational structure of water users' associations.

The tertiary unit impinged on the land of five villages. Boundaries were "walked" with village officials and recorded on the 1:5000 orthophoto maps. The same technique was used to record individual holdings, the boundaries of which were clearly defined by the bunds of paddy fields, easily identified on the orthophotos. Figure 1 shows the individual paddy fields and Figure 2 village and holding boundaries in the pilot tertiary unit. A comprehensive list of farmers (owners and sharecroppers) was prepared, of which there were 234 in the pilot tertiary unit in June 1982. Average holding size was 0.37 ha with significant differences between villages. The outline tertiary design which takes due account of both land tenure and topography is shown in Figure 3. The area of each quaternary block (a, b, & c) was determined by the need to keep quaternary units within about 15 ha, to keep quaternary boundaries within village boundaries and to avoid cutting existing fields with canals and drains. The tertiary unit is designed to be supplied continuously from the secondary canal (itself supplied by a river offtake). Rotation was required only between farm units within the quaternary unit to ensure that the farmers received a manageable stream (15-30 l/S).

Farmers' Organisation

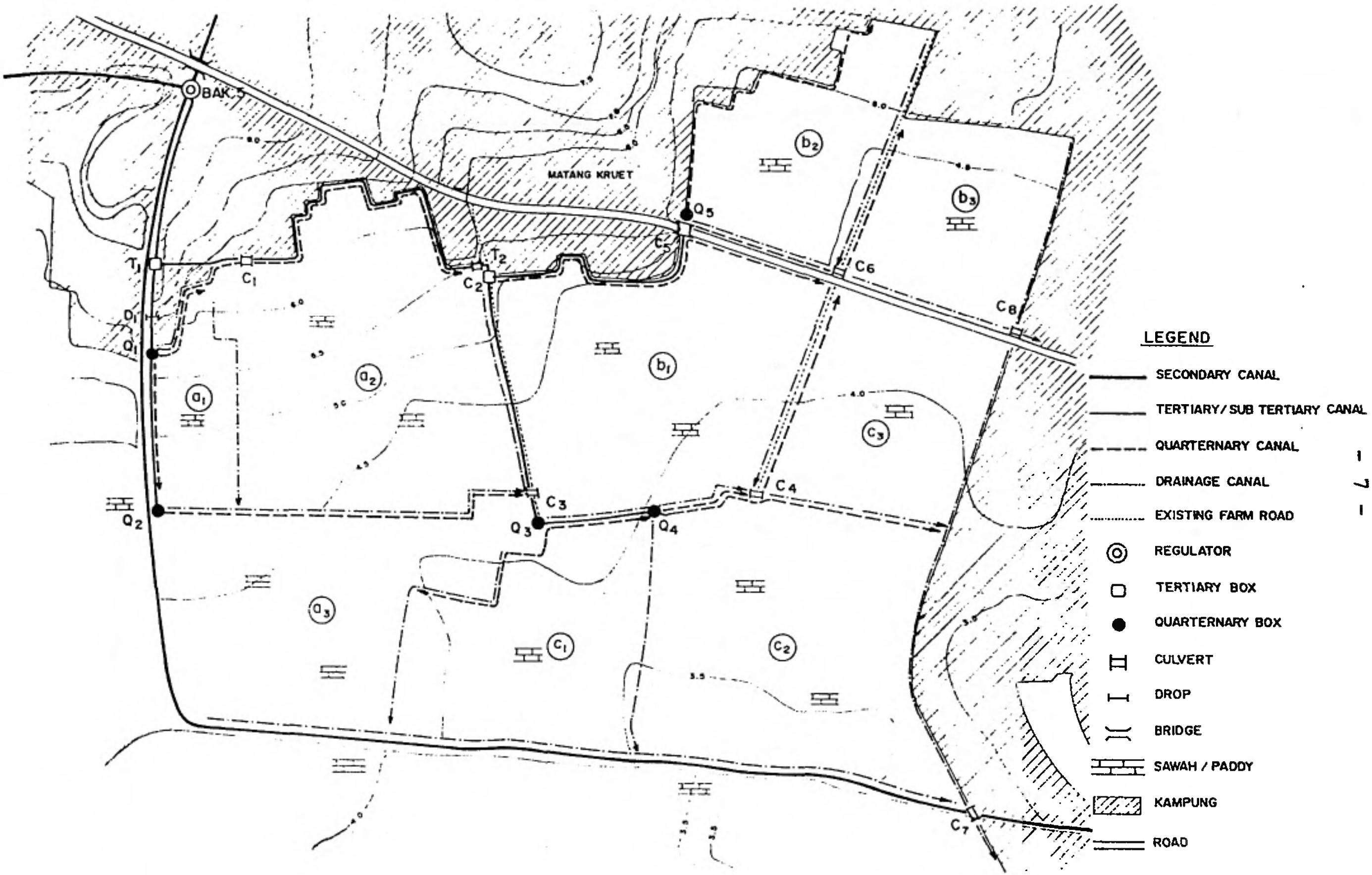
A feature of farmers' organisation in communal systems in Indonesia is their subdivision into small groups, each with its own leader. These sub-units have a leader and an assistant irrigator elected by the farmers within the sub-unit. The smaller the group, the greater the probability that common interest can be established and conflict avoided within the group. Sub-units are usually between 10 and 15 ha and rarely include more than 50 farmers. The tertiary unit shown in Figure 3 contains nine quaternary sub-units. The preferred organisational structure is shown in Figure 4.



ARAKUNDO—JAMBUAYE IRRIGATIO AND FLOOD CONTROL PROJEC FEASIBILITY STUDY	
RENDEL— PARKMAN	P.T. INDAH
INDIVIDUAL SAWAH IN PTU	FIGURE 1

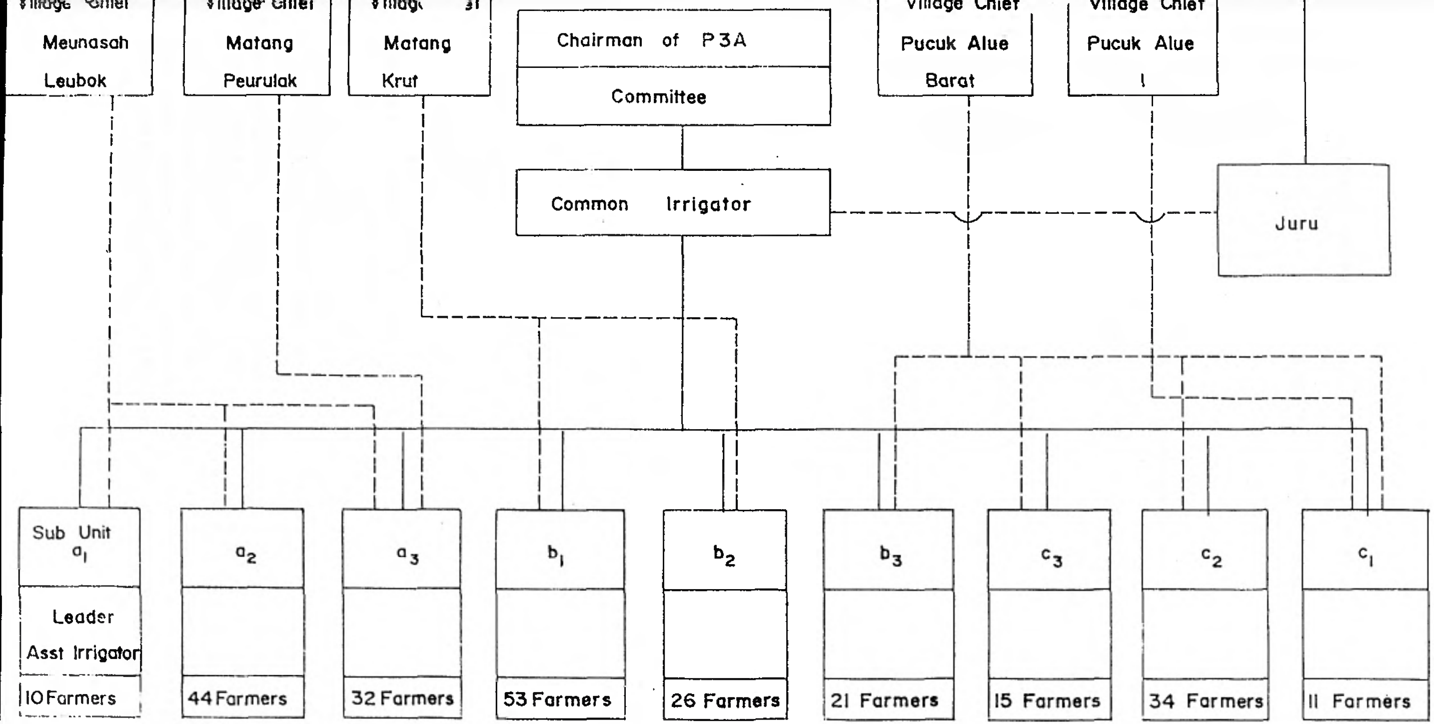
ARAKUNDO–JAMBUAYE IRRIGATION AND FLOOD CONTROL PROJECT FEASIBILITY STUDY

RENDEL – PARKMAN	PT INDAH KARYA
LAND TENURE	FIGURE 2 198.



ARAKUNDO - JAMBUAYE IRRIGATION AND FLOOD CONTROL PROJECT FEASIBILITY STUDY

RENDEL - PARKMAN | P.T. INDAH KARYA



Note: The total number of P3A farmers will be 234.
Some farmers will belong to more than one sub unit as they will draw water from more then one quaternary canal.

ARAKUNDO–JAMBUAYE IRRIGATION AND FLOOD CONTROL PROJECT FEASIBILITY STUDY	
RENDEL – PARKMAN	P.T. INDAH KARYA
PREFERRED ORGANISATIONAL STRUCTURE OF PTU(BAK5)P3A	FIGURE. 4 1982

B. RESULTS OF A FAILURE TO MAKE AN EARLY INVESTIGATION INTO LAND TENURE IN MOROCCO

David Seddon

The situation Martin Adams describes is one which, perhaps because of the particular characteristics of paddy cultivation, boundaries appear to be both clearly identifiable and uncontroversial, while title appears to be uncomplicatedly individual. However, all too often the existing structure of local land-ownership is complex, controversial and conflict-ridden; furthermore, the very significance of the existing structure of land tenure changes with the prospect of irrigation and agricultural development.

As an example, I shall refer to the Lower Moulouya Irrigation Project in north-east Morocco, which during the late 1960s and the 1970s transformed local agriculture from dry cereal cultivation to irrigation cash crop production; my data derive from two periods of fieldwork during 1968-70 and 1978 and relate particularly to the experience of changing agriculture in the Sebra plain[1]. The failure of those involved in the design of the irrigation system to recognise at an early stage the complexity and controversial nature of local land tenure led, firstly, to substantial delays in the implementation of the programme, secondly, to considerable local concern and even unrest, both at the way in which the programme was implemented and at the way in which local officials were involved in (and benefited from) the programme, and thirdly, to serious underutilisation of the irrigation facilities once installed.

It was assumed, contrary to evidence that was available to local officials, that the structure of landownership in the Sebra plain (one of the two plains on the left bank of the Moulouya river which were brought under irrigation in 1970) involved essentially private property and single title by local Moroccan owners. On this basis a plan of properties was drawn up, following a rapid survey by professional surveyors with the assistance of local officials; this plan was to form the basis of the subsequent 'remembrement' (sub-division and relocation to form appropriate elements of the tertiary system). Difficulties encountered at this stage led to an attempt to construct a full list of owners. However, by this time, 1969, primary and secondary canals had been designed and largely constructed, and the process of levelling and grading of land within the future irrigation perimetre was already under way. This process removed many recognisable features of the local landscape and hence in a significant number of cases the basis for determining precise boundaries and plot size.

Local farmers were extremely agitated to see their boundary markers disappear, knowing that a plan was being drawn up to relocate their land and having little confidence in the use of local notables, with whom in some cases they were in dispute over land, as the prime source of information regarding land ownership. This agitation developed, in some instances, into open confrontation between local farmers and local officials, and among local farmers themselves, over boundaries and ownership.

The survey 'revealed' that a significant minority of relatively large plots were owned by absentee Spanish landlords (the region was part of the Spanish protectorate of northern Morocco until 1956), although the land was farmed by local Moroccan squatters. It was also discovered that the majority of identifiable plots were held in joint ownership, in some cases by as many as fifty persons. All co-owners by virtue of inheritance and family sub-division had rights in the land and its produce, but as cereal cultivation in the Sebra plain prior to irrigation was a high risk activity and yields were low in any case, claims on the farmer(s) were rare and the legal rights remained unexpressed. With the prospect of irrigation, however, and of consequently greater farm incomes, the rights of co-ownership were increasingly emphasised. The resolution of these matters of ownership took considerable time and effort, involving recourse to the law courts in some cases. Eventually, those Spaniards who could not be contacted were expropriated by the state, while those that could were bought out at a nominal price; the claims of the squatters were heard and generally met with allocations of individual title over the land 'normally' farmed (although this gave rise to considerable difficulties given the variable area cultivated from year to year). In the cases where co-ownership constituted a problem, non-farming co-owners were persuaded to abandon their claims and rights, often with compensation; in some cases the farmers were persuaded to compensate their relatives and co-owners, in other cases the state was obliged to pay compensation.

The detailed investigation of local land tenure also revealed that two substantial tracts of land in the plain were still under a form of collective title (a relic of the pre-colonial period when all land in the Sebra plain was held collectively by tribal sub-groups and when individual private property was rare). In these cases, all members of the tribal collectivities involved had rights to cultivate and otherwise make use of the land, although, as in the case of privately owned plots, by no means all of those having rights to cultivate actually did so, given the risk and relatively low returns from dry cereal agriculture. With the prospect of irrigation, however, claims to access mounted. The problem proved sc intractable that eventually the state appropriated the collective property and re-distributed it to selected farmers. This process, which effectively disinherited a significant number of local farmers, led to considerable unrest. The ceremony at which the governor of the province officially allocated the new plots from the appropriated land of the collectivities was marred by open discontent and dissatisfaction and by the efforts of the local gendarmerie to prevent such expressions of protest.

Finally, in one area to the south of the plain, where a long-standing dispute over land previously collectively owned by a particular tribal sub-group remained unresolved since its beginning around 1914, (when the father of several important local notables reconstituted a portion of the sub-group's land as his own private property) the delays involved ensured that no effective irrigation was possible until the mid-1970s. Even in 1978, nearly ten years later, the matter had not been fully resolved and bitter local farmers were refusing to invest more than a minimum of their capital and labour in the development of land which was still subject to dispute.

The failure to explore the complex structure of land ownership within the area to be irrigated at an early stage meant that a) effective irrigation was considerably delayed in the plain as a whole, b) effective irrigation was even more significantly delayed in certain areas of the plain, c) the state was under pressure to resolve the complexities of local land tenure rapidly and arbitrarily to avoid yet further delays, d) considerable tension and unrest was generated by the implementation of the programme and by the actions of the state in dispossessing local landowners and resolving complex disputes by fiat (often, it was widely felt, in favour of those who had been or were still local notables and local officials).

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 7c APRIL 1983

IRRIGATION SYSTEMS - ALTERNATIVE DESIGN CONCEPTS

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ISSN 0260-8596

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This paper has, in agreement with Professor Horst, *been shortened and edited by* Mary Tiffen, *taking into account comments from* C H Swan *of Sir Alexander Gibb and Partners, and* Melvin Kay *of the National College of Agricultural Engineering, Selsoe, UK, whom we should both like to help for their help. The paper argues in favour of new engineering design concepts, aimed at overcoming mismanagement and malfunctioning of irrigation structures due to problems arising from the socio-political environment of some irrigation systems. Comments from networkers are invited and should be sent to Professor Horst, copy to Mary Tiffen, for possible inclusion in the next Newsletter.* C H Swan *comments as follows:*

> "I agree entirely with Prof Horst about the paramount need for simplicity; I also like his point about measurement. Engineers have a fixation about measurement; it is, after all, the basis of their training. Consequently, many existing schemes are littered with measurement devices, often costly, which are never used. Very little measurement is truly needed....I have never seen a scheme more than ten years old which is still supplying the cropping pattern for which it was designed! We must have flexibility."

Is it only engineers who have a fixation about measurement? What do economists and agronomists think? Is it agreed we need in most circumstances to design to give greater independence and flexibility to the farmers, and to reduce and simplify O & M? What is the minimum of measuring devices necessary for monitoring operation?

This paper should be read in conjunction with Network Paper 7d, by Syed Hashim Ali, *which illustrates the social and political pressures on operational staff, and the need for certainty in deliveries to farmers, and the need for some measurement to diagnose faults in water delivery.*

1. INTRODUCTION

Irrigation, in contrast with other infrastructural measures, is characterized by strong dependency of the user on the system. Users of most infrastructural measures such as drainage, roads, water supply, electricity systems, etc., can make use of the system when they like. The irrigation user, however, is often dependent on the managers of the irrigation system for the timing and quantity of his water supply. Moreover, again contrary to the other infrastructural systems, his dependency relates to a matter of central concern for his sheer economic survival.

This paper has been written to bring engineers into the management debate. Modern conventional design aims at accommodating the needs of presumed cropping schedules with high irrigation efficiencies. The main criteria have been physical and economic. Engineers have, therefore, designed sophisticated structures for measuring and regulating water flow as exactly as possible. The seasonal variation in crop requirements have been met by adjusting the structure to allow more or less water to pass in the desired direction according to quite complicated schedules. Engineers are still insufficiently aware of research into the socio-economic and political consequences of their designs (1), and that it is necessary to design also for the level of staff which will be available, and the economic and political pressures under which they will work.

Modern systems with adjustable discharge structures often suffer from low water efficiencies, low production, inequity, corruption, hostility between farmers and management (the latter often manifested by farmers 'taking their rights into their own hands' or water theft). As the situation is often made worse by a shortage of competent staff, training of staff, and increasing the number of measuring devices are proposed as remedies. However, many systems are so complicated or so corrupt that training of operational staff

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(1) Research carried out in the Philippines, India, Malaysia, Pakistan, etc, by various Universities and Institutes. For examples see ref 1.

will be of no avail; furthermore, an increase in measurement programmes will require a still higher level of staff competence and will considerably increase the work load of the operators.*

The paper is based on the following arguments:

A. The search for higher water efficiencies through complicated operational systems with much regulation and measurement will eventually result in low efficiencies due to operational mis-management.

B. The tendency nowadays of trying to increase irrigation efficiencies by increasing regulation and measurement of water, together with training of operators, should be considered a fallacy; it creates more complicated manipulations, more sources of error and does not prevent mal-functioning of the regulating structures. The operations are often incomprehensible to the farmer, and many of the adjustments are hidden from view, thereby increasing the operator's opportunity of accepting bribes without discovery.

C. A major system providing a dependable flow to all tertiary units will provide the foundation for a more equitable division of water between the farmers within the minor or tertiary unit.

D. Increased independence of the group of farmers in the tertiary unit from the main system management will lead to higher efficiencies and greater flexibility in allowing them to adapt cropping patterns to changing family and marketing requirements.

E. Simple operation will eventually lead to higher efficiencies.

F. The magnitude of corruption is directly related to the type of structures adopted in the major systems.

The paper reviews the historical development of design concepts and then considers four design types in relation

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* *Compare Syed Hashim Ali's estimate that effective operation in CAD areas in India might require a doubling of staff (Paper 7d, p.15).*

to simplicity of operation, and flexibility and independence for the user. It considers the design of structures for the main and secondary canals down to the tertiary intake. Any sub-optimum distribution of water at this level will aggravate problems of inequity and inefficiency at the tertiary level. It is limited to surface gravity irrigation, small farm holdings, and low income tropics.

2. DESIGN CONCEPTS

Structures for irrigation can be used for:

- control of water levels
- regulation of flows
- measurement of flows.

The suitability of different types of structure for these different purposes depends on their hydraulic properties. From a hydraulic point of view irrigation structures can be divided into two types:

- overflow type (weirs and flumes)
- undershot type (orifices).

In the original version of the paper Professor Horst provided details of the engineering formulae used to predict the changes of flow caused by the structures. Copies of these are available on request to the Irrigation Management Network.

In any irrigation system unwanted fluctuations in flow and waterlevels occur, caused by:

- changing flows at source (eg changes in flow of the river at the river headwork; failure of pumps, etc)
- improper manipulation of the regulating structures (due to incompetence or otherwise)
- siltation.

The way the fluctuations spread through the system depends on the hydraulic qualities of the structures at the bifurcation points, as shown in Figure 1. In Figure 1b the variation in flow is felt mainly at the head; this may occur, for example, with an orifice as the cross regulator and a weir as the offtake structure. In 1c the variation is felt mainly at the tail end; this may occur where a weir is the cross regulator and an orifice the offtake structure.

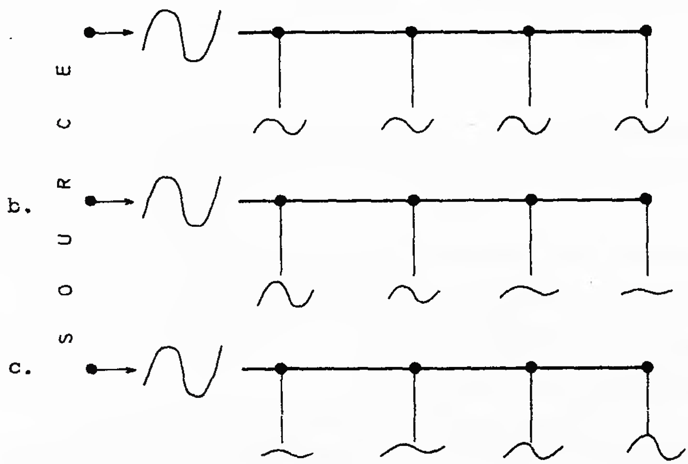

Figure 1 Propagation of fluctuations for different ratios between the sensitivities of two structures

Four types of system can be distinguished. These are

a. <u>Fixed proportional</u>

At each off-take or bifurcation point in the system, the water is divided according to the size of the irrigable area served by the structures; no adjustments are possible (eg fixed weirs or orifices). Fluctuation in flow at each bifurcation point are proportional to the fluctuation in the upper part of the system (Fig 1a).

b. <u>Open/closed</u>

Delivery of water to the various subsections is either full supply or zero; position of the structure is either open or closed (eg shuttergates).

c. <u>Graduated adjustment or modern "conventional"</u>

Water can be regulated and differently adjusted for each sub-section; regulation is either by hand or mechanically (eg gated orifices or movable weirs). (Automatic regulation, eg Neyrpic automatic gates, are not being considered, due to their limited applicability).

d. Reservoir

This system will be described later in the paper.

The sophistication and the difficulty of manipulation, increases from a-c. Likewise, the comprehensibility of the system to the farmers decreases from a-c. The "proportional" and "open-closed" concepts are not new. Although they are still in use, they are also found, in one form or another, in "traditional" irrigation areas. Systems a, b and d give less possibility of mismanagement, and greater independence to the farmer, than the conventional concept (system c).

3. DEVELOPMENT OF THE CONVENTIONAL CONCEPT

Each colonial power developed its own "irrigation school". Typical examples are: the automatic system by the French in North Africa, the gated diversion weirs and Butcher weirs by the British and the fixed diversion weirs and Romijn weirs by the Dutch. Differences between these "irrigation schools" can be traced back to different local conditions (eg development of the regime theory on the Indian continent due to silt laden rivers, scarcity of water in North Africa etc). These "schools" persist in the post colonial period: consultants from these former colonial powers are active in the developing countries and are often still applying designs of their own "school". They have been joined by the "American school" (structures like constant head orifices and emphasizing large holdings). Despite their differences, these "modern" systems have two important aspects in common: centralized management, and, adjustable structures making possible exact control over the water distribution for complicated irrigation schedules. The most usual adjustable structures (apart from the automatic ones) are gated orifices (meter gates or constant head orifice) or movable weirs (Butcher or Romijn weirs). They are calibrated and the flow through them can therefore accurately be determined. "Conventional" irrigation systems often comprise major, secondary and tertiary canals, each lower order canal taking water off from a higher order canal by means of structures enabling an adjustable discharge of the off-taking flow. In order to control the upstream waterlevel, a cross-regulator is usually placed in the higher order canal (see Figure 2). The proportion of the total flow (Q) sent down each minor canal can be varied, depending on the hydraulic qualities of the two structures. In practice either weir or orifice type of structures as off-take structure and cross-regulator might be encountered. It should be stressed, however, that, ironically, the choice of graduated adjustment structures, although facilitating a precise distribution of water, also makes possible a high degree of mismanagement.

This 'graduated adjustment' concept can be contrasted with the "open-closed", "proportional division", and "reservoir" concepts.

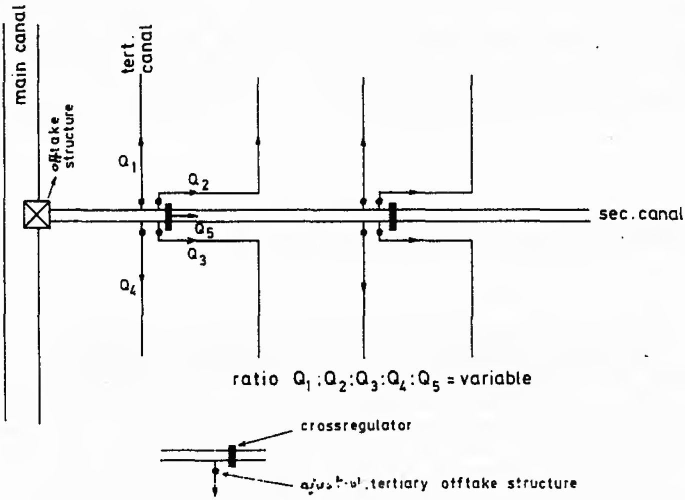

Figure 2 "Conventional" System

4. OPEN-CLOSED CONCEPT

This system can best be adopted in the secondary canals. The structures are hydraulically of a type in which the discharge is affected by the upstream water level only. The simplest and preferable concept is based on shutter gates of standard size which, when open, will pass a unit standard flow to a unit standard area. The cross-regulator will have a number of standard gates corresponding to the number of units served downstream. This concept might well be adopted for new projects with standard size tertiary units.

In case of uneven sizes of tertiary units, the following solutions can be considered:

- Standard size shuttergates: standard unit flows with different delivery periods.

- Shuttergates with different widths: different unit flows with equal delivery periods.

- Orifice module type (eg Neyrpic): here different unit flows and different delivery periods can be adopted.

Although these methods necessitate a somewhat complicated operation they should in most cases be preferable to a system with graduated adjustable parts.

5. PROPORTIONAL DIVISION CONCEPT

The principle of proportional division is found in many traditional irrigation systems (eg Subak at Bali, in North Africa, and on a larger scale in Spain, etc). It can be used with modern structures, and is especially suitable for the tertiary off-takes from the secondary canal. By contrast with the conventional system with a cross regulator in the secondary canal and adjustable off-takes to the tertiary canals, the proportional division concept has one structure, which assures flows into the tertiary blocks proportional to their sizes (Figures 1 and 3). The structure could consist of fixed overflow weirs, all with the same crest level, with widths proportional to the areas irrigated (Figure 3).

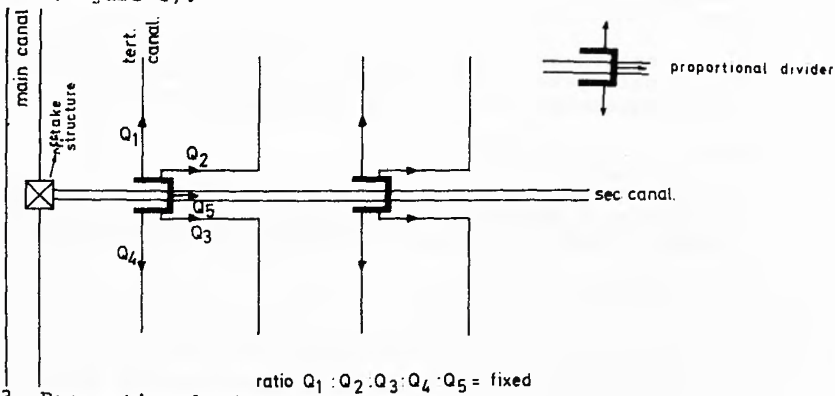

Figure 3 Proportional Division System

For a more detailed description please refer to ref (2). In Figure 4 the principle of a proportional divider is given.

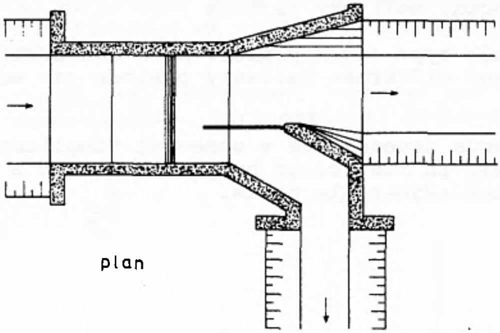

Figure 4 Proportional divider (simplified from ref 2)

Due to hydraulic limitations, too small off-taking flows could affect the proportional division (wall friction). This should be taken into account in the system lay-out design: instead of long canals with many small outlets, the design should aim at sufficiently large off-taking or dividing flows.

a. Suitability

The feasibility of this system depends on the cropping schedules practiced. It varies in the following different cases.

1. The entire secondary block is treated as one unit in the rotational system, with a uniform growing stage and uniform water requirement within each tertiary block.

Operational efficiency*: high

2. A tertiary block is a unit in the rotational system: each tertiary block will be in a different growing stage.

Operational efficiency: low

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* Operational efficiency is here being used to mean the measure in which the irrigation supply meets the actual field water requirements.

3. Rotational system within tertiary block: the early and late planting within a tertiary block will be arranged by the peasants.

Operational efficiency: high

4. Diversified cropping within each tertiary block: statistically each tertiary block will have high and low water requirements crops.

Operational efficiency: moderate to high

5. Diversified cropping among tertiary blocks: in each tertiary block a different crop will be grown.

Operational efficiency: low

Judged by operational efficiency, the system of proportional division can be employed for cases 1, 3 and 4, but not for cases 2 and 5. Since cases 1, 3 and 4 are extensively practiced in irrigated areas, proportional division could be widely employed.

The advantages of the system of proportional division are:

- Operation is simplified considerably. Adjustable structures may have to be set occasionally at the main intake at the head of the secondary canals. Elsewhere, the fixed proportional dividers require only inspection every now and then. Fewer field staff are required than at present.

- If less or more water is supplied, the shortage or surplus will be proportionally spread out over all blocks.

- The structures downstream of the secondary intakes are much cheaper (no movable parts).

- The distribution of water is simple and understandable, not only for the operator but also for the user. The system enhances the peasants' sense of right to water but also enables them to measure - themselves - how much they receive.

- This system gives little opportunities for mismanagement of water. Mismanagement of water will be clearly visible, unlike gated structures, where mismanagement is often hidden (eg opening of the bottom slide of a Romijn weir).

- An equitable distribution of water is enhanced.

The disadvantages of this system are:

- Since the water cannot be regulated, the system cannot be used for different crops in different tertiary blocks (eg one block of rice and one block of sugar cane).

- Rotation within the secondary block is not possible. However, in most projects this rotation would not be recommendable. Rotation <u>among</u> secondary blocks is preferable anyway.

6. RESERVOIR CONCEPT

a. General description

This system is recommended as it gives independence to the group farmers behind the offtake and decentralises decision-making to them. The layout and some sections are shown in Figure 5. The system consists of a network of main and secondary canals conveying the water to reservoirs. Each reservoir serves a tertiary unit. These reservoirs have storage capacities equal to a few days irrigation requirements for each unit. This concept is based on:

- great flexibility of operation

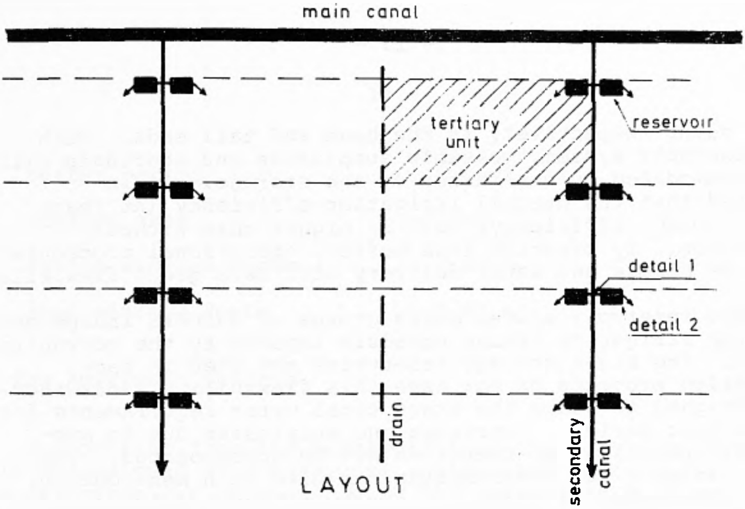
- simple operational procedures

- increased independence of the farmers from irregular water supply

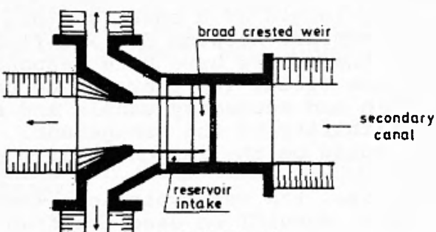
- possibly higher efficiencies

- fish culture.

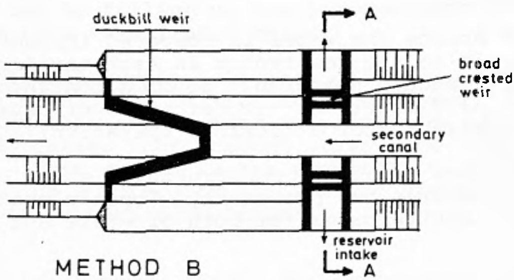
As indicated in Figure 1, a suboptimal operation of the main system of a conventional irrigation project will result in surplusses in one part of the project and shortages in another. These deviations from the required supply can be corrected by readjusting the appropriate division structures and off-take structures. During the period of suboptimal operation, however, the surplus water will be lost, while 'correction' of the shortages are generally difficult to achieve. In many cases these areas of surplusses and shortages are established as a consequence of irrigation system design, siltation or corruption. In practice they



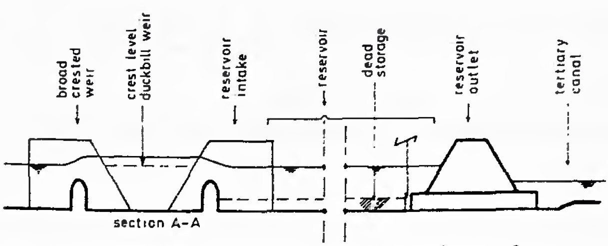
LAYOUT



METHOD A



METHOD B



DETAIL 1 DETAIL 2

often occur respectively in the head and tail ends. With the reservoir system, possible surplusses and shortages will be accommodated by the buffer of the storage. It is surmised that the overall irrigation efficiency (at least the actual efficiency) will be higher than without reservoirs. By creating this buffer, operational procedures could be simple and water delivery will have great flexibility.

The reservoir system makes groups of farmers independent from the irrigation timing schedule imposed by the conventional system. The night storage reservoirs now used in many irrigation projects do not have this flexibility since they are designed to store the exact total water requirements for one 12 hour period. Shortages and surplusses due to sub-optimal operation can therefore not be accommodated. The principle of a reservoir system has also been mentioned by Wade as a technical measure contributing to a solution of irrigation problems in South India, "to build many more 'on line' reservoirs along length of a canal system, to provide storage intermediate between dam and field"; "... and irrigators would themselves have more responsibility for allocating water to the fields (as they now do under 'tanks')" ref 3). O & M of main and secondary canals and structures should be the responsibility of the management. The reservoir and tertiary canal should be the responsibility of the farmers.

Owing to their size, the reservoirs can (and from an economic point of view, should) be used for fish culture.

b. The Main System

From the source the water is conveyed through main and secondary canals to the reservoirs in each tertiary unit. This conveyance should preferably be on a continuous basis in view of canal dimensions. (A certain over capacity, however, is desirable for a flexible operation).

The secondary canal offtake structures could be either adjustable structures or, preferably, "open/closed" structures (eg shuttergates for both off-take and cross-regulator).

c. The Reservoir

The surface area and water depth of the reservoir depend on local conditions. As an indicative example:

tertiary unit	: 30 ha
irrigation requirement	: 8 mm/day

buffer period	:	5 days
surface area	:	1 ha
active storage depth	:	1.20 m
dead storage depth	:	0.50 m

d. The Reservoir Outlets

The outlets from the reservoir into the tertiary canal could be designed as a metergate (calibrated sluice gate). This structure can be operated by the farmers in the tertiary unit. A metergate, due to its low sensitivity, gives little variations in discharge (in contrast to night storage reservoirs, re-adjustment of the gate would not normally be necessary during daytime operation due to small waterlevel fluctuations in the reservoir).

e. Reservoir Operations and Choice of Structures for Reservoir Intakes

Contrary to the conventional system where water is constantly re-divided and delivered according to pre-set requirement programmes, the operation of the reservoir system is limited to filling up the reservoirs. This can be done in the four ways listed below.

A. Proportional supply At each off-take point at the secondary canal, the off-taking flow to the reservoir and the ongoing flow are divided in proportion to the areas commanded, taking into account conveyance losses, if so required. This system is the simplest to operate and could well be adopted for areas where cropping is either homogeneous or very diversified.

B. Sequential supply Each off-take structure from the secondary canal consists of a broad crested weir. The upstream water-level will be controlled by a duckbill weir with a higher crest level than the off-take weirs - see sketch, Figure 5. When the reservoir is full, the duckbill weir will pass the on-coming flow with very little increase in waterlevel (due to its high sensitivity).

Once the reservoirs are filled up, the oncoming flow through the secondary canal will automatically keep the reservoirs at full supply level, provided that the supply equals the gross irrigation requirements including losses. In case of smaller or larger supply flows, the last reservoirs will either empty or overflow. Operation therefore should consist of monitoring the last reservoir levels in relation to the adjustment of the secondary canal intakes from the main canal. Admittedly, shortage of water will still be felt at the tail end. The buffer role of the tail end reservoir, however, will enable the management to take measures if so required. Naturally this method can only be applied when sufficient water at the source is always available.

C. Rotational Supply The same structures as in B can be adopted with the addition of gates at the reservoir intake structures. The reservoirs could then be alternately filled by opening and closing of the gates for certain periods. This method requires larger secondary canal capacities than for A and B, this being an important factor where these canals are mostly constructed in fill. Furthermore, it will lead to larger fluctuations in reservoir water levels which makes operation of the reservoir outlet more difficult (requiring frequent readjustments of gates), and it might affect fish culture.

D. Adjustable Supply This method, requiring adjustable gates at the reservoir intake structures, is not recommended since it entails similar problems to the conventional system.

From an operational point of view method A is to be preferred both for simplicity and for reduction of manpower, as no setting of gates is required. Methods B and C do not differ much in these respects.

From the point of view of misuse and wastage of water within the tertiary units, however, the preference may be different. Over-irrigation in the first units will not be checked with method B, as the reservoirs will automatically fill up. With method A over-irrigation in a tertiary unit will only result in depletion of the reservoir concerned. Methods A and C make it possible to monitor and possibly check over-irrigation.

Methods A and C are preferable if water charges are to be made since the water supply can be measured on a volumetric basis.

The overall irrigation efficiency should be high by methods C and A and less by method B.

It can therefore be concluded that method A would in most cases be preferable to B and C. Method B might be adopted in upper reaches, where abundance of water would keep the reservoirs full, and excess water could be used downstream.

f. Fish culture

The additional volume of earthwork required for a reservoir system compared with a conventional system could well be balanced by the benefits from fish. World figures vary widely for earthwork costs on the one hand and yields and prices for fish on the other; for the example cited on page 12,however, costs of earthwork in the order of \$ 5000 - \$ 10,000 and fish production of \$ 1000 - \$ 5000 per year, indicates the economic importance of fish culture.

For fish culture, a number of requirements should be met:

- A minimum waterdepth of 0.5 m. This could be obtained by utilizing the reservoir area as a borrow pit. This might, however, pose problems when complete emptying is required.

- No frequent or large fluctuations of the waterlevel. Here operational methods A and B might be preferable.

- In some cases, emptying of the reservoir to collect the yield and possibly, to dry out the bottom of the reservoir to prevent diseases. This cycle of emptying and refilling should be compatible with the irrigation cycle within the tertiary unit.

- Provision to prevent fish from entering either the secondary or the tertiary canal.

g. Feasibility

As discussed in the previous paragraphs, the reservoir system has clear advantages compared with conventional systems (easy operation, less manpower, greater independence of farmers in matters of water supply, less opportunity for mismanagement, possibly higher efficiencies, etc).

However, this system cannot be adopted under all circumstances. In very steep or very flat areas, the volume of earthwork will become prohibitive. In relatively permeable soils, the seepage from the reservoir will become too high, while lining might be too costly. In very densely populated and cultivated areas the loss of 2 - 4 % of the land for building reservoirs might be unacceptable. Some of the suggested methods of reservoir operation might be unsuitable when the cultivation pattern in the area is very irregular*.

7. PRELIMINARY EVALUATION

Evaluation of the last three systems discussed above can only be preliminary since not much experience is available, nor have comparative studies been carried out. Taking account of the present experience with "conventional" systems, however,it is surmised that the "proportional division" and "reservoir" concepts deserve attention wherever they are feasible. Not only do they create greater independence of the farmers from the vagaries of mismanagement of the major system, but they also cause a considerable decrease in the operational manpower requirements. Frequent operation of gates will be replaced by occasional inspection of proportional structures.

It is furthermore expected that these systems will eventually give higher irrigation efficiencies and uniformity than most "conventional" systems actually achieve at present.

In this paper a number of assumptions have been made, which have not as yet been corroborated by hard facts. Considerable research efforts are needed in this field, to arrive at definite answers.

** C H Swan comments that a possible serious disadvantage of reservoirs might be on the health side, if they might harbour the vectors of malaria and schistosomiasis.*

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 7d APRIL 1983

ONE SEASON OF 'INTEGRATED WATER MANAGEMENT' IN ANDHRA PRADESH

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1. INTRODUCTION

Andhra Pradesh (AP) is the only State in India which has a separate Ministry of Command Area Development (CAD) to deal exclusively with problems of irrigation utilisation and command area development. CAD was initiated at the national level in 1973 after studies had revealed the large gap which had opened up between irrigation 'potential' and actual utilisation during India's first four Five Year Plans. The CAD programme was intended to integrate the activities of the many different government departments concerned with the development of irrigated agriculture - particularly Irrigation and Agriculture but also agencies responsible for credit, marketing, storage etc - through a strong coordinating agency called the Command Area Development Authority (CADA). 78 major projects were covered by 60 such CADAs; of these AP had four CADAs covering seven canal systems on the Godavari, Krishna and Tungabhadra river systems.

In theory, the civil engineers in charge of constructing dams and canals were supposed to report the creation of irrigation potential only when water had been made available at the tertiary outlet level (c. 1 cusec capacity). When the CADAs were established in 1974, it was erroneously assumed that potential had been created in this sense and that all that had to be done was to develop the farmers' lands below the outlet to receive the available water (1). Watercourse and field channel construction was to be carried out at the farmers' expense and was included as part of a systematic land development programme. CADAs throughout the country struggled for several years to find means of financing this programme despite the ineligibility of many farmers to receive Bank loans. Special legislative and administrative measures were taken to enable collective financing of farmers irrespective of their eligibility, but there were still major delays in executing the work. The Government of India therefore decided that in the Fifth Plan period (1974-78) field channels should be constructed at government cost up to each survey number (c. 10 ac) and during the Sixth Plan (1980-85) up to each holding.

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(1) In practice potential was declared as created when water flowed in the main canal or in major distributaries, and there was a long time-lag between this delaration and the construction of distributaries, minor and outlets. For example, the foundations of the Rs 1910 (US$221) million Malaprabha project in Karnataka (command area 600,000 ac) were laid in 1963, but in 1981 the only completed components were the main dam, a branch canal and a small part of one of the main canals. There were violent farmers' agitations in the Right Bank Canal area because of non-availability of water, unsatisfactory conveyance system and the imposition of a levy on lands which had been notified for irrigation but had not received water (<u>Hindu</u>, 13 June 1981).

This decision affected the budgetary allocations for main system construction; but because of contractual and other commitments, the proportion allocated to field channels was low. Large areas for which potential had been created in the traditional sense did not get field channels. The AP government has now decreed that utilisable potential is created only when water is delivered to each holding.

Meanwhile, farmers were showing a marked reluctance to develop their own lands before water supplies to those lands were assured. Even when water was flowing in their local minor canal, they were unwilling to invest heavily in land development: the water had to reach their holding. This added to the frustration of all CADAs, which were employing a substantial multi-disciplinary staff for land survey, design and development.

The farmers' reluctance seemed justified when it was seen that in older projects large areas had not yet received water. The CADAs therefore had to turn their attention to ensuring reliable and equitable water distribution to the farmers' holdings as a precondition to asking for investment in land development - a major tactical change in the sequence of command area development. This led to a modest programme of Rotational Water Supply (RWS) being taken up below the outlets of twelve minors in the Rabi (winter) season 1978-79 - the assumption being that water was available at those outlets. But it was found that for various reasons, including inadequate design, imperfect execution, lack of maintenance and subsequent damage to control structures, no minor was capable of providing the design discharge at every outlet. Further expenditure averaging nearly Rs 10,000 (US$1155)(1) per minor had to be incurred before the minors could perform the function for which they were constructed. Only then could RWS be taken up below the outlet, though not on all twelve minors.

In the next two seasons the number of minors was increased to 112 and 350 and all had to be improved at the same average expenditure. It was then found that even when the minor canals were brought up to design standard or improved, the distributaries from which they drew water were also deficient. The main reasons were that assumed losses in the main canal were much lower than actual losses; and that the 'duty' (water requirement per acre) assumed at the head of each distributary was the same irrespective of the length of the distributary or its minors. High rates of seepage and system losses resulted in a visible tailend where no water was available in the canals (main canal, majors and minors) and in an invisible tailend where no water was available to the tailend lands under every outlet.

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(1) US$/Rs exchange rate at 1981.

This 'invisible' tailend was spread over the entire command area.

The CAD Department's next step was therefore to take up a study of distributaries in each canal system, to find out the details about their actual performance. This study led the Department to the conclusion that

A. unless each canal is operated in a well planned and systematic manner and the deficient supplies in each distributary are equitably allocated to each off-take and outlet, it may not be possible to stop the over-irrigation and wastage at the top end and allow the legitimate share of water to the tailenders,

B. unless a reliable discharge is available at each outlet it is not possible to ensure an equitable allocation of whatever volume of water is available at the outlet to each farmer and to implement RWS.

The Government therefore issued an order in August 1980 for *Integrated Water Management above and below the outlet* to distribute equitably the shortages in the canal system and to make water available to the tailends. The available water at every outlet was again to be distributed to farmers through a system of Rotational Water Supply. One hundred and five distributaries were taken up for Systematic Canal Operation, of which thirty-two were studied and monitored by the CADAs.

This paper is an account of what happened in the process of implementating this order in one season of 1980-81. It is based on the reports of Administrators and my own personal visits and discussions with CADA administrators, engineers, agricultural officers and farmers. The Chief Engineers (CE) of the Irrigation Department were also asked to send reports on the problems of implementation, but none did so.

2. INTEGRATED WATER MANAGEMENT (IWM)

IWM may be defined as

A. Systematic canal operation (SCO) by rotation of the main canal system to deliver the design discharge, or at least a reliable discharge, at every outlet by equitable allocation of water at each offtake for a just sharing of the inherent shortage of water resulting from engineering, operational and maintenance deficiencies; and

B. Rotational Water Supply (RWS) to farmers for equitable allocation of the available water at every outlet.

Before issuing the Government Order for IWM, I had long discussions with all Superintending Engineers (SE) of of the Irrigation Department responsible for Operation and Maintenance in the CADAs. A meeting was also held with their Chief Engineers to obtain their consent to the proposal. The 105 distributaries selected for SCO in seven canal systems covered an area of 194,000 acres; and within this an area of 35,742 acres was selected for RWS. Of the two components of IWM, the success of RWS is entirely dependent on the success of SCO. The emphasis in the first season was therefore more on SCO. The objective was to assure the farmers that water could really be supplied to them. RWS would in many cases be taken up only in next season.

SCO faced different problems in different canal systems. Of the seven canal systems taken up, four were on-going projects and three were older canal systems in a drought prone area. The approaches adopted in each of the four CADAs were also different, reflecting variations in the intensity of coordination between CADA and O & M staff, their skills and motivation, and the degree of water scarcity in tailend areas. But the emphasis everywhere was on reliable delivery of water to the tailend of the main system as a precondition to RWS below the outlet.

I have taken the details of only one major canal in each CADA for this paper. The purpose is to show the problems to be tackled, the level of understanding of the persons implementing the orders, the solutions attempted by different officers, and the measure of their success or failure in the process.

3. TUNGABHADRA CADA

This CADA deals with four canal systems in a drought prone area:

A. The Kurnool-Cuddapah Canal (KCC) (water first released in 1856)

B. The Low Level Canal (LLC) (1956)

C. The Rajolibanda Diversion Scheme (RDS) (1956)

D. The High Level Canal (HLC) Stages I (1964) and II (1971).

SCO was taken up in eight distributaries and three sub-distributaries in these four systems, following a joint appraisal by CADA and O & M engineers and the execution of necessary repairs. Out of the total command area of these selected distributaries, an area of over 4,500 acres had not been irrigated and developed for more than a decade. SCO resulted in an additional area of over 2,000 acres getting irrigated and cropped in the Kharif (summer season) of 1980. One of the selected distributaries of the KCC system was divided into two reaches. The upper reach, with a length of 1.8 km and a designed discharge of 16.6 cusecs, had a command area of 849 acres which was designated for ID ('irrigated dry' - i.e. non-rice) crops during Rabi. The lower reach, with a length of 2.7 km and a designed discharge of 13.1 cusecs, had a command area of 509 acres designated for 'Wet' (rice) cultivation in Kharif. Under this system of 'localisation' no farmer in the upper reach was entitled to draw water in Kharif or for rice cultivation in Rabi; and no one in the lower reach was entitled to draw water in Rabi.

It was decided that SCO should be implemented in the lower reach during Kharif 1980.

a. Conditions prior to IWM

In this distributary there was a gross violation of the cropping pattern. For more than twenty years powerful and in luential farmers in the top-end Village A had been illegally using 220 acres of their ID lands to cultivate paddy during both Kharif and Rabi. As a result, adequate water never reached the tailend for legitimate paddy cultivation in Kharif. Out of the 509 acres in the 'Wet' lower reach, the farmers of Village C could raise only 103.24 acres wet and 37.52 acres of ID crops in Kharif 1979. Their average yield was 10 bags of paddy per acre.

b. Pre-IWM appraisal and improvements

The distributary was in disrepair. There were twenty-one open cuts and a lot of weed growth. Illegal cross-bunding by top-end farmers was a common feature. There were no controlling devices in any of the offtakes. All drop structures were damaged. There were two unauthorised outlets. The shape of the distributary was so badly eroded that its bed width varied from 8 ft. to 12 ft. as against the designed width of 5 ft. Water was supplied only to 100-200 ac. 'blocks', below which there were no field channels.

At CADA's request the Irrigation Department's Executive Engineer took prompt action and all necessary repairs and improvements were carried out. All the open cuts were closed. All the ID sluices were fixed in concrete. The sluice openings were remodelled wherever necessary. Minor canals which had not been excavated or had silted up were re-excavated. Field channels were provided up to each survey number (c. 10 ac.). As this was an old project for which neither CADA nor the Executive Engineer had any funds, the District Collector (Administrator) had to sanction Rs. 63,000 (US$7280) from the drought relief funds for improving this distributary and one other.

c. Pre-IWM extension work

The first task was to prepare the tailend farmers to receive water and to persuade topend farmers to go for ID crops, some of which could bring them much more income than paddy. The tailenders were difficult to convince, since they had not received water for years, and it was evident that the topend farmers were strongly opposed to having their illegal withdrawals stopped. A motivation team, consisting of the Deputy Director of Agriculture CAD, Subject Matter Specialists CAD and Deputy Registrar of Cooperative Societies CAD, visited the tailend and topend villages thrice before the season began. In addition to assuring the tailenders that they would get water and that wet crops would not be allowed on ID-designated lands, they constituted 'pipe committees' to look after water management below the outlets under CADA guidance.

Under the prevailing system of water distribution, nothing was done about the allocation of water once it had been released into a minor canal. The CADA therefore had to make a further effort to introduce the concept of rotation between outlets; this involved the periodic closure of upper outlets to enable water to reach the tailend of each minor. A junior team was set up for the purpose, consisting of Assistant Engineer CAD (leader), Assistant Engineer (O & M) and an Assistant Agricultural Officer. Their work was supervised by a senior team at project level. Overall review of the progress of implementation of IWM was undertaken by an Apex Body formed by the Administrator of the CADA and the Superintending Engineer of the Irrigation Department.

When I visited the distributary before implementation as Secretary of the CAD Ministry, the farmers of Village A made very strong representation that they had invested large amounts in developing their lands for wet cultivation and that they were unsuitable for ID cultivation. One powerful farmer showed me a field with some standing water to demonstrate that ID crops could not be grown in it. On inspection it was found that he had deliberately diverted water to his field before my visit to make it look waterlogged. A decision was taken to provide a separate drain to avoid waterlogging, if any. When I then went on to Village C, a large number of Village A farmers followed my car and got into arguments and a near quarrel with the tailenders. The latter were told by me, and again later by CADA officials, that they should contact the political leaders and see that the topend villages did not succeed in encouraging political interference in the IWM scheme.

d. Implementation of IWM

When water was released on 13 July all the outlets in Village A were closed for the first time in several years and water reached Village C. Only when water was tested in the field channels (it had previously not even reached the minor canal) were farmers sufficiently confident to start agricultural operations - from 1 August. The Irrigation Department installed a gauge at the head of the distributary and gauge readings were recorded for the first time. Water distribution in the minors began from the tailend and worked upwards. Because the 1980 rains turned out to be unusually low, the main canal also had to be rotated from 6 October, with consequent modifications in the supply of water to the distributaries. The Irrigation Department's failure to implement the turn system strictly on the main canal created some problems at the distributary level, which required another visit to the area by the Administrator and the Superintending Engineer.

The farmers of Village A accepted this arrangement and raised a rain-fed crop instead of paddy in their ID lands. But in Village B, a leading farmer tried to raise paddy seed beds along with thirty others and made a representation to the Administrator, CADA that they were not aware of the new scheme. On enquiry it was found that the villagers were fully aware of it. But the same leader started troubling the Assistant Engineer CAD in charge of the distributary. When water to the village was stopped by the irrigation staff, he cross bunded the drain to raise paddy. This affected the ID lands in Village C and the AE removed the cross-bunding. When the farmer obstructed him a criminal case was filed against him. Another farmer's attempts to take unauthorised water through an underground pipe were stopped with the help of Revenue and Police officials. After the Administrator CADA had approached the District Collector and the Superintendent of Police to take immediate action against these farmers, they threatened that bombs would be thrown at the AE. When the threats failed, they approached the local Member of the Legislative Assembly to intervene. But the tailend villagers also approached him to say that they had not seen their legitimate share of water for more than twenty years and persuaded him not to interfere. The leading farmer was arrested twice for obstructing O & M staff. He was released on bail on the first occasion but on the second occasion, when he assaulted a ditchtender, nobody came to give him surety for bail. He had lost the support of his own villagers. Thereafter he created no further difficulty and the problem was overcome.

Despite the threats against him, the AE in charge of IWM worked throughout the season with great dedication. Moreover, at one stage, when deficient operation of the main system led to sudden water scarcity at the flowering stage of the crop, the villagers sent a telegram to the Administrator CADA and got him to see that water was released in time. This incident clearly shows how closely water management below the outlet has to be integrated with main canal operation. It also shows the need for intensively coordinated water allocation decisions and for strong administrative and political will to withstand pressures from vested interests.

e. <u>The benefits of IWM</u>

The benefits of IWM to the lower reach of the distributary are summarised below.

	Position as existing before IWM 1979 Kharif	Position after IWM 1980 Kharif
1. Average discharge (design discharge 13.1 cusecs)	9 cusecs	5.4 cusecs, ranging between 2.3 to 11.38
2. Area irrigated	140 acres	380 acres
3. Area not irrigated	187 acres (for 30 years)	76.62
4. Area needing land development	128.62	
5. Additional area irrigated	--	240
6. Total quantity of water used	119.6 M.Cft.	66.2 M.Cft.
7. Average duty per cusec	38 acres	66 acres
8. Yields bags per acre	10 bags (Farmer's statement)	22 bags (Crop cutting experiment)
9. Employment	9,566 man days	21,737 man days
10. Land Revenue income to Government	Rs 5,271	Rs 12,567 (Increase = 7,296)

As a result of SCO,

- the deprived group became conscious of its rights and the efficacy of group pressure on topenders and politicians;

- O & M staff became alert and conscious that reliable delivery of water to each outlet requires a lot of calculations and a systematic and dedicated approach to the main system operation.

- the neighbouring tailend villagers started exerting pressure on the O & M staff to deliver water to them also.

4. SRI RAMASAGAR CADA

This was the only project in which CAD work started along with the first release of water (in 1972). In this command area Rotational Water Supply had been successfully implemented in two minors in 1978-79, 100 in 1979-80 and 300 in 1980-81. The World Bank took very keen interest in this work. The CADA and the Irrigation officers worked with the closest coordination and excellent understanding of programmes, objectives and each other's problems. Four distributaries were taken up for IWM in this CADA. The O & M Engineers' understanding of the problem and their methodical, systematic and dedicated effort has brought out some facts which may be of great importance in designing and operating future projects. I will take as an example the operation of one distributary in Rabi 1980-81.

This distributary is the second largest in the canal system, with a design discharge of 766.25 cusecs and a command area of 83,383 acres (19,122 ac wet, 64,261 ac ID). However, it was only partially completed in Rabi 1980-81, when water was released up to Km 22.825 (for a command area of 27,606 ac) only. This meant that water had to be released at lower than design discharges, with the expectation that there would be problems in reaching the full length of the distributary due to inadequate driving head.

It was originally assumed that water would be supplied continuously, with 50% utilisation rate, a duty of 0.6 cusecs per 100 ac at the outlet, and 60% seepage losses (due to low supply depth and wide bed width). On this assumption, the discharge at the head of the distributary would need to be 132.5 cusecs:

Crop water requirement	$= 27{,}606 \times \frac{1}{2} \times \frac{0.6}{100}$	= 82.812 cusecs
Seepage losses at 60%		= 49.687 cusecs
Head discharge		= 132.499 cusecs

Against this requirement, a head discharge of 140 cusecs was allowed. However, as a result of further studies of water flows in the distributaries and of seepage losses on three selected minors, it was concluded that, under continuous flow conditions, the sixth and final reach (Km 16.900-22.825, commanding 3,900 ac) would be left with a meagre balance of 5.25 cusecs against its total requirement of 32.85 cusecs. To overcome this shortage, a systematic method of canal operation by rotation had to be devised.

For this purpose the distributary was divided into two zones (Km 0-7.60 and Km 7.60-22.825), with command areas approximately in the ratio of 3:4. The rotation was therefore based on giving water to Zone I for three days and Zone II for four days in a week. To compensate for the reduced periods of flow, the dosage of water was increased by 7/3 times for the minors in Zone I and by 7/4 times in Zone II.

The seepage losses under the new pattern of water distribution were again tested on the same three minors as before, and they were now found to average only about 25%. This meant that Zone I's requirements were only 111.01 cusecs for three days a week against the allocated discharge of 140 cusecs, while the shortage in Zone II was reduced to a mere 3.6 cusecs. Similar calculations were also made for rotation in the minors, where it was found that continuous flow at lower discharges would not have enabled the outlet pipes (located 1 foot above bed level) to get water. This pattern of rotation therefore solved the problem of the tailenders, who would otherwise have had no water.

The principal lessons learnt from the studies done on the four majors taken up in this CADA were:

A. In the prevailing conditions of incomplete canal construction, rotational distribution in both the distributaries and minors was much preferable to continuous flow, for the reasons explained above;

B. Repairs and improvements were needed in the minors at an average cost of Rs 63/ac (including the cost of field channels, but not that of silt removal, which was borne by the farmers); these had to be done well before the season;

C. Water scheduling in the minors had to be fixed with the full participation of the farmers, and particularly the topenders, well in advance of the season;

D. The present budgetary allocation for maintenance was totally insufficient. No IWM is possible without both the major and the minor canals being in good shape.

E. A minimum period of three months' coordinated efforts by all concerned disciplines was necessary for the success of the scheme, from the initial joint appraisal of the system, through its improvement, the calculations of losses and required releases, to its actual operation, which made much more intensive demands on staff than existing procedures.

5. NARGARJUNASAGAR LEFT CANAL CADA

This is a very large on-going project with an intended command area of 918,000 ac (613,000 wet, 305,000 ID). Actual irrigated area in 1979-80 was only 401,000 ac (302,000 wet, 99,000 ID) however. Water was first released into the system in 1967, but development of the tailend was subsequently financed by the World Bank in a composite loan which covered land development and agricultural extension as well as the usual engineering component.

Despite the low proportion of the command area actually irrigated, the Chief Engineer of the project claimed in a written report to a water management workshop in 1978-79 that utilisation was 90%. However, when RWS was to be introduced in two minors in the same year, it was not possible to find two minors capable of carrying the designed discharge to every outlet. The CAD did an appraisal of some distributaries and found many deficiencies in them. Consequently, when IWM was introduced in Kharif 1980 CAD proposed that work be attempted on six distributaries only; the CE, however, offered to implement it in all the larger distributaries.

A study by CADA at the end of 1977 found that shortage of water in the main canal would be clearly visible after mile 70 and that there might be very little water in the last 70 miles of the canal. The World Bank loan had to be reformulated and it was decided to line the early reaches of the canal to enable the water to reach the tailend canal financed by the Bank.

The Government Order on IWM was very clear about the manner in which CADA and O & M staff should be coordinated. It was expected that on this project, as in Tungabhadra and Sriramasagar projects, IWM would be a joint venture. However, it is significant that at a CEs meeting on IWM, the Chief Engineer of this project (having offered to take up IWM in all big distributaries as against the six suggested by CAD) finished by exclaiming "Now there will be no further contact with CAD". I answered by saying "I thought there was going to be day-to-day contact".

Apart from the design deficiencies identified in the pre-IWM appraisal by CAD, which made operation difficult, it also appeared that the O & M staff were either not really involved or were unaware of the problems in the system. The information they fed back to the CE was of a routine nature. This led to some interesting communications from the CE to Government. Less than a month after having agreed to implement IWM in all big distributaries, he wrote that IWM was unsuitable for red soils. This was followed by another letter which stated that IWM was unsuitable for paddy. A third letter stated that the experiment had failed and should be discontinued. I then had a rather frank discussion with him about his inadequate understanding of the very objectives of IWM and about the lack of coordination with CADA which resulted in such communications. At the end of the season he sent a report saying that IWM had been successful and that both area and production had increased.

In December 1980 while reviewing the IWM work in the CADA Working Committee of which I was the Chairman, I wanted to know the problems faced by the O & M staff in operating the distributaries. I was told that there were no special problems. Even my leading questions elicited no information about system deficiencies. I then took from my briefcase eight photographs of major defects in a single distributary which made it incapable of any organised operation.

The Government Order on IWM had laid down that the rotation in the main system should be organised by O & M staff in full consultation with CADA. But on this project, CADA was consulted only in the case of two major canals which I had visited previously. It was expected that each distributary would be taken up separately and a rotation fixed after finding out water shortages at the head of the major, seepage losses, etc. But this was not done. Instead of being a calculated and coordinated function, IWM became an adhoc trial and error exercise. This can be briefly illustrated by reference to one of the two majors (out of a total of 85) on which some coordination took place.

The major is 19.6 km long and has a command area of 21,304 acres covering fifteen villages. It has twenty-one minors and a total of 398 outlets. The design discharge is 336.2 cusecs. In my pre-IWM visit in April 1980 the then Superintending Engineer told me that on account of heavy seepage losses in the upper 77 miles of the main canal its actual discharge was 280 cusecs only. But when SCO was implemented the O & M staff assumed that full discharge was available. CADA's pre-IWM appraisal found that repairs to sluices, replacement of shutters, repairs to regulators and drops, closing of open cuts, strengthening of canal banks in the major and minors would be needed at a cost of Rs. 450,000. This work was however not taken up by O & M staff. Without any organised calculations, the major was first divided into six zones, each being closed for one day. This was changed to three zones in August with a two day closure in each zone, and then in September to two zones with closure for three days. In spite of this, the Superintending Engineer observed that the last three outlets were not getting water though each zone in its turn was getting the full discharge from the major. No one reported any protests from the topend paddy farmers when their suppl- was cut off for three days.

The Executive Engineer in charge of this work has to deal with 83 distributaries with a command area of 231,554 acres. One might have expected him to welcome the help available from CADA's irrigation engineers, yet no help was taken.

Even so, despite the lack of understanding and coordination, some new areas which had not been irrigated for over a decade did receive water in this command area - though the figures of the Irrigation, Agriculture and Revenue Departments were very different from each other.

The following lessons were learnt:

A. There were design, construction, operational and maintenance deficiencies resulting in water shortages in each distributary, but the CADA and the Government were not taken into the Irrigation Department's confidence.

B. CADA, the coordinating Authority entrusted with the task of IWM, found itself helpless since its offer of coordination and staff was interpreted as interference.

C. O & M staff continued to work on an adhoc trial and error basis and no organised thinking was done at higher levels before implementing the Government Order.

D. There was a strong case for separating construction and O & M responsibilities, since the engineers entrusted with lining the main canal were too occupied to pay any attention to water distribution.

E. The tailend farmers nevertheless became conscious of their share in the water which had so far been denied them.

6. NAGARJUNASAGAR RIGHT CANAL CADA

Water was released in the Right Canal in 1967. The design discharge is 11,000 cusecs and the proposed command area is 1.14 million acres. In 1979-80, the area irrigated was 779,000 acres (486,000 ac wet and 283,000 ac ID).

In a study made by CADA in 1978 it was found that the distributaries were generally underdesigned and underengineered and incapable of irrigating the entire area; about 8,000 structures would be required to make the canal system efficiently operable. In another quick study by CADA in July 1979, 567 defects were found in the canal system serving 232 villages. In a pre-IWM visit to the tailend area the responsible Superintending Engineer could not tell me the actual discharge which would be available to him in the main canal at the beginning of his jurisdiction, though he had worked out an elaborate system of rotation in impressive display charts.

Five majors were selected for IWM under this system. They were divided into seven zones which were closed for one day every week. The O & M staff had made some improvements to control structures but not in all cases, since the cost of the needed repairs was much more than the budget available to them. One of the majors was also selected for Intensive Water Use Management in black soils by the Water Technology Centre and the Ford Foundation. It therefore received more attention than the others and funds were available for constructing all the necessary structures. This major runs on a ridge with 25 direct outlets and no minors. Seventeen topend outlets are localised for ID and the eight tailend outlets for wet. The design discharge is 15.52 cusecs. The area irrigated up to 1979 was 1,876 acres and rose to 2,166 acres after IWM.

Up to 1979 all pipes were fixed in earth, making tampering with the system a routine matter for the farmers. There were no control arrangements. The drop structures were damaged and sills broken. The major was silted up and full of weeds. Before IWM all structures were constructed and desilting done. The topend farmers who had illegally taken up paddy were persuaded to change to ID crops, following intensive work by the extension services concerning their profitability. A set of three to four outlets were closed each day and with only this simple addition of three to four cusecs per day the command area of the tailend village received water for the first time. Crop yields increased. Consciousness about judicious water use increased in both topend and tailend villages.

This particular major was a success story. The same may not be true of the others. In a system with many deficiencies, the closure of offtakes was not possible in many cases. Higher level authorities were subjected to great pressure from the politically powerful topend district not to reduce the continuous supplies currently available to it. IWM may therefore have to be implemented in a better manner in the next season with educated political backing and strong group pressures from the tailend district.

The following lessons were learnt:

A. It was possible to substantially improve the performance of a major canal after detailed local studies of water availability and requirements and through systematic minor adjustments in water flows.

B. The great shortage at the tailend of the main canal could be reduced by systematic rotation of the main canal itself, before resorting to massive investment in lining.

C. Where good production results have been achieved, in spite of marked reduction in water supply, the designers' assumptions about water 'duty' need to be reconsidered.

7. *CONCLUSIONS*

This paper has described the implementation of IWM in four out of 105 distributaries in one agricultural season. More data would be required before firm conclusions could be drawn about the costs and benefits of this organised effort for better water management. For this, the work would need to be continued for at least three years with better coordination and better rotational scheduling procedures.

The main points to be drawn from this paper may be summed up as follows:

a <u>Administrative</u>

i Because Irrigation and CAD were under different Ministries, the response of O & M staff to CAD efforts for IWM ranged from total understanding and willing coordination to indifference and non-cooperation.

ii There is an urgent need to separate engineers' construction and O & M responsibilities and to integrate O & M functions with the agricultural production process.

iii IWM is a multi-disciplinary function requiring months of coordinated effort by concerned disciplines. A strong administrative and coordinating organisation with a single line of command is necessary for effective implementation and conflict management.

iv The present O & M staff are technically inadequate for IWM. They lack knowledge of the actual performance of the system. There is no water accountability and no system of proper allocation to each offtake and outlet. The allocation of water to farmers below the outlet is no-one's responsibility.

v There is a large scale indiscipline and the system is extensively tampered with by the farmers. Adequate legal, administrative and political backing is required to improve the situation.

vi Training for water management is necessary for O & M and agriculture staff.

vii Staff numbers will also need to be increased. The introduction of IWM was achieved at the cost of the additional staff which was diverted from CADA's agricultural and land development work. If the same work were to be done by O & M staff alone, their numbers might have to be doubled.

b Engineering

i There were design, construction, operational and maintenance deficiencies resulting in water shortages in each distributary.

ii The design assumptions for system losses were found to be unrealistic in all cases.

iii Systems designed for continuous flow could not supply water to the tailends. Intermittent flow by rotation resulted in some improvement. Overall seepage losses can be reduced by rotation.

iv Effective IWM is not possible without repairing or upgrading the system.

v In older projects where field channels were not included, the construction of field channels will have to be taken up as part of a modernisation programme.

c Operation and Maintenance

i Each distributary behaved differently. The final operational schedule in each case may require two to three years of organised work before it can be incorporated into an Operations Manual.

ii There are no Operations Manuals at present. There is no concept of operation of canals by definite objectives.

iii Maintenance grants are inadequate and are not spent according to any pre-determined objectives.

iv Even when an organised drive was taken up, the O & M hierarchy tended to follow an adhoc trial and error approach and, with some exceptions, there was no high level direction or field level thinking and planning.

d Farmer involvement

i Farmer involvement and intensive irrigation extension work is necessary. The agricultural extension service has to work in close coordination with O & M staff.

ii Individual farmers will not make sacrifices for the sake of others. System operators have to make misuse of water difficult. Water allocation to farmers has to be strictly implemented with the help of farmer organisations and group pressures.

An abstract of the Government of Andhra Pradesh's order of 5.8.1980, statistical details on actual irrigated areas up to 1980, and in 1980-81, are available from the Irrigation Management Network.

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NON-AGRICULTURAL USES OF IRRIGATION SYSTEMS: PAST EXPERIENCE AND IMPLICATIONS FOR PLANNING AND DESIGN

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1. INTRODUCTION

One USAID engineer's estimate that over 95% of all irrigation systems are also used for non-cropping purposes is plausible. The most frequently observed uses are for domestic water needs and for animals, but there are many others. However, it is not clear what the implications are for irrigation system planning, design and operation.

The purpose of this study was to review existing practices in order to begin to search for answers to some basic questions, which may lead to improvements in meeting users' needs. The following questions guided the investigation:

- What examples are there of irrigation and other water uses being mutually achieved?
- Who are the present and potential users of systems?
- Are there examples where there is direct competition for water from the irrigation system?
- What are the mechanisms for reducing conflict or achieving concurrent objectives?
- What guidelines, relating to other uses, are being used in the development of systems?
- What are the economic factors that encourage or prevent other uses?
- What are the benefits and costs of multiple uses?
- How does the type and size of the system influence other uses?
- What are the health issues related to the use of irrigation systems?
- What influence does reliability and proximity of the water supply have on the user?
- How are irrigation system maintenance needs reconciled with domestic water needs?
- Does improved efficiency of water use for agriculture conflict with other uses?
- Do inadequacies of existing irrigation systems act as obstacles (real or perceived) to development of other uses?
- What are the administrative obstacles to other uses?

- What are the prospects for experiment and innovation?
- What are recommendations for guidelines, "consciousness raising", experimental projects, involvement of poor groups, and research needs?

Not all these questions could be answered. The paper therefore closes with recommendations for further research.

2. METHODOLOGY

The multiple uses of water reservoirs for irrigation, power and recreation were specifically excluded from consideration . The focus is on the non-agricultural use of irrigation channels or wells. The three main information sources utilised were a computer based search for relevant studies; a review of summaries of selected project appraisal documents, and interviews with over fifty persons with experience in irrigation research and project development. This included many with World Bank and USAID project experience.

3. CATEGORIES OF NON-AGRICULTURAL USE

The literature review confirmed the compartmentalization of water resource research and development. *Irrigation* literature deals exclusively with agricultural production purposes. *Water supply* literature deals primarily with domestic needs and to a lesser extent with animal and industrial requirements. The few exceptions are references to multipurpose reservoirs from which both irrigation and domestic/industrial water releases are made, and to water supply systems used for irrigating home gardens. Some general information papers, such as one presented at the United Nations Water Conference in Argentina (UN/FAO, 1977:10), note that irrigation projects in developing countries nearly always combine the provision of perhaps polluted domestic supplies with water for agriculture, particularly in the case of the very large systems in Egypt, Syria and India.

The Document Review Summary, compiled by the Utah State Water Management Synthesis Project, indicated that fewer than 10% of the project papers reviewed made references to non-agricultural uses or health-related impacts. This reflects either a universal lack of awareness of non-agricultural uses or an inability to deal formally with them. Since such uses are observed to be widespread, it must be assumed either that the usage is completely unformal, or that the inclusion of structures and design modifications to allow such use are completed in the country of the project and are not found worth reporting in summary documents. In a few cases, "unquantified benefits" are reported which refer to domestic and other non-agricultural uses.

There is a significant body of irrigation-related literature dealing with the health impact of irrigation development. The majority of this literature is focused on schistosomiasis and to a lesser extent on onchocerciasis. Several books deal extensively with methods that have been employed in the design and operation of irrigation systems to control the spread of these diseases (McJunkin, 1975; Fogarty, 1977). The water supply and sanitation literature deals extensively with the range of water-borne, water-washed, and water-based diseases. Irrigation planning and design texts, however, seldom address the health issues and then only to warn against potential health hazards of irrigation development. Little information was found in these texts and manuals on design procedure to reduce the negative health impacts; and they made no reference to beneficial, non-agricultural uses of irrigation systems.

A notable exception is a guidebook prepared for USAID by Harza Engineers (USAID, 1980). This book lists environmental design considerations for rural development projects and includes a complete section on small-scale irrigation. While it assumes irrigation to be entirely production-oriented, it recognizes and discusses benefits and effects of non-agricultural uses. It particularly stresses the need for simultaneous efforts in health education, sanitation, water supply etc, if potential hazards resulting from the development of irrigation systems are to be avoided.

A summary of the information from the literature review and of observations and impressions from the interviews is given below, grouped according to the main use that was reported. Most of this information is based on casual observation. The few documented reports are referenced.

a. Domestic Use

i. Drinking Water Drinking water is taken to include water for food washing and preparation, and for washing dishes. Dependency on irrigation systems, for whole or part of the year, has been widely observed.

Gravity systems

In *India* and *Pakistan*, there are many examples where all domestic water is directly withdrawn from large perennial canal irrigation systems. In some cases the canal near a municipality or village is allowed to flow through a pond to reduce the velocity and facilitate silt settlement. The drinking water is then withdrawn from the pond. The water may be treated before it is distributed in pipes to the municipality, but in many cases it is distributed without treatment. Frequently, water is collected by individuals directly from convenient points on a canal.

A number of projects in *Sri Lanka*, include the Gal Oya, have had a mandate since their inception in the 1940s to supply water for domestic purposes. The design paper for the non-perennial Gal Oya system suggested that provision should be made for treated drinking water for 20,000 people, in addition to flood protection, irrigation and power generation (Unantenne). It was never possible to supply treated water as planned and a practice of making special issues of water through the canals for domestic needs was started. A common schedule of release is a 3-day issue every 10 days during the period between crops when the canal would normally be dry. In the view of the authors of the CH2M Hill (1979) report, this led to the following problems:

1. Domestic issues, though they generally represent far less than 10% of total annual issues, involve a very high rate of water wastage. Water is almost always issued into dry channels, and thus a great deal is lost by wetting of canal perimeters and by percolation. Domestic water issues seldom reach the tail ends of systems.

2. Channels are never dry for more than a few days at a time, and thus it is difficult to schedule regular maintenance.

3. People and animals damage the banks of channels and exacerbate siltation problems. All but a few systems lack access steps and special buffalo-wallows.

4. Farmers who have not adhered to agreed crop schedules can use an alleged need for domestic water as a pretext to obtain more water for their crops, thus further relaxing discipline.

5. The use of surface water for human consumption is more unhealthy than the use of well water.

The report concludes that the practice of making water releases for domestic needs continues, for two reasons. One is that settlers have come to expect it and feel a strong moral entitlement. The other is that settlers sometimes actually need it as they have no alternative supply. (Since the cultivators feel entitled to canal water for domestic needs, they have not made the same efforts to construct their own wells as the rural people who lived in the area before the projects.)

In *Nepal*, small mountain irrigation systems are purposely channelled through villages when possible, for domestic water supply. Rubbish from the house and street is disposed of by dumping or brushing it into the canal.

Piped systems

On a small piped irrigation system funded by USAID in *Guatemala*, a tap is reported to have been routinely installed in each yard, wherever the source was a covered spring (Annis and Cos, 1980). It was found that the extra cost of this service was very low and that it stimulated additional cooperation in building, maintaining, and operating the system.

Lift systems

Groundwater is frequently promoted for both irrigation and drinking purposes. On a groundwater project in *Nepal* the use of irrigation tubewells for drinking purposes was encouraged, with the suggestion that "gastro-intestinal diseases resulting from polluted water used by villagers is the most common health problem that the potable water from tubewells will solve" (Nepal/USAID, 1980).

In some areas of *Bangladesh* where tubewells were installed and operated for irrigation, the water table was reportedly lowered below the level of existing wells used for domestic water supplies. No information was available on the extent of this problem or the methods employed for resolving the conflict. In *Pakistan* and in some *Sri Lanka* projects, seepage and percolation losses from irrigation systems recharge the groundwater supply. This makes shallow wells possible which can be used for domestic needs and in some cases for supplemental irrigation.

A serious limitation in using irrigation tubewells for domestic water supplies is their intermittent operation and the consequent requirement of storgae facilities. The energy requirements for operating the pump for domestic needs when water is not required for crops is usally prohibitive.

ii. Washing Clothes and Bathing The most frequently observed non-agricultural use is for washing and bathing. A 3500 ha irrigation project in *El Salvador* has been called the longest bathtub in the world. The one canal through the centre of the valley is a natural place for people to congregate, wash their laundry, and bathe. In central *Java* where masonry flow-measurement structures were constructed for research purposes in an unlined canal, they immediately became the most popular washing and bathing places. Clothes could be beaten against the wall and the higher water velocity through the structure kept the floor clear of silt, a great improvement over a mud floor bathtub. Canals in *India* and *Pakistan* are often lined near a village and steps are constructed for easy access to the canal for washing and bathing. Although this increases the convenience to the users, the irrigation department's primary motivation is to protect the banks of the canal from damage.

Farooq, et al, (1966) examined the personal, social and religious aspects of people's use of irrigation water in a province of Egypt where schistosomiasis was prevalent. For young males, virtually all contact was through bathing and playing. For older males, principal contact activities were washing of cattle, ablution, and ritual washing before prayers. Young females bathed but their most frequent contact was while washing utensils. Utensils and clothes were washed by women and children while standing in the water.

iii. <u>Home Gardens</u> There were only a few reported observations of home garden irrigation. A possible reason for this is the need to protect the garden by having it very close to the house - and hence far from, and often at a higher elevation than, the irrigation system.

In *Bangladesh*, where land holdings are extremely small and hand pumps are frequently used to irrigate, they are also commonly used for home gardens. Some of the garden produce is also sold commercially and gardens are viewed as an agricultural activity.

A project in *Thailand* (ATIT/ILACO, 1971) promoted a practice also common in *Vietnam*. Ponds were constructed for fish culture. The earth removed from the pond was mounded to provide a site for the family to construct their house. The pond provides water for a garden in the dry season, as well as for drinking water if no other source is available.

The Resource Utilization and Conservation Project proposed by USAID for *Nepal* suggests that home gardens will be a component of the small-scale, hill-irrigation systems. Annis and Cox (1980) reported that in the piped irrigation schemes in highland *Guatemala*, where there is adequate water to encourage home gardens, they are a valuable source of food. The gardens are used both for home consumption and cash generation.

b. Sewage Disposal

In *Indonesia*, latrines are built directly over irrigation canals, while streams and rivers are preferred for bathing. This practice has been reported in *Egypt* and *Nepal* but not to the same extent as in Indonesia. Observations in several villages in central Java showed careful separation of water source uses. The irrigation system was used for defecation and rarely for other water needs, although there was contact with the water in land preparation, rice planting, and weeding. Wells were used for drinking water, which was reported to be boiled. The river was used for washing clothes, and bathing was done both at the river and wells.

Distance to the stream and no access to a well, however, forces many people in Indonesia to bathe and drink from irrigation canals that have been used for excreta disposal. If channels are used as sewers, it is nearly impossible to keep people from contact with fecal material in rice cultivation, leading to cholera epidemics and other water-borne diseases. Even though defecation in canals is considered a dangerous practice and sewage disposal is never intentionally designed into an irrigation project by development and lending institutions, the alternatives for Java are not clear. The engineers of a USAID contractor, designing irrigation systems in Indonesia, have been confronted with this problem. They know that the system that they design and build will be used for excreta disposal as well as bathing and other domestic requirements, but they do not have the mandate to design and build alternatives nor does a facility exist to provide the long-term education that may be required to change habits.

In many parts of *Latin America*, *India*, and *Africa*, people defecate in fields and either carry water with them or use the most convenient water course for anal cleansing. Anal cleansing may be a serious source of fecal contamination of the irriation water. Water courses, including irrigation channels, are also frequently used to dispose of rubbish and street sweepings.

Using human excreta as fertilizer is a common practice in many parts of the world and is particularly widespread and important in *China*. A common form of sewage disposal from urban centres in many countries is by using the effluent, either treated or in some cases raw, to irrigate crops. The effluent is diluted with water to provide the correct nutritive value for the crops that are being grown. This is usually done on carefully controlled farms, and crops are selected that minimize the health hazard of disease transmission by contact or injestion. This practice is well-researched and documented and may provide useful information on the hazards of the less formal sewage disposal through irrigation (Feachem, 1977; Papua, New Guines, 1974; Sastry, 1975).

c. Animal Use

Irrigation systems are an important source of drinking water for animals in many countries. A lift irrigation project in *Afghanistan* proposed ponds to provide drinking water for sheep so that they would not use the irrigation channel and destroy it. The same reasoning has been applied to provide animal access to irrigation water throughout Asia. Special ponds off the main water course are provided in many parts of *Pakistan* and *India*. One source reported that buffalo preferred the cooler moving water in the canals and that ponds have been abandoned. Lining, to protect the canal, and easy-access steps are now routinely provided for water buffalo in many systems (Irrinews, 1980:1).

Erkenci (1977:103) stated that in two provinces of *Turkey*, 235 small reservoirs were feasible to supply water to 365,000 cattle and sheep as well as to irrigat 18,000 ha of land. It was not clear, however, if the animals would be watered from the canals of the irrigation system, or separately from the reservoirs.

Fish in reservoirs, tanks and channels as well as in rice paddies, make an improtant contribution to the diet of many people in South and Southeast Asia. Except for the *Thailand* case (ATIT/ILACO, 1971) already cited, nothing was found in the literature review linking fish and fowl to irrigation development. Observations in central *Java* indicate that raising a few ducks, which use the irrigation channels freely, is an important part of the farming system for many families. Fish and ducks may make important contributions to family welfare in poor areas.

d. Power

i. Electricity Several examples of irrigation canal drops being used for the generation of electricity were found. A project in *Nepal*, funded by the Asian Development Bank, has incorporated an 80 kW hydroelectric project in the main canal. The electricity will be used for lighting and light industry in the community served by the irrigation system. Other examples of a similar nature exist in the hilly areas of *Thailand*, *India* and *Pakistan*.

ii. Milling Water-powered grain milling has been practiced for thousands of years. In mountainous countries such as *Nepal*, a vertical-axis water wheel is frequently incorporated into a drop in an irrigation canal to drive a stone flour mill. Since 1965 turbines incorporated in existing irrigation systems have been used to replace diesel engines in some modern mills. They can be used for grinding flour, hulling rice and pressing oil from seeds. They require typically from 4 to 10 kW of direct mechanical power. (DCS, 1980). Such mills make an important contribution to reducing women's labour burdens in food processing (Molnar, 1980).

e. Transportation

Most surface irrigation systems have roads and paths along canal embankments. Their prime purpose may be for inspection of the system, but they have frequently provided the first motorized access to rural areas. Paths along canals are usually adequately drained for easy travel during the rainy season, and they have an easy gradient for bicycles and walking.

Water from the irrigation system is also used in *India* and *Pakistan* for softening road surfaces prior to water grading them. Irrigation canals particularly in *Southeast Asia* and *China* are often used for boat transport.

f. Other Uses

i. Religious Irrigation systems may be used for ritual bathing and other religious ceremonies. Throughout areas of Hindu influence, there are temple gardens, ponds, and lakes, which are supplied with water from irrigation systems, with aesthetic as well as religious benefits.

ii. Trees Tree roots can cause damage to canal lining. Their water requirements can be high, (although possible insignificant as a fraction of the total water in the scheme). Some countries ban trees near irrigation systems, but in *Pakistan* trees are planted at about 30 m intervals along all of the major irrigation canals, providing shade and beauty in an otherwise treeless countryside, and earning revenue from sales of construction material and fuel.

4. FACTORS AFFECTING COMPATIBILITY OF USES

a. Hydrological Environment

The climate, rainfall intensity and distribution, soil moisture regime, topography, etc have direct influence on the availability of water for domestic needs and the degree to which it might be supplemented by an irrigation system. These same factors control the need for irrigation and greatly influence the type and size of irrigation systems that can be developed. Such environmental factors have little scope for manipulation and change very slowly over time. However, they greatly influence technical alternatives that might be considered for water needs.

i. Water Sources When the irrigation water is from a protected source, such as the springs in some of the systems reported in *Guatemala*, no filtration or treatment may be necessary in using the water for domestic needs. The same may be true for water supplied from tubewells, although there have been examples where taste was not acceptable and tubewell water was rejected in favour of the traditional surface source.

If the irrigation water is from a surface source, the water quality will be lower and is likely to be highly variable. The cost and reliability of treating this water must be compared with the cost of using alternate, better-quality sources. Epidemics are more easily spread when a large community uses a single, unreliable source. Multiple sources such as wells, even if recharged by surface water, may provide better disease control.

ii. Conveyance Methods Although only a small proportion of irrigation systems are piped from source to field, this is the system most compatible with domestic use. As villagers may be tempted to break the pipes for clandestime domestic water supplies, planning the incorporation of domestic taps may save water. A system in the *Philippines* sized the pipe delivering water to the village so that even if the taps were not closed, the losses would be acceptable.

Since access to a canal cannot easily be restricted, it will be used for domestic needs unless more acceptable alternatives are available. The convenience and perceived quality of alternative water sources are very important factors in a villager's choice of a water supply (White, 1972). If schistosomiasis is endemic, for example, control can only be effective if safe water is used. This water supply must be more acceptable by the villager's evaluation of convenience and quality than the traditional source, which might be the canal. Disease control mandates the investigation of water supply alternatives which will be acceptable to the community. Even though the irrigation system may not be compatible for domestic use by WHO standards, it must be considered among the alternatives within the community's and country's technical and financial resources. If no better alternative supply can be delivered, incremental upgrading of the canal water may be possible by using infiltration galleries or other treatment methods. Health and sanitation education can also be carried out to change what is acceptable by the villages. Such education is essential but may require a generation to take effect. The irrigation water's source and conveyance method together indicate the degree of compatibility with domestic water supply.

b. Cultural Environment

Social, religious and cultural practices are perhaps the most important factors in considering alternative uses of an irrigation system. For some, body relics, especially excrement, must not be touched if the body is to be protected. The ritual purity requirements of high caste Hindu families may lead to frequent bathing, careful cooking, and other dirt avoidance, probably corresponding with good "scientific" hygiene. However, other practices definitely do not. There is no agreement between science and ritual on the subject of what is dangerous and polluting.

Religious observance may be an important health factor if it leads to uniform practices. Ablution as practiced by Muslims is an example. There is evidence in *Bangladesh* that water-related disease infestation is more likely to occur due to ablution and bathing than from water use in the home for drinking and food preparation, even though the source of the water is the same.

Habits may differ between groups of people served by even a small irrigation system and may dramatically alter the options available for water use. Generalizations that are drawn from limited observation of habits cannot be applied universally or even regionally, unless there is certainty that the option chosen is the best alternative for the worst situation possible in the community. In situations of limited information, treated drinking water piped to all households has been the solution chosen to cover the worst possible situation. Unfortunately, economic constraints limit the choice of alternatives in rural areas to standards usually far below those for treated water. A sociocultural survey that identifies traditional water use, hygiene, and sanitation practices of all groups within the irrigation system is essential to establish planning and design criteria for the use of water for non-agricultural purposes.

c. Health Environment

The relationships of water supply to health has led to a considerable number of investigations and publications on exactly how and why water supply influences health. Feachem

(1978) classifies water-related infections as follows:

Fecal-oral diseases: (eg cholera, typhoid, diarrhoeas, dysenteries, hepatitis, ascariasis)

Water-washed diseases: (eg infections of the skin and of the eyes) These are all infections related to poor hygiene (therefore water-washed) but which are not fecal-oral and are not water borne.

Water-based diseases: (eg guinea worm, schistosomiasis, clonorchiasis) These are all the helminths which have an aquatic intermediate host.

Water-related insect vector: (eg malaria, filariases, yellow fever, trypanosomiasis (Gambia only)).

Water-borne transmission occurs when the pathogen is ingested in polluted water. Water-washed transmission occurs when the pathogen is passed from man to man by a route which reflects poor personal or domestic hygiene and, therefore, might be controlled by the use of more water as an aid to hygiene. Water-borne transmission is thus related to water quality while water-washed transmission relates to water quantity.

Numerous studies were summarized by Feachem (1978) demonstrating that several fecal-oral diseases (diarrhoea, cholera) are not reduced by improved water quality. A second theme which emerges from these studies is that the provision of public taps in a community may not in itself change hygiene or water-use patterns and may not even increase the water used per capita. A third theme is that where the availability of water is greatly improved, and particularly where communal washing or laundry facilities or house connections are provided, a marked reduction in water-related disease may occur. The main conclusion relating water supply to health is that an improved supply is a necessary but not sufficient condition for health improvement. For health benefits to be realized, sanitation and health education efforts must be carried out at the same time.

5. DESIGN: THE STATE OF THE ART

The designs of inspection roads and associated culverts and bridges are well developed. Local cost information is available in every irrigation department. Designs for animal uses of irrigation water have also evolved and the design for buffalo baths can be found in Trout and Kemper (1980). Considerable work on the development of water power for milling within irrigation systems in Nepal has been completed. Installations are reported to cost about $6000 with 10 kW of shaft power and three milling functions - flour milling, rice hulling and oil pressing (DCS, 1980).

Design considerations for domestic water use from irrigation systems cannot be generalized. In the piped small-scale gravity systems in Guatemala, they tapped small lines directly into the main pipe for stand pipes and house connections. No filtration or treatment is required if the water is from a safe source.

If irrigation water is contaminated, use of the irrigation system must be evaluated against the alternative supplies, treatment, or no treatment. An algorithm of this decision process is given in Feachem, 1977:88.

Water supply should receive the minimum possible treatment. The problem with treatment is that it needs looking after and even a very simple treatment process will fail if it does not receive adequate attention.

Designs for storage and various levels of treatment exist (see for example Feachem, 1977; Pacey, 1977; McJunkin, 1975; Mann, et al, 1976) but case studies and examples are few.

(Yoder's examples are mainly drawn from Feachem, 1977, Pacey, 1975, in some cases utilising Intermediate Technology Group equipment. Some of the alternatives do not use irrigation systems.)

Of particular interest for irrigation systems are low cost infiltration galleries and storage facilities that would allow settlement which both clears the water and reduces the number of pathogens (Feachen, et al, 1977). If schistosomiasis is present, a minimum of 48 hr storage will effectively kill the cercaria. But the water supply needs to be adequate and reliable or people will still go into open water for washing clothes and utensils and become infested. Storage along canals which receive water on rotation can supply domestic water while the irrigation water is directed to another channel. Shallow wells that are recharged by water from irrigation systems provide this function but they depend on the groundwater table remaining high.

In flat areas it is possible to pipe water by gravity to under-ground storage tanks in or near points of use. Pipes distribution from most gravity irrigation systems for sewage disposal as reported in Indonesia has been universally discouraged. Alternatives within the resource of communities have not, however, been identified. Research that both investigates the actual danger that exists from the present practice, and tests alternative designs that can cope with the high water table, is urgently needed.

The subject of sanitation in general needs equal attention to water supply in situations where health improvement is a goal in developing a water supply from the irrigation system. A variety of methods and designs are available for effective on-site excreta without sewerage (see Feachem, 1977; Pacey, 1978; Kalbermatten, et al, 1980).

Feachem, 1977; 93 provides a guide to the analysis procedure for the selection and design of a water supply in a low-income country.

6. UNRESOLVED ISSUES

The non-agricultural uses of irrigation systems that do not directly involve human health such as fish culture, animal watering, milling, etc, are well established and to some extent institutionally accepted. Some, such as transportation and trees, are even formally included in the design and planning of projects. The issues with such uses is generally not the availability of technology, but their cost effectiveness and benefit distribution. Some common problems exist at both the national and international level that must be dealt with if non-agricultural uses of irrigation systems are to receive planned input. Issues relating to benefit distribution, cost, and design alternatives are very site specific but they need to be addressed systematically in order to allow maximum transfer of knowledge between sites.

a. Design Alternatives

In the past few years, some effort has been made to understand the planning and design alternatives for both water supply and sewage disposal. The extent of the research and development effort, however, has not been in proportion to the need. No organization or research program was found that is focusing on the development of new and improved design alternatives for the utilization of irrigation systems for domestic water needs.

b. Cost Effectiveness

If animals or people are destroying canal banks and causing siltation, the chief beneficiaries of a structure to facilitate access to the water are the irrigators, since it will improve the performance of the canal. The same is true of culverts and bridges for crossing the canal and roads, since they give the farmer access to the field. The decision to build these structures is usually on the basis of cost effectiveness to the irrigator, even though every-one in the area benefits.

The impact, and to some extent the value, of multiple uses of an irrigation system is dependent on who will be participating in the uses. It is also dependent on the alternatives that are available. Since White, et al, (1972) initiated data collection and analysis of rural water supplies, interest in this field has been growing. However, no data has been collected on the use of irrigation systems for domestic needs. At best there are observations that some people both pollute and withdraw water from a system, but who they are, how many people, what alternatives exist for them or even exactly where they are, is unknown. Even in a resettlement project like the Gal Oya scheme in Sri Lanka where there is currently a rehabilitation program for the irrigation system that includes the domestic needs, there is no information on the number of the target group.

The numeration of costs and benefits and the evaluation of alternatives is somewhat simpler for uses such as milling, fish culture, trees, transportation and even animalneeds than for domestic water use. Savings of time and energy are important benefits from improved water supply and milling. In most countries these tasks are the responsibility of women. One method for quantification of these benefits is to express the time spent in the activity (water collecting or milling) as a percentage of the total available daily activity time. Alternatively, some investigators (White, et al, 1972) have placed a monetary value on the water collection journey by costing the amount of staple food required to produce the number of calories which are needed for this activity. The cost of water to the individual, as suggested by White, et al, (1972), is made up of the sum of:

A. any cash payment made to the water authority, to the standpipe owner, to the water carrier or vendor, etc;
B. the value of the time-energy expended in collecting water where the individual lacks water supplied to the dwelling;
C. the cost of sickness related to the use of polluted water, to the use of insufficient water or to disease acquired in the course of water collection.

A water supply designed for domestic use that does not meet WHO standards is a risk-taking design. Research in tropical epidemiology will increase the ability to quantify the risk associated with particular levels of polluted water supply. As this ability develops, it will be appropriate to use monetary values for illness and death in analyses which consider the costs and benefits of different levels of water treatment (Feachem, et al, 1977).

Costs for domestic water use cannot be generalized. Piped, gravity, small-scale irrigation systems are reported in Guatemala that cost $340 per family including standpipes for domestic use. These were compared to piped drinking water systems for the same service at $175 per family (Annis, 1980a). The range of size, distance to the water source, command area and other related factors are infinite, and costs of alternatives can only be compared on a site-by-site basis.

Countries, lending institutions and aid agencies frequently recognize domestic water needs but lack knowledge about both engineering alternatives and cultural constraints. Being unable to supply treated water, they choose to do nothing at all. The villager who is without resources to make improvements, is left to make his own choices as to whether to use irrigation water. An information base is needed, including both socio-cultural practices of different groups and detailed field and engineering data, to facilitate improved planning, design and cost-benefit evaluation.

c. Standards and Professionalism

The traditional method for achieveing consistent results has been to set standards. Although national and international standards for water quality are valuable for the purposes of surveillance, considerable judgement and flexibility is required in application. Water considered unsafe by WHO standards may, nevertheless, represent a marked improvement over the previous supply. "Better-than-nothing" solutions are available that would meet the economic and operational ability of many situations and more could be developed if flexibility would be politically acceptable. However, standards provide protection for professionals. If engineers choose an unorthodox solution to a specific problem and there is a failure that leads to disaster, they carry the burden of responsibility, but if they adhere to the accepted design conventions they are not blamed. Both expatriate and national engineers are particularly sensitive about this issue, and their attitude, however understandable, has been a significant obstacle to the development of low-cost water supplies in Africa (Pacey, 1977).

d. Information Flow

With the current intense pressure to improve the agricultural performance of irrigation systems, it is not surprising that this issue dominates at the planning and design stage. As the required level of treatment to meet normally accepted safety standards for domestic needs, at a multitude of points along a canal, is beyond the available resource of any agricultural, production-oriented project, it is, by traditional convention, assumed without calculation that domestic water supply from an irrigation canal is not feasible. Health experts now nearly all agree that in many communities with poor water supplies, increasing the *quantity* of domestic water has immense benefits even if the *quality* cannot be improved. Until this information is translated into standards, it will not be available for use in designing.

e. Departmentalization

It has been observed that trees, inspection roads along canals, and other structures that are a direct benefit to the Irrigation Department are generally better maintained than the facilities that are important only to the irrigator. Since health and sanitation are the responsibility of other departments, co-operation between departments is necessary if water from the irrigation system is to be used for domestic purposes. Departmental rivalry can be an obstacle. Unless the operation and maintenance technology, as well as the cost, are capable of being carried out or checked by users, and unless the users perceive the benefits to be worth the cost and effort, these joint porjects are likely to fail.

On a higher level, the donor agencies have internal communication and rivalry problems. Annis (1980) pointed out that in Guatemala both small-scale irrigation systems and drinking water systems were designed on the same floor of the same building, yet each group was almost entirely unaware of the other. The technology was very similar but the end use put them into different groups within the agency. In the Guatemala case, the objectives of the two projects were compatible, but in many cases they conflict. As Bradley (1977) points out, "all too frequently, when advice is sought by a planner or engineer, the medical authorities may be less than helpful. Too often their advice may tend to resemble that given to the man about to be married, 'don't', and this may be economically and, even more, politically unacceptable."

Departmentalization along professional disciplines may be a major reason that planning of non-agricultural uses of irrigation systems has lagged behind the policy changes that suggest inclusion.

f. Water Laws

In gravity irrigation systems such as the Gal Oya, where there is already a conflict over water for agricultural requirements, domestic needs greatly complicate the situation. A combination of technical (wells) and organizational (water user association) solutions are being pursued.

Water disputes are well known and cross farm, district, regional, and international boundaries. Where water is scarce, there are usually priorities on its use. Irrigation frequently takes second place to water source development for domestic use in developed countries but the situation is not so clear for developing countries. No legal restrictions against using irrigation systems for other than agricultural purposes were found in the review, but priorities are an important issue. If a drinking water system is built with initial excess capacity, there is frequently reluctance to use the excess for irrigation. Rights to water are usually established by use and there is fear that in later need, the water may not be redirected for domestic use. The reverse, however, should not be true except in very small irrigation schemes. Except for cases where groundwater recharge is important for wells used domestically, the quantity of water withdrawn for non-agricultural uses has been a very small fraction of the total irrigation water.

The need and desirability of water laws to ensure access to irrigation water for non-agricultural purposes must be studied on a country-by-country basis.

7. IMPLICATIONS FOR POLICY

The degree of planning and design for non-agricultural uses of irrigation systems in ancient times is uncertain. That systems built even centuries ago are still being used for such purposes today is clear, but one cannot generalize that the bureaucracies that constructed the ancient schemes were concerned about the convenience or impact of water access by people and animals. In many cases it is more likely that populations adapted to the changed environment of a new irrigation scheme rather than the system being planned for improvement of their well-being.

Although awareness of health issues related to water supply and sanitation grew in the later stages of the colonial period, little evidence is found that it influenced the planning or design of irrigation systems. Exceptions are found in the way the colonialists protected the reservoirs which supplied water for their own domestic needs (McJunkin, 1975). As already noted, the religious needs were carefully incorporated into the irrigation systems in India. This was certainly for political rather than health reasons.

In the early post-independence phase, the major emphasis from aid agencies was on increased productivity. In the late 1960's concern about quality-of-life began to qualify the preoccupation with gross national product. Such a concern is reflected in the guidelines for the preparation of feasibility studies of rural development projects for FAO and the World Bank (FAO/World Bank, 1975). The new orientation, however, has not as yet been reflected in the planning and design process for irrigation systems. The quality-of-life issues such as ease in access to water, health impact, etc. are not included in the FAO/IBRD (1970) guideline currently used in preparation of feasibility studies.

Negative environmental impacts, including health aspects, are routinely assessed through environmental impact studies, as the project is planned. The results of such studies have frequently compelled modification of the original plans at a significant cost in time and money. USAID has recently initiated a trial program for small rural development projects where a manual of environmental considerations will be used by the planners in an effort to reduce the environmental conflicts (USAID, 1980). The manual uses appropriate technology guidelines and places special emphasis on social and public health consideration. It recognizes and encourages multi-uses of irrigation water as long as the uses are limited to plants, animals and fish. It stops short of formalizing planning and safer design for domestic needs, although these have been informally met by irrigation systems since the beginning of irrigation history.

The stated development policy of lending and aid agencies, to provide benefits directly to people, is compatible with, and at least partially fulfilled by, the non-agricultural uses of irrigation systems. The major implication of a policy of widening the benefits of irrigation systems is the need to shift from the current no-risk approach to planning and design to one of incremental improvements.

8. RECOMMENDATIONS

The following are recommendations that could lead to the expansion and improvement of non-agricultural uses of irrigation systems.

a. Research

i. Documentation of current uses Thorough in-country investigations should be made of the present non-agricultural uses of existing irrigation systems. Several countries should be selected for the initial study that would represent different climatic and cultural environments. All agencies and institutions involved in irrigation planning, design, and operation should be contacted. This investigation should:

A - Review the literature, planning and design papers;

B - Collect information from agency personnel on both official policy about multi uses and what actually happens in the field;

C - Make field observations of the informal uses of systems, including the degree of utilization, users' relationships and proximity to the system, and the users' status in the community;

D - Identify methods and designs incorporated into the use of the system and make scale drawings and costs estimates where appropriate;

E - Estimate the water quantity used and health impact.

ii. Collection of planning and design information A methodology should be developed and tested for rapid and complete assessment of which of a community's needs could be met by the irrigation system. It should particularly focus on the factors that relate to hygiene and health such as: endemic diseases, sanitary habits, religious and cultural practices. It should identify factors that may concern or conflict with goals of improved health. It should evaluate the present water supply sources and possible alternatives, both for acceptability to the people and the cost of improvement. It should also document the complementary needs of health education and sanitation facilities.

iii. Research and development of designs The literature indicates that very little concerted research and development effort has been made on designs appropriate for the use of irrigation systems for domestic water needs. A project should be undertaken that will:

- Categorize the need for methods, devices and designs to facilitate irrigation system usage;
- Evaluate the designs that are observed in the field;
- Produce designs for incremental levels of improvement in quality, cost, and convenience;
- Field test the designs in pilot projects where they will be monitored and modified to improve operation.

- Make recommendations for: design standards; planning and design considerations to be included in handbooks and manuals; training that will be a part of irrigation engineering programmes.

b. Increase Awareness

A programme should be undertaken that will increase awareness about the present use of irrigation systems for non-agricultural purposes. The objective should be to inform the following groups of the water related needs that could be met by the use of irrigation systems:

- Field personnel
- Government leaders and irrigation policy makers
- Irrigation consultants and contractors
- Policy makers in lending body and aid agencies, in the areas related to irrigation, water supply, sanitation and public health.

Educational programmes that train irrigation engineers and managers should be modified to include sections that explicity address the potential for, and limitations on, multiple use of irrigation systems. Publications should be produced and seminars held that reach the small number of persons in groups making policies and consulting on irrigation projects. Pilot projects should be undertaken for demonstrating the potential uses to a wide audience, including government officials.

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IRRIGATION MANAGEMENT NETWORK

EWSLETTER 8a OCTOBER 1983

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1. EDITORIAL

a. Network Papers

I hope that the new policy of getting out Newsletters and Papers every six months will encourage members to write in with notes and comments on material in them. The Network is intended as a vehicle for the exchange of information. Papers are selected mainly with a view to promoting discussion, or to elaborating and confirming preliminary suggestions and findings published in earlier papers, particularly by giving concrete examples arising from practical experience. We also welcome quite short notes of comment.

The current set of papers contains three on farmers associations and one, Paper 8e, arising out of comments and discussion on Professor Horst's paper on alternative design concepts, Paper 7c.

Several comments on paper 7c focussed on the meanings of the term *flexibility*. At the same time I noticed other terms such as *reliability* , *predictability* , etc. used in different ways in recent papers. I am therefore offering in 8e some definitions for discussion, in the hope we may eventually all come to agreement. I also intend to provoke discussion and probably disagreement on whether *equity* should necessarily always be a dominant objective. Paper 8e also contains a comment by *Henry Gunston* of the Institute of Hydrology, Wallingford, on *Merriam's* On Demand system installed in part of the Mahaweli Development Area, as an alternative method of giving greater freedom to the farmer. He ends with a request for further information from Sri Lanka.

The sense of *Professor Horst's* Paper 7c was so clear in arguing for 'increased *independence* of the group of farmers in the tertiary unit from main system management' (item D, page 3) that not all readers may have noted the unfortunate error that causes this actually to read 'dependence'. Please make the necessary correction to your copy.

The first of the papers on farmers' associations is by *G Diemer* and *E van der Laan*, (Paper 8b). It describes how skills already developed in traditional village communal activities have contributed to the success of village irrigation associations formed along the Senegal River since 1974. Paper 8c by *K K Singh* describes how Pipe Committees were set up to assist in the implementation of the Command Development Authority's rehabilitation work in Andhra Pradesh (reported on by Syed Hashim Ali in Paper 7d), and follows this with an examination of their functioning in the operational phase two or three years later. Not surprisingly, the new Committees have a mixed record, which leads him to make recommendations on ways in which they can be strengthened, particularly by the experience of success, in their early years. Farmer Associations are increasingly being promoted to reduce government's responsibilities and costs in operation and maintenance of the lower levels of irrigation systems. As *Singh* concludes:

The establishment of Farmers' Associations or Water Users' Associations is not an easy solution to irrigation management problems. It requires intensive government effort, appropriate training institutions, staff who stay in a district long enough to become familar with its social structure and to gain experience in the techniques of building up farmer participation, and a consistent policy over the term of years necessary for new social institutions to acquire their own norms and legitimacy.

Paper 8d is not included in this batch but will be sent to anyone requesting it. It is a paper prepared in 1980 by *Clare Oxby* and *Anthony Bottrall* reviewing the literature on farmers' associations in communal and joint systems. As such,it is now slightly out of date. It has never been available except in duplicated form, but has nevertheless been quoted sufficiently often to show people have found it useful. It seems worthwhile, therefore, to make it available in a more convenient form, as an Irrigation Network Paper. One of its most interesting findings is that in many traditional systems water distribution in time of scarcity is based on prior rights, not equality. It reviews 8 systems - the communals being in Tanzania, Spain, the Philippines, and Senegal; and the joint systems in Taiwan, Java, Andhra Pradesh and Pakistan Punjab. The Matam, Senegal, study was made in 1977 by *Fresson* and it is useful to compare this with the study of the same associations, now larger in number and stronger in effectiveness, observed four years later by *Diemer* and *van der Laan* in Paper 8b. This reinforces *Singh's* point about the necessity of time and a consistent policy to develop new institutions.

There have been so many requests for Network Paper 1/80/3 *Irrigation in Egypt, Past and Present*, that it has been reprinted. We have, unfortunately, to charge for reprints. If you would like a copy, please send £2 with your order. We have a limited number of free copies for those with insuperable currency problems. The paper consists of a first section of thought-provoking extracts from the writings of Sir William Willcocks, 1852-1932. The second part reports on an EWUP evaluation of the Mansouria Canal System in 1979.

This is perhaps a good point at which to make it clear that Network Papers are provided as a service to those interested in the improvement of irrigation management. Please feel free to photocopy them and redistribute them to others if you wish.

b. Future plans - Africa, land allocation procedures and recurrent costs

We are still awaiting the outcome of an application to the European Economic Community for joint Anglo-French research on African irrigation. Meanwhile I remain interested in land tenure issues and would still like information from networkers on case-studies to investigate. Robert Chambers, Ford Foundation, 55 Lodi Estate, New Delhi 110003, India, would also like to know about any *experience with buying out all the farmers in a command and then reallocating the land.* Please send information to me for forwarding.

The Recurrent Costs Workshop (see p 9) was held in response to the problems many governments now have over agricultural recurrent costs. It explored methods of reducing these by more cost-effective management, by better financial planning and by querying which functions must be carried out by a government agency and which should be dropped, or transferred to private sector commercial interests, or left to individual farmers or farmer groups. These issues are fundamental to good management of irrigation. Mr Osei, Personnel Manager of the Ghana Irrigation Authority, has recently been discussing with me the problems he faces in reconciling a level of water charges which farmers can tolerate, and the level of expenditure on existing staff. If any member can report on successful measures introduced to reduce recurrent costs without reducing efficiency, this could form the basis of future discussion papers.

c. Future newsletters

The next newsletter will go out in April 1984. Comments, and news by March 1st please and suggestions for papers by February 1st 1984.

d. Membership

The table giving a breakdown of membership on p14 of the last newsletter omitted the 144 UK members, which brought the total at June 1982 to 685. Since then, many new members have joined and others have been dropped in a revision of our lists. We hope to issue a new members' register in 1984.

2. NEWS FROM NETWORKERS

a. International programmes

At a meeting in Paris in May 1983, final steps were taken to establish an *International Irrigation Management Institute* and to elect a governing Board. Subsequently the following accepted invitations to serve and have held their first meeting.

Members

Mr Nanda Abeywickrema - Sri Lanka
Dr Abdalla Ahmed Abdalla - Sudan
Mr Benjamin U Bagadion - Philippines
Mr David Bell - USA
Dr Kamla Chowdhry - India
Dr Robert Cunningham - UK
Mr Gilbert Manuellan - France

Dr Moise Mensah - Benin
Dr Amir Muhammed - Pakistan
Dr Dean Peterson - USA
Dr F E Schulze - Netherlands
Dr Kunio Takase - Japan
Dr Thomas Wickham - USA

Observers

Mr Peter Dieleman, FAO
Mr Guy LeMoigne, World Bank
Mr W Robert Rangeley, President, International Commission on Irrigation and Drainage

Dr R K Cunningham was selected as chairman and Dr Amir Muhammed vice-chairman. A short list of candiates for Director General is now being examined; Dr Ralph Cummings (812 Rosemont Avenue, Raleigh NY 27607, USA was asked to be acting DG pending this appointment. The Government of Sri Lanka has agreed to provide land and buildings near Kandy for the headquarters in late 1984. A proposal for a co-operative participating unit in Pakistan has been tabled for discussion and consideration.

The genesis of the current $20 million, 5 year *USAID Water Management Synthesis II (WMSII) project,* and some of the achievements of the previous WMS I, are described in *Horizons* Vol 2, No 3, March 1983, published by USAID, Washington DC 20523, USA. WMS II has three components: training and the development of training materials; a technical assistance component, responsible also for country and sector reviews; and longer running research. The three US Universities involved are *Colorado State University* (Max Lowdermilk, Engineering Research Center, address CSU, Fort Collins, CO 80523) *Utah State University* (Jack Keller, Agricultural and Irrigation Engineering, UMC 41, Logan, Utah 84322) and *Cornell University* (Walt Coward and Norman Uphoff, Dept of Rural Sociology, Warren Hall, Ithaca, NY 14850). So far they have been working mainly in Asia, Egypt and Latin America, but this summer Walt Coward of Cornell and Jon Moris and Derek Thon of Utah State have made brief fact finding missions to West Africa to identify needs there.

Colorado State and Utah have produced *Guidelines* on *Water Management, Pumping Systems and Levelling,* based on Egyptian and Pakistan experience, in English, French and Spanish. They are intended for laymen. They will be happy to send copies to networkers, and would welcome suggestions as to how to refine them for sub-Saharan African conditions. Write to Max Lowdermilk or Jack Keller.

Land and Water Development Division, FAO, have produced a report on the Expert Consultation on Training in Water Management, held at FAO, September 1982. Further information from P J Dieleman, FAO 00100 Rome, Italy. They have also produced guidelines on Women in Land and Water Development - write to Ms Marjan Heibloem, same address.

b. Meetings and seminars

A workshop on *Small Scale Irrigation in Kenya* was held by the Small Scale Irrigation Branch of the Ministry of Agriculture in Nairobi, Kenya, in February 1983. Gert de Gans reported on the rather mixed record of church schemes for destitute Turkhana. Those with a *do with* rather than a *do for* philosophy succeeded best. Details from him c/o the Reformed Church of East Africa, PO Box 749, Eldoret,Kenya.

A National Seminar on *Drip Irrigation* was held at Tamil Nadu Agricultural University, Coimbatore, India on March 5 and 6, 1983.

IRRI organised a conference on *Women in Rice Farming Systems*, Los Banos, Philippines, September 1983.

The Centre d'Etudes Juridiques Comparatives, University of Paris I, hosted an international colloquium on *Peasant Participation and Water Policies in Africa*, October 14-15, 1983. The papers, mostly in French and mainly concerned with irrigation, will be published. Details from Mme C Savonnet-Guyot, Centre d'Etudes Juridiques Comparatives, 14 Rue Cujas, 75231 Paris, France.

The Centre of Excellence in Water Resources Engineering, University of Engineering and Technology, Lahore, Pakistan, is holding an *International Seminar on Water Resource Management*, October 1983. Details from Dr N M Awan.

The University of Gezira, Sudan is holding a conference this October on the *State of the Art in Water Management*. The proceedings will be published later.

The Bihar College of Engineering, Patna 800 005, India is hosting a *Symposium on Strategies for Irrigation Development* 23-25 February 1984. Information from Dr T Prasad, Director Water Resources Studies Programme.

Alois Hungwe, Department of Land Management, University of Zimbabwe, PO Box MP167, Mount Pleasant, Harare, Zimbabwe, is organising an *African Regional Symposium on Small Holder Irrigation*, 5-7 September, 1984, jointly with Hydraulics Research, Wallingford, UK, and with sponsorship of the British Overseas Development Administration. The organisers will welcome abstracts from prospective authors by 13 January 1984, preferably based on experience of specific schemes, for one of the three categories: design; management; the role of the farmer.

c. Reports from the field

The University of Zimbabwe's Department of Land Management and Economics and the Hydraulics Research Station Ltd, Wallingford, UK, are co-operating in a project to investigate and evolve design criteria and management strategies for smallholder irrigation schemes. The Nyanyadi Irrigation Scheme is being used for field studies.

Bauchi State Agricultural Development Programme, Nigeria, held a Seminar on fadama (wet land) cultivation, July 1983. Topics ranged from appropriate tubewell and pump technology, to marketing problems for vegetables. Details from Dr N Chapman, Senior Evaluation Officer, BSADP, PMB 230, Azare, Nigeria.

CARE,Bangladesh, is working to help groups of farmers to maintain a deep tubewell, and distribute water costs and inputs fairly. This is in co-operation with the Bangladesh Agricultural Bank and the Bangladesh Agricultural Development Corporation. In 1982, CARE worked with 19,000 farmers around 215 tubewells, which attained double the national average acreage irrigated per well. Details from Dr Sandra Laumark, c/o CARE, GPO Box 226, Dhaka, Bangladesh.

Ford Foundation is supporting the Social Research Centre, American University of Cairo, in a study of the relationship between the energy source used at the point of lift, and the land tenure and farm organisation below. The principal investigator is Mrs Sohair Mehanna.

The Water Research Centre, Ministry of Irrigation, Cairo, in co-operation with Colorado State University and Ford Foundation have carried out farm management and technical studies. They are preparing to look at the management aspects of the conjunctive use of groundwater and canals in a system near Minya.

Dr Narayanamurhty and his associates at the Operations Research Group (Dr Vikram Sarabhai Marg, Baroda, 390 007, India) have developed computer models to enable the Gujarat State Authority responsible for the Narmada Irrigation Project to consider different operational policies during project preparation. The models take into account both the ways in which the neighbouring state of Madhya Pradesh is likely to operate the up-river reservoirs, and the availability of groundwater, which can be used to reduce inter-year variabilities in irrigation supplies. On the supply side this gives a better estimate of water utilisable by Gujarat under a Tribunal award than the traditional Indian practice of using the flow available in 75% of years for planning utilisation. Further models have been developed to test different operational policies drawing supplies from both reservoirs and groundwater for all the 12 regions within the command, and for guiding the choice of size of canal branches. Demand estimates derived from likely future cropping patterns were based on studies of changes that have already taken place in cropping and of farmers' likely behaviour with projected prices and yields.

A leaflet has been prepared describing the Khon Khaen University, Thailand, New Zealand joint water resource project. It gives some technical details, costs and pictures of the types of weir built by self help labour for villages requesting technical assistance from the University. A typical weir costs US $ 3,000 and repays its cost in 2-3 seasons. Details from Office of Water Resource Development, Faculty of Engineering, Khon Khaen University, Khon Khaen 40002, Thailand or New Zealand Embassy, PO Box 2719, Bangkok 10500, Thailand.

Several networkers are studying small scale and/or communal systems in Nepal with a view either to assisting these, or to learning how to transfer features of their management style to larger systems. They include Ujjwal Pradhan (communal systems, Nepal Irrigation Research Project); Iswer R Onta and Prakash C Joshi (East Consult (P) Ltd, PO Box 1142, Kathmandu - users' participation in projects) Dr P Pradhan, (DRCG, PO Box 958, Kathmandu - communal systems' management style); Hugh Turral, KHARDEP, Dankhuta, Nepal (address c/o British Embassy, Kathmandu - user self management); Jo Williamson (Nawal Parasi Hills Development Project, PO Box 126, Kathmandu - communal systems and new systems).

d. Training programmes

Ford Foundation is sponsoring a *MSc in Water Management* at the University of Gezira, Wadi Medan, Sudan, under Professor Usman Fadl, Faculty of Agriculture.

Utah State University, Logan, Utah 84322, USA, is running a 3 week course November 13 - December 3 1983 on *Irrigation Water Production Functions*.

The Overseas Development Group, University of East Anglia, Norwich, NR4 7TJ, UK is running a course *Irrigation in Development Planning* 30 April - 22 June 1984.

Silsoe College, Silsoe, Bedford MK45 4DT, UK, has courses on *Irrigation* 2-6 April 1984 and *Irrigation Project Planning* 16-19 July 1984. It has also short courses on Air photo interpretation and Remote Sensing. Details from Mrs P Cook.

e. Other newsletters and journals

Irrinews No 29, 1983 focuses on health issues. It notes the third meeting of the WHO/FAO/UNEP Panel of experts meeting on vector control of water-borne diseases. Information from T H Mather, Land and Water Development Division, FAO, 00100 Rome Italy.

United Nations University Newsletter Vol 7 No 2 is devoted to water.

3. RECENT PUBLICATIONS, REPORTS, ETC

There has only been one request to maintain the lengthy bibliographies normally published. This issue therefore will only call attention to some recent publications received.

T K Jayaraman, M K Lowdermilk and W Clyma, *Command Area Development Authorities for Improved Water Management*, WMS Report No 8, 1982, available from Colorado State University, Fort Collins, CO 80523, or Utah State University, Logan, Utah 84322. This report surveys the varying success of the CADA model, which has taken different forms in different states and the reason for the general concentration only on constructing on-farm development works. Developing the appropriate incentives, institutes and organisations to support the farmers in operating and maintaining the systems has been neglected. CADA implementation also demands a unified career structure for those engaged in water management, and suitable training programmes.

N M Awan and M Latif, *Technical, Social and Economic Aspects of Water Resources Management in Salinity Control and Reclamation Project No. 1 (SCARPI) in Pakistan*, Centre of Excellence in Water Resources Engineering, University of Engineering and Technology, Lahore, Pakistan. Jan 1982. The report comments on the several changes in management style, 1964-1981 - project management introduced in 1964, disintegrated management by line departments after 1970, followed by 1981 discussions of a CADA style. On farm management was given to the Agricultural Department which had to build up expertise from scratch. It is implied it would have been better to add this function to the Irrigation Department, which had staff and expertise, though it had neglected this aspect in the past. The report also traces the rise and subsequent decline of production and economic returns. As public tubewells, created to improve drainage and supplement canal water, frequently went out of action, farmers turned to private wells.

Agrarian Research and Training Institute *1980 Yearbook for Sri Lanka Water Management Research,* PO Box 1522, Colombo 7, June 1982. This contains papers on the principal initial findings of a baseline study in 1980 of farmers on the Left Bank Gal Oya scheme. It includes an analysis of farmers' perceptions of water problems. An interesting finding is that farmers with the worst water problems tended to favour the appointment of a single farmer representative with executive powers, those with moderate problems favoured a farmers' council, and those with few problems favoured a government officer, to manage water supplies. The research was carried out in co-operation with Cornell University as part of USAID's Water Management Project.

4. LUNCHTIME MEETINGS AT ODI

The following lunchtime meetings have been held at ODI

18 May 1983: Dr Ian Carruthers and Mr Martin Burton *Management simulation and role playing exercises for training irrigation managers* (Ian Carruthers, School of Rural Economics and Related Studies, Wye College; Ashford, Kent, TN25 5AH;

Martin Burton, Sir M Macdonald and Partners, Demeter House, Station Road, Cambridge, CB1 2RS).

29 June 1983: G Diemer and E van der Laan *Small-scale irrigation along the Senegal River* (Afrika-Studiecentrum, PO Box 9507, 2300 RA Leiden, The Netherlands, Tel 071-148333 ext 4059 or 4062).

4 October 1983: Nick Chisholm *Groundwater development in Bangladesh - farmer organisation and choice of irrigation technology* (The University of Western Australia, Department of Agricultural Economics, Nedlands, Western Australia 6009).

5. OTHER AAU ACTIVITIES SINCE APRIL 1983

a. The recurrent costs workshop

In July, the AAU organised an international workshop on financing the recurrent costs of agricultural services in developing countries. John Howell will be editing these for publication. L Fredericks, University of Malaya, analysed the growth of recurrent costs and of subsidies of the Muda Agricultural Development Authority and B El Bashir discussed the horrendous effect of shortages of diesel and spare parts on pumping schemes in Sudan. A full list of papers is available, and, pending publication, we can send photocopies at 7p per page plus postage.

b. Publications

The Agricultural Administration Network issued a Newsletter in August 1983, with accompanying papers on reforming research and extension services in Africa by Jon Moris, and on the training and demonstration system in Northern Nigeria by Nick Chapman.

The Pastoral Development Network issued a Newsletter in July 1983 with three accompanying papers, two concerning the Fulani in Nigeria and one examining credit arrangements for animal husbandry activities.

Stephen Sandford's book, *Management of Pastoral Development in the Third World* is available to Network members at a special price of £15.25 including seamail p & p (20% extra for airmail). Write to the Publications Officer, ODI.

Mary Tiffen

21 October 1983

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 8b OCTOBER 1983

USING INDIGENOUS SKILLS AND INSTITUTIONS IN SMALL-SCALE IRRIGATION: AN EXAMPLE FROM SENEGAL

* Geert Diemer and Ellen van der Laan are social anthropologists working at the Afrika-Studiecentrum, PO Box 9507, 2300 RA Leiden The Netherlands. Telephone 071-148333 ext 4059 or 4062

Introduction and project background

This paper illustrates the capability of African farmers in managing collective funds, in allocating water, and in organising collective work. The authors trace this to abilities used and trained in traditional village institutions in Halpulaar (Toucouleur) society in Senegal.

A lesson of wide validity can be drawn from the paper - the importance of realising and utilising existing village capacity. This is particularly important in any scheme with a self-help element, or where some management functions are to be delegated to a Farmers' Association. Sophisticated, educated personnel, whether expatriates or educated and urbanised nationals, sometimes assume ignorance and lack of resources in a village, and therefore, make top-down arrangements for planning, direction, training, input supply etc. that may be inappropriate or unnecessary. In an aided integrated development programme I visited in Kenya in 1982, planners and implementers had made elementary mistakes in regard to self-help activities because they were unaware of a forty year record of self-help achievements, and even, to begin with, of the existence of a professional community development staff employed by the (unconsulted) local government authority. There is a great need for an equality of respect between local institutional knowledge of how to make things work, and imported technical skills.

The authors rightly stress the importance of scale. Management structure for an independent unit of a maximum of 25 ha with a maximum of 120 members, as in this case, is within the capabilities of unpaid village leaders. By contrast, the Farmers' Associations of the MUDA irrigation scheme in Malaysia, with over 1,000 members, need to employ professional management staff, under an elected Board.

In some respects, the paper describes a rather special case. Economic considerations seem not to have been overriding since the aim of the aid was a secure food supply for each rural family. The schemes were small, as the plots were limited to a size appropriate to consumption needs, and it was relatively easy to find, by general agreement, irrigable land which was not prized for traditional flood recession agriculture. Where small areas of flood recession land were included, and those with customary rights objected, their claims were invalidated under a land law. The early situation of relatively few conflicting claims for irrigable land is now beginning to change, and some economic competition for the land is developing. Customary owners are promoting private irrigation schemes and getting protection for their rights under the land law. Some of these aim at cash as well as consumption. New schemes may have to use land further from the river.

The village schemes (village perimeters) described are supported by SAED, an Senegalese parastatal (Societé d'Aménagement et d'Exploitation des Terres du Delta et des Vallées du Sénégal et du Falémé). They originated in 1974. The first perimeters were aided by FAO/UNDP, with more river one finds gardening plots with a variety of vegetables, tubers and grain. Before 1973 rice cultivation and irrigation were confined to a single scheme, and were unknown elsewhere. While all households have access to millet-fields, access to the more secure flood recession agriculture is restricted. In our survey only one third to one half of the households had access to a flood-recession plot during the years for which we have information.

3. THE REGION'S AGRICULTURAL ADMINISTRATION

Agricultural extension services of the Ministry for Rural Development have offices in the central places of the valley but officials do not possess the means to travel to the villages. The parastatal SAED is the only administration of importance for agricultural development and is empowered by the Senegalese government to initiate, authorize and control all action with respect to the social and economic development of the region. SAED is mandated to promote both irrigated and traditional agriculture, to coordinate the supply of inputs and the marketing of agricultural produce.

SAED employs approximately 1,000 people, 250 of whom are assigned to offices in the middle valley. SAED also has extension officials who fix the dates of sowing the seedbeds, planting the seedlings and the first day of the harvest on the village schemes. However, they leave all other management tasks to the farmers and do not interfere with the distribution of water, the financial operation or the physical maintenance of the schemes.

SAED's activities in the middle valley therefore contrast with its large schemes elsewhere, where it takes all the decisions required to make the 9,000 hectares of irrigable land produce paddy and tomatoes. Farmers on the large schemes could best be called labourers if only their position offered them the security of a wage.

4. PHYSICAL FEATURES OF THE SCHEMES, ACCESS TO PLOTS AND CROPPING PATTERNS

Individual schemes vary in size between 10 and 25 hectares and are divided into 40 to 120 plots. Plot size varies between 10 and 45 ares. The schemes are located on the high levees bordering the river. Water is lifted by a pump that floats on the river. Tubes lead to a stilling basin that may be 2 to 10 meters higher. The length of the canal from the stilling basin to the scheme varies. In the 1970s little or no earth-moving equipment was available. The schemes constructed then border the river, occupy sandy soils and the canals are only 5 to 20 meters long. For the new schemes earth-moving equipment was available. As a result most of them are situated on clayey soils located at several hundred meters' distance from the river, and they therefore have a longer canal.

SAED introduced a method of plot distribution which is now common practice in the middle valley. When the construction is finished the names of the heads of the participating households are written on pieces of paper that are put into a hat. The participants then start walking over the scheme and make a stop at each plot. A leading personality takes a piece of paper out of the hat and the plot is attributed to the household head whose name is written on it. Inevitably, village chiefs and board presidents sometimes get plots with disadvantages.

Every village household may request a plot. In fact, in many villages all inhabitants possess one. In villages where this is not the case the major social categories (eg. the people of free birth, the people of slave origin and the members of the intermediary artisanal order) are represented on the scheme in proportions that are similar to their numbers in the village. This may be termed a revolutionary change for in Halpulaar society ownership of land is the privilege of free-born men. On non-floodable land persons of slave origin are under a nominal obligation to give ten percent of the millet harvest to the free-born family who 'owns' the plot. On floodable land slave descendants are forced to accept unfavourable sharecropping contracts. But on the irrigation schemes persons of slave descent are no longer under any obligation whatsoever to individual villagers and the schemes have clearly diminished their dependence on the land-owning class.

In the northern half the farmers on the schemes grow rice twice a year and in the southern part maize follows the rice. According to SAED one hectare of rice yields between 4,000 and 5,000 kilos of paddy or 2,500 to 3,000 kilos of edible grains. An average maize harvest equals approximately 2,000 kilos of edible grains. Irrigated cereals now account for a least half of the staple food of the participating households. (SAED's estimates may be on the high side.)

5. THE CONSTRUCTION OF THE SCHEMES

Once the SAED and the farmers have agreed upon a site it is cleared of the usually fairly dense forest vegetation. On old schemes the participants had to dig out roots, excavate canals and create divisions between the plots manually. Practically no money was involved; the participants' contribution consisted of approximately fourteen man-years of labour.(3) On schemes where clearing and earth-moving equipment was available, participating households paid for the fuel and the lubricants that the bulldozers and graders consumed, fed the drivers and contributed manual labour. The irrigation engineer of a Dutch project in the area estimates that the use of this equipment costs about £540 per hectare. On both the old and the new schemes the cemented parts are built by village masons with SAED supervision, and paid by the villagers.

When the construction is finished SAED installs the pumps and a 20 horsepower engine, together with two pontoons and a set of tubes and accessories. This pump-set costs about £10,450. It is furnished to the village on a grant basis but replacements are supposed to be paid for by the participants. On new schemes total investments add up to £21,250 or £1,060 per hectare. This compares with £2,000 to £3,000 per hectare on large-scale schemes.

6. THE RECURRENT COSTS FOR HOUSEHOLDS

As participants in a scheme, households share certain costs like the expenditures for fuel, lubricants, repair, travel by board members, the pump driver's salary, etc. At the start of a growing season the participants hold a general meeting and agree upon the dues that every household must contribute in advance to the scheme's fund. If the expenditures outrun the sum collected, a second round of payments is held. For a typical scheme these costs represent £10 per plot.

How do the households finance their dues and the other expenses related to irrigation? After all, since the object is subsistence, they sell only small amounts of paddy and maize. The answer is that they use a mixture of money earned externally and payments in kind. In our survey 60% of the households participating in the schemes (32 cases), mentioned sources located outside the village when asked where the money for the fuel fees had come from. These usually consisted of remittances by some male member of the household working elsewhere in Senegal, or, more likely, in some other African country or in France. For a minority of households the source was the rents of houses in Dakar or a pension, both income-generating assets usually derived from previous long stays in town. Only 40% of the participating households (21 cases) declared that the money had been earned by activities inside the village, or had been borrowed. Since almost all money that circulates in the valley has its origin in migration, most of the purchasing power for the services and commodities that these households provided was generated by migratory activities. It may therefore be said that the crucial fuel fees are paid with money earned by migrants, directly or indirectly.

The payments in kind are for the amortization of the pump-set and the reimbursements of the short-term credit for inputs supplied by SAED. Payments are due right after harvest. The survey found 89% of the households preferred to pay in kind even though SAED also accepted payments in cash. The sum involved £3.50 on average, and was less than the fuel fees that must be paid in cash. This emphasises the cash shortage.

When the two payments are added, the total required is £13 to £14 per household. According to SAED estimates, this sum enables the household to grow an average 1,050 kilos of paddy. It should however be noted that this sum includes heavily subsidised fertilizer and that the amortization rate set by SAED is too low to provide realistically for replacement; it should be doubled or perhaps even tripled.

7. THE OPERATION OF A SCHEME: LEADERSHIP, BOOKKEEPING AND MAINTENANCE

The rapid spread of the small schemes is related to a number of factors. One of them consists of the management capabilities inherent in the village societies to which the participants belong. Once a scheme has been installed, it is run by the farmers with the SAED officials providing support services only.*

The way in which authority on the schemes is exercised is modelled on the village power structure. In a Halpulaar village usually only one free-born lineage has the privilege of presenting candidates for the position of village chief, but two to six free-born lineages have the right to nominate. A village chief cannot wield his authority in an autocratic manner. The length of his stay in office depends on the extent to which leaders of the electing lineages feel that they are given a sufficient say in village affairs. (4) On the scheme a similar arrangement prevails. The board members, of whom only the president and the secretary/treasurer are important, are chosen by the participants from among their midst. However, only persons who belong either to the eligible lineage or to one of the appointing lineages are chosed for the office of the president. In other words, only a circumscribed category of participants is eligible for that position, although exceptions occur. The person chosen will only stay in office for the length of time that the other eligible participants feel that they are sufficiently involved in the decisions that affect the scheme, and refrain from mobilising the other participants.

* *SAED officials played a more dominant role in the early days, according to Fresson. See Network Paper 7d.*

The power structure in a Halpulaar village is not autocratic yet it is not democratic either. When it comes to important decisions the village chief first consults an inner circle composed of three to six men. It consists of the leaders of the nominating lineages, and some others, who may belong because they are the village's imam, control much floodable land or play an important role in the party political machine of the region. Matters of importance to the village are first discussed within this inner circle and only brought out into the open when unanimity is reached.

The schemes are managed in a similar fashion. Most participants are kept out of the decision-making process. For example, in one scheme it was decided not to grow maize during a given year, as the leading participants preferred to migrate. They communicated their decision to the other participants. Many of these, in particular those with large households, strongly opposed the decision but did not succeed in having it revised. The president, who in other situations had shown firmness, frequently changed his mind as he was torn between his fear that he would be unseated and his obligations to conform to the decision that had been reached with the leading participants. Perhaps the most interesting part about this example is the fact that the large households did not take matters into their own hands and cultivate anyway. In fact Halpulaar are chacterised by their great respect for authority. If an individual receives an order from a person invested with some kind of relevant authority he will most probably do as he was told.

Two other Halpulaar institutions that are of particular relevance to the operation and management of small irrigation schemes are the age groups and the youth clubs. All boys and girls between the ages of ten and twelve years join an age group. They then elect a chief and several officials. The chief almost always belongs to the lineage that is entitled to provide the village chief, or to one of the nominating lineages. Starting out as play groups, the male age groups turn into debating clubs when its members reach the age of eighteen years. The age groups have strict rules with respect to the ways that their funds should be handled and dues collected and as regards the sums that a member may spend on the occasion of his wedding. If someone breaks a rule, serious and long-winded discussions follow and a sanction may be administered. In the age groups young villagers learn how to wield and respond to authority. In the words of one age group chief: "They are one of our schools. Here we learn how to live together." Through the age groups all villagers learn how to participate in collective decision-making and how to enforce those decisions. In addition, the members of the dominant lineage are trained in the art of giving leadership to their peers.

An institution that is similar to the age groups is that of the youth club. It is a recent institution. In most villages the foundation of the youth club dates back twenty years at the most. Persons of under 45 years of age may belong. A monthly subscription is collected and the fund is utilised for village amenities. In one village, for instance, the youth club purchased and prepared the food for the well-repair men that the Ministry for Rural Development had sent. And in most villages the youth club is in charge of organising the wrestling matches that are a highly appreciated sporting event. Youth clubs have strict formal rules of order for the conduct of their meetings. As a consequence, persons who come late, who interrupt or who do not comply with the injunctions of the chair are liable to be fined.

The importance of both age groups and youth clubs to the effective operation and management of the irrigation schemes hardly needs to be underlined. In the age groups the rules for access to leadership positions are internalised and the members of the dominant lineage are trained in giving leadership. In both the age groups and the youth clubs, young villagers are educated in collective decision-making and learn the ways in which to enforce such decisions. They learn to respect authority when it is exercised by a member of the dominant lineage or when it is based on a decision that was taken collectively.

Clearly, the fact that the participants have learned to accept authority contributes significantly to the fairness with which water is distributed. On Halpulaar schemes conflicts over the allocation are remarkably rare. In our survey 94% of the participating households (n=51) said that they were satisfied with the water that they had been receiving and 86% (n=49) declared that, on their lateral, no water was stolen by anyone. It may be supposed that two factors account for this state of affairs. The first factor is a material one. In the present phase of irrigation development water simply is not scarce. When a plotholder desires to receive additional water his demand may be satisfied by having the pump run for some more time. As production is subsistence-oriented no profit margins can be squeezed when additional costs are incurred. The second factor is linked to Halpulaar respect for persons invested with authority.

It is a rule common to all Halpulaar schemes that the plotholder decides when his plot has received sufficient water. When for some reason his off-take is closedbefore he considers his plot has received sufficient water the plot-holder may complain to the president. The latter usually goes to see for himself and then allows the former to take additional water. If the farmer continues to take water for some length of time the president may order him to close his offtake. We watched a plotholder react violently to this command and abuse the president. We heard of an old woman abusing the president in a similar situation. Both were fined on the spot and both came to pay their fines at the end of the day. Both also were excused as they had shown that they were willing to make amends.

The successful operation of an irrigation scheme not only requires effective leadership patterns but also requires elementary bookkeeping skills. One of these consists of the command of a form of script and another of some kind of institutionalised control, both of which are part of the Halpulaar stock of assets.

Koranic schools are found in every Halpulaar village. As a result every Halpulaar village has men who are sufficiently proficient in Arabic script to be able to register the payment of subscriptions. Collective funds are so common that there are well-established rules about how they should be managed. Our research diary gives one example:

> An elderly man was seated in the market place today and held a large black book on his lap. He showed us the names of all household chiefs and the names of the Islamic months, all of which he had written in Arabic. He had marked how much each household had contributed to the fund for which he was responsible. It had been established for the purpose of the construction of a new mosque. Every first Friday of an Islamic month, after the prayers at 14.30, he is to inform his fellow believers on how much money was received that month. They then recall the total that was reached last month, add up the new subscriptions and together establish the new total.

Various collective services are financed in this way, like the purchase of a new canoe, the construction of a dispensary and the formal education of a village midwife. Halpulaar village society offers many positions that enable villagers to learn the art of keeping collective money. Therefore, when the participants on a scheme have to select a treasurer they can usually choose from a number of people with considerable experience and a reputation for reliability.

If leadership and bookkeeping are essential, so is maintenance. Collective work is already institutionalised. When it was decided that enough money had been raised for the new mosque, the villagers started to bring sand and stones to the site. Every other Friday morning the village was busy with carts transporting these building materials and with men and boys loading and unloading them. Every household had to be represented by at least one able-bodied male person. Households that were not represented and had no valid excuse were fined 250 cfa or about 50p.

A similar principle operates for the maintenance of the dykes and ditches, (though this is not done as often as engineers deem desirable). The president, after discussions with the secretary/treasurer and with the leading participants, sends a crier through the village who announces that in one or two days a collective work party will be held. All plotholders or their representatives have to be present and those absent are fined 50p or even £1. In one case the household of the village chief was fined for that reason and the village chief actually paid the fine. If in a household the only adults are females at least one woman has to present herself. She is then usually excused as it is not customary for women to work in the fields.

8. CONCLUSIONS

In the course of its history Halpulaar village society has developed institutions that are of great significance to the operation and management of the small irrigation schemes that now line the banks of the Senegal river. Elements of the power structure, the age groups and the youth clubs, the collective funds and the collective work parties are all instrumental to the relative success of the schemes.

They do not guarantee, of course, a smooth ride. Board presidents may be contested, collective decision-making stalemated, treasurers may secretly borrow from the scheme's fund and unresolved political conflicts may interfere with the operation and management of the schemes.

Yet by and large one cannot explain why the schemes have multiplied so quickly without taking these village institutions into account. Their presence laid a base for the management structure that is now developing. The physical dimensions of the schemes are crucial also. The very fact that they are small-scale makes them commensurate with the management capabilities of the village societies. It also implies that production is subsistence-oriented and in concordance with existing producer objectives.

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4 We are grateful to Mr Jean Schmitz of the 'Organisation pour la Recherche Scientifique et Technique Outre-Mer' for sharing his insights into Halpulaar political structure with us and for providing information on Halpulaar history and economy. Other social features, such as the relationships of the slave descendants to the free born, and the role of gerontocracy and theocracy, which are less relevant to the operation of the schemes, will be discussed in 1 above.

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IRRIGATION MANAGEMENT NETWORK

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ASSISTANCE NEEDS OF WATER USER ASSOCIATIONS IN THEIR FIRST YEARS - THE EXAMPLE OF POCHAMPAD

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Development of the command area of the Pochampad Dam, Andhra Pradesh, India, has continued since 1970, under the Command Area Development Authority (CADA) structure described by Syed Hashim Ali. He promoted the formation of farmer groups, called Pipe Committees, to assist, under CADA guidance, with on farm development and to look after water management in the area, known as the Chak, below the pipe or outlet. K K Singh, while at the Administrative Staff College of India, Hyderabad, carried out studies of how these functioned, 1979-81. This included surveys in 1980 of 5 pipe committees in Chaks already having* warabandi *(rotational water distribution)*, and two areas where warabandi was about to be implemented. The paper is of interest because it shows the amount of planning and teamwork required to set up the committees, their usefulness at the implementation phase, and their need for assistance in the early years in carrying out operation and maintenance.*

It is important to distinguish between the phases of IMPLEMENTATION and OPERATION. It is generally agreed by community development workers that popular committees get off to a better start if they are involved in planning and implementing a new facility, since they then feel it is their project and their future responsibility. (It also has technical advantages in tertiary command development referred to in Paper 2/81/1 by Othman and Moya.) However, the establishment of efficiency in the subsequent year to year grind of operation and maintenance, revenue collection and communication with external institutions depends on the slow process of establishing the legitimacy of their authority not only in the eyes of fellow villagers, but also in the eyes of other villages in the command system, and of the bureaucratic management. The bureaucracy, as Singh shows, can hinder this process by failing to respond to the committee's communications. This is not only a question of bureaucratic attitudes, but also involves political decisions. It is also necessary to consider what positive educational support the Irrigation Authority could or should provide to farmers' committees during their difficult formative years. Farmer Associations are not the easy answer to irrigation management problems. They can contribute to improved productivity and reduced operational costs, but only if resources are put into initiating and sustaining them till maturity. As trained staff, and the money to pay them, are limited in most developing countries, this may involve hard choices. Retraining and redeploying some extension staff as community development workers may be more cost-effective than adding to existing numbers on the central or local government payroll.

** See Network Paper 7d. Syed Hashim Ali was formerly secretary to the Ministry of Command Area Development, Andhra Pradesh.*

1. THE ORIGIN OF PIPE COMMITTEES

The arrival of a canal, fed by the Pochampad Dam, made possible a shift from predominantly rainfed agriculture with paddy on relatively small areas of tank and well-irrigated land to irrigated farming with two and possibly three non-paddy crops per year. In the initial years, the farmers drove away survey teams; sometimes they were afraid that canal water would lower the potency of water in tanks and wells. It was important to allay such fears. Farmers had to be involved in the scheme of land development. They had to be persuaded to do the work themselves or through the agro-industries corporation, according to plans prepared by the land development wing of CADA. They had also to be convinced in favour of non-paddy crops which could yield better returns on investment provided two to three crops a year were grown, one in Kharif (rainfed), one in Rabi (canal irrigated) and a third in the summer, using the last irrigation before the closure of the canal to prepare the fields. This also involved the concept of a single crop per pipe command. Pipe committees and extension contacts were employed to achieve these objectives.

A few farmers' pipe committees were formed in 1974-75. At the time, it was thought that 5 to 6 articulate and interested farmers, one each from the tail, middle and upper reaches, and a few representatives of backward groups, would adequately elicit people's cooperation. Some committees took interest in what the government personnel had to say and also passed the message to other farmers. Gradually, pipe committees were established in many outlets. Quite early, however doubts had been raised about the selection of members by government officials. Many committees preceded warabandi by about three years. They were first conceived by Syed Hashim Ali and colleagues as an instrument to help establish the credibility of CADA as a well-wisher of the people in the task of promoting water utilization, creating dialogue on land development, cropping patterns and field preparation for irrigation.

With the introduction of warabandi, several irrigation zones in a pipe were created taking into account the size of holdings, number of farmers and the direction of water flow. The irrigation zone, a geographical entity, led to the notion of the irrigation group comprising farmers located in a zone. And from this emerged the idea of *group leaders* who could represent the interests of zones and also assist individual members. The idea of the *pipe president* followed logically from the fact that a pipe had several group leaders and a representative was required to represent the pipe as a whole. The initiative exercised by the government in selecting the members of the pipe committee now passed to the farmers and with this a different emphasis on functions came about. Superimposed on the earlier concern for land development and cropping pattern was the responsibility for water distribution. The pipe committee was to ensure that everybody got water on his turn, nobody usurped the rights of others and that the costly irrigation infrastructure was preserved and upgraded to continued service. Instead of the field level personnel of the government looking into each and every detail of a Chak, a task they could not possibly undertake, ground was laid for the involvement of farmers in the management of Chak affairs. Government officials (village level irrigation and extension workers, etc.) would then become resource personnel, helping farmers solve difficulties.

2. ADMINISTRATIVE SUPPORT IN THE IMPLEMENTATION PHASE

The apparent ease with which farmers now accept warabandi does not reveal the enormous preparation and coordination that the administration has to put into educating them and planning the execution of the many interdependent tasks. The foremost requirement for an efficient operation is the training of personnel and building them into a cohesive and well motivated work force, with the necessary attitudes and skills. This involved developing a people-centred administrative style. The officers of the government, by and large, believe in the wisdom of the people and try to work out problems through persuasion rather than prescription. The response of the farmers is taken as an important indicator of one's own achievements.

The first task, therefore, is to train the officers and workers so that each officer is conversant with his specific role with reference to the farmers and his colleagues. The second is to mobilise teams to work systematically through an area (which may include 60 villages, 400 pipe commands and some 40,000 farmers) in 4-6 months. A team of officers is headed by a leader usually of the rank of assistant engineer or assistant director of agriculture. Subordinate officers belonging to the cooperative, agriculture and irrigation departments are placed directly under the leader. The team divides its tasks into manageable units and concentrates on villages and minors in a pre-determined pattern.

The agriculture officials and CAD engineers are given the main responsibility for educating farmers, particularly the group leaders and the pipe presidents. The supervisors (irrigation and CAD) discuss with them on-farm development plans and also construct field channels, division boxes and drop structures according to the maps prepared earlier. The cooperative supervisor talks about credit facilities, while the agriculture extension officer discusses recommended agricultural practices for warabandi. The revenue officials provide land records and titles to land which assist both the engineers and the cooperative officials in their work. The irrigation department, though not under the CADA, coordinates its work in respect of upgrading the minor to ensure the desired discharge of water at the outlet.

Once favourable ground is prepared, the senior officers, to whom the teams report, call a meeting of all the farmers in an area covered by, say, several minors or a distributory. With facts and figures they indicate how with warabandi, land development and a better choice of crops the farmer can get good yields. Although every effort is made to get all farmers belonging to a pipe to attend a meeting, this may not actually happen. Since government officers are under pressure to meet other pipe groups, they depend upon the farmers to carry on the dialogue beyond the scope of a few officially convened meetings.

Having once established direct contact with farmers, the teams proceed in the following manner: (1)

A. The irrigation department upgrades the minors by constructing cross regulators if necessary, and installing measuring devices such as flumes or notches at suitable locations;

B. The map of each pipe is prepared indicating the holdings of each farmer, field channels and the internal field channels to each individual's land;

C. Field channels capable of carrying water with designed discharge are constructed by the irrigation and CAD engineers down to each holding;

D. The area within a pipe is divided into groups (zones) based on physical location of field channels and convenience of water distribution. Group leaders and pipe presidents are selected in consultation with farmers, and informed about their respective responsibilities;

E. Technical knowhow and funds are made available to farmers for their on-farm works with the assistance of engineers, bankers and cooperative department officials;

F. Irrigation schedules are calculated and displayed indicating time and day when water will be delivered to each farmer.

3. THE FUNCTIONING OF PIPE COMMITTEES

Pipe committees have been a clear success in the implementation phase. A Chak which earlier took about one year to develop can now be completed in all respects within four to six months, sometimes quicker. Educationally, the system has been successful. The survey showed 76% of farmers could define warabandi and 63% could give the day and time of their turn. Others knew their place in the sequence. Only 6% said they had any difficulty. Warabandi had brought 25-35% additional land under irrigation, at a more intensive level, with new cropping patterns and increased farm-level investment in infrastructure and inputs.

The level of consciousness about the pipe committee was less. The survey showed 60% of farmers knew the names of group leaders and 30% knew the exact number of farmers in the group. Knowledge about the group leader depends on the follow-up effort of the CAD officials. Close supervision has not been possible. Group meetings have been infrequent. The level of knowledge, in the circumstances, is quite high especially as the "group leader" was a new role in the village social organisation. It is noteworthy, however, that 86% of farmers in one village knew the group leader as compared to 4% in another, where the extension worker in charge was said to have been frequently away.

One-third said the CAD officials selected group leaders. Due to the pressure on time, the officers responsible for consulting the villagers frequently suggested the name of one who in their opinion would make an acceptable leader. Some one-fourth, however, mentioned discussion and consensus over the group leader. Many did not recollect how the group leader was selected (46%), the largest number belonging to village with the absentee extension worker. About 60% of farmers knew the functions of the leader. Most prominently mentioned are adherence to the time schedule (25%) and maintenance of irrigation structures (20%). Representing the interest of the group in irrigation matters is mentioned by 10% and the settlement of disputes by 7%.

Nearly 70% of farmers did not know how the pipe president was selected. Some 13% mentioned the CAD authorities while some 17% said that the selection was unanimous or in consultation with the villagers. As regards any problem on which help from the pipe president was received, 90% said they had no occasion to ask for assistance. The farmers were much more aware of the group leader.

Enforcement of turns and the maintenance of irrigation structures were the two most important items for which the group leaders were said to be responsible. Nearly one-third said they were very satisfied with the group leader and another 16% did not find any reason to complain. Some 50% did not give any answer on the grounds that they had nothing concrete on which to base a judgment.

4. PIPE COMMITTEES IN THE OPERATIONAL PHASE

The government's main objective in establishing pipe committees was to use them for:

A. Water distribution

B. Conflict resolution

C. Enforcement of rules and prevention of wilful damage

D. Maintenance of irrigation infrastructure

E. Linking with concerned government departments for i. feed-back on operation and rectification of technical difficulties, ii. problems arising from the behaviour of head-reach villages.

Success in these areas has been uneven.

a. Water distribution

The surveys took place in 1979-80 when water supply was generally abundant. The test of the system came in 1980-81, when the command area had 40% less water than in the previous year. Instances of deliberate tampering with irrigation structures were few, which was attributed to the good relations established with farmers. Information interviews were carried out then to see how the committees were functioning. The reports suggest a few generalisations: First, where extension contacts (of the government) have been good, pipe committees have been active and the problems of water distribution addressed effectively. Second, when water is abundant there is no need to follow turns or to seek the assistance of group leaders or pipe presidents. A farmers' organisation does not gain strength under this condition, because its functions are not seen as necessary. Third, when water supply is very inadequate there is resentment against the government. Farmers try to use the committee's structure to get their officers to remedy the situation. They lose interest when solutions are not found, and the pipe committee tends to become defunct. Individuals and groups may, however, take the initiative, helped by the legitimacy of the new organisational structure, but cohesive social action is improbable. Both effective interaction with official agencies, and the adequacy of water supply, affect the strength of the farmers' organisation and its capacity to deal with problems in water delivery and distribution.

b. Conflict resolution

Ignorance about turns, the feeling that someone takes more time than allotted and irresponsible behaviour on part of the other person are among the important causes that lead to conflict. The pipe committee, specially group leaders and the president, are expected to look into such cases and find amicable solutions.

Disputes between farmers that arise from lack of correct information are easier to resolve than those from the desire to corner resources for oneself or to intimidate the "weak". Disputes due to insufficient supply of water to an outlet because upstream villages behave unlawfully is even more difficult to tackle. The research did not reveal examples of two pipe committees resolving such difficulties themselves. Usually, the authorities intervene to prescribe a solution. A few instances came to notice where illegal cultivation of paddy by upper reach farmers had been effectively stopped on the initiative of middle and lower reach farmers with the assistance of the irrigation authorities.

c. Enforcement of discipline

In old community-managed irrigation schemes, norms have been evolved regarding the enforcement of discipline, offering voluntary labour for maintenance and monetary contributions for repairs. Such norms have not so far been developed by farmers' organisations created in the Pochampad project.

Apart from indiscipline motivated by the desire to have access to water at convenience, there is wilful damage to irrigation structures installed to measure and regulate the flow of water. Farmers, by and large, do not understand the purpose of the various artifacts. Social pressures cannot yet be brought to bear against offenders. The pipe president finds himself totally ineffective as, according to one of them, "nobody listens to me".

Norms, of course, develop over a period of time. Frequent meetings and discussions between farmers help emphasise appropriate conduct and attitudes. The warabandi meetings in one village were used to emphasise the importance of irrigation structures. "It was decided" says a group leader, "that irrigation structures should not be damaged, and whoever breaks them will have to restore them. It was also decided that warabandi was beneficial to farmers and we should keep it up." Meetings helped to develop common standards to judge the appropriateness of behaviour. Indiscipline has been minimal in this village. But not many villages have received the quality of extension help received in that particular place.

d. Maintenance of the irrigation infrastructure

Maintenance of the irrigation infrastructure at the farm level is, of course, very important. Field channels have to be excavated, weeds and silt removed and necessary repairs of structures carried out. There are instances where farmer groups have volunteered to deepen several kilometers of a minor to enable water to reach the village. Many such instances of one time effort have come to notice. However, in a village when someone's cart accidentally broke an underground pipe, reducing availability of water to the tail end, a satisfactory solution could not be found.

Farmers in Pochampad indicate willingness to contribute towards the cost of maintenance. Many feel they must take care of the irrigation structures and contribute for repairs. Many say that anyone who damages a structure should be fined so as to serve as an example for others. An overwhelming majority (70-80%) consider maintenance to be the responsibility of the farmers. The minority that did not hold this view felt that the government should carry out maintenance since the farmers pay irrigation charges. Most felt that maintenance charges should be levied relative to the acreage held by a farmer in the outlet command (85%). A per acre contribution of Rs. 20-30 is considered satisfactory. A fairly large number felt that the cost of repairs should be estimated and farmers asked to pay in proportion to their holdings. In other words, they did not favour a fixed charge.

When asked who should collect funds, around 80-85% farmers saw it as the responsibility of group leaders and pipe presidents who should also get the repairs executed. Those who saw maintenance as the responsibility of the government (15%) either did not get any water or received an inadequate quantity. It is natural for them not to feel responsible for maintenance. Discussions with farmers in a few villages showed that they felt misuse of funds collected for maintenance could be prevented. Some felt that a close watch could be kept on those given the responsibility. Others suggested that an account could be opened in a bank or a post office in the name of two individuals. Funds could be withdrawn according to need and a statement of accounts submitted to the total membership at one of its several meetings. Some suggested that the government should oversee the expenditure. Farmers are quite willing to raise funds provided a method of collection, deposit and expenditure is established. The importance of the pipe committees in this regard is clearly accepted. However, no group effort has so far been made in spite of the favourable sentiments expressed by farmers. A few pipe committees could be encouraged to take the lead. Extension assistance might be necessary for establishing the accounting system. The ground for popular participation is quite favourable unlike that found in many other irrigation projects in the country.

If farmers can carry out repair and replacement they will save government enormous sums. The annual cost for the 2,000 odd outlets under warabandi up to 1981/2 was estimated at Rs. 16,200,000 ($1,620,000). Without repair and replacement, by either government or the farmers, the system will of course gradually go out of operation.

e. <u>Links with government agencies</u>

Links with concerned government agencies is important for two reasons: first, receiving advice and taking decisions on matters of common interest that require the support of <u>all</u> the farmers, such as for the choice of crops, agronomical practices, economical use of water, and crop water requirements. Second, conveying information from the farm level up to the agency on issues that are important for the satisfactory performance of the Chak irrigation system. Relevant here are: the behaviour of the main canal system, wasteful use of water in the upper reaches, conflicts that farmers cannot resolve, misuse of position by lower level government functionaries and dialogues on problems on which an understanding between the farmers and the irrigation authorities is required.

Linkage and feedback is the least well performed of the five tasks required of farmers' organisations. The CAD authority has to create a system through which both downward and upward flow of information can take place. Farmers often take their problems to higher levels of government for redress. But usually they return disappointed. "The village elders and the pipe committee leaders went to Raikal and Jagtial to tell the officers of water shortage. They were assured that something would be done about it, but nothing has been done. The farmers had written to the administrator in Jagtial and also to the higher authorities in Hyderabad, but nothing was done. Even now we are not getting enough water."

5. CONDITIONS FOR SUCCESS

While warabandi has come to stay, the same cannot be said about farmers' organisations, which today exist in different states of health. Some deal reasonably effectively with the internal problems of water distribution, conflict and maintenance. Others survive not as corporate bodies, but as fragmented entities around resourceful leaders. In one village, several head-reach groups managed water distribution and routine maintenance in their own interest but the pipe president, a conscientious farmer, is ineffective. In another, the pipe organisation is defunct although one irrigation group has asserted its rights within the framework of the pipe committee.

Group leaders and pipe presidents are convinced about the importance of pipe committees and are confident about getting popular support from all farmers. An overwhelming majority is willing to contribute for Chak maintenance, paying either a fixed sum or the actual amount required as a proportion of the land owned in an outlet. Thus, the basic ingredients for the success of pipe organisations are present. The main question is: what are the chief obstacles that prevent them from becoming viable and what could contribute to their effective performance?

K K Singh identifies one major problem as the acquisition of institutional legitimacy. This affects most new organisations. Although an overwhelming majority of farmers (70%), group leaders (85%), and pipe presidents (94%), said that the pipe committees were required to solve problems, in practice many farmers turned to older social institutions for dispute resolution. How can these artificial organisations of irrigators become a self-sustaining social organisation? Two factors seem important. First, the acquisition of social identity and second, the experience of success. Education about objectives and functions, participation in group meetings, mutual consultations, and decisions by consensus on problems of common concern affirm social identity while the ability to tackle problems which members fail to resolve in their individual capacity, confronting challenges and developing a shared point of view, gives rise to the experience of success as a corporate entity. In the initial stages, therefore, education of pipe committee members and follow up by the field-level officials is essential. Appropriate social norms will develop in due course on the corpus of common experience and the incorporation of cultural behaviour modes. New tasks will be identified and functions assigned to individuals (role differentiation) according to organisational needs. Institutional identity and the experience of success are mutually reinforcing.

A divisive village or a factionally fragmented farmers' organisation can hardly be expected to mobilize itself for common purposes. However, there are ways in which authority can help. Firstly, legal authority has a place in giving legitimacy to the committee. Secondly, there have to be administrative mechanisms for forwarding upwards farmers' complaints to the level they can be effectively answered, so as to give the essential experience of success. Removal of technical flaws reported by pipe committees requires planning and investment decisions beyond the authority of subordinate officers who are usually approached for assistance. Even senior officers are unable to commit resources without approval from headquarters. Defensive explanations of shortcomings, such as the following are often given: "the difficulties you point out are genuine, no doubt, but if you work earnestly you can resolve them". Farmers complain repeatedly but eventually give up when positive outcomes elude them. Many officers offer assistance but much depends upon how the problems are presented to them, by whom and the attitude of the superiors, including those at the headquarters. Creating a higher level forum consisting of representatives of pipe committees, government officers and local political leaders to articulate and review problems is a possible solution.

Thirdly, the training of the lower level staff with whom the farmers are continually in contact needs adjustment. The training of this category of personnel so that they can support and educate farmers' associations requires high level of training skill and is more challenging than generally recognised by senior government officials. Fourthly, the supportive activity needs to continue for a longer period than the one season allocated to it in Pochampad.

The degree of success in Pochampad already achieved in regard to farmers' participation owes itself to a fortuitous combination of senior officers who believe in the bottom-up approach to irrigation development. With hardly any familiarity with the subject, they learned from experience, developed inter-departmental work teams, bridged departmental boundaries and hierarchy, shared information freely and used it for motivating officers and farmers in a well sequenced programme of work. Such a rare combination of officers does not materialise too often in government administration. Even so, resources were always inadequate. The work teams were always under pressure to move on to new areas, chasing targets which required them to put in a ten to twelve hour workday. They never had the time to work with pipe committees even for one full irrigation season (five months). There was no organisation or personnel to provide back-up support. The services of the T and V staff was available only for short periods of time. The arrangement to put one field worker to supervise some five pipe commands (150 ha) was abandoned after the first year because of the lack of funds. Thus, pipe committees were set up but could not be assisted in their growth. Similarly, knowledge about the factors contributing to self-management was not within the grasp of most officers. While the necessity to keep the committees active was continually felt and articulated in the fortnightly meeting held at the project headquarters, effective measures could not be adopted. Questions about institutional viability were hardly ever raised. On the contrary farmers were blamed because they did not appear to have acted responsibly. Only the rare village extension officer took interest in the success of the pipe committee. Whatever success came by way of Chak management was due to the active interest of the project authorities, the field officers and the village leaders, including the members of the pipe committees.

Contrast this with the well organised intensive work undertaken in the Philippines under a pilot project to build enduring farmers' associations on small irrigation schemes where Community Organisers were appointed for a system covering 200-400 ha, to work with an association between six and nine months before construction began (2).

The establishment of Farmers' Associations or Water Users' Associations is not an easy solution to irrigation management problems. It requires intensive government effort, appropriate training institutions, staff who stay in a district long enough to become familiar with its social structure and to gain experience in the techniques of building up farmer participation, and a consistent policy over the term of years necessary for new social institutions to acquire their own norms and legitimacy.

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IRRIGATION MANAGEMENT NETWORK

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THE ROLE OF FARMERS IN DECISION MAKING ON IRRIGATION SYSTEMS

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This paper was originally written for the Development Studies Association conference in Swansea in 1980. It has since been frequently quoted, so it seems useful to make it more easily available.

At the time it was written, the main criticisms of large irrigation schemes were their generally low overall efficiencies of water use (particularly in large canal systems) and the generally unequal distribution of water between head-reach and tail-reach farmers. Water users' associations were seen as a means by which extension officers could improve farmers' *efficiency in water use below the watercourse outlet. An alternative view was that farmers' associations would improve* bureaucratic *efficiency by enabling farmers to bring pressure on officials. Other functions of farmers' associations are discussed in Network Papers 6b and 8c.*

One of the most important findings of the paper is that in many traditional systems equity, *as understood by many irrigation planners, is not an objective. Rather, there are generally certain categories of user or of land having* priority *to water in times of scarcity. These are the users/lands for which the system was first built.*

1. INTRODUCTION

In the study of the management of irrigation systems a distinction is commonly made between *community*, *bureaucratic* and *joint systems*:

> In general, existing irrigation systems approximate one of three types: they may be *community systems*, operated and maintained by the water users themselves and/or their representatives; they may be *bureaucratically managed systems*, fully administered by an agency of the government; or they may be *jointly managed systems*, in which some functions are performed by the irrigation agency while others are the responsibility of one or more water-user communities. (Coward 1980:27)

This paper explores differences in the organisation and management of community and joint systems. A few selected case studies have been summarised and juxtaposed. They illustrate certain fundamental differences in patterns of decision-making and in notions of equity of water distribution under the contrasting conditions of community and joint management; but they also indicate the wide diversity of decision-making patterns, and results, to be found within each of the two broad categories. It concludes with some generalised propositions for discussion and considers (a) to what extent lessons about management from communal systems can in fact be transferred or adapted to joint systems; and (b) to the extent that they can be transferred or adapted, whether increased farmer participation in decision-making is likely to be a sufficient condition for bringing about significant improvements in the performance of joint systems.

2. COMMUNITY SYSTEMS

a. Characteristics

Community systems are generally quite small, both in terms of area commanded and in terms of irrigators, but some individual systems reach up to 5000 ha in size and may involve the use of quite complex organisational structures. A distinction can be made between community systems which have come into existence relatively recently through the initiative of an outside agency (government or non-government); and those, commonly termed 'indigenous', which have been operated and maintained by the water users often for a very long time. Of the community systems reviewed here, only one (Matam, Senegal) belongs to the first category and the other three can be described as indigenous.

Most indigenous community systems tend to be associated with certain types of physical environment. Many are found in fairly small river valleys, often upstream of larger lowland plains, and have been developed through the construction of diversion structures built out of locally available materials. Others (not presented in the case studies below) are systems dependent on small reservoirs (known as 'tanks' in South India and Sri Lanka) (1). By contrast, the technologies on which externally-initiated schemes depend are sometimes quite complex, eg. electric or diesel pumps.

b. The case studies

Many detailed studies have been made containing information about the management of indigenous community systems, particularly by anthropologists. Extensive bibliographies can be found in Coward 1976, IRRI/ADC 1976, Hunt and Hunt 1976. The four selected for comparative study here are: R Gray, 1963, based on fieldwork carried out among the *Sonjo* people in 1955 in what was then Tanganyika; A Maass and R Anderson, 1978, based on fieldwork done in *Valencia* in the late '60s; R P de los Reyes, 1980, based on fieldwork carried out in various parts of the *Philippines* in 1977 and 1978; and S Fresson, 1979, based on 1977 fieldwork in *Matam*, Senegal. Table 1 gives their basic characteristics. It is important to distinguish between two main areas of decision making - those relating to the *establishment*, (overall planning, system design and construction) and those relating to *recurrent management*, (operation, maintenance and dispute settlement).

Table 1; Broad characteristics of the 4 examples of community systems

	SONJO	VALENCIA	PHILIPPINES	MATAM
Topography	hillside	Turia river plain surrounded by hills	Some hillside some lowland	valley of river Senegal
Type of system	diversion	diversion	diversion	pump
Size of command area	? (180 families in the village)	between 300 & 3000 ha	between 1 and 4600 ha (average 100 families)	between 7 and 16 ha (20 to 80 families)
Length of operation	beyond anyone's memory	from 13th century	at least one century old	from 1974
Irrigation decision-makers	hereditary elite	hierarchy of elected representatives	community leaders	individual irrigators providing link with government agency

In the first three case studies little information is available on the *establishment* since the water users inherited the system ready made. This does not detract from the interest of the studies since decisions about operation and maintenance are more critical for the functioning of the institution because they involve the long term.

Sonjo: The system described by Gray (1963) is one of several autonomous diversion systems from streams in the hilly Sonjo area. The system dates from beyond living memory. The water comes from a hill stream and is augmented near the village by water from a number of springs. The diversion and channels are made from local materials (wood, stone, clay). Gray does not mention the size of the command area but crops from the irrigated fields belonging to the village studied support 180 households (along with pastoral products from sheep and goats).

The social organisation of the irrigation system is cotermious with that of the village; major decisions about irrigation, in the same way as all other major decisions, are taken by a group of hereditary councillors and minor councillors during their almost daily council meetings. Authority resides with the group as a whole, not with members as individuals. The 17 councillors vote on important decisions and unanimity is expected before proceeding. The 13 minor councillors take part in discussion but have no vote. Twenty to twenty-five selected elders may listen to the proceedings.

Gray makes a distinction between primary rights to water and secondary rights. Only the councillors, minor councillors and selected elders have primary rights; the latter acquire temporary rights to water (eg for a month) by paying tribute in the form of goats to the councillors; these goats are used mainly for ritual purposes associated with irrigation. Irrigation water is rotated between users and the cycle lasts approximately 14 days; each session lasts for about 6 hours (eg. from dawn till noon). The councillors have their turn first, then the minor councillors, and then the selected elders. These 60 or so people constitute just half of those requiring irrigation water (the smiths and the younger men or 'warriors' do not farm). The remaining irrigators have only secondary rights to water, in that they have to ask someone with primary rights - for example a relative - to give them any excess water in return for a small fee of honey, grain or money. The author refers to those with secondary rights as clients.

Every year when the rains have finished,the elders of the council set a time for the repair of damage to furrows and dikes and call all the able-bodied men of the village to do this, (except smiths, who are exempt); this work takes about three days only. During times of shortage, water theft is not uncommon; theft is fined by the councillors if discovered, but not very heavily since it is recognised that this is done out of dire need. The councillors are the only effective political authority and can enforce decisions - whether about irrigation or not - by the threat of refusing irrigation water.

Among the Sonjo, decisions about irrigation and other matters are therefore taken by a large hereditary elite constituting roughly half of the water-user population, and benefits are distributed preferentially.

Valencia: 8 canals are diverted in different places off the river Turia in the plain of Valencia (Maass and Anderson 1978). This plain is formed by stream deltas and is defined on three sides by mountains and on the fourth by the Mediterranean Sea.

The system dates from the time of the Moors and there are detailed written records about it dating from the Middle Ages. The diversion structures and canals have been damaged and rebuilt many times; some of the canals are lined. The command areas of the 8 canals vary from 300 to 3000 ha each. Over 99% of the irrigated farms are less than 5 ha each, and 83% occupy less than 1 ha.

Each canal has an 'irrigation community' constituted by landholders only (thus excluding tenants and sharecroppers) who have one vote each in the general assembly, held every two years. The assembly votes on proposed changes in the canal's policies, rules and regulations concerning water distribution, canal maintenance, taxes for major replacements and new construction, and on officers to administer the canal's affairs. Each landholder pays expenses for operation and maintenance in proportion to the amount of land owned.

The assembly also elects an executive committee, consisting of between 4 to 8 delegates, to conduct the canal's business until the assembly meets again. In the larger canal communities, delegates represent the interests of different canal zones. The committee is chaired by a farmer who is canal officer for two years; the canal officer is often re-elected. There are also several permanent employees; each canal has a secretary and a part-time lawyer, and several guards who patrol the canals and, on orders from the canal officer,operate the canal's principal control structures. The guards are not farmers; the job is often passed down from father to son. In times of water shortage, irrigators nominate some of their number as ditchriders to assist the canal officer in distributing water.

Priority to canal water in times of shortage is based on time of settlement.The farms within the boundaries set up in the middle ages have priority over more recent farms outside these boundaries (canal water is supplemented by pumped groundwater on the peripheral farms). The government has unsuccessfully tried to oppose this priority system and substitute a system whereby water is allocated proportionately to the size of landholding.

The organisation of each canal is not autonomous since the officers of the eight canals have weekly meetings in Valencia at the conclusion of the water court on which the canal officers serve. This is a popular court, not a national court; but the farmers usually prefer to use the popular court rather than the official court since the judges - who are the canal officers - are farmers, the proceedings are almost free, and the decision is immediate. The guilty person is sentenced to paying damages and fines according to the particular ordinances of his canal community. The sentence is enforced by the guilty's canal officer, who may threaten to turn off his water if he doesn't pay, or to seize his property and sell it (but no one can recall a case of either). Thus the national courts are not normally involved in disputes either within each canal community or between members of the eight canal communities.

Major decisions about irrigation are taken by a hierarchy of farmer representatives at the sub-canal (delegates on the executive committee),canal (canal officer) and multi-canal (water court) levels.

Philippines: Reyes (1980) analyses 51 autonomous diversion systems in different regions of the Philippines. The command areas vary from 1 ha to 4600 ha; 59% serve less than 50 ha. Smaller systems predominate in the more mountainous up-stream areas. Most of the systems have existed for more than a century.

Fifty three per cent of the systems have received financial assistance from the government: for the repair of damaged structures, or for the replacement of temporary structures made out of local materials with semi-permanent or permanent ones. The government requires each system to repay the cost of the improvement by organising the collection of fees; it also requires the water users to distribute the water 'equitably', to maintain the new structures, and to be able to resolve conflicts among themselves.

Two-fifths of the system have a formal irrigation association. These are often set up specifically at the request of the government at the time of improvement. One reason for this is to establish a legal body to which loans can be made and from which they can be recovered. Loans are made more often to the larger systems; likewise formal associations are found more commonly on the larger systems.

All of the formal irrigation associations have irrigation-specific leaders: these have been appointed or elected specifically to manage the irrigation systems. The remaining three-fifths have no formal association. A few of this remainder do have irrigation-specific leaders but the majority do not: their leaders have assumed leadership positions even though they were not elected or appointed specifically to do the job. The author groups these leaders of the latter type into three kinds: those who derive their authority from their wealth; those who own dams, or their representatives; and those who derive their authority from positions in the local government or within the community (eg. elders of the village council). Just under two-fifths of the systems have water distributors; one-fifth of the systems have at least one leader who gets some form of compensation; and one-fifth require the irrigator to pay a fee (both payments usually in the form of an amount of rice).

The formal irrigation associations do not seem to be effective in enabling joint decisions by groups of farmers; the author rarely mentions the associations in connection with decisions about operation, maintenance and dispute settlement; and the leaders appear to take decisions on behalf of the other farmers (although the process whereby they do so is not made clear). For example, farmers are 'notified' about maintenance activities by the leaders which rather suggests that the farmers are not making joint decisions. The author even goes so far as saying:

> Like most formal organisations in rural Philippines, the communal associations apparently are not effective in drawing farmers' participation in decision-making processes. (p45)

So the most characteristic organisation seems to be: community leaders who derive their authority from their role in society and who take decisions, including irrigation decisions, on behalf of other farmers. As over half of the systems have received government assistance, their leaders are expected to operate in accordance with certain rules laid down by the government until the loan is repaid.

Matam: In contrast to the previous three case study areas which have involved simple diversions, this last one is dependent on pumps: the water is pumped out of the river Senegal in 19 separate places into each command area. The system dates from 1974 when the pumps were installed by the government, and was studied in 1977 (Fresson 1979). The command areas varied from 7 to 16 ha each. Each contained between 20 and 80 plots and the average sized irrigation plot was 0.2 ha. (1)

The 19 pumps were installed by the government agency SAED (Société d' Aménagement et d'Exploitation des Terres du Delta) in the mid seventies. The water users had no say in the design, planning or construction of the systems. They just provided the labour and the wherewithal to pay for a mason where necessary. The main reason for tentatively categorising this system as a community one is that the government intends the farmers to take over a share of organisation and management responsibilities (2).

The water users were selected for settlement on the irrigated commands from volunteers in the local community by the village headman. All of the selected farmers automatically became members of producers' groups, and they in turn elected from within the group a chairman, vice-chairman, treasurer and four committee members (all unsalaried). There is no mention of reappointing group officers so it may be that these are permanent positions (3). They also nominate a pump operator, the group's only paid assistant; he is paid in cash, kind, or is given a first or second plot according to the group's decision. The pump operator is given one or two days training at SAED headquarters in Matam town. (3) Maintenance and repairs of the pumps are done by a SAED mechanic, whose labour was free to the irrigators; but the group has to pay the cost of fuel, lubricating oil, replacement filters and spare parts.

The irrigators must maintain the channels yearly according to their agreement with SAED. Fines, the amount to be decided by the group officers, are imposed in order to penalise thefts of water and other breaches of discipline.

The groups' officers, rather than being farmers' spokesmen, take on the role of intermediaries between SAED and the farmers: they are the medium through which SAED relayed information to the group (and there was no indication of the reverse process:

(1) Irrigation Network Paper 8b describes the systems in 1981-82.

(2) Irrigation Network Paper 8b argues that this has in fact happened.

(3) Not always, see 8b.

relaying information from the groups to SAED). The officers have to order supplies for the pump, organise transport to the villages and raise funds from the farmers to pay for this. They are also encouraged to place orders for general agricultural products (eg. fertilizer, seed, insecticides) with SAED, to raise funds and to organise redistribution to farmers. In other words, the group officers are not solely responsible for operating and monitoring the irrigation system, they are the link with the government agency and are there to ensure that the irrigation system works in accordance with SAED's plans.

As in the previous case study area, there is not much consultation between leaders and those they are supposed to represent. The 'producers' groups' do not appear to mean much more than 'those farmers on command area X'; and the group officers are able to take the initiative only insofar as it conforms with SAED's overall plans. For example, SAED 'strongly encourages' its 'advice' about which crops to grow and when:

> The decision to grow a second irrigated crop during the dry season stemmed first, from SAED proposals and advice, and second, from general agreement by the group. (p90-1)

Although the group officers were meant to be in charge of operating the pump, the following quote by a SAED officer shows that the practice was often somewhat different:

> When the time comes, I do not leave it to the chairman. I take charge of it myself. (p110)

So although the Matam systems are considered here as community systems, they were in fact borderline joint systems in 1977 (1).

c. Priority rights and equity

Though organisations on many indigenous systems are notable for the effectiveness with which they take decisions in accordance with their own customary rules, these decisions do not necessarily lead to an equitable distribution of water resources: the most common basis on which water is distributed is not proportional to area of land owned (which would be regarded as *equitable* in the limited sense of the word used by many irrigation planners and commentators) but *prior water rights*.

Among the Sonjo just over half of the water users have no direct rights to water but must acquire it indirectly via those who do have rights in return for small payments. Those who run out of funds to pay for water are in trouble, especially during times of water shortage. There is a strong belief that certain people have priority of access.

In Valencia the water users recognise the importance of two concepts: igualdad (equality) and equidad (equity or fairness). These concepts are discussed at length by the authors but it emerges that they operate only in relation to the landowners, not to the tenants or sharecroppers (unfortunately the authors do not indicate how many tenants or sharecroppers there are or how they gain access

(1) Paper 8b argues that in 1981 they were taking more of their own decisions - for example - one group decided not to grow a second crop.

to water). Also, in times of water shortage, priority is given to the landowners within the boundary of the old system thus excluding landowners on peripheral areas.

The National Irrigation Administration of the Philippines gives assistance to communal systems on condition that (amongst other things including the repayment of the original loan), water is distributed equitably to the users and delivered on a reliable basis to the maximum number of farmers. This implies that the distribution of water might otherwise not be equitable. Indeed the author writes that in some Mountain Province systems priority is given to the older rice terraces, irrespective of their location vis-a-vis the irrigation canals.

One reason why priority rights are so prevalent on indigenous community systems is no doubt that, in contrast to jointly managed systems, they were developed incrementally by the irrigators themselves, and that the greater rewards are thought to be due to those whose predecessors pioneered the system than to those who followed later.

In Matam, SAED ensures a certain degree of equity but the following dispute shows that the water users, if left to themselves, might prefer working a priority system: in one command area, the officers had decided to give priority to watering the plots of tiedo (warriors) at the expense of mationdo (captives). SAED was quick to intervene arguing that this contravened technical requirements: the disadvantaged plots furthest from the pumps should be watered first, so as to achieve equitable distribution.

3. JOINTLY MANAGED SYSTEMS

a. Characteristics

Most jointly managed systems are significantly larger than community systems and some are of an entirely different order of magnitude: discrete command areas in the Indus plain, for example exceed 500,000 ha (covering as many as 150,000 farms). The physical environment in which most jointly managed systems have been developed is significantly different from that of most community systems. They are generally found in lower riverain plains, where the size of the rivers, and the scale, complexity and expense of the technology required had led to the principal role in planning, design and construction being taken by governments (or in some cases, large private corporations) (Bennett 1979; Roder 1976). This need not exclude the delegation of a considerable degree of responsibility for planning, design and construction to representative farmers' organisations at various levels as practice in China has shown (Nickum 1977); but usually governments have not sought farmers' participation in decision-making at the establishment stage.

Once established, irrigation schemes of this kind require some sort of specialist agency to help manage them, most obviously because of the widely dispersed but highly interdependent distribution system. This is not to say that the agency must necessarily be a government-employed bureaucracy. In some cases, as in Taiwan, methods of joint management have been developed in which the agency's members are employed by, and accountable to, farmers and their representatives.

Relatively little detailed information is available about farmers' decision-making on jointly managed systems. The four case studies summarised here, selected on the basis of their contrasting physical and social environment, are from Taiwan (Vander Meer 1980; Abel 1975; Ko and Levine 1972); Java (Satya Wacana University 1975; Pasandara and Taylor 1976); Andhra Pradesh (Wade 1979); and Pakistan Punjab (Mirza 1975; Mirza and Merrey 1979; Merrey 1979). Basic characteristics in each case are sumarised in table 2.

Taiwan: Under Japanese colonial rule the organisations promoted by government to supervise the management of irrigation throughout the island were called Irrigation Societies. These had government-appointed managers and senior staff, though legally ultimate authority lay with the committee of 'irrigation judges', half of them appointed by the manager, half elected by local farmers. Until 1930 the campaign to increase rice production, much of it for export to Japan, made frequent use of authoritarian methods; 'police stayed in the local communities and effectively participated in agricultural extension services'; later more emphasis was given to economic incentives.

Post-independence in 1945, the societies were replaced by Irrigation Associations, headed by fully elected Members' Representative Committees responsible for formulating policy, approving budgets and electing the IA Chairmen. The chairmen have been the IAs' chief administrators, selecting their own full-time staff. Though government helps to subsidise major capital improvements, the IAs are dependent for their recurrent finance (including officials' salaries) on farmers' membership fees. (Abel: 7-10, 22-24; Vander Meer: 235-6).

Over time, with rising population and incomes, there has been increasing pressure on Taiwan's limited water resources, leading to increased overall planning and interdependence between irrigation systems. This has been reflected in the tendency for Irrigation Associations to be amalgamated and get larger: from over fifty earlier they were reduced to 14 by 1975, with average jurisdictions of almost 40,000 ha. Vander Meer has described changes brought about in the water distribution methods and farmers' organisation on a small upland irrigation system, the Nan-hung system, between 1936 and 1966. It receives water by diversion from a river. There are two cropping seasons and rice is the principal crop. Construction began 140 years ago and the system reached its present dimensions in 1907.

Until the late 1950s, canals were unlined and outlets were of local design and construction. Farmers irrigated their rice by the traditional continuous flow method. Sufficient water was available to all farmers in the second season; but serious shortages frequently occurred during the first (January - June). In periods of shortage, water was allocated on a prior rights basis. Class A land had primary rights, assuring it of sufficient water to grow rice in both seasons; Class B land could take only that water not needed on Class A land, enabling it to grow a first crop in some years but not others; and Class C land received water only in the second season. These differential rights reflected the historical sequence in which different areas

Table 2: <u>Broad characteristics of the four examples of joint systems</u>

	TAIWAN	JAVA	ANDHRA	PUNJAB
Topography	small sloping coastal plains with foothills	small sloping coastal plains with foothills	fairly flat, broken by outcrops and river gorges	very large, flat alluvial plain
Type of system	diversion (plus wells in some areas)	diversion	diversion (plus up-stream storage)	diversion (plus up-stream stor-age and large tubewells)
Size of command areas	600 - 50,000 ha	on average ?c, 10,000 ha	(1) 40,000 ha (2) 130,000 ha	670,000 ha
Length of operation	hill systems, old plain systems, mainly 1900-1930	hill systems, old plains systems 1900-1940	(1) from 1957 (2) over 100 years old	from 1905
Character-istics of irrigation organisation	<u>System level</u> Irrigation Association with profes-sional man-ager and staff (till 1975 appoint-ed by Farmers' Representa-tive commit-tee; after 1975 by Government) <u>Watercourse level</u>: Rotation groups, with elected leaders	<u>System level</u> Public Works Dept operates and maintains down to water-course outlets <u>Watercourse level</u>: village or watercourse committees, with appoin-ted or elected water distribu-tors	<u>System level</u> Irrigation Dept operates and maintains down to water-course outlets <u>Watercourse level</u>: spontaneously formed village irrigation committees in more water-scarce areas (not official-ly recognised)	<u>System level</u> Irrigation Dept operates and maintains down to water-course outlets <u>Watercourse level</u>: no formal com-mittees; <u>Ad hoc</u> arrangements for operation and maintenance

had first gained access to canal water. In this it is similar to the three communal systems described earlier.

When water was short, farmers sharing the same irrigation ditch tended to form spontaneous groups to secure water and allocate it among themselves: cooperation was particularly marked in Class B land areas, where large numbers were vulnerable to uncertainty and shortage. In the 1930s two informal associations emerged, one for upstream and one for downstream farmers. Each has an elected chairman, supported by assistants from different areas. These supervised small channel maintenance and water distribution and the chairmen provided a regular line of communication to the "canal traveller" employed by the local Irrigation Society (which was responsible for supervising several other systems besides Nan-hung, maintaining main canals and structures, enforcing water rights and collecting members' fees). Water disputes were frequent and, if serious, were referred through the canal traveller to the Society's manager and committee of irrigation judges.

External intervention in Nan-hung's affairs appears to have been fairly limited until the 1950s, when the government launched an island-wide campaign to introduce rotational irrigation in place of the continuous flow methods. This followed detailed experiments showing that good rice yields could be achieved with much less standing water than was previously assumed. At the instigation of the Irrigation Association, changes were made in channel layout and open turnouts were replaced by adjustable and lockable gates. As a further measure to conserve water, the main canal was lined. This work was partly subsidised by government. There were no changes in the amount of water entering the Nan-hung system or in the customary rules governing water rights. The new layout did however require internal reorganisation among the Nan-hung farmers to facilitate cooperation in enforcing rotation schedules.

Six rotation groups (with areas of 50-140 ha) were formed within the structure of the Irrigation Association, each with an elected and unsalaried chairman. Each group is responsible for operation and maintenance within its area. The six chairmen act as a committee which takes the lead in planning the timing of the rotation schedules to be adopted under different conditions of water scarcity. The groups are subdivided into working teams of 15-20 farmers based on sub-channels. The group's chairmen's link to the Association headquarters is through one of the IA's professionally staffed field stations.

With the construction of the new layout, the Irrigation Association undertook to teach farmers the new rice cultivation techniques and water-control methods. There was initial resistance from Class A land farmers, not so much because they received less water than before (they were still entitled to priority in times of plant stress) but because, instead of taking water at times of their own choosing, they now had to comply with a schedule. Most Class B farmers accepted the changes readily. The principal benefits of the changes have been: (a) substantial increases in overall production; (b) a more equitable pattern of water availability (cropping patterns in all areas of the system are now similar); (c) less labour required for obtaining water, especially in downstream areas; and (d) fewer water disputes.

Similar technical and organisation changes have occurred elsewhere in Taiwan. However, small upstream systems like Nan-hung have probably always enjoyed a greater degree of internal autonomy than larger downstream systems which were initiated through major investment by government. For example, on the Chuo Main Canal system (command area 40,000 ha) described by Ko and Levine, farmers' choice of cropping patterns within rotation areas is severely restricted by water distribution schedules devised by the IA(water supplies are insufficient for double rice cropping in most areas); and prime responsibility for water scheduling within rotation areas rests with professionals in the IA's working stations (at the 1500 ha level), albeit in frequent consultation with rotation group leaders.

In 1975 the government reintroduced greater control over all IAs by suspending the Members' Representative Committees, reportedly on a temporary basis, and appointing their chairmen directly. This move appears to have been partly influenced by local politics; but it was also a response to the increasing financial difficulties faced by many IAs. Taiwan's rapid industrialisation has brought about a corresponding decrease in the relative profitability of farming; farmers have not been able or willing to pay as high a proportion of IA costs as before and the IAs have been increasingly subsidised by government. Nevertheless, IAs continue to depend for a very substantial part of their revenue on members' fees and this still gives staff an incentive to provide farmers in all areas with good service.

Java: In its topography (steep mountain valleys and fairly restricted coastal plains) and climate (semi-humid; bimodal rainfall pattern) Java has many physical similarities to Taiwan. Other similar features include the prominence of rice in irrigated cropping patterns; the very high population densities (average size of irrigated farm units is about 0.25 ha); and the pattern of irrigation expansion, with small upstream systems being developed by farmers independently of government and major new construction being undertaken in the coastal plains by the Dutch colonial government in the early decades of this century. The pattern of development of irrigation institutions has been different, however.

Responsibility for operating and maintaining the canals on the larger systems was retained by the agency responsible for constructing them, the Public Works Department, and this pattern has persisted until today. Below the watercourse outlet, however, responsibility for operation and maintenance is transferred to a separate local organisation. In most of Java, the organisation is the village council, a frequently powerful body, whose heads (sometimes locally elected, sometimes government-appointed) have become salaried government officials. The village heads and their councils are directly linked to the Department of Local Government through councils at the sub-District and District levels. Among the staff appointed by the village head is an official responsible for irrigation affairs, frequently known as the ulu-ulu.

The principal responsibilities of the village ulu-ulu are to supervise water distribution and maintenance below the watercourse head, and to make reports on cropping patterns and the state of crops within the village boundary to the Public Works Department 's ditchriders. He is paid in kind by the farmers of his village. In some areas, the PWD is supposed to distribute water on a strict proportional basis;but in certain parts of East Java the more flexible but complex pasten method described by Pasandaran and Taylor, is used. In the dry season when there is insufficient water for all to grow rice, this method provides a basis for providing differential supplies to different watercourses according to the actual cropping patterns which farmers have adopted (within certain government-imposed constraints about the limitations of rice areas). In pasten areas there is particular need for frequent meetings between ulu-ulus and ditchriders if the "fit" between supply and demand patterns is to be kept close, as the method ideally intends. It also calls for considerable skills in measurement and computation on the part of both ulu-ulus and ditchriders.

Despite the often frequent interaction between officials and farmers, three main weaknesses have been identified in this pattern of management. First, the lack of congruence between village boundaries and watercourse commands can create difficulties in the management of single watercourses and complicates the water requirements assessments of ulu-ulus and ditchriders. (The reason for the development of this unusual pattern may be that traditionally independent channel-based water management organisations similar to the Balinese subaks were destroyed when the colonial canal systems and methods of "compulsory cultivation" were introduced, leaving only the vestiges of strong village organisation behind - see Satya Wacana 1975.) Secondly, ulu-ulus have often been found to be partial in performing their water distribution tasks, particularly tending to favour the village heads whose appointees they are, and their associates. Thirdly, farmers have no representative body at a higher level than the village or watercourse which could monitor the PWD's operation of the main system.

Attempts were made in the past in parts of central Java to overcome the first two problems by having 'distributor ulu-ulus' for each watercourse, who were to be elected by the farmers on the channel concerned, not appointed by village heads. And new pilot programmes have recently been started by government in certain areas designed to promote stronger channel-based organisations and to reduce the influence of village heads and ulu-ulus. But farmers still remain unrepresented at higher levels of the system.

Andhra Pradesh: The topography of the area described by Wade (1979) is mainly flat, broken by rocky outcrops and rocky gorges. There is sufficient rainfall to permit some rainfed agriculture; the principal irrigated crop is rice. The area is irrigated by the main canals; one, constructed over 100 years ago and irrigating about 130,000 ha, the other, completed in 1975, irrigates about 40,000 ha. Water releases to each water course outlet are controlled by the state Irrigation Department, which also maintains the system to the same level. The normal rule of water delivery on both canals is continuous flow, but at times of intra-seasonal shortages, crude rotations between the upper and lower outlets on each distributory may be practised. The pattern of the main system water distribution is extremely unequal as between head and tail reaches.

There are no formally recognised farmer' or water users' organisations for the Irrigation Department to deal with. However a number of spontaneously formed organisations are to be found on the two systems, mostly in villages towards the lower end of the main canals or in other areas conspicuously vulnerable to uncertainty or scarcity of water supply. The same degree of corporate organisation for irrigation purposes is not to be found elsewhere on the system and is virtually absent in the water-abundant head reaches.

Wade describes the structure and activities of one of the most active village committees (which is entirely separate from the statutorily elected village council, or *panchayat*). Its members, usually between eight and ten, are locally described as 'respected persons'. They are nominated - in practice reaffirmed - once a year at a general meeting open to all cultivators. The committee concerns itself with aspects of rainfed as well as irrigated farming and it manages a village fund, but its principal irrigation functions are: firstly, to appoint 'common irrigators', who distribute water amongst farmers' fields in turn: about 15 to cover 450-500 ha of rice fields; their rate of payment is decided by the committee, and farmers pay them direct; secondly, to appoint sluice guards to patrol the distributory canal above the watercourse outlet and check that upstream villages are not blocking the flow or keeping their sluice outlets too high; thirdly, to represent the village, before officials or politicians, on a village basis.

Wade made the following comments:

i. The location of the most active village committees along the canals strongly suggest that the principal reason for their emergence has been water scarcity.
ii. The committee's irrigation functions have two main objectives: firstly to try to extract a greater share of the total flow from the main distribution system than they would get otherwise from the Irrigation Department; and secondly, to ensure that water is efficiently distributed below the watercourse outlet.
iii. The committee's externally directed activities are organised on a village basis (perhaps reflecting the need to generate maximum support from within the community to put pressure on officials and politicians), while the internal water distribution activities are organised, for functional convenience, on a channel basis.
iv. The common irrigators (always low-caste) are organised in such a way to make them accountable in various ways to the farmers, while at the same time the committee attempts to protect them from unwarranted interference. They have to submit themselves for reselection by the committee at the start of each first irrigation season. They are paid directly by the farmers,

not the committee. And each batch of common irrigators works on one specific part of the village land, so that the same relatively few farmers are dealing with the same common irrigators.

The fairly sophisticated character of the organisations which have emerged in certain parts of the irrigated area suggests that if improvements could be made in the pattern of main systems water distribution, so that periods of scarcity were more evenly shared throughout the whole system, there could be a promising basis for further committees to develop much more widely, with subsequent opportunities for federation at supra-village and system levels.

Pakistan Punjab: Merry's detailed study of farmer behaviour on a single watercourse in Punjab was carried out in a village irrigated by the Lower Jhelum Canal system. The total command area - like most canal commands in the Indus Basin - is very large indeed: almost 630,000 ha. The topography is very flat: slopes average about 0.2 metres per kilometre. It was constructed in 1905 to open up new cultivable land on which to settle farmers from the poorer drought-prone areas of East Punjab. Between 1963 and 1973, tubewells were installed by the Irrigation Department. Farmers are held responsible for operation and maintenance below the water course outlets, but they have no formal organisations through which to deal with the Irrigation Department. Watercourse command areas are often very large: average size is about 225 ha, with 3.3 km of main channel and almost 40 km of farm ditches. About 50 farmers might share an average watercourse, but the numbers are often more.

In general, the level of local cooperative activity in Pakistan Punjab, both at the village and watercourse levels, is low. There is no system of representative local government at present and many government-sponsored cooperatives (mainly for the supply of credit) are moribund. Such communal activity as there is at the village level is of an informal nature and tends to be centred round local biraderi (brotherhood) groups. Besides being responsible for mobilising local support for the construction and maintenance of schools and mosques, it is the biraderi groups which help to organise periodic maintenance work on watercourses.

The general level of watercourse maintenance is poor. Although studies of watercourse command areas have tended to emphasise social and cultural reasons for this, some physical and technical difficulties should also be mentioned. First, there is the sheer size of the average watercourse command, which complicates the task of work mobilization among farmers. The flatness of the topography also creates problems with regard to the disposal of accumulated silt and the maintenance of channels at their correct elevation.

Sample surveys of watercourses found that quality of performance of maintenance tasks tended to vary according to the degree of polarisation and power among the farmers within them.

Communities characterised by two or more biraderis of about equal size and power were likely to be divided by conflict and to be ineffective in organisating for collective projects. Conversely, those dominated by a single biraderi or having a number of small biraderis none of which were dominant were found more cooperative. Large landlords were less cooperative in cleaning and maintaining their watercourses and more prone to factionalism and also tended more often to violate sanctions (such as for non-participation in watercourse cleaning) than smaller farmers.

Merrey, in his study, describes the numerous difficulties and conflicts which he observed on a particular watercourse when it was selected for physical improvement as part of a pilot government scheme (with government supplying technical advice and supervision and certain materials and farmers supplying labour for earthwork and other technical improvements). Although the watercourse had been in a delapidated state and a prior survey by the author had indicated farmers' eagerness to improve it so as to reduce water losses, the execution of the project was attended by many disputes, not only between farmers and officials but among the farmers themselves. The project, designed to take two months, lasted for six, and even then sections of the system had to be left.

Merrey attributes some of the difficulties to poor relations between officials and farmers and some to the unequal distribution of benefits which were perceived to come from the project (in particular tailenders stood to benefit more than those with land in the headreaches), However, some of the disputes could not be explained by these factors, since the instigator of the disputes stood to gain as much from the project as his rival. In Merrey's view, the major source of conflict was the concept of <u>izzat</u> (honour, status or face) characteristic of Punjabi rural society. Izzat can only be acquired at others' expense: 'as in a zero-sum game, the success of one person is a threat to all the other players, a characteristic that generates competition and jealously' (p30). Merrey concludes that the community he studied was not untypical: in some villages there are some leaders who are sufficiently trusted (or feared) to ensure that farmers cooperate to maintain their watercourse, but it is not true of most communities, and is not a permanent characteristic of any community.

Given this pessimistic analysis, it is somewhat surprising that Merrey ends his paper with support for a proposal to encourage the development of formal water users' organisations on selected watercourses. His view is that if the initial watercourses were carefully chosen, if the formal organisations were given substantial responsibility, if significant rewards could be offered for good performance and effective sanctions against saboteurs, real progress could be made. The basis of his hope may lie in the observation that 'in opposition to outsiders, villagers will act together...to preserve the izzat of their village' (p36). As in Andhra, the creation of an external challenge (in this case parts of the irrigation bureaucracy?) could perhaps prove the best stimulus to greater cooperative effort and social cohesion (Wade, 1979, p17).

4. SOME PROPOSITIONS

With reference to the eight case studies reviewed in this paper, the following generalised propositions are offered for discussion.

a. The character of indigenous community irrigation systems and their organisation

A. Indigenous community systems are not found in all kinds of irrigation environment, but only in those where the topography has been such as to allow relatively small communities to harness and distribute water, with their own technical and human resources, with no outside help.

B. The need for irrigators on community systems to depend exclusively on their own collective action in order to continue irrigating - the absence of an external agency to fall back on - has often been a powerful reason for the vitality and effectiveness of the systems' management.

C. Irrigators on community systems have developed their own customary rules for water distribution, maintenance and conflict resolution over the years. The rules have legitimacy deriving from tradition and general consent and are therefore more easily respected than those imposed from outside.

D. Where conflicts of interest do arise (and they always will in times of water scarcity), they are likely to be most easily detected and resolved within small unitary systems or within small groups on larger systems. Breaking the rules will be spotted by others in the group; and knowledge of this, and of the sanctions which could follow, will tend to act as a deterrent.

E. In upstream areas, where many indigenous community systems are located, water is usually more plentiful and easily acquired than in downstream areas. Where this is so, water distribution will often be a simpler task than in areas further downstream and overall efficiencies of water use may sometimes be low, even within the limitations of existing technology. It does not follow therefore that because a communal system works effectively in the upstream situation that a farmers' association will be able to manage the downstream situation without advice and technical assistance.

F. Though organisations on many indigenous community systems are notable for the effectiveness with which they take decisions inaccordance with their own customary rules, these decisions do not necessarily lead to an equitable distribution of water resources: the most common basis on which water is distributed is not proportionality to area of land owned (which would be regarded as 'equitable'in the limited sense of the word used by many irrigation planners and commentators) but prior water rights.

b. External attempts to assist or establish community systems

G. Where dynamic and effective indigenous organisations are already in existence, planners seeking to help improve their irrigation technology would be wise to work with those organisations, whatever their reservations about the present pattern of distribution of benefits, and seek to adapt them gradually rather than try to replace them with entirely new organisations. This may involve working with leaders who derive their authority from their role in local society (1).

H. Where governments are interested in trying to introduce improved technology to increase the efficiency of water use in upstream systems (as they have been in Taiwan and the Philippines), their efforts are likely to meet with less opposition from farmers where a significant degree of existing local scarcity provides scope for increasing productivity and equity within the systems concerned (as in Nan-hung) than where the object of the exercise is to reduce the total amount of water supplied upstream in order to transfer more to downstream users. In the latter case the official planners' objectives of increasing overall equity of water distribution within a river basin will come into conflict with the upstream farmers' adherence to the principle of prior rights.

I. Where governments or other external agencies are aiming to establish new irrigation schemes which will be managed by local communities, choice of appropriate technology will be of critical and prior importance. Wherever possible, technologies should be encouraged which will allow significant participation of future beneficiaries in planning, design and construction and which will minimise their need to depend on uncertain sources of external support for subsequent operation and maintenance. On indigenous systems the water users typically possess the information and skills to construct, operate and maintain their own schemes (as among the Sonjo); or else the skills, information, spare parts, etc. are easily available in the locality (as in Valencia). Neither of these conditions seem certain to apply in the Matam pump scheme, Senegal. Where the topography rules out the possibility of small-scale irrigation except by pumping (as it probably does at Matam), very careful consideration will need to be made between alternative pumping technologies (and the supporting services required by them). Where the technology requires extensive external support, there is a major danger that farmers will be unable to maintain the system themselves (through lack of spare parts, fuel, etc.) and/or that they will need to depend indefinitely on government-supplied administration

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(1) cf. Levine: 'The argument frequently is made that adapting to existing social constraints reinforces the existing social structure ... In principle there is no disagreement. However, I would argue that moderate adaptation with specific equity or development goals in mind is a more effective and efficient mechanism for achieving these goals than is the introduction of foreign institutions with a high probability of failure'. (1980:p61)

and equipment, which defeatsthe initial government objective of promoting community-managed irrigation.

c. The character of jointly managed irrigation systems and their organisation

J. The topographical conditions in which most jointly managed systems are found are quite different from those generally associated with community systems. They are such as to have required the initiative in planning, design and construction to be taken by governments (or large corporations), or not at all. This conditions both government attitudes, and farmer attitudes. Having committed often very substantial investment in their planning, design and construction, governments want to have a substantial say in the way in which they are subsequently managed and will try to ensure they contribute to national rather than local economic objectives. Because farmers have rarely been given an effective part in the establishment stage, they do not feel it is *their* system. Their main interest in group mobilisation may be to extract as much as possible for their own immediate vicinity, without much concern that they are doing so at the expense of others, most of whom are far away and unknown to them. Most farmers will have little initial technical knowledge about, or interest in, the operation and maintenance of the system as a whole and the development of that knowledge and interest may often require considerable effort and time.

K. The vitality of farmers' organisation within jointly managed systems varies substantially from area to area. Much of this variation may be due to social factors unrelated to irrigation. However, the significantly greater propensity of farmers to cooperate in Taiwan and Java than in Central India and Pakistan suggests that there may be some important ecological influences at work as well (eg. greater spread of minor irrigation prior to introduction of larger systems; and a long tradition of rice cultivation, requiring cooperation between farmers for field-to-field irrigation, as well as higher population densities).

L. The development of active participation by farmers and their representatives at higher levels of jointly managed systems than the watercourse is unlikely to occur on a significant scale, or in a mutally beneficial manner, without substantial encouragement and assistance from the government side: the process took up to 50 years in Taiwan. It may involve political decisions on the balance of power between elected farmer representatives and appointed bureaucrats.

d. Can lessons in management be transferred or adapted from community to joint systems?

M. There are lessons to be learnt about the size of effective groups; about local methods of selecting leaders and resolving conflicts; about local collection of funds for maintenance and operations for direct local payment for needed staff and materials. However, the difficulties in developing active farmer management in large systems *imposed* on farmers, in contrast to the small systems *proposed* and managed by the farmers (or their forebears) should not be under-estimated.

e. Is greater farmer participation likely to be a sufficient condition for improved joint system management?

N. No, although it is an essential condition. In most cases where irrigation management is markedly deficient, the present position is
i. that farmers' organisation is extremely weak and,
ii. that many of the deficiencies in management stem from inefficiency and corruption within the irrigation bureaucracy. Without a simultaneous effort to improve the performance of the bureaucracy, significant improvement in the effectiveness of farmers' organisations is unlikely.

One reason for this is that much of the responsibility for encouraging stronger organisation at the water c ourse level will rest with the (unreformed) bureaucracy. Another is that, even if official campaigns to develop water users' associations meet with some encouraging initial responses, a sustained commitment by farmers to improving watercourse operation and maintenance (to say nothing of participating in higher level representative bodies) is likely to require sustained and predictable deliveries of water to the local watercourse outlet, (eg. Hashim Ali, 1978; Moore, 1980).

Scholars who concentrate on farmers' decision-making at the local level without reference to bureaucratic behaviour patterns in the management of the system as a whole will be - unconsciously - aiding and abetting those officials and planners who find it convenient to suggest that the creation of water users' associations is likely, by itself, to break the back of the management problems of large bureaucracy-dominated systems.

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IRRIGATION MANAGEMENT NETWORK

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ALTERNATIVE DESIGN CONCEPTS FOR IRRIGATION SYSTEMS

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A. DEFINITIONS AND OBJECTIVES

Mary Tiffen

1. INTRODUCTION

Professor Horst's paper 7c *Irrigation Systems - alternative design concepts* stimulated discussion on designing for social realities which I hope will continue. The dialogue between social scientists and engineers will probably benefit from a classification of what is meant by terms frequently in use: *flexibility, equity, relibility* etc. In this paper I am bringing together some definitions used by Ir. Rien Jurriens, International Institute for Land Reclamation and Development, Wageningen, The Netherlands; Michael Snell, Principal Engineer in a British consultancy company; Robert Chambers, Ford Foundation, Delhi; and C M Wijaratne of ARTI, Sri Lanka. (1)

2. THE EVOLUTION OF A PROJECT DESIGN

Jurriens distinguishes between planning choices and design concepts. *Planning choices* concern matters in which the financing agency and/or the government concerned insists on a decisive voice. Examples could be: the combination of crops; the type of farm organisation (state farms, owner-farmers, tenant of irrigation authority farmers); the method of irrigation - surface, sprinkler, etc, the source (gravity supply, pumped etc.). These choices may be politically rather than socially based, and the difference will be discussed in the fourth section of this paper. The design engineers then evolve, consciously or unconsciously, a *project concept* related to the way water distribution will be organised, the abilities of the management and the field personnel, and the project objectives. The selection of the types of hydraulic structure, their numbers and location is based on technical and economic requirements in combination with the project concept.

The project concept takes account of the trade-offs between different project objectives. One desirable objective can perhaps only be attained by tolerating a lower achievement of another desirable feature. Economically, there are well known trade-offs between higher initial capital costs and lower recurrent costs or simpler management procedures, and vice versa. In discussing trade-offs and their costs, certain words tend to get bandied about. Snell and Jurriens, in their comments on Horst's paper, both focussed on *flexibility* and found respectively 3 and 6 different meanings in the irrigation context. Each kind of flexibility comes at a price and may have trade-offs against the others

3. DEFINITIONS

Before tackling flexibility, it might be useful to look at other attributes of water supply systems. The supply can be described as:

A.	*Predictable*	This is sometimes used in the same sense as reliable or adequate. I would prefer to see it used simply for foreknowledge of the characteristics of the supply. It may not seem an advantage to know in advance that the supply will be inadequate and/or variable but I will show later that this does at least allow the farmer to adopt appropriate economic strategies.
B.	*Reliable*	Predictably adequate and predictably timed. Timing and amount are separable, as Chambers remarks in saying farmers 'would rather have a predictable water supply, even if a lesser amount, than to have more water in a less assured manner' (2). *Predictably timed* can be used where it is only the timing that is certain.
C.	*Adequate*	Always sufficient for a particular crop in a particular season.
D.	*Timely*	At a time desired by farmers and productive for their crops (Chambers).
E.	*Variable*	Having a strong tendency to fluctuate. This can be caused by external events, but is also affected by the choice of structures, (see figure 1 in paper 7c) poor maintenance, faulty operation, etc.
F.	*Steady*	Chambers defines this as: having a constant or near constant flow.
G.	*Fixed availability*	Supplied only during limited periods (eg. in fixed rotational systems).
H.	*Flexible availability*	The period during which water is available is increased beyond that in G but does not reach F (eg. where there are intermediate reservoirs with one or more days supply).
I.	*Management adjustable*	Direction and quantity can be varied by the Irrigation Authority. This contrasts with F J and K (mainly up-stream control).
J.	*Farmer adjustable*	Flows controlled by the farmer from either a fixed availability, a flexible availability, or a steady source. If it is from a steady source it is an *on-demand* or downstream control system.
K.	*Non adjustable or rigid*	Flows controlled by eg. fixed proportional dividers, or by on-off devices.

L. *Equitable* Supply proportionate to land-holding in the command, thus equal between top-enders and tail-enders. Depending on circumstances this may mean equality of variability for all farmers.

M. *Based on priority rights* Water supply is reliable only for the earliest developed parts of the system (first in time, first in rights, as in the USA (3)) or for top-enders, as in some Islamic systems (4). The basis for priority varies in different irrigation cultures (see Network Paper 8d), but the result is predictably adequate supplies for some farmers, predictably variable supplies for others.

The above list already provides substitutes for some of the uses of *flexibility*. *Flexible availability* covers the reservoir system discussed by Horst in Network Paper 7c and is what Michael Snell has described as short-term operational flexibility. *Flexible availability* provides the farmer with some flexibility in the timing of his operations and/or in the choice of crops. *Adjustability* (by management or farmer) covers what Jurriens has called discharge flexibility - the ability to vary the flow.

Some uses of flexibility could perhaps be eliminated or avoided. One, which Professor Horst used in the original version of his paper, and which Ir. Jurriens repeats in his comments, concerns the *hydraulic flexibility* of structures - the ratio of the rate of change of discharge into the off-take to the rate of change in the continuing canal. Snell says British engineers would usually refer to the *relative sensitivities* of the structures. Since the formula for hydraulic flexibility is indeed the ratio of the two sensitivities, this would seem the preferable term.

The term flexibility should also perhaps be avoided in discussing rigidities of systems where there are considerable time lags before alterations upstream affect downstream supplies.

We are now left with two sorts of flexibility as defined by Snell:

A. long-term operational flexibility - which could be called simply *long-term flexibility*. This allows for changing cropping patterns and some variation in operational modes in the future, without modifying canals and structures.

B. *Design flexibility* This Snell uses to describe the ability of the project concept to tolerate wide variations in block size and canal layout, and also in water availability between seasons. *Design flexibility* permits an irrigation layout to accommodate existing irregularities in the size of villages or other social units, or in tenurial boundaries, as opposed to the type of design that requires equal sized irrigation zones or blocks.

3. DETERMING FARMER REQUIREMENTS

One of the ways in which social scientists can contribute to the formation of a valid project concept is by bringing in data to decide project objectives. What are farmer requirements - do they value long-term flexibility? Do they need flexible availability? Do they value equity, even at the cost of variability, or do they prefer predictable adequacy for some and predictable variability for others, as data from some traditional systems would seem to indicate, (Network Paper 8d).

On this last point I think we need to be clear as to whether, in a concern for equity, we are imposing external value judgements on farmers. It is also wrong to suppose that farmers cannot adapt to very variable water supply. Obviously, they prefer predictably adequate supplies, which should be the objective wherever physically and economically feasible. However, farming systems can adapt to predictable variability. I have seen spate systems in North Yemen of extreme variability. Farmers appeared to calculate on having some water on some of their land in 2 or 3 years out of five. They planted barley or sorghum, utilisable as grain or fodder, and kept herds of camels, sheep and goats, using migratory grazing to even out fodder requirements and livestock sales to even out income variations. The system appears to have worked for a quite substantial period but was unable to cope with a ten year drought. Two of the villages had had an arrangement to build a dam only in alternate years - in other words, in year one, farmers had a relatively good chance of catching a flood, in year two they knew there would be no water. (This arrangement also broke down in the drought.) Some farmers in a communal system in Kenya also arrange annual rotation, indicating the adaptability of their economic system to predictable annual alternations between nil and adequate supplies (5). In some circumstances it may be better to assist tail-end farmers to incorporate variable water supplies into their economic system than to make promises of reliable supplies which management is unable to deliver. What is needed is an equitable distribution of incomes, which is not necessarily the same thing as an equitable distribution of water (6).

4. POLITICS AND OBJECTIVES

Finally, one has to recognise the political limitations to meeting farmer requirements. This brings us back to the note by Anthony Bottrall in Network Paper 1/80/2 on the political sensitivity of irrigation decision-making, and to the distinction between *planning choices* and *project concepts*. It is normally the government concerned, its politicians and senior officials (sometimes in consultation with an aid agency) who determine the spoken and unspoken planning choices, and who produce the terms of reference to which a consulting firm has to work. Othman spoke in Network Paper 2/81/1 of the planners' neglect of the target beneficiaries who then reject it: 'the project belongs to those who plan it, so let them maintain it' (p3). A consultant wrote in response 'it is really very sad to learn how often members of the authorities for whom one works think of the farmers as of no consequence. In a sense they are right since politically speaking the farmers command no block of votes ... but socially they are badly wrong for the reasons that Othman gives.' For some government authorities, the unspoken first objective for a project is 'to satisfy political and financial ends' and the 'second (a long way behind) to improve agriculture and help the farmers. The public at large is not really interested in the cost-effectiveness of projects because the money is not looked on as 'their' money'.

What is needed, therefore, is an educational process in which consulting firms but also others must take part, to convince politicians and officials to improve communications with the farmer. It is also necessary to persuade them to look at problems not just on a 'project basis but on an area basis, including the likely problems upstream and downstream of new large scale irrigation systems. The process of consultation should involve not only the farmer himself (through social surveys etc.), but also consultation with, and determination of planning choices by, the local government authorities of the areas likely to be affected. These often have a far more realistic apprehension of local needs and of the possible consequences of changes in agricultural systems than better educated central government planners. The introduction of a more effective local government voice in planning choices is, however, another politically sensitive area. It has to be recognised that in this imperfect world we can only hope for a gradual improvement in planning choices, consequent project design, and a resulting positive impact of irrigation systems on agricultural productivity and rural welfare.

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Ir. Jurriens, in another comment on Horst's paper (with which he was in general agreement), felt that Neyrpic and similar automatic systems should not be neglected, as they had been successfully used in north African countries. They could provide flexibility in meeting changing demands, particularly in association with downstream control equipment. In this respect, he referred to the need for more information on Merriam's experiments in Sri Lanka, on which Henry Gunston has produced the following note.

B. IRRIGATION SCHEDULING BY FARMERS' DEMANDS - MERRIAM'S TRIALS IN SRI LANKA

Henry Gunston

Arising from points made by Professor Horst on alternative irrigation design concepts in Irrigation Management Network Paper 7c, the following comments are offered on Professor Merriam's trails of his Demand Irrigation Scheduling in Sri Lanka. They are based simply on site visits and discussions with Professor Merriam and Sri Lankan irrigation engineers, and aim only at suggesting that Merriam's experiences in Sri Lanka need to be more widely discussed as a radical alternative to traditional centrally controlled irrigation distribution systems.

Merriam has for some time been recommending surface irrigation systems which provide the farmer with a limited flow on demand at the field, rather than make him dependent on distribution schedules imposed by an irrigation authority. As developed for use in the western USA (1), the basic components of the system were:

- an on-farm reservoir
- level topped feeder canals, from which field supplies were taken at offtakes
- automatic control gates at the heads of feeder channels, which maintain a full supply level in the channel over a wide range of flows.

In the Mahaweli Development Area of north central Sri Lanka, Merriam's system was laid out in two trial areas. At the larger area, of some 100 ha in Block 404 of Mahaweli System H, a regulating reservoir fed a level topped canal via a Neyrpic automatic constant level gate, which controlled flow up to 0.7 cumec (25 cusec). From the level topped distributary canal, traditional field channels were replaced by underground pipelines of reinforced concrete pipes, grading down from 300 mm (12") to 200 mm (8") internal diameter from the upper to lower parts of the pipeline. The individual farmer's access to water was via a field outlet, comprising a concrete base in which was mounted a 90 mm (3.5") diameter brass screw valve from which water flowed through a small V-notch weir to the fields. The outlet valve was designed to allow the farmer to take up to 7 ltr/sec (0.25 cusec) on demand at any time when water was available in the system.

The basis of *demand scheduling* was therefore that the farmer simply opened his outlet valve when he wanted water, and closed it when he had taken sufficient for his immediate needs. Reservoir storage and channel and pipeline flow capacities would be designed to match likely inputs to the system (irrigation water from above the regulating reservoir, plus rainfall) to farmers' demands spread over land preparation and the paddy growing season. Not surprisingly, Merriam encountered difficulties during his trials. Reinforced concrete pipes were expensive to make and lay, and local lack of experience in producing the types of pipe resulted in production and quality control problems. Brass outlet valves were broken, and the Harris float valves used to prevent excessive pressure build-up in the pipelines, although supposedly tamper-proof, could be jammed open by farmers thus giving some users more water than the design allowed for. Operationally, farmers needed convincing that water really would be available throughout the season. The concept of shutting off the water supply after their irrigation was new to them since many were new settlers from wetter parts of Sri Lanka, where they had not had to practice water economy.

During a lecture at Wallingford, in June 1982, Merriam stated that two years after the start of operations in Sri Lanka, some 60% of farmers in the trial areas were making some attempt to shut off flows when they were not needed, and around 20% were very actively cooperating. He estimated that at current costs in Sri Lanka his system would cost 90% more per acre than a traditional channel system laid out using current local design practice. However, despite limited trial results in terms of crop yields and seasonal water use, he was confident that the benefits of his system, in terms of water economy and availability of water on demand to both top-end and tail-end farmers, would make it worthwhile in the longer term.

Certainly the idea of *demand scheduling* is appealing, placing many of the day-to-day water allocation decisions in the hands of the farmers, but reaction amongst experienced Sri Lankan irrigation experts was lukewarm. A more general assessment of the potential of Merriam's system in the large government-managed smallholder paddy rice schemes of southeast Asia must await the publication of his overall results. Meanwhile, it would be interesting to hear from networkers in Sri Lanka how farmer usage is developing.

(I would like to thank Messrs Dennis Holmes and Jim Weller of the Kaudulla Water Management Study team of the Hydraulics Research Station for useful discussions during the preparation of these notes.)

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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER 9a APRIL 1984

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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER 9a

APRIL 1984

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1. NETWORK PAPERS

a. The Current Issue

Paper 9b, *Evaluation of Irrigation Design - A Debate* is the long promised result of the comments by many networkers on an initial paper by *R. Jurriens*. Jurriens contended that in many evaluations poor performance was blamed on poor operational practices and bad management, without sufficient consideration as to whether the design of the systems was at fault. If the situation would have been better if the design had been different, there will be important lessons to learn in designing future schemes. *Anthony Bottrall* sent this paper out with a set of questions on ways to improve the design process. He has now finished the difficult task of editing extracts from some 40 replies into a coherent discussion. Most of the correspondents were experienced members of design teams, of all disciplines and many nationalities.

A separate discussion of how new design concepts could help to minimise the need for detailed water management by large numbers of low-level, inadequately trained and motivated staff was initiated in Paper 7c, when *L. Horst* discussed the advantages of proportional dividers and the use of buffer reservoirs.

Two further responses are published as paper 9f. *Gowing* points out that structures which are management adjustable are essential to cope with certain, not uncommon, patterns of flow distribution. Professor *Merriam* has responded to Gunston's request in Paper 8e B for more detail on the results of his trials of an automated system, which is an alternative method of replacing bureaucratic control of water issues by farmer control.

The economic evaluation of the additional cost of this on-demand system is very positive, due to land saving and yield increases. The case that on-demand systems can lead to water savings has not been established as completely as Merriam would have liked, partly because of familiar troubles over lack of communication between engineers and those responsible for agricultural extension, with consequent failure to communicate to farmers new techniques of water management.

Improved design is important for new schemes or when major rehabilitation is taking place. But on most exisitng schemes 'Good managers can increase the productivity of even poorly designed systems, and conversely, poor managers cause poor investment returns to even well-designed and well-constructed irrigation systems'. The quotation is from *Frederick L Hotes*, who sums up his experience as the former Irrigation Adviser to the World Bank in a survey republished as Irrigation Management Paper 9d. He has important things to say on cost recovery, not merely as an end in itself, but also as an aid to good management and maintenance. Most of WB aided projects show good economic rates of return, despite under-estimated costs and construction time, partly because in the period under review crop prices exceeded appraisal estimates by 38%. With continually escalating costs for new irrigation, future projects may have greater difficulty in meeting economic targets.

It is interesting to read Hote's paper in conjunction with that of *Hellmuth Bergmann*, (Paper 9c B) who discusses organisation and management of Mediterranean irrigation. It is noteworthy that division of responsibilities between the engineering side and the agricultural side can cause problems in Europe as well as in "developing" countries, although sometimes there is effective co-operation. An interesting model is the French Societés d'economie mixte, a locally-based semi-public authority.

The farmers are not represented on the governing body. However, the authority's funds for operation and maintenance derive from its contracts with the farmers. Local decision-making is supported by local funds, and management has to take into account user satisfaction. Nominal representation of the users on governing bodies, in a system where final decisions are made centrally and funding depends on central government subsidies, (as in Italy), does nothing to improve management. Systems locally managed by farmers' associations, fixing their own water tariffs, as in Greece, work successfully. Both Bergmann and Hotes find it difficult to make generalisations on which type of management structure is best. However, one could perhaps suggest after reading their papers that responsiveness to farmers' needs, and decision-making at scheme-level have to be built in. The mechnism is variable - financial dependence on local water rates, a career structure which enables management to identify with the scheme, a management board elected by farmers, etc.

The last mentioned model, management by elected farmers' representatives, will only work effectively where the farmers understand the principles of accountancy and can check that the tariffs they agree are adequate and properly utilised. Many administrators and planners would say the model would not work in their country because farmers are illiterate. *Guy Belloncle's* paper (9c A) gives a methodology tested in several West African countries for giving essential accountancy skills to farmers' leaders in a surprisingly short time. Illiteracy need not be a permanent barrier to management control by farmers if there is political will to transfer power.

Incidentally, there is a tendency to believe that a management structure essentially controlled by user representatives is only appropriate to small systems, and that large systems must be government managed. Professor *Robert C Hunt* Department of Authropology, University of Pennsylvania, Philadelphia, PA 19104, USA. is researching on whether there is any relationship between type of management authority and scale in canal systems.

So far he has found a surprisingly large middle band in which management authority may be derived either from the national government, or from the irrigation community. His smallest national system is 700 ha and his largest community system 263,000 ha - see appendix to this Newsletter. Please send comments on, or additions to the list, direct to Robert Hunt.

Really small systems, of 10 - 50 ha, are perhaps normally managed by the farmers themselves. Problems arise in deciding how to help farmers technically upgrade their system, or to construct a new small system, without creating dependence on government and undermining the community's capacity to manage its own affairs. In Paper 9e *Evan Mayson* describes the methodology evolved in collaboration with the University of Khon Kaen, Thailand. This helped villagers construct some 40 small weirs, 1978-1983. These very small systems are not unimportant. In Korea *Robert Wade* has reported 64% of the irrigated area is served by systems of less than 50 ha, and *Walt Coward* of Cornell University notes they also are important in Tamil Nadu, India, in the Philippines and in parts of Latin America.

b. Future Papers and Newsletters

The current set of Papers is larger than usual. Even so, I have had to hold some contributions over to the next issue. I should be glad of reactions from members on what they think is the desirable number of papers. Presumably, the more there are, the less they are likely to be read?

At present, all papers are sent to every networker. Would it be better simply to list and describe them, and for you to send for those you wanted?

I would also welcome suggested topics for discussion. One suggestion has come from *A S Widanapathirana*, Co-ordinator Gal Oya Water Management Project :

> I suggest that we must plan one issue of network papers for a discussion on different approaches adopted to get farmer participation for water management across the countries. I am aware that many countries have experimented with different models of farmer participation. However, I (hopefully other readers too) do not have information about their success (or performance) etc. If you can bring them together in a form of one network paper, would be of much benefit. I can provide you with the different models being adopted (or experimented with) in Sri Lanka.

This seems a good suggestion. We have already made a start with *Singh* on Pochampad, India (Paper 8c) *Diemer* and *Van der Laan* in paper 8b, and *Belloncle* in Paper 9c B, both on francophone West Africa. I have already received for the next issue in October 1984, a paper by *Nick Chisholm* summarising a five year follow up study on the performance of farmers' associations in tubewell areas in Bangladesh. I would welcome more papers evaluating the performance of farmers' associations, preferably those established at least five years, and relating this to their constitution, functions, financial arrangements and actions taken to help establish them. Has the establishment of FAs led to reductions in cost or numbers of irrigation staff or to measurable improvements in staff efficiency? It would be necessary to distinguish between unitary associations, where one community is served by one water source, and federal associations, where several communities share the water, and some authority must allocate water between them. It will also be necessary to specify if water is in short supply or not, the degree to which irrigation is essential to crop production, and the degree of community experience in irrigation and in community action for other purposes. Depending on what you send in, we could either publish two or three more case studies, or I could edit a composite paper from your contributions. Preferably they should not relate only to Asian rice growing areas which will be covered by an FAO consultation - see section 2b below.

Another suggested topic is *design for ease of maintenance. Ian Rule*, responsible for maintenance in one of Zimbabwe's Regional Water Authorities, has already sent in notes of some of the problems he encounters that could have been avoided by slight modifications at the design and construction stages. If any other maintenance engineer has views on this, I would be glad to receive them by end August, in time for the October issue.

I am enclosing with this issue a form on which you can put down your views on editorial policy, and on papers or notes that you would like to contribute to, and subjects on which you would like to read of the experience of others. You may get ideas as you read below on topics discussed at some recent conferences. The difference between a Network and a journal is precisely that a network reflects the views and experience of its members. Please don't leave participation all to the farmers!

Finally, we intend that the October issue will be accompanied by a revised *Register of Members*, so that you can communicate with each other direct when you have similar interests.

c. Correction to Paper 8b

In Paper 8b, on small-scale irrigation in the Senegal, by *Geert Diemer and Ellen van der Laan*, the word "cannot" unfortunately was omitted in typing. On page 7, section 7, second paragraph, the third sentence should read "A village chief <u>cannot</u> wield his authority in an autocratic manner". Please amend your copy.

2. NEWS FROM NETWORKERS

a. International Programmes

Dr Thomas Wickham has been appointed first Director General of the new *International Irrigation Management Institute* as from June 1, 1984.

Dr Wickham has a rich background of technical competence and practical experience in multi-disciplinary approaches to irrigation management. He served for about four years with the International Voluntary Service (IVS) in South East Asia in the early 1960's, and later did thesis research on irrigation management at the International Rice Research Institute in the Philippines, on a co-operative programme within the National Irrigation Administration. He served on the staff of the International Rice Research Institute from 1972 - 1978, first as Agricultural Economist and later as Agricultural Engineer and Head of IRRI's Department of Irrigation and Water Management. Since that time, he has divided his time between serving as an irrigation development consultant with the World Bank, IFPRI, the Asian Development Bank, USAID, and OXFAM, largely in South and South East Asia, and operating the family fruit and vegetable farm on Long Island, New York.

The *World Bank's AGREP* Division, with UNDP support, initiated in July 1983, a two year study of 'Options and Investment Priorities in Irrigation Development'. This will be aimed at testing and refining a quick and cheap methodology for utilising existing information. It is being carried out by a French consortia (SCET/AGRI; GERSA; SEDES). They are collecting and analysing information on :

(i) the options and priorities for irrigation development in the country, taking into account other options for expanding agricultural output;

(ii) the implications of such development on human health conditions;

(iii) the main "non-tradeable" constraints to the development of the country's irrigation potential;

The first country studies are of Morocco, Mali, Sudan, Thailand and Peru.

In a second phase, the study may be extended to other countries with irrigation potential, if there is bilateral and country support.

Douglas Merrey, *Bureau for Science and Technology, USAID,* Washington DC 20523 has provided further details on WMS II (see Newsletter 8a p.4)

> The longer term research under the WMS II Project is focused on three broad themes : development of computer models for improving main system management (Utah State primarily); improvement of the interface between Agency and farmers at the unit command level (primarily Colorado State); and improvement of small-scale locally-managed irrigation systems (primarily Cornell).
>
> Dr Dan Lattimore is presently Project Director for Colorado State University's activities under the WMS II Project. Dr Wayne Clyma is the overall managing director of the project; his main responsibility is to co-ordinate the activities of the three universities in the project. The address for both Dr Clyma and and Dr Lattimore is : Water Management Synthesis II Project, University Services Center, Colorado State University, Fort Collins, CO 80523, USA.

b. Meetings and Seminars

I have attended two seminars recently. *Cornell University* held a stimulating workshop on *small scale irrigation*, Nov 29 - Dec 1 1983, with discussion papers on investment policy, design, local organisation and participation, and Agency roles, drawing on examples from Asia, Africa and Latin America. Walt Coward has since prepared a draft paper on "Improving policies and programs for the development of small scale systems", on which he is inviting further comment. Other papers are also being prepared for publicaion. Details from Barbara Lynch, Cornell University Irrigation Studies Group, 372 Caldwell Hall, Ithaca, NY 14853, USA.

Bauchi State and Kano State Agricultural Development Programmes organised a second *Fadama Seminar*, 7-8 March, 1984. In the last two or three years many hundreds of individual farmers, or small groups of farmers, have been investing in small diesel or petrol pumps to obtain water, mainly for vegetable production, either from a nearby river, or from a shallow well or borehole, in the fadama or flood plain areas of northern Nigeria. The purpose of the seminar was to demonstrate and exchange informaton on cheap drilling methods (farmers pay for their wells), extension methods both to farmers and to village-level mechanics (for maintenance) and problems arising out of the programme. The expansion of demand for the pumps and wells is so rapid that one forseeable requirement is co-ordination in ground water monitoring and in allocation between the State agricultural programmes and the Federal River Basin Development Authorities, which have programmes for river regulation and for large-scale schemes. I was asked to initiate enquiries into the adequacy of land tenure arrangements, and marketing arrangements. Papers will be published : contact Dr N Chapman, Bauchi State ADP, PMB 230, Azare, Bauchi State, Nigeria, or c/o BASRA, 28 Old Church Street, London SW3, U.K.

A report, *Aid for the Development of Irrigation*, OECD, (1983) has been published, in both English and French. Edited by Ian Carruthers, it contains the papers (including that by F L Hotes which also appears as IM Paper 9d), of a workshop attended by experts from aid agencies and from developing countries, in September 1982. The discussion was based on two papers by Ian Carruthers. One, on the implications of recent aid experience in irrigation development is wide-ranging both geographically and in terms of subject matter. He emphasised the need to keep existing works in good order, and hence, the need to give a realistic weighting to recurrent and local costs in project design. His discussion of O & M deficiencies includes practical examples of management tools used for diagnosis in Pakistan and Bangladesh. While some other papers had an african orientation, the report as a whole and its major conclusions are worth study by all concerned in irrigation management. It is available from OECD, 2 rue Andre Pascal 7577, Paris Cedex 16, France or from OECD Sales Agents in various countries.

A workshop on the *Scheduling of Irrigation* took place at the Water and Land Management Institute, Aurangabad, Maharashtra, India in November 1983. The papers are available from the Institute price Rupees 100. The papers and discussion reveal a good deal of improvisation and innovation in the scheduling and distribution of water on main canal systems. Robert Chambers describes it as a seminal workshop. The papers demonstrated gains to be won through three appraoches - scientific precision, based especially on crop water requirements, pragmatic management based on common sense and rules of thumb, and through the combination of both approaches.

A one day seminar on *Participatory Approaches to Irrigation Management* was held at the Agrarian Research and Training Institute, PO Box 1522, Colombo 7, Sri Lanka, in January 1984. The proceedings will be published - contact A.S. Widanapathirana at ARTI.

A two day workshop on *Irrigation and Human Welfare* was held at Rutgers University in November 1983, with the support of UNDP. The focus was on integrated planning and management of irrigation and related water supply and sanitation projects. A good summary of the discussions on the obstacles to the integrated approach and of the papers prepared for the workshop, is worth obtaining from Leslie E Small, Department of Agricultural Economics, Cook College, Rutgers University, New Brunswick, New Jersey 08903, USA- particularly if you are interested in the health impact of irrigation. A short course on the same subject is being organised by Mr Small, May 28 - June 8 1984, at Rutgers University.

A Seminar on *Information for Improved Irrigation Planning and Management* in Bangladesh, was organised by the Water Resources Centre of the Department of Water Resources Engineering, Bangladesh University of Engineering and Technology, Dhaka-2, on 21-22 March 1984. (Contact person : Prof M Shahjahan, Department of Water Resources Engineering, BUET).

The German National Committee of ICID is sponsoring a one day symposium on *traditional irrigation systems*, focussing on lessons to be learnt for modern systems, on 24 April 1985. Contact person : Dr F J Mock, Technische Hochschule, Rundeturmstr 1, 6100 Darmstadt, West Germany. The German ICID works closely with the German Association for Water Resources and Land Improvement, (DVWK) which had an excellent symposium on *Man and Technology in Irrigated Agriculture* in 1982. Its proceedings are now published as DVWK Bulletin 8, 1983, available from Verlag Paul Parey, Spitalerstr 12, D-200 Hamburg 1. One paper, by H Bergmann is reprinted as IM Paper 9c B. Papers on irrigation management and problems in African and Mediterranean countries are particularly interesting.

FAO Land and Water Division and USAID are sponsoring jointly with the Komite National PBB Pertanian an International Expert Consultation on *water management* to learn from recent experience in farmers' participation and organisation, in Asian rice growing areas. Case studies will be presented. A published report is intended. Contact : P J Dieleman, FAO, 00100 Rome, Italy. The meeting is in Jogjakarta, Indonesia, 16-21 July, 1984.
FAO Land and Water Division are preparing for a workshop on *small scale swamp development*, in Sierra Leone, 26-30 November 1984. Contact Harry Underhill, FAO, 00100 Rome, Italy.

There will be a Seminar on *Command Area Development Authorities in India* in late July or early August. Contact : Dr B K Narayan, Nagarbhai PO, Bangalore 560072, India.

The British National Committee of ICID and the Ross Institute of Tropical Hygiene are organising an *International Symposium on the Re-use of Sewage Effluent*, 30-31 October 1984. Contact: Norman Tyler, Institution of Civil Engineers, 1-7 Great George Street, London SW1.

Further details on the *African Regional Symposium on Smallholder Irrigation* which will be an interdisciplinary exchange of information and experience, to be held in Zimbabwe 5-7 September 1984, are available from Dr Alois Hungwe, Department of Land Management, University of Zimbabwe, PO Box MP 167, Harare, Zimbabwe, or from Hydraulics Research, Wallingford, England. (I will be giving a paper and am looking forward to meeting some African networkers there).

c. Reports from the Field

The Ford Foundation is setting up a *Program on Water Management* in Mexico, where the irrigated area now exceeds five million hectares. Contact: Arjen van der Sluis, Ford Foundation, Apartado Postal 105-71, Mexico 5, D.F.

The *Gal Oya Water Management Project*, funded by the Government of Sri Lanka and USAID, has two major programmes of research. One programme involves the fielding of a catalyst agent in order to promote farmer organisations. The other is to undertake continuous evaluation of project activities. Six-monthly reports will record changes in systems performance as a result of project activities at the end of each season. Details from A.S. Widanapathirana, Co-ordinator, Gal Oya Water Management Project, PO Box 1533, Colombo 7, Sri Lanka.

ILRI have been working on a model for a small-scale irrigation system equipped with a windpump. Details from Ir L.R. Van Veldhuizen, ILRI, PO Box 45, 6700 AA Wageningen, The Netherlands.

d. Training Programmes

The Government of India, with the assistance of USAID has launched an ambitious *Irrigation and Management Training Project.* During its seven year life, this project will strengthen selected Indian institutions and develop human resources responsible for management and use of irrigation water. Project elements include :

* Training for all levels involved in irrigated agriculture, from senior officials, to field technicians and farmers, in five state training institutes (Maharashtra, Madhya Pradesh, Rajasthan, Gujarat, and Tamil Nadu) and at new central training facilities.

* detailed long term studies of operating irrigation systems, using an interdisciplinary "diagnostic analysis" approach.

* adaptive research on specific irrigation problems by participating institutions.

* development of mechanisms for disseminating more effectively the results of research, new training materials, ideas, and improved technologies.

* formulation, implementation, testing and evaluation of new organizational and procedural concepts and their institutionalization on a wider scale, and

* development of an improved capacity for river basin/water resources planning.

The project will link with USAID-assisted projects being planned or implemented in four of the states.

Further information from Dr Max Lowdermilk, Water Management Specialist, USAID, U.S. Embassy, New Delhi, India.

Video tapes on diagnostic analysis, which may also meet other training needs, have been produced covering agronomy, economics and engineering. A leaflet with prices is available from Dr Wayne Clyma, Water Management Synthesis Project, Colorado State University, Fort Collins, CO 80523, USA.

The Commonwealth Secretariat and the Indian Institute of Management, Bangalore, ran a Training Course for Senior Irrigation Managers and Management Trainers from Commonwealth countries of East and Central Africa and South Asia, 15 Mar - 20 April 1984. The course covered operational aspects of irrigation management through lectures, case studies, discussion groups and field visits. The objective was to enable the participants to introduce improved management systems on irrigation schemes in their countries, and to initiate in-service and on-the-job training programmes for their staff. The Commonwealth Secretariat hopes to assist countries in mounting national and regional programmes in years to come. Details from A. Ellman, Commonwealth Secretariat, Marlborough House, London SW1Y 5HX, U.K.

Silsoe College, Bedford MK45 4DT, UK has added Drainage and Reclamation, and Soil Conservation to the options in its MSc Irrigation Water Management Course.

3 ECONOMICS AND EVALUATIONS - A REVIEW

I feel it worth drawing attention to some useful recent publications. The first is a reissue of the classic textbook *I. Carruthers and C. Clark*, The Economics of Irrigation, Liverpool University Press, 1983. This is a second impression of the revised 1981 edition, now available as a paperback at £10.50, or in the ELBS edition at £3.50, prices at which students can be encouraged to buy for themselves. Many a project manager would also find it a useful reference book, abounding in practical illustrations ranging over the economics of ox power, the relationship of sharecropping and salinisation, the importance of the precise timing of water applications, ground water economics, charging for water, etc etc.

A short paper by *H Bergmann*, 'Economic Considerations in Choosing Irrigation Systems' (15pp) is forthcoming in the Israelian Irrigation Review. It looks at surface-furrow irrigation, (earth and lined canals); sprinkler irrigation (mobile and fixed); and drip. It includes a matrix ranking them for their advantages and disadvantages for water consumption, investment costs/ha, social factors, O & M costs, time, land use, and ecological factors. Bergmann emphasises, however, that exact cost figures can only be determined locally, according to the scarcity value of water, the cost of labour, cost of materials, prices for agricultural inputs and outputs, etc. He notes that for most crops the water production function is concave, eg one can produce with 70% of the optimal water 95% of the maximum obtainable yield, which has implications for land and water use. Amongst social factors he considers labour input for maintenance and for irrigation, physical effort, need for technical skill, ease of night irrigation.

Sadigul I Bhuiyan has written on Irrigation System Management Research and Selected Methodological Issues, IRRI Research Paper Series No 81, Oct 82, 9pp. available from IRRI, PO Box 933, Manila, Philippines. He considers criteria for evaluating field research on methods of improving irrigation system performance. He discusses in turn, crop yield, cropped area, water use efficiency, irrigation efficiency, relative water supply, water adequacy and water distribution equity. It is an extremely useful and clear sighted discussion, very relevant to the needs of many systems in South and Southeast Asia, his area of interest. These are countries with established irrigation systems needing to use water efficiently to cater for increased population, and where investment costs per ha for needed improvements may be low. He therefore feels "water and its benefits to people" should "be the central focus of evaluation".

The danger would be in using only these criteria in inappropriate situations. Where it is a question of high cost improvements (eg some types of salinity control) or of deciding whether to invest in a new and expensive irrigation system, returns to investment, which he leaves aside, must be considered. If it is not water, but skilled management personnel that are in short supply, the capacity of the system to be managed by local people must be a criteria. If land is plentiful and farmers have other income earning options, as in parts of Africa, the returns per labour unit in the farm family become of central importance. Research, investment and evaluation have always been specific to local needs.

WMS I has produced an *Irrigation Projects Documents Review*, which lists USAID and IBRD irrigation projects giving standardised data from project preparation documents. It is intended as a resource paper indicating general directions of irrigation project investments. As such, it provides useful data on project objectives and anticipated costs; it does not attempt evaluation of completed projects. Appendix A relates to The Indian Subcontinent; B to East Asia; C to Near East and Africa; D to Central and South America. Available from Water Management Synthesis Project, Utah State University, Logan, Utah 84322, USA.

Just arrived, but too late to review, what looks a valuable report, Irrigation and AID's Experience : A Consideration based on Evaluations, AID Program Evaluation Report No 8, August 1983, USAID, Washington DC 20523, USA.

4 LUNCHTIME MEETINGS AT ODI

13 December 1983 : Dr F D O'Reilly *Traditional Management of Rice Cultivation in the Sokoto Rima Irrigation Area* (N W Nigeria).

5 OTHER AAU ACTIVITIES SINCE OCTOBER 1983

John Howell has written an ODI Working Paper on *Small Farmer Services in India*. This is a study of the provision of agricultural services by government or government-controlled agencies to small and marginal farmers in two Blocks in Orissa State. The study examines issues of access to services (particularly extension, credit and the supply of fertilizer) by investigating levels of farmers demand in selected villages, and issues of efficiency by investigating the performance of different mechanisms of service provision. The study has a particular focus on two projects : the Indo-British Fertilizer Education Project and the World Bank-assisted Orissa Agricultural Development Project. The report (pp178) is available from the Publications Assistant, ODI, price £6.00 (including postage).

The Pastoral Development Network issued a Newsletter in February 1984 with 3 accompanying papers, on financing animal health services in Africa, the integration of pastoralism and semi-mechanised farming in Eastern Sudan, and the pastoralist economy in a conservation area of Tanzania.

Mary Tiffen

6 April 1984

Appendix to Paper 9a

Chart 1. Measures of Size and Source of Charter for Allocation Executive

Name	Size (ha)	Charter
San Juan, Mexico	600	Irrigation Community
Tayuban, Java	700	National Government
Zanjera Danum, Philippines	1,500	Irrigation Community
Vicentre Guerrero, Mexico	1,575	Irrigation Community
12-Go, Japan	5,500	Irrigation Community
Moncada, Valencia, Spain	7,000	Irrigation Community
Morelia, Mexico	8,000	National Government
New Cache LaPoudre, USA	15,400	Irrigation Community
Angat River IS, Philippines	26,890	National Government
Rio Mayo, Mexico	95,973	National Government
Fresno Irr Dist, USA	97,000	Irrigation Community
Chia-nan Irr Assoc, Taiwan	150,000	Irrigation Community
Hindiyah Barrage C, Iraq	209,000	National Government

King's River W A, USA	263,000	Irrigation Community
Gezira Scheme, Sudan	730,300	National Government

Compiled by Robert Hunt, University of Pennsylvania, Philadelphia, PA 19104, USA.

Please contact him direct on queries or discussion.

odi

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 9b APRIL 1984

EVALUATION OF IRRIGATION DESIGN - A DEBATE

R Jurriëns, A F Bottrall and Others

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In September 1980 Anthony Bottrall sent the following paper by Rien Jurriëns to a number of network members with a particular interest in irrigation design. The most important comments this stimulated form Section C of this paper. Network members are invited to continue to participate in the debate on means to secure appropriate design, and on the necessary reforms in planning methodology, to provide a basis for better managed, more productive irrigation schemes.

A. IRRIGATION DESIGN AND OPERATION - *Rien Jurriëns*

The possible relationship between the planning and design of irrigation schemes on the one hand and their performance on the other is a central issue in Network Papers 1/80/2 and 1/80/3. It has long been suggested that planning and design should be improved - that they should be more 'farmer-oriented', 'integrated', 'multidisciplinary', and so on. Up to now, however, although general agreement exists on what to do, there seems to be a lack of operational knowledge on how to put this into everyday practice. One of the reasons is a lack of systematic approach to evaluating irrigation schemes (discussed so often by Bottrall); another related reason is the biased view that evaluators hold on many subjects, causing them to draw too swift conclusions and preventing further investigations from being undertaken. To illustrate such bias and to show how scheme performance can be improved by improving the design, let us take as an example the often discussed phenomenon of 'head-tail differences' within the tertiary unit. Usually there is little doubt in the minds of evaluators: these differences are a matter of poor operational practices. The blame is placed on scheme management, farmers' organisations, social structures, farmers' practices, water regulations, etc, and the conclusion is invariably that the operation has to be improved. Of course, all this may be true to some extent, and the reports and papers are often interesting to read.

But why not - for a change - consider the problem primarily as a matter of design? Why not consider whether the canal capacities are too small, whether there is too little water available, or whether the rotational schedules are inadequate? If this is found to be true, design practices could be improved, which would be infinitely easier than attempting to improve operational practice to a standard not commensurate with the circumstances. The first question to answer is: 'Would the situation have been better if the design had been different?' If the answer is 'yes', the second question is: 'What lessons can be drawn for future design?'

The first question is often impossible to answer because the information required for the purpose is seldom provided in the literature.

Within the tertiary unit, the 'technical' parameters that can influence head-tail differences are: cropping pattern, water requirements, number of farmers, rotational schedule (interval, duration, flow-rate), tertiary unit dimensions, irrigation efficiencies realised, and canal capacities. A detailed investigation of these parameters could well lead to one or more of the following conclusions:

- The field application efficiencies are much lower than the design values, but the farmers, under the given conditions and with their given abilities, cannot be blamed and cannot be said to waste water purposely;

- The water requirement is higher than the design values, perhaps because of different cropping patterns, additional water use, too long irrigation intervals;

- The irrigation flow rate is too large to be handled by the farmer, making extra losses inevitable.

If these problems cannot be recognised and corrected through existing means of technical and social control, the result will be a higher water use by the head farmers and water shortages for the tail farmers.

Other possible distribution problems are the following:

- The losses in the tertiary canal are higher than had been foreseen;

- Farmers have different farm areas and different cropping patterns, leading to operational problems and losses;

- There are too many farmers for the tertiary canal to be effectively operated;

- Facilities for measuring flow rates or volumes are lacking, leading to ignorance of what is actually happening and inducing extra operational losses.

All this might well be true and if so, although farmers and their organisations may be doing their utmost to control the situation, it is far too complicated for them to manage.

Now we come to the second question: 'What lessons can be drawn for future designs?' There are various possibilities, first at farm level:

- Being more strict on farm dimensions and layout;

- Assuming more realistic farm efficiencies;

- Assuming more realistic water requirements, taking into account possible variations in cropping pattern and other water uses;

- Choosing a different irrigation interval by taking into account variations in climatic and cropping patterns;

- Choosing another irrigation flow rate and taking into account physical parameters, farm dimensions, farmers' abilities;

- Choosing another combination of flow rate and duration of irrigation turn, taking into account the above parameters, local habits, and labour requirements.

Further, for the distribution system:

- Having fewer farmers on the tertiary unit, which can mean a shorter tertiary canal;

- Assuming lower distribution efficiencies;

- Improving water management by changing the rotational schedule or by better water measurement facilities;

- Dividing the farms by giving one farmer several plots on different locations along the tertiary canal.

The above items involve many choices, in which purely technical considerations play only a minor role or merely determine the boundaries within which a wide variety of possibilities remains open. The choices within these boundaries could be called *conceptual design*, which means making choices on the basis of non-technical (social and economic) considerations or, more specifically, on the basis of considerations that take into account the possibilities and constraints of all resources: physical, financial, economic, *and* human. The conceptual design, while exerting a strong influence on the ultimate performance of a scheme, is often applied inconsistently and unsystematically and is frequently based on personal preferences that are not founded upon any substantial theoretical and experimental knowledge. Much work remains to be done to enable a quantitative substitution of the above suggested improvements.

This discussion of the head-tail differences in a tertiary unit has been given merely as an example. A similar discussion could be made for other items in an irrigation scheme. The following conclusions could then be formulated:

- In evaluating the performance of an irrigation scheme, one should avoid all bias towards management or institutional aspects. One should review all possibly relevant information, including the technical data. Only then can an answer be found to the essential question: 'How much of this poor performance is attributable to inadequate technology and how much to inadequate management?' (*Bottrall*, Network Paper 1/78/3).

- Greater knowledge is required to improve conceptual design. This is the real implication of frequently heard statements about 'the need to integrate non-engineering aspects in planning and design', and similar vague recommendations.

- To collect the knowledge required for the above improvement, investigations should be less descriptive. Instead of considering the irrigation system as a given fact and then investigating its operation, one might do better to consider the operational potential as a given fact and then investigate what makes the system so difficult to operate. The investigations should try to distinguish the various potentials and then determine their impact on the conceptual design.

B. QUESTIONS *Anthony Bottrall*

Accompanying Jurriëns' paper was a covering note from Anthony Bottrall which suggested that networkers might also wish to address themselves to the following broader questions about the nature of the design process:

1. What range of information (on physical, technical, economic, financial, social, administrative and other matters) is needed for good irrigation design? *(Jurriëns pointed out later that this question should have read: 'What range of information ... is needed to evaluate irrigation design?')*

2. Is Jurriëns correct in saying that this information (or guidance on how to obtain it) is 'seldom provided in the literature'?

3. Alternatively, does the information and guidance exist but only in spearate unidisciplinary compartments, so that it is difficult to combine and apply in practice?

4. Alternatively, is the information easily available but, for certain reasons, rarely applied? (If so, what are the reasons?)

5. If the approach required for good irrigation design is interdisciplinary, what implications does this have for the range of disciplines which should be represented in the design team, their respective roles, the amount of time required for fieldwork, etc?

6. What part can farmers play in improving irrigation design?

7. How important is it to evaluate the design of already installed irrigation systems before designing new ones?

8. What measures are most urgently needed to improve the quality of irrigation design practices?

The note also suggested that some respondents might wish to discuss the system design process within the larger context of the planning process, substituting 'planning' for 'design' in the questions listed above.

C. THE DEBATE

The paper produced a large response. Out of the 100 or so networkers who received it, 35 sent back comments, often at some length: two comments (of 9 and 13 pages respectively) were substantial 'papers' in themselves. While such a degree of interest was gratifying, it presented considerable editorial difficulties and inevitably meant that, if this Network Paper was to be kept to manageable proportions, justice could not be done to everyone's contribution. In the sections that follow as much space as possible has been given to the views of the respondents, listed at the end of the paper. The link passages and editorial comment have been supplied by Anthony Bottrall, who takes responsibility for any distortion or misrepresentation which may have occurred.

1. Design versus Operation - a Red Herring?

Rien Jurriëns' somewhat provocative remarks about the biases of evaluators who 'invariably' attribute poor irrigation system performance to bad operation rather than to bad design (para 1) probably helped to stimulate the large response; but it may also have diverted some respondents' attention away from the central issues he wished to have debated. It is in fact something of a red herring; and, though not without interest, it is probably best removed from the discussion at an early stage. The main points seem to be these:

a) It is true that most recent evaluations of the performance of irrigation projects have been undertaken by social scientists rather than engineers or other technical experts; moreover, these social scientists have obviously been better equipped to comment on details of management than on details of technical design. On the other hand, many of them have surely recognised the existence of design deficiencies and the limitations they impose on what can be done by improved management alone. *Kathpalia* appeared to doubt this:

> In recent times most of the analysis of operation of irrigation systems done by sociologists and economists has tended to neglect the aspect of irrigation design. As such the solutions often recommended are not realistic and may not achieve the desired objectives.

P.S. Rao agreed. *Farbrother*, however, pointed out that in Anthony Bottrall's Comparative Study of the Management and Organisation of Irrigation Projects for the World Bank, 'pride of place is given to "Deficiencies in Technical Design"'. See also, for example, the work of *Robert Wade* and *Mick Moore;* and Network Paper 1/80/2, whose contents were taken entirely from studies by social scientists.

b) Everyone, including social scientists, would prefer to see interdisciplinary evaluations being done which would enable specific answers to be given to the two questions in Jurriëns' second paragraph. Unfortunately, however:

> designers of irrigation systems are rarely, if ever, involved in evaluation of the management and performance of existing irrigation systems. *Lenton.*

> Technical evaluation of design is very rare. Jurriëns' question, "Would the situation have been better if the design had been different?" is not answered by the literature simply because the analysis has not been done. *Vincent.*

> This sort of ex-post research and evaluation is not part of the culture of irrigation bureaucracies. *P.S. Rao.*

For some of the reasons, see below *(Passim).*

c) Several respondents took exception to the reverse bias implied in the suggestion that the problem be considered 'primarily' as a matter of design (para 2), and *Farbrother* poured scorn on the idea that it would be

> infinitely easier to design a new scheme in such a way as to accommodate incompetence and corruption among field staff than to strive to eliminate them.

But nearly all accepted that there were widespread weaknesses in irrigation planning and design, especially those working in the Indian sub-continent (an exception being *Srivastava*, who argued that practices had improved substantially since 1960). The most common view was that design and operational weaknesses were <u>both</u> serious problems, their relative importance being a matter to be determined on a case by case basis.

> No amount of effort at improving standards of management and farmer discipline can compensate for poor design or maintenance of physical structures. It is equally true however that the effectiveness of the most excellent scheme design, with the highest standard of maintenance, is easily subverted by undisciplined or untrained staff and farmers. *Devitt.*

Pant and *Khan* cited examples where, in the absence of adequate institutions, apparently sound water-course design had not led to satisfactory performance, on the Kosi (Bihar, India) and Mahaweli (Sri Lanka) projects respectively. *Chambers* added that 'without discipline among farmers, I cannot see that the "head and tail" problem can be solved by improved design'. This was balanced by *Sinha* 'Where the design is not appropriate, management would seem to play the role of a captive pilot'. *Sundar* summed it up:

> Design improvement is only one aspect. Operation and farmers' organisations cannot be overlooked. It will be by combining both that we reach the right solution.

e) Very often, bad design goes hand in hand with bad management, and good design with good management, not so much because one is causally dependent on the other as because they each represent two sides of the same coin. In other words, the factors to which poor design is usually attributed tend to be remarkably similar to those typically cited as the reasons for poor management; and to the extent that these factors are present in any particular context, the quality of both design and management is likely to be similarly affected. Thus, as explanations for poor design, just as for poor management, we find

i) <u>Unclear or conflicting objectives</u> These can occur at the level of government, where there may be

> unclear objectives on the target group to benefit, and political conflicts on the optimum size of the scheme. The size of holding sponsored for political reasons may be inconsistent with financial objectives or family labour; etc. *Vincent*.

> Although farmers' satisfaction is sometimes stated as an objective, it is not uncommon for the real objectives (unstated) to be quite different - eg. satisfaction of political objectives. *Griffith*.

> The undertaking of a project is often decided on non-economic considerations. The exercises that follow are thus attempts to clothe a socio-political decision so that it looks rational and acceptable. *Sinha*

Such sources of inconsistency are 'very hard to tackle' *Vincent*. The same may be true of some activities at the planning or design agency level: eg.

> If the designer's main aim is to maximise profit on building a dam and project works, or to sell his proprietary equipment, then it will be unlikely to lead to good design. *Griffith*.

But many of the inconsistencies at this level should be less intractable, eg. where design practices have failed to keep pace with changes in objectives over time:

> In parts of India where irrigation has been practised for the past century, much work was done on the design of irrigation systems to achieve certain social and economic objectives, and detailed design parameters were spelt out. But in the last 30 years this aspect of irrigation design has been neglected and has not been brought up to date with changing social and economic objectives. *Kathpalia*.

ii) Lack of co-ordination Rigid compartmentalisation of responsibilities among different government agencies is common, contributing not only to poor lateral communication between planners and designers of different disciplines, but also to a virtual segregation of planning and design from operation and management.

> Irrigation and Agriculture Departments have been operating in isolation and no coordination at any level has been forthcoming at the planning stage. *Rege*.

> Under a highly departmentalised organisational structure, certain crucial parts of the system operate largely unaware of, and unaffected by, the end results of the system as a whole, with naturally unsatisfactory consequences. But under a body accountable for all aspects of irrigation, there would be an increased tendency to judge the designer, not on the plans he produced, but on whether those plans proved implementable; and planning could be more easily treated as a process of continuous refinement, with designers and implementers being jointly involved through all the stages from concept to management. *Parker*.

iii) Domination of decision making by narrowly-trained engineers In planning and design, as in system operation, engineers tend to dominate the decision-making process; and especially where responsibilities are highly compartmentalised, this can mean that relevant information obtainable from others is not sought or - for reasons of interdepartmental rivalry - may even be deliberately ignored. Two highly critical comments from India:

> Because of the absence of an interdisciplinary approach, each participant basks in the glory of his expertise and refuses to accept the possibility of error in his discipline. I have seen irrigation projects where almost everything was available in the documents, but the designers cared to consult them only reluctantly, if at all. *Sinha*.

> Even if some important information is available it is rarely applied, either due to sheer negligence or ignorance, or both. *Rege*.

Swan may have been making a similar point, somewhat more gently, when he observed that available information is 'often not applied because of pre-conceived opinions'. *Srivastava* felt that engineers were more sinned against than sinning:

> Disciplines other than irrigation are lukewarm about furnishing information required for irrigation design.

Leakey considered it

> essential that thorough agricultural studies should precede in time the studies of other design team members;

Parkes was the only respondent whose experience led him to suggest that 'too few engineers are included in design study teams'. More common was the view that most design engineers are too narrowly trained; eg.

> Most irrigation programmes ignore synthesis; they deal only with the individual components. Improvements in conceptual design must therefore begin with improvements in the basic quality of irrigation engineering instruction. *Lenton* (cf. *Allison*, *Kathpalia*).

iv) Lack of accountability With reference to the general absence of information which would enable a system's performance to be related to its design, *P.S. Rao* observed that in irrigation bureaucracies 'the concept of accountability is not commonly talked about'. *Parker* referred to the particularly marked absence of accountability on schemes where responsibilities are divided among several departments.

v) Insufficient resources Just as system operation and maintenance are often regarded as low priority, low budget activities, so many of the activities which could help to improve irrigation design tend to be neglected or inadequately performed, because insufficient finance - and time - is made available for them. Thus, on information-gathering generally:

> A thorough study of the geographical, agricultural and relevant sociological literature of countries in which irrigation schemes are to be planned is unfortunately very seldom carried out, or considered necessary by consultants. If it is considered necessary it is not adequately costed, so that in practice it cannot be carried out. *Leakey*.

Cf. the necessary time needed to collect and collate the information required is unacceptable to the client. *Parkes*.

Similarly, on the use of evaluation as feedback to planning,

> funds are not earmarked in any project for ex-post evaluation. *P.S. Rao*.

> Most of the literature on evaluation is by academics in the social sciences - the one group in a research/financial position to undertake such work. There is very little money for technical evaluation.

> Where the capital for irrigation schemes comes as aid, it is usually specifically allocated for construction without allowance for future evaluation; and no large scheme that I know of could afford to pay for an evaluation out of its own budget, even if the management wished for it. *Vincent.*

Sweet, on discussions with farmers:

> Most clients give very little time.

Devitt, on the effective use of sociologists in planning and design:

> The "human aspects" of irrigation schemes are increasingly recognised as important, even at the design stage, but when budgets are tight and time inputs of team members have to be trimmed, the rural sociologist's time seldom escapes unscathed.

And *Chambers* on innovative field experiments:

> Frequently impossible on account of cost, time and the willingness of a client either to wait or pay for trials. In practice, both client and designer tend to fall back on traditional or standard designs - the fact that the latter don't work or are inappropriate is beside the point.

vi) The political economy of irrigation development
This underlying explanation is implied in many of the comments quoted in i) - v) above. To these may be added *Parker's* comment that

> appreciation of the critical importance of good design and planning is only half the battle. Appreciation frequently fails to persevere in the face of (often hidden) vested interests.

> Design is indeed important, not in the sense of a project "blueprint" but as a reflection of the ideology of the designer, of the political and economic influences on those who plan reservoirs, canal layouts and location, etc. For example, local forces in society often influence the way water is allocated between regions and within canal systems. *Gupta.*

f) Once one accepts that there are widespread deficiencies in both design and management, and that they tend to have common causes, the important question to be asked in each case is not 'can the problem be solved by better design or better management?' but (cf. Jurriëns' paper, last paragraph)

> To what extent is poor irrigation performance attributable to planning and design, and to what extent is it attributable to poor management procedures? The question is important not from the point of view of attributing blame, but rather from the point of view of policy: what are the returns to investment on improved management of existing irrigation systems versus investment on improved design of current and future irrigation projects? *Lenton.*

2. Evaluating System Design

a) Objectives of design evaluation

None of the respondents argued against the desirability of evaluating existing irrigation systems as a means of improving system design. Indeed, many regarded it as essential for the purpose *(Adams, Framji, Gupta, Leakey, Lenton, H. Rao, P.K. Rao, P.S. Rao, Rege, Shaikh, Stern, Sundar, Takase, Vincent).*

The objectives and scope of such an evaluation may differ according to circumstances, however. In the case of established systems which may have design deficiencies but are capable of substantial improvement, the object of evaluation would often be to identify the extent to which design on the one hand and management on the other have contributed to present levels of performance and to identify a combination of actions needed to improve performance, either on the system being evaluated, or on other existing systems with similar design and management characteristics *(Lenton).* Or the object might be to identify appropriate designs and management systems for new projects to be introduced into similar physical and social settings:

> Any irrigation systems already in the neighbourhood, or using water from the same source, etc., should be thoroughly studied and understood before undertaking new designs. *Leakey.*

In the case of new projects to be introduced into areas without previous irrigation experience, it may be difficult to find representative areas for study which will provide clear pointers for future action, however. *(Sweet). Adams,* involved in a project which was required to propose new models for irrigated settlement in Egypt's 'New Lands' (currently desert), reported that

> the comparative evaluation of existing projects was instructive about what would not work, but told us little about what would be successful.

Similarly, *Johnson,* with reference to desert groundwater schemes in Jordan and Saudi Arabia

> which started with no experience of abstraction from the aquifer or of irrigation in the locality. Techniques have been developed for the evaluation of physical resources from scarce data, but quantitative information about how farmers actually perform under the various constraints and incentives to which they are subject is often scanty.

Nevertheless, *Devitt* pointed out that valuable sociological information, eg.

> The best size of self-managing farmer groups, can often be observed under non-irrigated conditions ... It may then be possible to design the physical infrastructure of a new scheme round this basic group of farmers.

To *Sundar*, the purpose of evaluating design was not only to improve the performance of particular projects but to improve general understanding of design principles. In this context, a system might be evaluated in order to discover 'whether it was constructed as per design' (in fact an evaluation of the construction) or 'whether it performs as under design assumptions' (an evaluation of the conceptual design).

Anon (World Bank) argued that as a means of obtaining a better understanding of design principles, there should be 'more research directed towards learning the lessons of good projects'. And he added:

> I am almost ready to conclude that resources are being wasted studying poor projects which, unfortunately, are in the vast majority.

The poor projects he had in mind were no doubt of the kind described by *Sinha*, including one in which efforts to reduce project costs

> resulted in the capacity being so low as to be practically useless for one-third of the probable tail-enders of the system;

and another case of canal-bed lining where '35% extra cost was added to save only 5-10% water'. Or the Chambral project in Rajasthan referred to by *Rege*

> where, despite prior soil surveys indicating the dangers of irrigation without drainage, failure to instal drainage resulted in severe damage to the land.

Clearly there is little point in examining such projects in great detail with a view to obtaining insights into the principles of good system design. However, their evaluation is essential as a means of making public the underlying

> 'reasons why such basic faults keep on occurring' and thereby helping to bring about fundamental institutional changes in the planning and design process. The principal aim of such evaluation

> should be to provoke 'full and open discussion at the top of the administration in order to establish and institionalise a new set of planning and design principles'. *Parker.*

b) The need for an analytical framework

There was general agreement with Jurriëns that there was no literature available on how to evaluate irrigation system design.* By implication, it would seem that there is no literature available which deals satisfactorily with Jurriëns' conceptual design concerns, at least at the more general, theoretical level. *Anon* cited Etcheverry (1914) as 'a classic - as yet unequalled for presenting the basic principles' of irrigation design. Other publications mentioned were Pruitt and Doorenbos, and Withers and Vipond, but these all deal with principles of technical design, not conceptual design. Respondents seemed to be generally agreed that the difference between the two was that conceptual design is concerned not only with

> the hydraulic design but also the agronomic and agro-climatic and soil conditions, the social and economic objectives to be achieved. *Kathpalia;* cf: *Powell, Sinha, Stern, Devitt.*

The absence of a conceptual design literature does not mean that the better planners do not address themselves to conceptual design issues. *Adams, Farbrother, Swan* and *Withers* implied that they do - but the evidence is to be found in consultancy reports. These relate to particular contexts, may rarely be explicit about the underlying principles on which their conclusions are based, and are not widely available. In practice, sensitivity to key issues usually seems to have been built up in a pragmatic, ad hoc manner through in-depth knowledge of a particular environment (eg: *Johnson:* 'the Mawagil scheme in the Sudan ... could draw on a century of study of the Nile and forty years of well-documented experience of irrigation in the Gezira'). Some seemed to feel that intelligent pragmatism was enough and that there was no need for a general theory. For example, *Allison:*

> There is no reason to expect that for irrigation engineers there should be a complete design cookbook. We are meant to earn our qualifications to practice by technical training and broad experience. Each new project should be approached afresh, and all the necessary information collected in the field before the design is completed. Our training and experience should tell us what to collect, and it is unreasonable to expect to find it anywhere except right there in the field.

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* Though *Framji* mentioned a special session at the ICID's Eleventh Congress in Grenoble, 1981, on 'Methods of post-project evaluation: achievements and remedial measures'; and *Takase* referred to the ADB's 'Guidelines on logical framework planning and project benefit monitoring and evaluation', August 1980.

Similarly, *Farbrother:*

> Every single irrigation scheme is an absolutely unique case in its own right, in which even the smallest difference, physical or social, may make all the difference to success or failure. For this reason, I do not believe that it is practicable to list all the information that should be gathered.

But this reliance on 'training' and 'experience' to deal with unique situations does not seem to provide a very satisfactory means for disseminating to others the lessons that the 'good' designers have learnt. Cookbooks, lists and blueprints are certainly not needed. But why assume that the critical locale-specific variables - which do indeed make each context unique and are the main elements missing from the existing design literature - are incapable of being addressed systematically through a single coherent method of analysis? In other words, no-one is looking for standard answers: but what should be the standard questions, and what are the underlying principles that should guide us in our efforts to answer them?

Anon's suggestion that we concentrate on learning lessons from 'good projects' is fine, provided that (as he himself insists) the researchers are able to 'differentiate between principles and specifics'. In other words, the object of such exercises would be to understand the nature of the design process on these projects - the ingredients of success in those particular contexts - rather than (as often happens when 'good projects' are studied) to recommend the transfer of the successful project designs, or designs-cum-management systems, to other entirely different contexts (the 'blueprint' approach).

> It is futile to impose an improved design model from one area on another irrigation scheme ... in another part of the world. *Shaikh.*

Even the design process is likely to require some adaptation to local circumstances, for a host of political and other reasons.

For evaluating the design of existing irrigation projects, adequate locale-specific information is reportedly often not available, even with regard to key technical factors such as actual 'crop water requirements, farm efficiencies, conveyance losses and distribution efficiencies' *(P.S. Rao;* cf: *Sundar, Sinha, Rege, Johnson).* This implies a major criticism of the way these projects are currently being managed, since apparently they lack an effective monitoring or information system *(Gupta, P.K. Rao);* and it may also imply the absence, or insufficiency, of certain basic design requirements for adequate management, such as water measurement devices *(Sundar).* However, the factors which most respondents saw as being the most difficult to incorporate systematically into a coherent analytical framework were the wide range of potentially relevant political/cultural/institutional/social variables - no doubt because, in addition to being locale-specific, they are often difficult to quantify and hence appear intangible. For example, *Parkes* perceived such design information as being 'subjective or difficult to obtain' and saw this as a major reason why 'the designer is often left to make an "engineering judgement"'.

c) Incorporating non-technical variables

To introduce some order into thinking about these non-technical variables and to understand how they might be incorporated into a systematic evaluation framework, it is necessary to begin by recognising that they affect design choices in two principal ways: i) through their influence on the external (macro) policy environment in which irrigation planning, design and management decisions have to be made; and ii) through their influence at the system level on detailed design decisions of the kind discussed by Rien Jurriëns - size of tertiary unit, water rotation schedules, canal capacities, etc.

i) <u>The external environment</u> Some common negative aspects of the policy environment have already been discussed at several points in this paper. But bad policies aside, the environment itself may place often quite substantial constraints on the range of choices which may be open to a design engineer. These constraints need to be clearly understood and taken into account by all evaluators of system design.

First of all, irrigation projects should be developed within the broader context of regional and river basin planning. Thus, *Griffith* commenting on the 'current proliferation of projects' in parts of West Africa:

> No project is an island. Is it worth irrigating 25,000 ha at the cost of radical disturbance to the agriculture of perhaps ¼ million farmers downstream?

Similarly *Gupta*, who with *H. Rao* criticised the narrow vision often shown in developing large watersheds in semi-arid regions of India, emphasised the need to take into account the

> many implications of canal irrigation projects for farmers <u>not</u> in the direct command area.

At the level of the individual irrigation system, availability of financial resources is a critical factor over which the designer has no direct control. Limited resources demand 'the production of a design which will be cost-effective in operation' *(Johnson)*. Where limited resources are combined with topographical conditions which favour large gravity canal systems and/or with social policies which favour extensive rather than intensive patterns of water distribution, certain key parameters may have to be accepted by the designer - and the design evaluator - as 'given', though they have far-reaching consequences for management practices and attainable levels of performance:

> Larger projects, though they reach more people at lower unit costs than smaller projects, present inherent allocation problems, because of the difficulties of accurately providing the right amount of water at the right time into the root zone of a crop located at great distance from the source of water. Projects with a low duty (ie. with a low intensity of water supply per unit area), though they serve a larger number of farmers and lead to a greater total agricultural productivity than projects in which the water is spread less thinly, require much tighter management procedures for water allocation if they are to truly achieve equity objectives. *Lenton*.

Shaikh also referred to the difficulties of preventing head-tail differences 'in schemes where, for socio-political reasons, designed water allowance is for a smaller intensity of cultivation'. He also argued that in those parts of North India and Pakistan where such schemes have been long established and no supplementary groundwater is available, their 'inadequate design becomes a given fact' and in the short term at least there is no alternative to 'investigating existing potential for operational improvement'.

These comments raise some interesting questions with regard to evaluation criteria. For example, in what sense are the designs to be judged inadequate? In some absolute sense; in relation to a better (but costlier) design; or in relation to alternative designs with the same objectives which could have been achieved at the same or less cost? And are there really, even now, no opportunities for relatively low-cost design modifications? Whatever the answers, it is clear that the scope for improved design has been severely limited by (not necessarily bad) past policy decisions; and it is likely to be the case that if alternative design modifications are to be entertained (within the limited range of options imposed by past decisions), such experimentation could not be undertaken without the prior consent of present policy-makers, for 'socio-political' as well as financial reasons.

Limited financial resources are likely to impose constraints on an irrigation system's flexibility, in two ways:

(1) in terms of its operational flexibility (or capacity to respond easily to local variations in demand for water at any given point in time), or

(2) in terms of its long-term flexibility (or capacity to adapt to major changes in water scheduling practices in response to changes in cropping pattern over a long-term period).

Both kinds of flexibility imply higher costs and there is a limit to which these will be feasible or justifiable in a particular context.

Increased operational flexibility may be obtainable in a number of ways: eg. by providing additional control structures, on-system storages *(Sundar, Reidinger, Vincent)* or automatic 'on-demand' systems *(Leakey, Swan)*, but all entail varying levels of extra capital cost. Whether more flexibility is necessarily always a good thing is an issue discussed later in the paper.

With regard to long-term flexibility, some respondents advocated designing conservatively in order to accommodate future changes in cropping pattern and water demand, while recognising that this would often involve substantial extra costs now *(Swan, Johnson)*. Others, for financial and other reasons favoured lower initial investment followed by iterative monitoring of changing conditions and eventual remodelling. eg. *Shaikh:*

> Planning for assumed ultimate conditions ... is not only initially costly, but leaves a system underutilized for a very long time.

And *Sundar:*

> Redundancies have to be built in. All these mean more money. This may mean building fewer projects elsewhere. Is this not against the principles of equity?

Others with comments on this issue included *Leakey, P.S. Rao* and *Rege*.

Two other important policy issues which will significantly influence the range of options open to designers in different contexts are the land tenure pattern and the farmers' freedom to choose their own cropping patterns. With regard to land tenure, size of land holding is not a manipulable variable in already settled areas with long-established private land rights, in the way that it can be on new settlement schemes. In the former case (which accounts for a very large proportion of the world's irrigated area), the designer is in no position to be 'more strict on farm dimensions or layout' (Jurriëns' page 2), as *Conlin* pointed out; rather he has to adapt his design to the existing tenure system and the complex social relationships it often implies. The position with regard to choice of cropping patterns is similar. In some cases (usually settlement schemes), the cropping pattern may be strictly determined by the project management; in others, for reasons of water availability or soil suitability, the cultivation of certain crops may be legally restricted to specified areas. In these cases, one of the most important variables with which the designer has to deal is either wholly or partially controlled, and his choices are made that much easier. But the task again becomes distinctly more complex when (as in very many cases) farmers' choices are determined by family preferences and the market, subject only to the availability of irrigation water and other inputs.

ii) Factors at the system level Within the project area itself, the non-technical factors which most closely affect choice of project design may be summarised under the phrase 'management capabilities'. The object of the evaluator must be to assess the compatibility of the present system design with present management capabilities and to suggest to the designer what kinds of future designs might be compatible with future management capabilities. These capabilities - present and potential - will need to be assessed at three levels: the main system, in the case of large projects (usually bureaucratically managed); the level of communal management by farmers (usually the watercourse on large projects, but often the whole system in the case of small projects); and individual/family management at the farm level.

With reference to the main system, *Johnson* commented:

> The operation of irrigation schemes could be improved and the management made easier if the design were made to fit more closely the conditions in which the scheme has to be operated and managed rather than the other way round.

Withers concurred. But *Farbrother* asked:

> How should design engineers cope with some of the more serious social shortcomings? Should one accept the inevitability of bureaucratic inefficiency? Should designs accommodate the typical "diploma" trained civil engineer in positions of responsibility for operational management of large-scale schemes, knowing that their two-year course contains nothing to prepare them for water management? Should one be prepared to build incompetence and corruption among field staff into a new scheme, simply because they are the facts of life in existing schemes?

These are not rhetorical questions. The answer in each case must surely be 'no' - but it might often have to be a qualified 'no'. Where such serious shortcomings exist, it would be absurd to invest heavily in system design without commensurate investment in improved management. Only with investment on both sides does it become possible to design a new system on the assumption of improved management capabilities in the future. On the other hand, the likely extent of that improvement needs to be assessed realistically and the design should reflect that assessment.

The same point applies to evaluation of the design implications of farmers' present and potential capacities to organise at the watercourse level. On this, *Ryman* observed that:

> For a successful irrigation scheme it is essential that the size of flow and amount of water are consistent with a group of co-operating farmers who can organise an appropriate frequency, reliability and flexibility of water distribution among themselves.

Devitt had this to say on the choice of size of tertiary unit:

> One of the factors engineers should consider in laying out irrigation blocks, canals and drains is the optimum size for a self-managing group of farmers. There are many circumstances in which a scheme only becomes economically viable if most of the smaller canal, drain and bund maintenance is carried out by farmers themselves, if irrigation efficiencies are kept above a certain level, if credit repayments are kept up, etc. This may only be possible if farmers accept a high degree of responsibility for disciplining themselves and one another, and is seldom achieved in groups which are either too big or too small. There are schemes where the tertiaries supply several hundred farmers. There is no way so many people can form a tightly knit self-managing, self-disciplinary unit, and no scheme management can manage as intensively as is then required. At the other end of the scale, groups of a dozen or so farmers can seldom provide the degree of leadership and diversity of experience to develop much independence. On a number of African schemes, groups of between 25 and 40 seem to work best.

Meanwhile, *P.S. Rao* warned of the difficulty of promoting effective farmer organisation in 'countries with exploitative social structures', and *Gupta* criticised the 'naive view that farmers can form an association around a commodity like water which will not have conflicts between big and small partners'. He argued that 'farmers' associations for the regulation of water will have to be class based'. An essential requirement was that all farmers be given an opportunity 'to monitor water flow and distribution' (a point also stressed by *Sundar*); the resulting conflicts 'would ensure more equitable distribution than the model of harmony which rests on theory only'. *Gupta* also suggested that designers might often be able to influence the pattern of water distribution in favour of smaller farmers through careful selection of canal layout and tertiary outlet locations. Powerful farmers would however seek to 'influence the interpretations of technical design' at the implementation stage by pressing their own case as to 'where the outlet should be provided, whose fields should be totally protected during canal digging, etc'.

Khan confirmed the lack of realism behind the assumption on the Mahaweli system in Sri Lanka that if 12-20 farmers were organised into blocks of 30-50 acres commanded by a turnout gate (where water could be measured)

> they would on their own maintain the irrigation works and field channels within the turnout area. Human skills to co-operate and manage do not come naturally but have to be imparted.

He went on to describe an extension programme aimed at 'achieving social cohesiveness'.

With regard to water management at the <u>farm-level</u>, most respondents were emphatic that an irrigation system should be designed 'from the bottom up', in accordance with the capabilities and needs of the users (eg. *Chambers, Framji, Griffith*). The alternative approach - designing according to 'principles of efficient water distribution' and then trying to get farmers to conform - 'imposes unrealistic demands on the users'. *Withers*.

> Much of the design work falls down because it is adapted to the way in which the designer considers the farmers ought to irrigate rather than the way in which farmers actually do irrigate. *Swan*.

Hence *Farbrother's* conclusion that, for evaluation purposes

> studies of farmers' actual management of water are essential for successful understanding of the farmers' needs. And, perhaps even more important, the observer should be capable of interpreting what farmers <u>could</u> do, given the water.

Griffith, after reference to irrigation schemes in West Africa which had been 'imposed' on farmers and to which they had in some cases reacted violently, observed that

> forcibly fitting the farmer to the design can work, though few of us would recommend it.

None of the respondents did recommend force of the kind he was referring to. On the other hand, a totally flexible system which would allow each farmer to do as he liked is scarcely feasible under the financial and social conditions prevailing in most developing countries. The advocates of designing a system to suit the way farmers actually irrigate or could irrigate would presumably accept that this is a goal which must always be accommodated to a greater or lesser degree within the numerous constraints already discussed (water availability, finance, equity considerations, etc). In that case, *Srivastava's* view that 'rotational irrigation including night irrigations be enforced' should obviously be regarded as excessively inflexible if advanced as a universal rule - but might there not be particular circumstances in which the constraints were such that it would be a tenable position? Several other respondents assumed that, for financial reasons (including the high cost of on-system storage and hence an obligation to irrigate at night), some form of rotational water scheduling must be adopted (*Sundar;* cf. *Rege, Parkes*).

This implies that the real question we should be considering is this: within certain unavoidable constraints, what is the scope for maximising farmers' convenience with regard to water availability? *Farbrother* argued that a key variable in this context is the size of water flow delivered to the field; yet it is a factor which has traditionally been determined 'from on high' by engineers, in the name of 'efficiency' and in accordance with 'fashions that have changed over the years':

> In the early classical developments in India and Egypt, really sizeable "main" canals were the favoured basic units for scheduling. From about 1920, however, the smaller distributories and watercourses at about 10 cusec* came in, with 4 cusec (in the Gezira) being regarded as the lower irreducible minimum. Post-war developments in India and Pakistan brought in rotational supplies at 3 cusec; then 2 cusec; and finally, the 1 cusec design criterion of the recent CAD planning. The current rehabilitation proposals for the Gezira anticipate a reduction from 4 cusec (417 cu.m/hr)

* cubic feet per second

> down to 1½ cusec (130 cu.m/hr), but this will be shared simultaneously between four or five individual farmers, (say 0.3 cusec each). Elsewhere, we now have the strange spectacle of some engineers apparently agreeing in terms of rotating 0.1 cusec around 5 one-acre holdings - under pressure from the solar-power enthusiasts.

The following extracts from *Ryman's* extensive treatise on irrigation design concepts (to which this paper cannot do justice) give an indication of the different kind of results which would follow if the design process were reversed:

> The only way to be systematic in irrigation planning is to start with the farmer. Three questions have to be answered, namely how much water should the farmer apply, through what size of flow, and with what frequency, reliability and flexibility of distribution. There is usually a wide range of irrigation design concepts from which a choice has to be made ... Guidance on size of flow is perhaps the most poorly documented aspect of irrigation planning, although it is an area which offers a lot of scope for sound planning ... The question of size of flow is interrelated with channel densities, numbers of control structures, intended degree of lining and minor canalisation and required frequency of irrigation.

A point underlined by these and earlier observations is that many of the critical determinants of design (especially at the lower levels of the irrigation system) are highly locale-sepcific. This has important implications for the way in which evaluation cum-design should ideally be carried out (see section 3 below). It may also partly explain why relatively few other detailed comments were offered on the design parameters referred to by Rien Jurriëns. There were however some additional comments on cropping patterns and water distribution methods.

Several respondents discussed the formulation of design <u>cropping patterns</u> in the context of the need to obtain accurate estimates of future water requirements. *Sundar* doubted the possibility of foreseeing at the design stage the advances that would take place in breeding new crop varieties over the next 10-20 years and for this and other reasons argued that irrigation designs and design assumptions should be reviewed every 10-15 years. In the meantime, he agreed with others *(Griffith, Leakey, Parkes)* that best estimates should be made on the basis of farmers' current farming systems, their perceptions of the potential benefits of different crops, and labour requirements and availability.

<u>Water distribution methods</u> have already been touched upon, mainly in relation to financial constraints and water management at the farm level. But it is a subject which needs to be considered at all levels of the irrigation systen - main system, watercourse and farm - since the choice of method in any particular context needs to take into account management capabilities at each of those levels. Methods referred to by respondents ranged (in order of increasingly flexible availability) from continuous flow systems with strict rotation, through systems with small storage reservoirs, to an experimental 'on-demand' system in Sri Lanka 'where the farmer has only to open his valve on a piped supply, thereby automatically opening the gates along the system back up to the supply point' *(Swan)* and a large-scale automated, 'on-demand' system in Rumania *(Leakey)*.

Leakey felt that on-demand systems, though expensive, were of

> very great promise in offering the possibility of side-stepping all the problems presented by designs which call for complex human management of water allocation and distribution ;

but *Swan* wondered, in the Sri Lanka context,

> how much interference will take place with the installations.

More generally, the respondents concerned appeared to assume that, cost apart, the more operational flexibility a system has, the greater must be its capacity to perform well. But while this should be true in terms of overall productivity of water use, it is not clear that it must be true in equity terms: greater operational flexibility implies a greater scope for A to manipulate the system at the expense of B. It could be that in many contexts an optimal solution would be a certain level of flexibility, combined with clear-cut operational rules designed to secure tail-enders and small farmers a proportionate share in the potential benefits made available by that flexibility.

3. From Evaluation to Design

Most respondents saw design evaluation of existing projects as a necessary, but not sufficient, condition for the development of an appropriate conceptual design. *Adams* reported that in the Egyptian project which required the production of plans for three pilot irrigation schemes in the desert, the initial evaluations, followed by detailed physical resource investigations

> were not the only inputs into the conceptual design of each project ... The basic starting point in each case was to devise an irrigation system which could cope with the difficult physical conditions and, having made that choice, to provide the widest possible range of organisational options and flexibility. The process of iteration and re-iteration in which the team participated was fairly long drawn-out ... It was in these discussions that the recommended approaches emerged.

The different physical characteristics of each of the three sites led to the adoption of three quite different approaches, both technically and institutionally.

Several respondents argued that, following the kind of evaluation undertaken by Adams and his team and perhaps concurrently with the iterative planning sessions referred to above, some form of experimental action research was required as a prelude to the final formulation of system design (eg. *Chambers, P.S. Rao*). This was felt to be particularly important as a means of identifying and testing alternative management methods at the watercourse and field levels. *Swan* advocated

> trials of different design approaches in a trial farm under the same conditions and cropping as proposed on the main scheme, supplying ordinary farmers, over a season or two before design is finalised.

Withers, with reference to the same trials (in Sri Lanka), commented that they offered

> many lessons if one cares to read them - in engineering, management, settlement, farm size, etc. - but the main message is that the problems are extremely complex.

These comments, together with others cited earlier on the complexity of the relationships between different variables operating at the local level, suggest that the evaluation of irrigation system design (and operation) should ideally be undertaken from two directions, and on two different time-scales. On the one hand, a relatively quick evaluation needs to be undertaken 'from the top down' in order to establish the nature and dimensions of all the major constraints under which a system is currently operating and those under which it is likely to have to operate in the future. On the other, there is a need to evaluate 'from the bottom up' all the various design and management options which may be feasible within the constraints identified. And for the latter process, substantial time may need to be allocated for field experiments, as suggested above.

As a means of substantially raising the quality of debate with regard to returns on investment on improved management of existing systems versus investment on improved design of current and future irrigation projects, *Lenton* proposed that detailed evaluation of actual performance of a particular system be followed not only by action research but by simulation exercises employing data obtained from the action research. These exercises could initially be used to evaluate the potential performance of a particular irrigation system, given (i) existing design constraints and improved management procedures; (ii) improved designs and current management procedures; and (iii) improved designs and management procedures. A next stage could be to analyse the cost of alternative design and management practices, which would allow the evaluation of trade-offs between costs of improved design and management practices and attainable levels of performance.

Others saw, or wished to see, the evaluation - action research - design sequence conducted rather differently: not as a series of discrete 'one-off' activities undertaken at isolated points in time, but rather as parts of a continuous process, linked as closely as possible with day-to-day system management. Thus *Farbrother* argued that it

> should be an obligatory part of all agricultural research workers' duties to undertake field surveys, in which farmers are observed three times a week, for at least a complete cropping season.

Frequent interaction between system designers on the one hand and system operators and system users on the other was also implied by *Johnson* when outlining his favoured approach to developing new schemes in areas with little previous irrigation experience and with limited availability of relevant data:

> Provided that sufficient information is provided to start a scheme, there are economic advantages in getting it into production as early as possible and deferring expenditure on acquiring such further information as may be necessary until it can be used, as well as the advantage of being able to utilize experience of operation to guide these further investigations.
>
> Design is best viewed as a framework within which those concerned with operating the scheme can work out their own way of exploiting all the resources available to them in the economic, social and political conditions that prevail. The better adapted this framework is to these conditions and to the physical resources to be developed and the technology of the farmers, the easier it will be to operate. Details of cropping pattern, farm and irrigation practices would best be left to the farmers and the management's irrigation and agricultural staff to work out in co-operation ... These considerations emphasise the need for adequate technical staff under the project management, and for continuing evaluation by the management in co-operation with the technical staff, supported as necessary by experimentation.

The importance of trying as far as possible to internalise responsibilities for evaluation/monitoring and planning/design within the implementation agency was also emphasised by *Parker* and *Rege.* And *Gupta* and *P.K. Rao* called for the establishment of monitoring systems which would make both designers and operators accountable to the water users.

On the best-managed (and best-designed) systems - eg. in Taiwan - a substantial capability of identifying design deficiencies, and even to some extent for remedying them, has been built up within the implementation agencies and among the farmers. This should clearly be a long-term objective in all countries. However, in many cases, as *Parker* and *Rege* pointed out, substantial institutional changes will need to be made before such capabilities can begin to be developed on a significant scale. In the meantime, external evaluations and externally initiated action research will continue to be essential, though it goes without saying that the project management, system operators and water users should be involved in the process as closely as possible.

4. Who Should Evaluate and Design?

Several respondents argued the desirability of involving the designers themselves in the process of evaluating system performance. According to *Lenton,* designers would soon 'obtain a better appreciation of the relationship between irrigation design and management procedures, and of attainable levels of performance' if they were obliged to evaluate existing operating procedures and performance. *Parker* and *Rege* advocated that designers should work together with members of the implementing agency in joint evaluations of system design and management issues, so that each could better appreciate the other's concerns and constraints. In this context, there was significance in *Devitt's* comment that

> The separation of the "physical" from the "human" aspects of irrigation schemes is rarely found among experienced and successful scheme managers. It is far more common among planners, designers, researchers and evaluators.

There was widespread agreement that both evaluation and design teams should be multidisciplinary, interdisciplinary or comprehensive. Many respondents specified the disciplines they felt should be involved. Most lists included an engineer and agriculturalist, a sociologist and an economist. Some added soil scientists, agronomists and managers or administrators. It was also pointed out that the smaller the project, the smaller the number of 'experts' needed or justified. In such cases, 'the disciplines of the "design team" may be incorporated in one person' *(Sweet);* and in *Allison's* view, 'it's bound to come down to the question of finding an adequately broadly trained and experienced engineer'.

The latter idea was extended by some to apply to larger projects as well. They felt that the emphasis should not be on the precise disciplines of the individuals involved, but on their character, mentality and breadth of vision. In this connection *Gupta* quoted *Robert Chambers:* 'The assumption that by making the team multidisciplinary all relevant aspects will be covered is suspect. The most significant aspects may not be in the domain of any discipline...' *Withers*, referring to his own experience as a member of a consultancy team, commented:

> The individuals were, in many cases, used to working as individuals, each responsible for his own annex ;

and he concluded:

> Effective interaction depends almost entirely on the character of the individuals and the team leader.

Stern took the view that:

> For effective operation a design team should be predominantly of one discipline, but it is very important that the members have sufficient breadth of vision to see their problems in the proper perspective.

Kathpalia felt that the team leader should be

> basically an irrigation engineer but one who has the special knowledge of socio-economic and agronomic conditions and as such can take a balanced view from his experience.

Leakey did not commit himself to the discipline of the team leader but regarded it as essential that he

> should be the member of the team who individually has the broadest view and widest interdisciplinary knowledge. Otherwise, merely including people from a large number of disciplines in the team may have no practical results since the project leader will over-rule ideas which run contrary to his own particular expertise.

Two recommendations from *Adams* were:

> when drafting final recommendations, hold an extended "house party" of experienced consultants with flexible attitudes about boundaries between disciplines ;

and (in cases of foreign teams),

> consult with local experts and give very careful consideration to any departure from local practice.

A few remarks were made on the timing of individual contributions.

> Assuming that the purpose of a good irrigation design is to make irrigated land available for agriculture, I would regard it absolutely essential that the agricultural studies should be thorough and should precede in time the studies of other members of the design team. In practice what tends to happen in mixed teams is that the agriculturalists are asked to provide conclusions at the start of their studies to enable their colleagues to begin work. *Leakey.*

> Speaking as a "rural sociologist" who usually joins an irrigation scheme evaluation or project planning team for the beginning, end or middle of its work, but rarely for the whole period [I find] this arrangement is almost always unsatisfactory. If I come at the beginning nobody yet knows what the technical parameters are, so I am working without the most basic information on the situation; on the other hand I am able to participate in the formulation and orientation of the project. If I come in the middle of the project many decisions have already been taken, and many issues are now closed to discussion, but there is still little firm technical data to work with; there is nevertheless more of a framework than at the beginning and there is still some room for new ideas. If I come at the end I am presented with physical plans, cropping schedules, output targets, numbers of settlers, target dates, etc. which can hardly be altered and I have to do my best to shoe-horn the people into a boot that is already made. *Devitt.*

The reasons for these sorts of problems are (as discussed in section 1) the limited finance and time usually allocated to evaluation and design work. The type of two-level evaluation-cum-action-research approach recommended in this paper would seem to require substantially <u>more</u> resources (in time at least) than is conventionally <u>allowed</u>. To create a constituency for such an approach, the clients (ie. governments) - and perhaps donor agencies too - will have to be persuaded that it is in their longer-term interests to support it. In the meantime, evaluation and design teams will need to concentrate on identifying the most cost-effective ways of providing the essential data needed. In this connection, *Johnson* mentioned a study which 'suggests that there is scope for reducing costs of land surveying by more realistic assessment of what is really needed and can be used, and discusses methods of doing so'.* *Adams* advised that 'physical resource

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* *V. Robertson and R. Stoner,* <u>Land use surveying : a case for reducing the costs</u>, World Land Use Survey Occasional Papers No.9, Geographical Publications Limited, Berkhampstead, Hertfordshire, U.K., 1970.

surveys should concentrate on the crucial agronomic parameters and judiciously apply sampling theory', and added (wisely but perhaps somewhat hopefully): 'In these days of increasing competition between consulting firms, make sure you do a professional job'.

Finally, there is the question of farmers' participation in evaluation and design. From the comments already presented, it is clear that respondents were overwhelmingly in favour of a 'farmer-oriented' approach. But few respondents were able to envisage an active role for the farmer in the evaluation or planning of system design - particularly in areas with no previous irrigation experience:

> Meetings and discussions with farmers, yes; but how do you explain irrigation to people who have never encountered it? *Sweet* (cf. *Allison, Rege, Sinha*)

Farbrother was more generally sceptical:

> What part can farmers play in improving irrigation design? Directly, I would say none at all; as all farmers are born liars on all matters concerning money and water. On the other hand, independent observational studies ... are essential. Certainly no questionnaires; it is not what farmers say that matters, but what they actually do.

Similarly, *Sinha:*

> Very few farmers may be able to understand the needs of a project design; fewer still can contribute to its improvement. On the other hand, those responsible for the design are likely to produce a half-baked product if they have not had strong interaction with farmers (on a sample basis, of course).

Others concurred with this view of the farmers' essentially passive role: someone whose problems, aptitudes, aspirations, labour situation, farming practices, etc. needed to be studied and understood - from the outside (eg. *Chambers, Framji, Leakey, Sundar*).

Rege went a little further by suggesting that, especially in areas of limited irrigation experience,

> the farmer may find it difficult to give positive suggestions on the improvement of "design". However he should be able to highlight his problems in getting adequate and timely supply - particularly the latter - and that information may be used to advantage in designing the irrigation system. Such consultation would also give him a feeling of involvement.

P.S. Rao went further still with the broad statement that

> in any development project - and irrigation is one such - the organised involvement of the beneficiary at various stages of the project formulation, implementation and operation is bound to have a positive and desirable influence.

But he acknowledged that the stimulation of such involvement was not easy, especially in developing countries. *Gupta* argued that farmers' participation in influencing irrigation design would become relevant only when they were provided with the means of monitoring water flow and distribution.

Conlin went furthest in advocating that farmers be directly involved in evaluation and design, implying the need for a very different style of project development from the one conventionally adopted:

> There is still an assumption /in Jurriëns' paper/ that the engineer is designing for others rather than with their cooperation. We should start to look at the whole context of planning and how people can be brought into discussions which, at present, are often mystified as purely technical. As soon as we admit that there are "human" factors then we should recognise that the people "under study" are the best exponents of their own interests.

For specific suggestions on how such an approach might be developed in certain contexts (so far, significantly, on small, communally-managed irrigation projects), see Network Paper 4c, 'Promoting participatory management on small irrigation schemes : an experiment from the Phillipines'. *(Bagadion, Korten and Korten).**

4. A Last Thought

Linden Vincent had this proposal to make:

> I would like to suggest that a group of us - perhaps those who have corresponded on this subject - come together in some way, and ask respective governments for the technical documents for a small number of schemes which have management problems documented by us ... Those of us interested in the agronomic and engineering design could review the design package, and

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* And also, the accompanying paper 9c, 'A small scale water resources development project in North East Thailand'.

subject it to a thorough sensitivity analysis on all the technical points Rien Jurriëns lists. Others interested in financial and management problems could discuss the implications of these results, and say what else to try ... This kind of work could show up just which are the "rules of thumb" which need most careful investigation. Is anyone else interested?

LIST OF RESPONDENTS

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Stephen Allison

Anon (World Bank)

Donald Chambers

Sean Conlin

Paul Devitt

Herbert Farbrother

K.K. Framji

W.J. Griffith

Anil K. Gupta

Charles Johnson

G.N. Kathpalia

Shoaib Sultan Khan

Colin Leakey

Roberto Lenton

Niranjan Pant

Neil Parker

Martin Parkes

M.T. Powell

T. Hanumantha Rao

P.K. Rao

P.S. Rao

N.D. Rege

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R.M. Ryman

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 9c APRIL 1984

FARMERS' ASSOCIATIONS - MAKING THEM EFFECTIVE OR MAKING THEM UNNECESSARY

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Two papers on Farmers' Associations, one drawing on experience in West Africa and the other in Southern Europe, are linked by a common theme - the need to perceive the reality behind fine words. In the first, reality is only given to management by farmers' associations when they are given comprehensible management tools, in their own language, and the skill to read these. In the second, the various constitutional forms prevalent for irrigation management in Southern Europe are discussed. They include both the familiar division of authority between Departments of Agriculture and Public Works, and examples of localised unitary authorities similar to the Command Area Development Authorities of India. Either form may or may not have formal farmers' associations. What seems to matter in practice is first, the degree to which decision making is truly localised, and second, the degree of practical interaction with farmers. When this interaction is based on revenues from the farmers for the working of the authority, the authority is obliged to take note of farmers' needs, whether or not these are formally elected farmers' representatives. Network members working in developing countries may be heartened (or disheartened?) to see their problems reflected in European experience.

Guy Belloncle's *paper was first presented at an International Colloquium on* Agricultural Development and Peasant Participation : The example of Water Policies in Africa, *organised by the Centre d'Etudes Juridiques Comparatives, University of Paris I, 14-15 October 1983. The proceedings will be published later in 1984 by* Economica, *Paris.*

There must be many countries where management and accountancy forms in an incomprehensible vocabulary, in a foreign tongue, are provided for farmers' associations whose leaders are either only literate in their native language, or illiterate. In such a situation it is useless to expect either that the officers of the association can manage their financial affairs, or that the members of the association can check on the use of communal funds. Yet most illiterate farmers necessarily have in their heads the management skills needed to keep their own farms viable. Guy Belloncle *illustrates a method of finding out and utilising the actual language peasants use to talk about the need to put money aside for new equipment, and to provide for working capital. This meaningful language can then effectively be used as the basis of a rapid and effective literacy programme which gives the officers of the farmers' associations literacy, numeracy and management tools.*

Those who would like more details of the method and experience of Guy Belloncle *and his collaborators should refer to the case studies, texts and examples quoted in* Belloncle, G. Easton, P. Ilboudo, P. Sane, P. Alphabetisation et Gestion des Groupements Villageois en Afrique Sahelienne, *Editions Karhtala, Paris, 1982.*

A. GIVING MANAGEMENT SKILLS TO FARMERS' GROUPS

Guy Belloncle

(Translated by Susan Woodland, Overseas Development Institute)

Today, peasant farmers' inability to come to terms with management accounting systems is one of the biggest obstacles to any real grass roots participation in producer organisations, be they co-operatives, government-formed groups or the more spontaneous associations supported by a number of NGOs. The situation can be briefly summed up by saying that today, in the Sahel countries, accountancy is doubly foreign to the peasant farmer: both in its language, which is French, and in its vocabulary, which is completely esoteric and often appears the opposite of common sense.[1] This state of affairs was already serious for producer organisations dealing with relatively simple economic activities such as marketing, purchasing and credit, but it becomes even more so for the management of irrigation schemes with their canal networks, pumping stations and, in the majority of cases, equipment needed for mechanised cultivation.

In the four cases where we acted as consultants in West Africa (SAED in Senegal, the *Office du Niger* in Mali, irrigation schemes on the River Niger, and the swamp irrigation project at Marabadiassa in the Ivory Coast) the result was always the same: no peasant farmer was in a position to understand the details of the sums that were claimed from him, either at the level of the group, or at the individual level of his own farm accounts, and so everywhere the money claimed became known as *'the tax'*. More seriously, none of the village level officials, who were supposed to explain these mysterious documents to the peasants allocated plots, understood them. Everywhere we got the same reply:

> "We get the forms from the people in the offices. We are only here to tell the peasant farmers to pay up".

The peasant farmers, therefore, see these documents as relating to intolerable levies on their harvests. One of the most common comments to be heard is: "On the irrigation schemes, all you do is work for the government".

A necessary condition for re-establishing confidence and the possibility of real dialogue is thus the need to

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1. For a more detailed analysis please see Belloncle, G. and Diarra, M. 'Organisation et gestion des cooperatives agricoles en Afrique et en Haïti' *Archives des Sciences Sociales de la Cooperation*, No 63, January-March, 1983.

make the meaning of the accountancy documents clear to all partners. Experience shows that no matter how complicated the accounting situation may be at the beginning, it is possible to develop a system of management and of accountancy which really does lie within the grasp of the locals (or at least in the first instance, of their elected representatives), as long as you have real political will to clarify the accounts on the one hand, and have an adequate methodology to do this on the other.

It is this methodology which we would briefly like to discuss here, using the concrete examples mentioned earlier.[2]

First step

All the French accounting documents must be collected and the way in which the system works must be analysed.

Second step

Each of the accounting documents must be re-translated into basic (or simple) French, with every technical term being replaced by its 'functional' definition.

Third step

A preliminary draft translation of the simplified documents must be made into the native languages of the peasant farmers concerned. This draft translation should be carried out by the officials of the irrigation agency, using official systems of transcription which exist nowadays for almost all African languages. The main aim of this third step is to get the officials ready for the workshop sessions to come, when the peasant farmers will take part in the final drafting of the documents.

Fourth step

A translation workshop must be organised with a group of farmer representatives to undertake the final drafting of the documents into these native languages. Experience has shown that the key to success lies here. To let people name something enables them to appropriate and use the concept behind it. So letting peasant farmers take part in terminological research not only ensures that they will understand the documents which are prepared in this way, but also that they will understand the way each document works and how it fits into the management system as a whole. At the end of the translation session, you are usually left

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2. This methodology was described in more detail in *Alphabetisation et gestion des groupements villageois en Afrique Sahelienne*, Karthala, 1983, p270.

with quite a large number of documents (somewhere between 25 and 30) which are pinned up on the walls of the room where the meeting was held. All the participants know their importance, but only a fraction of them (the few who are literate) are able to make them out. It is easy to understand how the frustration resulting from this situation can lead to a powerful desire to become literate (and we can confirm this for the four cases already mentioned). Now, it is time for the fifth step.

Fifth step

An intensive, selective and functional programme of literacy workshops must be initiated for the officers of local groups or co-operatives.

There is a false but widely prevalent idea that adult literacy is a long and difficult process. Various experiments carried out in the Sahel (see *Alphabetisation et Gestion des Groupements Villageois* for further details), have shown that within 200 hours a motivated adult can gain sufficient command of reading, writing and arithmetic in his native language to be in a position to use all the accounting documents which had previously been drawn up, as long as the method of teaching used is intensive, selective and functional.

Intensive Learning must be full-time, with all lessons concentrated in the off season (or at least, the time of year with least agricultural work). Several methods have been tried: six full-time sessions a week in alternate weeks; three periods of two weeks each separated by a week's rest; or three months of working in the afternoons only. The local people must decide for themselves which timetable is best suited to them.

Selective Each peasant grouping (between 50-100 families) will be asked to send five or six representatives to take part in the literacy programme. These should be either people who have already been elected leaders, or those who are to take up responsibilities after the course, and so will at once employ their skills.

Functional From the beginning, the literacy programme should be based on the accounting documents which are to be used by the peasant groupings. By doing this you kill two birds with one stone: not only do you teach reading, writing and arithmetic, but you teach book-keeping as well.[3]

3. Which does not mean to say that it will not be necessary to organise further training sessions, notably to cover the transition from taking down the facts to their interpretation.

Experience has shown that you only need a short space of time to create a hard core of literate officials within each group of peasant farmers, who are able to understand all of the documents which have been translated into their language and are in a position to clarify them to others. A concrete example will illustrate the methodology. In Niger, the co-operatives responsible for the management of the irrigation schemes received, and no doubt still receive, a duplicated form entitled 'Standard Management Balance Sheet' which contains the following headings:

Electricity
Fungicides
Fertilizer
Agricultural Chemicals
Miscellaneous Expenditure
Maintenance of Pumping Station
Wage of Pump Operator
Amortisation of Pumping Station
Provision for Renewal
Provision for Repairs
Provision for Engineering

Opposite each heading is the corresponding income and expenditure and, of course, the total amount to be paid - it being left to the director of the scheme to work out the amount to be levied per hectare and the amount to be paid by each plot holder (the area of the plots being usually between a quarter and half a hectare).

You can imagine the confusion caused by this sort of document when it comes into the hands of peasant farmers who are 55% illiterate in French,[4] and, for that matter, when it comes into the hands of the village-level official in charge of the local irrigation scheme, who is theoretically responsible for explaining it. In the first place, the title means nothing and has no relevance whatsoever to the contents of the document which only deals with the expenditure necessary to calculate the levy. Then, each of the headings presents problems of interpretation. Let us ignore the first of these, 'Electricity', as everyone realizes it refers to the electricity used to run the pumps. However, there is nothing in the next three columns that suggests that they relate to the preparation of the seed-beds. Hence, you run a high risk that there is confusion between the fungicides, fertilizers and insecticides which are intended for the peasant farmers' *own* use and which are accounted for on another form - and

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4. We must stress 'in French' as there are many who can read and write their mother tongue - Zarma - whether using Arab characters (which are learned at the Koran school), or Latin characters (which are learned at the literacy centres).

this has indeed happened. The 'Miscellaneous Expenditure' column is hardly more explicit (in fact, it refers to printed matter). But it is above all the columns headed 'Maintenance of Pumping Station', 'Amortisation of Pumping Station', 'Provision for Renewal', '...Repairs' and '...Engineering' which are particularly obscure - and not even the scheme leaders can explain them. So, using the method outlined above, it was first necessary to 'translate' these columns into basic French and distinguish between:

'the money which maintains the pumps'

'the money which repairs the pumps'

'the money to buy new pumps' (which incorporates the two old column heads 'Amortisation of Pumping Station' and "Provision for Renewal")

and 'the money to maintain and repair the pipes, banks and drains'.

From then on, it becomes a lot easier to translate all of this into Zarma. But, that was not the end of our problems, for we also had to 'translate' the units of account used in French (CFA Francs per hectare) into units of account which could be readily understood by the peasant farmers, whose currency is the *dala* (5F) and who have no conception of a hectare. So, all expenditure was calculated using the *are* (which farmers could visualize as the size of the yard outside the meeting room) and the *dala*.[5] As soon as expenditure was presented in *dalas* per *are*, things became much clearer and very fruitful discussions about how to reduce certain expenses and thus total expenditure, could take place.

Many other concrete examples can be found in the four reports on the projects carried out for the *Office du Niger* (Mali), the SAED (Senegal), ONAHA (Niger), and SODEFEL (Ivory Coast), which we hope may be published shortly.

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5 We are attaching the final document as an appendix, which compares the situation of the two co-operatives (Loosa and Soona) which took part in the course.

APPENDIX

dan yang fo kulu leasaabu yang nooro kang alfari fo kulu ga bana nga faro se (the paper for calculating what each peasant farmer must pay for his land)

	Loosa	Soona
1 - janjo nooro (the cost of fire)	d58	d54
2 - ta nongo nooro (the cost of the seed-bed)		
dumo safaro (seed medicine)		d 1
birjo (fertilizer)	d 5	d 5
noono safaro (plant medicine)	d 1	d 1
3 - tirey nooro (the cost of the papers)	d 2	d 1
4 - pompey feerika nooro (wage of pump-operator)	d 2	d 3 t 2
5 - pompey saajaw yang nooro (money to maintain the pump)	d 3	d 7
6 - pompey hanse yang nooro (money to repair pump)	d 2	d 3
7 - pompi taji day yang nooro (money to buy new pumps)	d13	d14
8 - hari surey nda jasey saajaw yango nda hanse yango nooro (money to maintain and repair pipes and banks)	d 5	d 5
	d91	d94 t 2

1. The monetary units are the dala (5F) and the tamma (1F); the total represents the amount to be paid per are. To know the total amount to be paid by each farmer all you have to do is multiply by the number of ares in his plot.

2. The break after the first five columns indicates that until there you are dealing with <u>real</u> expenses, the last three columns being provisions for <u>estimated</u> expenses.

Dr Hellmuth Bergmann *is Chief Technical Adviser to the European Investment Bank and the author, with* J.N. Boussard, *of* Guide to the Economic Evaluation of Irrigation Projects, *OECD, Paris, 1976. In a paper given at the* Man and Technology in Irrigated Agriculture *symposium organised by the German Association for Water Resources and Land Improvement (DVWK) in 1982, the proceedings of which are published as* DVWK Bulletin 8, *Verlag Paul Parey, Spitalerstrasse 12, D-200 Hamburg 1, Federal Republic of Germany, 1983, he summarised the experience of the Bank with the different structures for implementation and operation of irrigation projects in the Mediterranean region. The Bank has helped finance some 700,000 ha, of which 300,000 ha were in southern Italy (the 'mezzogiorno' region). The rest were in Greece, France, Turkey and Portugal.*

He concludes that whether farmers are formally represented in the management structure is not so important as decentralisation of decision making to a local body, which makes its own contracts with farmers, and the degree to which managers and employees are really concerned with the interest of the final user. Network members in developing countries will be interested to see the repercussions for the collection of water dues and on the need for subsidy. In the extracts published below he is expressing his personal opinions, not those of the Bank.

We are grateful to DVWK and to the publishers for permission to reproduce this material.

B. MANAGEMENT STRUCTURES IN MEDITERRANEAN IRRIGATION

Hellmuth Bergmann

1. ORGANISATIONAL

In the countries with which it deals, the Bank has encountered three types of structure for implementing new irrigation schemes.

a. Centralised dual structure

This form of implementing irrigation projects involves two Ministries who share the responsibility of study, design, tendering and implementation of irrigation projects. Each one has its regional and local offices which have very little independence and act mainly in a supervisory or executive capacity. The planning and design offices are located in the capital, and all important decisions on awarding of contracts or on alteration of the original design are taken at the central office, often by the Minister or his Secretary of State.

The department of the Ministry of Public Works concerned is responsible for the main works, eg dams, weirs, main and primary irrigation and drainage, canals, pumping stations both for irrigation and drainage, river regulation works, levees and sea-dykes.

The appropriate department of the Ministry of Agriculture is responsible for the secondary and tertiary irrigation and drainage network, rural road construction, land consolidation - if any - and land levelling, the latter being mostly carried out by direct labour, for the establishment of an organisation for operation and maintenance of the project, as well as the extension service.

This system is found in Greece, Turkey, Portugal and Ireland (land drainage only), and can work surprisingly well, despite its seemingly complicated nature, provided there is close cooperation between the General Directors of both Ministries. In Greece, for example, co-operation was such that the two Ministries made a joint invitation to tender for the construction of individual irrigation sectors and together awarded one contract for works forming a technical unit (primary, secondary, tertiary irrigation, drainage and road networks).

On the other hand, it sometimes happens that the General Directors responsible are more concerned with the power of their own organisation than in implementing the works which is often detrimental to the other party. Even at the planning stage (drawing-up of the final design) delays of two or four years can occur.

This serious "human" problem may be solved - at least partly - by a strict and effective definition of responsibilities and clear administrative regulations, as in Turkey, for example.

b. Decentralised mono-structure

In this case, planning, implementation and operation are in the hands of one local semi-public company in which local bodies such as the Chamber of Agriculture, local administrative bodies, etc,have interests.

Central authorities (eg Ministry of Finance, of Public Works or of Agriculture) only supervise funding and certain major decisions on technical matters, but in general, management is quite independent. Water users are not, however, directly and formally involved in the organisation.

This structure is common in France (sociétés d'économie mixte) and now tested for the first time in Western Crete. In Greece too, there are local irrigation associations or irrigation cooperatives for small irrigation schemes.

This type of organisation works very well, because it is nearer to farmers and tends to co-operate more closely with the future water users than organisations which are mainly responsible to the Ministry in the capital. Decisions are taken rapidly and give careful consideration to the farmers' needs and worries.

c. Vertical mono-structure

In Italy, a central body, the Cassa per il Mezzogiorno, is responsible for planning, financing and implementation of irrigation projects and other works in the south of the country. Its decision-making process is not independent but related to other Government bodies and therefore complicated. Agencies responsible for the actual implementation and supervision of works, and to a certain extent, also for planning and design, are called "Consorzi di Bonifica" of which all land owners concerned have to be members (similar to the German "Wasser- und Bodenverbände"). However, all final decisions on financial and technical matters depend on the Cassa which has itself to refer to other central authorities.

The strong centralisation of decision-making in the capital leads automatically to a lack of real, permanent involvement on the part of the farmers concerned, although the organisation chart of these Consorzi provides for an "assembly general" of all land-owners, election of a "president" by the land-owners, etc.

The lack of communication and the alienation between the farmers and the organisation is remarkable and the decision-making process extremely slow and complicated, although the basic administrative structure seems to be very well adapted to decentralised rapid decision-making and to close co-operation with the farmers.

2. METHODS OF EIB FINANCING

The EIB is very flexible, and can make loans:

- to the Government or a Government body such as the Cassa (direct loans);
- to the implementing body (société d'économie mixte) (direct loans);
- to private irrigation associations or co-operatives or individual farmers indirectly through an intermediate financial institute (agricultural or development banks, etc).

In the two latter cases, according to its statutes, the guarantee of the State, and in all cases the authorisation of the European Commission, are necessary.

3. ORGANIZATIONS FOR CO-OPERATION AND MAINTENANCE

a. State bodies - dual structure

In Turkey and Portugal the same organisations responsible for implementation are also in charge of operation and maintenance later on, ie

- the Ministry of Public Works, for the main works, and
- the Ministry of Agriculture, for the secondary and tertiary networks.

Both create local branches and have available the necessary equipment and machinery. Water tariffs are fixed by the State.

b. Management by the body responsible for implementation

In France and Italy the body responsible for implementation (société d'économie mixte or Consorzio de Bonifica) is also responsible for operation and maintenance of the scheme, but the results and the efficiency are not the same.

In France, the companies are financially independent and have to cover all financial and operational costs from their own revenues, Water delivery contracts are therefore concluded with the future users right from the start, and a secondary and tertiary network constructed only when 60% of contracts have been signed in respect of maximum throughput. Normally, contracts cover 70 - 80% of the maximum throughput. Tariffs are composed of a fixed charge per l/s provided for under contract and a variable charge per m^3 consumed. The latter is lower during the low-season and higher during the peak season and depends also on the distances from the main water source.

These companies are financially sound, and the use of the irrigation network, in spite of relatively high water costs, quite satisfactory. However, farmers are not part of the organisation, and the official advisory service is organised by the Ministry of Agriculture. For this reason, most companies have created their own services which keep in contact with the farmers and teach them how to make better use of water. In addition, the companies carry out a substantial amount of applied research work on sprinkling equipment, water consumption, etc.

The Italian Consorzi have, in theory, a more democratic structure but are, in fact, very dependent on the local Governments (Regions) which are also responsible for the extension service. Tariffs are not fixed according to financial needs, but according to political considerations and do not normally cover administration, operation and maintenance costs, although farmers do not contribute towards capital costs. The Consorzio therefore depends on subsidies from the local Government.

The use of the irrigable area seldom exceeds 50 - 60%, because:

- the irrigation networks (surface and sprinkling) are not constructed according to actual and controlled demand;
- the water tariffs in the case of non-utilisation of the system are low;
- the advisory service is weak, etc.

c. Farmers' compulsory co-operatives

In Greece, the secondary and tertiary irrigation networks are managed by local co-operatives (TOEV) of which all land owners and water users of any village are members. They elect their own managers and fix by themselves the water tariffs. The Ministry of Agriculture supervises their technical and financial performance and approves the budget, etc.

An association of the local co- operatives (GOEV) is responsible for operation and maintenance of the main works, and the Ministry of Agriculture is represented in the management body.

As far as water distribution is concerned, these TOEV work very well. Only the maintenance of the drainage network is unsatisfactory. Water tariffs are mostly too low to cover all costs for operation, amortisation and maintenance and it is naturally the latter which suffers.

The extension service is independent, but there is close co-operation - at least in EIB-financed projects - between it and co-operatives, as their offices are situated close together.

Network utilisation is high (80 - 90%) and the budgets of the organisations are well-balanced.

4. CONCLUSION

In Mediterranean areas, the type of organisation, its bureaucratic or democratic structure and the official participation of farmers in the management have little effect on the success of irrigation schemes if the criteria are equal water distribution, high utilisation of the network, and expenditures and receipts of water charges are balanced.

More important than the organisational structure is the spirit of the managers and employees responsible. If they really wish to implement the project rapidly, efficiently, and according to the financial and technical plan in the true interests of the final users, if they care also during operation for the well-being of the farmers and therefore co-operate with them, even without any formal structure to do so, the project will work satisfactorily.

The most decisive factor is not the organisation itself, but the spirit of co-operation and the ambition of everybody to contribute directly and personally to the needs of efficient regional and agricultural development.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 9d

APRIL 1984

WORLD BANK IRRIGATION EXPERIENCE

Frederick L Hotes*

* Frederick L Hotes joined the World Bank in 1973 and served as Irrigation Adviser from 1975 till his retirement in 1983, reviewing all projects supported by the Bank which included irrigation and drainage components. The views expressed in this paper are those of the author and not necessarily those of the World Bank.

This paper first appeared in the International Journal of Water Resources Development, *Vol 1, No 1, April 1983, published by Tycooly International Publishing Ltd, 6 Crofton Terrace, Dun Laoghaire, Co. Dublin, Ireland, and edited by Dr Asit K Biswas. We are grateful to Dr Hotes, Dr Biswas and the publishers for permission to reprint it here, and hope it will stimulate comments. In an era of increasing financial stringency, what he has to say on cost recovery indicates, I think, an area that requires much more thought from us all in future.*

This paper is also available in French and Spanish from Room N-1147 World Bank, 1818 H Street NW, Washington DC 20433, USA

MARY TIFFEN

ABSTRACT

Irrigation is the largest subsector of the agricultural and rural development sector of World Bank and IDA lending. The very first loan to a developing country, made in March 1948, was to Chile, to the amount of US$13.5 million, for power and irrigation. Since that time, up until June 1982, agricultural lending has amounted to $26.7 billion, of which more than $10 billion was for some 285 irrigation projects. Total project costs have been about 2.5 times the amount of the loans. Irrigation lending represents almost 10 per cent of all past Bank lending and about 38 per cent of agricultural sector lending. It is also worth noting that 90 per cent of all agricultural lending has occurred within the past decade. The experience gained from these activities has been considerable and varied. It is the primary purpose of this paper to discuss briefly several of the important lessons learned from, and issues raised by, this experience and to indicate some of the guidelines and procedures developed to help address them. In addition, a brief summary is given of the types of irrigation projects funded by the Bank and of some of the overall results of past projects.

TYPES OF IRRIGATION PROJECTS

Irrigation is viewed within the Bank as a principal vehicle for expanding domestic food supplies in developing countries. Lending for irrigation is based on support of national efforts to intensify water use in order to increase agricultural output and reduce annual fluctuations in food production.

Projects financed encompass almost all types: from large dams to handpumps and shallow wells; from completely new irrigation systems for desert lands to rehabilitation or extension of existing systems in monsoon climates; from large canal distribution systems to on-farm water management; from land levelling and land consolidation to the use of sprinkler and drip irrigation systems; from planning new projects to the operation and maintenance of equipment, organization and training for on-going systems; from large systems with more than a million hectares to groups of small irrigation sub-projects with individual sizes of from 50 to 500 ha; from support of large state institutions to credit for land and system improvements for farmers with small holdings.

Bank-supported projects to promote irrigation usually include other components, of which the following are typical: rural roads, credit, extension, marketing, research, education and training, health, potable water and electrification. In practice, irrigation systems costs may amount to 45 to 90 per cent of total project costs. Non-irrigation components are not usually included in projects unless they are necessary for the project benefits to be realized, can be independently justified, or are part of preparatory work for future projects. In the main, however, most of these components are essential to improve the livelihood of small farmers and to generate rural employment opportunities - two important objectives in Bank-supported projects.

There is also an issue concerning the duration of an irrigation project, especially when it may be part of an on-going programme. While it is preferable that projects be planned so that they are technically and economically viable as entities, the Bank has also agreed to finance 'time slices' of very large projects which cannot be completed within the normal project loan period of 5-7 years. For example, a project with an ultimate irrigation area of 424,000 ha would require about 15 years to complete; the first time slice of 5 years would bring about 105,000 ha under cultivation. The economic rate of return (ERR) for the first phase would be about 10 per cent and the overall rate of return for the entire project would be expected to be about 16 %. This project presents no problems. In another project of about 630,000 ha however, the ERR for the first time slice is estimated to be negligible. This raises some important concerns and several tests must be met by such projects before the Bank will agree to finance a time-slice project of this kind. These include: (a) is the overall ERR for the full project satisfactory? (b) can the Bank rely on the Government's commitment to complete the project expeditiously and soundly, especially as the Bank will not give any advance guarantee that it will participate in the financing of later phases?

2. GENERAL EXPERIENCES

a. Time and Costs of Execution

There are two broad lessons that can be learned from the Bank's experience with its agricultural projects. The first of these is that a project usually takes longer than anticipated by the official planners, especially a project that involves infrastructure and capital works. The reasons for this are many, but as a rule most people working on projects simply underestimate the problems inherent in bureaucracies, especially those which are intended to handle routine activities and so have great difficulty in absorbing incremental activities. Most agencies do not have the flexibility in terms of staff or budgets to accommodate additional demands and it takes time to prepare budgets, recruit trained personnel and adjust to new circumstances. Also, it is usually assumed that distinct activities will take place at the scheduled time. Despite allowing for contingencies, there is invariably an underestimation of disruptions due to breakdowns in schedules which, unfortunately, seem to occur with depressing regularity.

Another major contributing factor to this problem is inadequate project preparation, which also has contributed to significant underestimation of the amount of work necessary and the cost. Where projects have been well-prepared, both costs and duration have proven to be more in line with original estimates.

Since 1981, the Bank has had a requirement, for all types of projects, that field investigations, engineering work and detailed designs should be well advanced at the time of loan approval, so that bidding documents could become available and tendering could begin shortly afterwards. Generally, this requires final designs for large monolithic structures, such as dams and other major structures and canals, and detailed designs for the first year of work for other facilities. For irrigation projects, this means that plans, profiles and cross sections should have been made for the main system, with detailed designs and estimates for representative areas of the project. There should be no major surprises in quantities during construction.

Similarly, software components - for example training programs or organization reforms - should be fully designed and possibly underway. The project organisation should be formulated and the initial staff scheduled and provided for in the local budget. Housing and equipment requirements should be developed and initial procurement ready to go. Agricultural research should be sufficiently advanced to make results available for dissemination by trained extension agents and on the social side, preparation for farmer participation should be underway.

Greater precision in formulating project measures, as part of project preparation, can reduce uncertainties, delays and cost overruns, and so can spare borrowers significant amounts of commitment fees they would have to pay on loans that disburse more slowly than planned. Such detailed planning and preliminary implementation measures may have an added advantage: as experience is gained, this can lead to useful project adjustments early on in terms of targets, scale, timing or even basic design. The Bank has three ways to support this type of project preparation: it can agree to a loan advance from the Bank's Project Preparation Facility; it can agree to the allocation of project preparation funds under technical assistance loans; or the funds can be provided by inclusion as a component in a prior project.

b. Rates of change under the project

The second broad lesson from the Bank's general experience is that most planners tend to be over optimistic in terms of rates of change arising from the project. The most noticeable area of over estimation is the anticipated rate of increase in output. There are many reasons for this. Perhaps the two most important are the failure to appreciate the logistic problems in securing yield increases and the failure to understand the dynamics of change at the farm level. Yield estimates are usually based on experience of yields elsewhere under conditions thought to be similar and on results already obtained by more progressive - though not necessarily typical - farmers, supported by data from research stations and, when available, from local trials. The assumption is that, given the necessary inputs, farmers will see it as in their own best interests to increase their output through use of inputs, as recommended on the basis of research results, following their demonstration by the extension service. But before they can do so, there has to be a ready and timely supply of inputs. Experience, however, indicates that time is needed to develop suitable distribution systems - even the simplest - to ensure ready availability of seed, fertilizer and credit. In addition, experience also indicates that, even where inputs are readily available and it can be demonstrated that they can be used profitably, there is still the question of the rate at which farmers adopt changes. This varies enormously; it has been rapid in some places such as the Punjab in India, but usually change comes relatively slowly. This, in turn, means that total output increases far more slowly than expected. Past experience teaches that this phenomenon cannot be ignored and has to be analyzed *in situ*. One simply cannot transfer experience and say that because output grew at 'x' or 'y' per cent in Israel or Japan in irrigated agriculture, it will also do so elsewhere. We have learned that much more realistic estimates are required of the time needed to obtain benefits from projects.

c. Summary of the two broad lessons

Basically, the Bank's experience indicates that there is a general tendency to underestimate the managerial and staffing problems and the time required to implement projects, as well as the time needed to organize and derive the benefits of projects. This applies to most agricultural projects and arises from factors as diverse as the problems of co-ordination within governments and the conservatism of most producers. These issues cut across all countries and all projects.

3. IRRIGATION PROJECT PROBLEMS

a. Inadequate preparation

Inadequate preparation has already been mentioned as a major contributing cause for projects taking longer, and costing more, than estimated at the time of project financing. Better preparation would mean more attention being directed to the other problems that will be discussed subsequently. Adequate preparation means more detailed engineering and careful cost-estimating and it means, of course, specific attention to the special technical features of each project, such as quantity and quality of water supply, land classification, agronomics, a host of economic factors and a long list of others. It is beyond the scope of this paper to mention all the different ways in which projects could be improved. In the sections that follow, emphasis will be placed on those believed to merit much more attention during project preparation and operation than generally would seem to have occurred.

b. Management and organization

Irrigation projects are intended to provide adequate and timely supplies of water to farmers so that they can increase their output. Thus, the design and implementation of projects calls for an interaction of engineering and agricultural expertise. One of the most vexing problems is that of organizing the interaction. In some countries, the tendency is to favour autonomous institutions or authorities. In others (as in Thailand and the Philippines), there has been a national irrigation agency, while some governments have an umbrella Ministry which includes an irrigation department. In still others, project success depends upon the efforts of two or more Ministries. Then there are also problems of the degree of decentralization - whether to have control at state, provincial or local levels.

The Bank has found that the majority of the projects which give the best performance are operated under the aegis of nationwide irrigation agencies. Many of the poorly operated systems are managed by newly created institutions, but there are so many exceptions that it is not possible to draw a general conclusion as to which course is the best. Weak institutions are one of the main reasons for poor delivery-system water management, in any institutional situation. Institutional performance can be hampered by difficulties in securing enough qualified personnel, especially staff at the project site - even if hardship allowances are paid; by inadequate financing; by lack of staff training; by failure to establish clear project objectives, policies and lines of communication; by failure to understand farmers' needs and goals; and, in some cases, by lack of adequate legal administrative authority. A detailed analysis of management and organizational problems is contained in the World Bank (1981) report.

The Bank's view is that lack of good management is the primary reason why so many projects fall below their full potential. It believes that investment in management training for key project staff would pay high dividends. Good managers can increase the productivity of even poorly designed systems and, conversely, poor managers can cause poor investment returns to even well-designed and constructed irrigation systems.*

c. <u>Engineers and agriculturists</u>

Another problem encountered in Bank-supported projects is the lack of communication between engineers and agriculturalists Irrigation systems - especially the main, secondary and tertiary canals - are usually designed by engineers concerned with transporting water, most of whom have had little direct experience with irrigated farming. The systems are often designed without giving due attention to the most appropriate mode of delivering water to farmers as and when they need it for raising agricultural productivity.

Modern irrigated agriculture requries that attention be focussed on the farm needs when designing and operating irrigation systems. This requires the inputs not only of engineers and agriculturalists, but also of economists and other social scientists. The Doukkala project in Morocco can be cited as a good example of attention being paid to most aspects of both engineering and agriculture. Engineers need to know more about how water should be and is used by agriculture and agriculturists need to have better knowledge of how engineering can or should be used to improve farm water deliveries and on-farm water use.

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* The author has observed that in most well-managed irrigation systems around the world, the manager and key staff are career project staff. Many spend their lifetime on one or two projects; their livelihood is linked with project success. On the other hand, where management is rotated, well-managed schemes are difficult to find.

d. Farmer participation

Participation of farmers in irrigation projects is an important issue. Relatively few of the large irrigation projects in the developing world involve farmer participation in project design and management, although many do depend upon some kind of help from farmers in handling the water beyond the government delivery points. This help,unfortunately, tends to be poorly organized, financed and operated. Bank staff have observed that where farmers participate in the mangement of systems, this helps assure equitable and more efficient use of water resources. In this regard, it is interesting to note one of the conclusions from the post-project Impact Evaluation Report, by the Bank's Operations Evaluation Department, of the San Lorenzo Irrigation Project in Peru, a project that throughout its execution and initial years of operation was generally considered a problem project: 'Five years after completion, it appears that the most notable accomplishment of the project was the successful establishment of strong farmer organizations. The project today is a remarkable example of the way farmers can progressively and successfully take over project responsibilities and substitute for government institutions; it also demonstrates the need to anticipate and prepare during project implementation for such a transition of project authority.'

e. Operation and maintenance

The Bank's experience makes it clear that operation and maintenance (O & M) is a major issue. A review of 30 audits by the Bank's Operations Evaluation Department in 1981 revealed that most project agencies were not prepared to undertake system operations after completion of construction. Government authorities often have erroneously viewed maintenance efforts as a low priority and easily postponable, so that budget allocations are negligible, and the best staff are assigned to design and construction. The result is that O & M assignments are rarely considered desirable. Some project analyses have indicated that more attention to O & M could easily add at least 10 per cent to the amount of land capable of being irrigated with existing systems. In other words, more attention to operational water control and maintenance can pay very large dividends.

The use of a cost per hectare estimate for O & M during project preparation is not only of very little use but can also be misleading, if not dangerous. Requirements for O & M personnel, equipment and facilities should be carefully developed with attention to the relationship between system design and O & M requirements. The Bank's experience is that most feasibility studies have paid little or no attention to development of realistic O & M plans and organization.

Not enough consideration has been given to several of the options offered by modern hydraulic engineering systems, such as the upstream and downstream automatic control gates used on several projects in the Mediterranean region. This requires greater capital costs, but there is a tradeoff in reduced operating costs and vastly improved reliability of water deliveries to farmers to meet their varying demands for irrigation: this in turn increases project agricultural production and benefits. The efficiency of the conveyance system of the Doukkala District in Morocco can again be cited. For the year 1977-78, efficiency of the main canals and distribution system was 76 per cent.* The main canal is unlined, but is equipped with downstream constant-level gates which adjust the flow automatically to farm demand. The distributaries are largely lined. It has been estimated that efficiency will improve to about 85 per cent as the system moves towards full-capacity utilization, since the operating losses are largely independent of the volume conveyed. It should be noted that disappointing results with automatic controls have been experienced in several instances, but the troubles could be attributed to inadequate engineering design, maintenance or operations.

More attention should be given to the use of underground pipe distribution systems as a means of improving O & M. Construction techniques have been developed in the western USA which permit concrete pipes to be placed and backfilled at the same, or lower, cost as open lined canals, at significant savings in farmland and maintenance costs. The Bank is financing some pilot schemes in India and Sri Lanka using piped underground systems and it is expected that the results will indicate the cost and water savings involved. The rapidly developing technology of plastic pipes would also seem to hold interesting possibilities for improved distribution systems.

There is an important gap in the financing of irrigation projects. Developing countries should be encouraged to formulate O & M projects, which could be funded in five-year increments over a 15 year period, to include management, technical and vocational training and equipment, as well as rehabilitation and modernization. O & M continues over the life of every project and is of vital importance in providing irrigation water when and where needed, at required rates, and also in minimizing rehabilitation costs, which usually significantly exceed any apparent savings realized by deferring required maintenance. O & M should receive much more attention from both borrowers and lenders.

f. Drainage

An important point is the need to provide for both surface and future subsurface drainage requirements. The experience of

* Efficiency is the ratio, expressed as a percentage, of the amount of water delivered to farmers divided by the amount of water supplied to the main canal intake.

the US Bureau of Reclamation is that 85 to 90 per cent of all irrigation projects eventually require supplemental subsurface drainage facilities. Not all of the land in such projects needs to be drained, but about 50 per cent of all irrigated land in the western USA, for which the Bureau has responsibility, has required such work. Our experience convinces us that more attention needs to be given to this aspect in project preparation and management. Usually, soil surveys concentrate on the top metre of soil and little information is available to the engineer about the existence of possible barriers to downward drainage within 5 to 10 metres of the ground surface. If such barriers exist, drainage and waterlogging problems can be expected to occur within a very short time.

While it is not always necessary to install artificial drainage facilities during the initial years, the need for possible future drainage facilities should be included in the cost estimates and economic analysis, and a reasonable drainage plan formulated for implementation as needed.

g. On-farm water management

On-farm water management is a very important aspect of irrigation that is receiving more attention recently. Improved on-farm water distribution increases crop yields, frees more water to irrigate additional areas and reduces project drainage installation and operating costs. Studies have shown that there is a very high economic payoff from on-farm improvements, but this is not always obvious to project authorities or farmers. Extension efforts and field demonstrations may be the most effective way of getting the message across to farmers, but these have to be supplemented by other activities such as planned educational and training programmes. The Bank is now making loans for the purpose of improving on-farm water management, their main focus being on research, extension, education and funds for minor on-farm improvements of irrigation facilities.

h. Land settlement and resettlement

Land settlement projects have many special problems that can be eased by careful planning and preparation. During the early planning stage, some research or set of trials should be established to study soil, water and plant relationships in the new lands and to develop the most suitable cropping system from among several alternatives for the soil and water regime. One that can easily be understood by the settlers is essential for success. In the early years, a different set of crops may be appropriate from those recommended for later years.

Another important element which affects design is the size of the farms and this is something which needs a lot of foresight. Many a settlement project has not provided enough land to each family to produce a reasonable income and so has created rural slums. On the other hand, there is considerable evidence that owner-operated smallholdings are the most effective social means of ensuring successful irrigation schemes. Not only do small holders use agricultural land more intensively than large farms - particularly those large farms under parastatal management - but where farmer-owners organize themselves to manage and operate their projects, this has contributed greatly to effective operation and maintenance.

Bank experience indicates that it has taken about 8 or 9 years for large numbers of farmers in irrigated areas to change from traditional to more intensive techniques, even where the cropping patterns have been proven to be more profitable. Special training for newly arrived settlers (on a special training farm) may be a good way to deal initially with these problems. This provides a solid basis on which subsequent extension services may be built. Since new settlement schemes are built from the ground up, more attention than usual may be needed for planning the means for farmers to obtain inputs and credit, and for their access to marketing facilities.

The construction of irrigation and drainage projects frequently requires that people living in the project area be moved to another location. Some of the more dramatic issues in this regard involve the relocation and resettlement of people living in designated reservoir areas; but equally important is the involvement of people displaced due to the alignment of canals, drains, roads or other project facilities, and even realignment and reapportionment of farm boundaries (sometimes called 'land consolidation'). The costs of resettlement may be considerable: over $200 million has been spent in some reservoir relocation efforts and costs of $8,000 to $10,000 per family are not unusual, even in very poor rural areas. Such costs should be included in project costs and provided for in financing arrangements. Involuntary resettlement generally is (and certainly always potentially is) a politically sensitive measure, giving rise to special social and technical problems. It is important that a resettlement plan be developed in considerable detail during the feasibility study phase. Such a plan could include some level of compensation as one element, but also should include definite locations and alternative locations, and facilities to help ensure that settlers are offered opportunities to become established and economically self-sustaining in the shortest possible period, at living standards that at least match those before resettlement.

i. <u>Increasing costs</u>

Another point to be noted is that of the continually increasing real costs of new irrigation projects. An investment of $5,000/ha in irrigation requires a net annual return of $800 to $1,000/ha to yield a rate of return of 12 per cent. Higher investment costs would require proportionately higher net annual returns, which can usually only come from the production of high unit value crops. There are few cropping patterns that can produce adequate returns over extended areas and a common error is to program for elaborate production systems that include unrealistic cropping patterns of high unit value crops for the whole project area. When investments of $10,000/ha are proposed, as has been the case for some proposed projects, the realism of attaining crop yields and prices which would net $1,600 to $2,000/ha annually should be critically evaluated.

j. Cost recovery

Cost recovery is one of the most, if not the most, controversial aspects to be encountered in formulating and operating an irrigation project. While charges for electric power and municipal and industrial water supplies can also be controversial, there is much less controversy proportionally in those sectors than in the irrigation sector. The reasons for this are complex but, for the moment, it is sufficient to recognize that the issue of cost recovery for irrigation project O & M costs and for investment costs is one which should be faced during project formulation. The extent and manner of cost recovery directly affects the cash flow of the farmer, the project organization and other government organizations, as well as affecting the distribution of the national income; it therefore must be realistically approached. Cost recovery can also affect the economic results of a project. If cost recovery imposes too heavy a potential burden on farmers, there may be insufficient incentives for them to fully participate in the project and the projected output will not be achieved. On the other hand, if O & M budgets are insufficiently supported by farmers and/or Government, water deliveries to farmers may be unrealizable and insufficient, and production could again suffer. This sensitivity of farmer and Government incomes to cost-recovery decisions makes these decisions political issues. Cost recovery involves human reactions and opinions, as well as hard financial facts that ultimately have to be faced.

The Bank has always maintained that farmers should be charged for their irrigation water because this has many beneficial effects: it keeps farmers aware that the water is not a free good, but has been provided at high cost and must not be wasted; it is a way of reducing somewhat the inequality of income distribution between irrigated and rain-fed areas, by recapturing some of the benefits from those for whom the investment was made; and it provides some funds which, if specifically set aside, can be used for essential maintenance work on the irrigation systems. Most serious studies of irrigation water charges seem to come to similar conclusions.

The following is a summary of the principles which could form a sound basis for water charges: recovery of irrigation project costs by direct and/or indirect methods should cover O & M costs, plus as much as reasonably possible of capital costs, taking into consideration the capacity of beneficiaries to pay, the need for them to have adequate incentives to participate in the project, possible disincentives, problems of tax evasion, cost of collection and differences in income levels. Final decisions on cost recovery for public projects must remain with the Goverment.

Cost recovery on Bank-supported projects varies greatly. There are projects where recovery amounts to $400-$500/ha/year, mostly because of indirect recovery through controlled farm prices, while the direct charge for water may be only $5/ha/year. One interesting aspect is the existence of private tubewells, where all investment and operating costs are paid by the farmers, in the same areas where public tubewells do not recover even O & M costs. Unfortunately, public lending agencies have tended to have a poor cost-recovery discipline for irrigation projects, with predictable results - poor O & M, poor project performance and continuing deterioration of the system. However, cost-recovery is not an end in itself. The true benefits of enlightened cost-recovery policies are those already mentioned - fiscal viability of the project to help ensure good O & M, fiscal viability of the farmers, improvement of water efficiency, equity and public savings which can be used to provide future benefits.

k. Overall economic policies

The importance of overall economic policies as they influence any project must be emphasized. They refer to agricultural pricing policies, input distribuiton, marketing policies and conditions governing employment in the Government. These policies have a major role in establishing the framework within which farmers find their production opportunities and they should be reviewed seriously by lending agencies and borrowers before investing in irrigation development. Frequently, such an examination is beyond the terms of reference of those preparing the projects, but the examination should be made an integral part of every project preparation and appraisal effort.

4. PROJECT RESULTS

a. Post-project evaluation results

A review of forty Bank-assisted irrigation and drainage projects gives some interesting insights into the effect of Bank-lending for irrigation. Despite the problems previously noted, it is worthwhile to note that most of these projects contributed positively to the economic and food-production growth of the borrowing countries. The projects were financed during the period 1961-1976, all except four of them in the ten-year period 1966-1975. Average loan size was $22 million and the average estimated cost was $50 million. Actual cost was 38 per cent higher than estimated, on average. The average area irrigated per project was 106,000 ha and the average farm size was five ha (after development).

All but eight of the projects had audited economic rates of return (ERR) of 10 per cent or better; more than half exceeded 15 per cent. A few projects had very low ERRs and some had ERRs greater than 30 per cent. Nineteen out of 40 projects actually exceeded their projected ERRs. Apparently, this was mainly due to the higher than expected crop prices in more than half the cases, which combined with higher output than projected in 18 of 34 projects, to more than offset delays and cost overruns. On average, actual crop prices exceeded appraisal estimates by 38 per cent. Only nine of the 40 projects were constructed on schedule; 25 experienced cost overruns of 20 per cent or more, and nine suffered from doubled, or more than doubled, costs. Construction delays affected all but 12 of the projects, with 24 projects experiencing time overruns of 20 per cent or more and five projects taking more than twice as long as scheduled to complete. While the area served fell short in most projects, the volume of output fared slightly better, with 18 out of 34 projects reaching or exceeding targets. In general, the 19 rehabilitation/expansion projects outperformed the others. This should be expected, both from the standpoints of lower costs and the relative ease of improving productivity of farmers already experienced in the use of irrigation.

b. Trend among on-going projects

From reviewing the Bank's semi-annual supervision reports on 180 current on-going irrigation projects, it is clear that many of the same problems are still being encountered. It is known that specific, sometimes intensive, efforts have been made to mitigate or avoid these types of problem, with considerable success in many instances; but much more still remains to be done. One wonders whether the higher costs of current projects, especially if accompanied by delays in achieving benefits, will be offset by higher-than-projected prices. Perhaps so, but project success should not be dependent on such anomalies. It would be unrealistic to expect perfect execution; indeed, slippage and problems of some kind should be anticipated in any project.

5. CONCLUSIONS

Irrigation is viewed by the World Bank as a principal vehicle for expanding domestic food supplies in developing countries and the Bank plans to support economically viable projectsto harness new sources of water, to expand areas already irrigated, to rehabilitate and modernize older systems and to provide for extension, credit and marketing services at farm level. It is hoped that future projects will be prepared even better than in the past and that the key problems discussed in this paper can thereby be minimized. Irrigation projects can yield high returns to participants and to national economies, but they are costly and not simple to do well. There are no short cuts. It is hoped that the lessons and experiences from the Bank's projects will be helpful in strengthening proposed and on-going irrigation projects around the world.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 9e

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ASSISTING VILLAGERS TO BUILD THEIR OWN IRRIGATION SCHEME – AN EXAMPLE FROM THAILAND

*Evan Mayson**

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Small scale projects providing water for 50ha or less are often ill adapted to the working requirements of either central government agencies or international aid agencies. However, there are areas where several hundred such projects could make a considerable difference to the agricultural production, to water supply and the health and comfort of a substantial number of families. The problem is to find a suitable intermediary institution to assist local people to carry them out. This article describes how the Office of Water Resource Development, Faculty of Engineering, Khon Kaen University, Thailand, with New Zealand aid, helped villages to construct 40 small weirs (and many other projects) in a five year period, evolving training techniques to help villagers help themselves. The demonstration effect should ripple out to many other communities over the next few years.

The programme began in 1978 when the government of Thailand asked New Zealand to co-operate with Khon Kaen University in a Small Scale Water Resource Programme (SSWRP). *The small scale approach was preferred as a solution to water needs because it avoided flooding large areas and dislocating communities. Brian Warboys was appointed first adviser to Khon Kaen's office of Water Resource Development, and the author of this article, Evan Mayson, joined the project in 1981. The programme is now continuing with a Canadian* volunteer *and Canadian funding.* Dr Wirojanagud *of the Faculty of Engineering, explains that the Department hired its existing technicians to do extra work in training village-level technicians. On a voluntary basis, about a dozen students a year helped supervise the irrigation weirs, gaining valuable insights into village requirements. It is hoped that in the next phase the Social Science and Agricultural faculties will co-operate in the evaluation of the social and economic impact.* Mayson *adds that unfortunately, for mainly administrative reasons, the University could not provide a staff member to work alongside him in the field. He feels that had this been possible, it would have increased the impact of the short training courses the University ran for District level government engineering staff, since there would have been greater awareness of the educational level of the participants and the nature of field problems.*

Networkers interested in the administrative difficulties of implementing a rather similar programme on a national scale, for rather larger schemes, should look at Holoran, S. Corey, G.L. and Mahoney, T. Sederhana: Indonesia Small Scale Irrigation, Project Impact Evaluation No. 29, 1982, USAID, Washington DC 20523. *Please write direct to USAID for a copy not to ODI. This involved upgrading 700 schemes, of 50 to 2,000ha using two technical assistance contractors to work with the relevant Ministries. The programme did increase production, sometimes dramatically, but progress was much slower than expected and design suffered from inadequate farmer consultation.*

1. INTRODUCTION

In the semi-arid impoverished area of the North East of Thailand, the lack of water is considered to be the biggest single constraint to development. Recent surveys carried out in the area have indicated that between 60 to 80 per cent of NE villagers rated water for irrigation, consumption and general use as their most important requirement.

In 1978 the Government of Thailand asked New Zealand to co-operate with Khon Kaen University in setting up a small scale water resources development programme. The University of Khon Kaen (KKU) was chosen as a suitable institution for a small scale project because of its geographical location, in the centre of the NE region, and also because it had an extension service which enabled it to carry out training programmes for farmers and local government officials within that area. The project was a bilateral aid project, the NZ government providing two vehicles for two advisers, their salaries and a small budget (US$30,000), for a small rural construction programme in the vicinity. The University provided housing and the Thai Government, through the Department of Economic and Technical Co-operation, provided a budget to run the vehicles and office running expenses. The total amount of money committed by the New Zealand/ Thailand Governments amounted to approximately US$450,000 from 1978 through to 1983.

The objectives of the Khon Kaen University-New Zealand project are:

i. To build a series of small scale projects in villages, which can be used as a basis for demonstrating techniques taught in training seminars run by the Office of Water Resources, KKU.

ii. To acquire practical experience and understanding of small scale project construction.

iii. To provide small scale projects in villages, that improve the water resources of the rural areas and at the same time demonstrate the kinds of projects that can be implemented by villagers themselves.

The project was conceived as a small scale operation partly for financial reasons, but it also stemmed from a recognition of the importance of a small scale strategy when tackling the problems of water shortage for the majority of the population in the NE. In 1978, a report,requested by Water Resources Planning Subcommittee of NESDB (National Economic and Social Development Board, Thailand), was produced by the Asian Institute of Technology which indicated the areas of the NE which could be served by distribution of water from existing resources such as large reservoirs and rivers. The remaining 80 per cent of the population were to be served by the construction of small tanks, natural or dug ponds, weirs, topographical alterations and shallow and deep wells. Unfortunately, in practice, large technical line development agencies within and without the Thai

Government never seriously considered individual village projects costing less than US$5000. There was also no recognition of the reservoir of technical skill that exists at village level, a skill which can easily be tapped in small scale development projects.

At present there are approximately twelve government departments involved in water resource projects in the NE of Thailand. The two main-line technical agencies are involved in larger scale village projects - usually, reservoirs over 100,000 m³ in capacity, with individual projects costing from $5,000 to tens of thousands of dollars (apart from their well projects). Reservoir and pond projects, although technically sound, have not recognised the level of management and technical skill at village level and have not involved them in critical decisions of design and planning with the result that benefits dependent on village co-operation do not eventuate.

Other agencies have attempted small scale projects but are severely restricted by insufficient technical back-up and a large number of their engineering type projects have failed after a short time. This is particularly applicable to irrigation weirs. Projects such as the government job creation scheme, while having a size within the capacity of villagers to organise and manage are often technically unsound and fail for this reason. Insufficient technical input at the planning and construction stage is the major contributing factor. One government department is hampered by the fact that its offices are on a regional (not provincial) level so that those technical resources it does have are very stretched. Another department has the necessary staffing set-up but its village level workers do not have the technical abilities to produce a successful project. In the construction of weirs, for example, all departments are hampered by using inappropriate and inadequate standard designs.

Numerous failed diversion weirs and spillways dot the countryside. Of those observed by the project personnel, well over half have failed within the first year of operation. Most have involved the local farmers in their construction under the job creation scheme where they received a wage for building their own weir. (The main purpose of such projects was to create jobs.)

Over the five years of field operation the Khon Kaen University-New Zealand (SSRWP) has attempted many types of small scale projects related to water resources. It has, however, tended to concentrate on irrigation weirs and rainwater storage facilities. This is probably a reflection of the advisers' particular interests. Both being civil engineers, they tended to focus on projects that require a higher degree of civil engineering skill, but it could also be said that these projects also needed the most technical input, were easily assessed as being of direct benefit, and were certainly the kind of project that was popular within the areas in which they worked. In addition to weirs and tanks the project has been involved with windmill pumps, shallow and deep well rehabilitation and in the construction of small village reservoirs.

2. PROCESSING PROJECTS AT VILLAGE LEVEL

It has been recognised in the past that the basis of decision making for small scale development has to be the village. The SSWRP has relied heavily on direct contact with the villagers or local village expertise in the form of leadership, for the construction of its projects. Although at no stage have villagers been requested to pay for projects, they are certainly expected to provide their labour for nothing or, in a minority of cases, at a nominal charge. It has been found that generally this presents no problem,the villagers are quite willing to contribute their labour if the need is there and they have confidence in the ultimate success of the project itself.

a. Instigation

The large majority of all projects constructed have resulted from direct approaches to the project personnel by farmers and generally have resulted from interest generated by previous successful projects in the area.

It has been found that once one successful (as seen by villagers) project has been built in one area, the information quickly travels by word of mouth and further requests for small scale projects arise. For irrigation weirs development has spread up and down river valleys. One successful irrigation weir (ie one that does not fail) in one tambon (local government area) leads to up to six requests for similar help the next year in the same area.

The project has had a particular advantage in that it has not had to suffer from the restraints of Thai bureaucracy in responding to these requests. The fund was independently administered by the New Zealand advisers and this has tended to encourage this type of instigation procedure. It has been this flexibility of SSWRP in terms of project initiation that has contributed more than anything else to its success. For rural development, a project needs to be able to respond quickly and effectively to requests for help.

b. Planning and design

The fact that most projects attempted were instigated by the villagers themselves means that to a certain extent preliminary planning has already taken place in the village before help was requested. The need for the project has been established by the villagers, as have other decisions on things such as site, access, labour availability, and multi-village co-operation and management if required. If the project follows on from one in a nearby area, the local village communication system is generally sufficient to explain the type of help that they can expect and what their responsibilities are.

A series of meetings is arranged as standard practice in any case, and this provides an opportunity for these points to be explained (the free labour question is of particular importance), as well as giving project personnel a good chance to judge the amount of interest there is for the development. At these meetings (usually on site) virtually all the planning decisions are made. The expected benefits are explained by the villagers and suggestions made to the advisers on things to be incorporated in the design. All that remains are the technical design problems which are left to the advisors to solve.

These meetings, normally arranged through the local village headman or gumnan, are good indicators of the local leaders available (not necessarily the headman or other village officials) who will be useful during the later stages of construction. These local leaders are normally the local village technical expert (chang),or simply a local leader who can organise people well. If there is a village technician in the village or a neighbouring one, who has already been trained by the University,then he also plays an active role at these meetings and adds his advice on technical aspects.

It is important to take major decisions openly at public meetings in order to avoid benefits being monopolised by a few people, and to prevent corrupt use of funds.

c. Implementation

Once the planning procedure has been followed through, the role of the local village chang or expert (or a project-trained village technician) becomes increasingly important. Most of the problems from now on are technical ones. Any other problems which may arise,such as labour management, are the responsibility of local village leaders. The imparting of the technical information to villagers from the design board is a problem that has been a particular concern of the project and a number of techniques have been employed to facilitate this.

i. Standard designs are used,ones that require little alteration from site to site and are therefore easy to become familiar with, particularly by trained technical help.

ii. The designs have simplicity in dimensions and construction techniques. They are designed to be understood and built by villagers with little technical background and to be insensitive to inaccuracy in construction technique.

iii. Extensive use is made of models and construction manuals that present the technical information in simple three-dimensional picture form. Conventional engineering drawings are rarely used and even more rarely understood.

iv. Where possible a villager with basic experience in construction and who is trained by the SSWRP will act as an on-site representative and technical adviser for the project. This village technician is normally paid a daily allowance by the project.

This village technician plays a vital part in small scale development strategy, acting as a middleman between engineer and villager and providing much needed intensive supervision when required. The failure to recognise and exploit the high level of technical and managerial skill that is available at village level is a serious omission on the part of a number of rural development agencies in Thailand.

To July 1983 the project personnel have been directly involved in the design and construction of approximately 40 weirs and other irrigation structures. This number does not include those which have been built using designs directly supplied by the project and where, in some cases, some assistance was also given in the supervision of the construction. At present costs these weirs are costing approximately US$400 to US$450 per metre width for materials. Labour is normally provided free by the local villagers and supervision is carried out by the SSWRP. This means that an average 8 metre wide weir would cost between US$3200 to US$3600 to build. This does not include the cost of supervision. The main purpose of the weir is to provide a controllable water source for wet season irrigation of rice, something which has been obtainable to a very limited extent by traditional wooden and mud dams. In addition the water stored behind the weir during the dry season provides a significant storage of water for vegetable growing, kenaf retting, fishing and (with pumping) seedbed preparation for rice production.

d. Monitoring

Since the first weir was built in 1979, the designs of the weirs have been developed and changed in the light of past performances. The performance of each weir design has been monitored carefully so that designs could be further developed to reduce construction and repair costs and to be more suitable for village-level construction techniques. This regular monitoring has enabled the project to maintain a very high non-failure rate for its weirs. Out of all the forty weirs constructed so far over the last five years, to our knowledge, only two have suffered significant damage and they were repaired at a small cost. This rate can be compared to other weir construction programmes which suffer from little or no technical input and whose failure rates have been quoted as high as 90 per cent. This applies particularly in the job creation scheme programmes created by the Government.

e. Water management

An important aspect of the weir construction programme has been the absence of any water management problems that plague the larger irrigation schemes. The SSWRP has never had to (or desired to) become involved in the water management side of the operation but has observed how things are managed at village level. The absence of any formal water management group at village level and the absence of any major problem in this area is due to a number of reasons:

i. The farmers decide where the weirs are to be built and to what levels the water is to be controlled. At this early stage of planning the farmers already know where the water will flow and how it will be managed. They know this because of the management techniques used in past years.

ii. The site for the weir is often the site for a previous failed or traditional weir so water management techniques are often already developed before construction begins. A new weir represents an improvement to their traditional system but does not require marked changes in water management practices.

iii. Once the rains start there is never any shortage of water available for irrigation. Most of the flow is still down the channel and flow from the paddies quickly re-enters the main channel downstream. In most cases there does not need to be any restriction in water use.

iv. The number of farmers involved is small and they can usually resolve problems without a formal management structure.

f. Economic evaluation

The most notable feature of these weirs is the high rate return on investment. It has been estimated that a weir built under this programme, using free labour, can pay for itself within three years of construction. The potential for this type of development in Khon Kaen province is very large and up until now, not recognised. I estimate that there are potential sites for approximately 800 to 1000 weirs in Khon Kaen province alone, providing regular wet season irrigation for more than 48,000 hectares, ie approximately 14 per cent of the present area under rice production. This could be obtained for as little as US$100 per hectare. If an average rice production figure of 1,875 kg/hectare is assumed, a 15 per cent production increase represents a benefit of $38/hectare each year (rice price at 40c/kilo). An average weir might cost in the order of US$4,500 which represents an investment of approximately $100/hectare.

It can be seen that even ignoring the very significant benefits from dry season cultivation of vegetables and fishing, the investment is likely to pay for itself in three years, probably less. If the cost of supervision is considered, at the most it would only increase the investment to under US$200/hectare, substantially less than large irrigation schemes in Thailand. This is achieved without land being flooded and without water management problems because the farmers have been involved in the design and have built up their own project.

3. *FEATURES OF THE SMALL SCALE DEVELOPMENT STRATEGY*

The comparatively low construction costs and high degree of acceptability at village level that the SSWRP has obtained for the majority of its irrigation weirs has proved that the truly small scale strategy works. The NE villager has the basic technical skill, the management capability and the motivation to contribute significantly to his own economic improvement. All he lacks is some technical and material back-up.

Over the last five years the following principles have been employed on the construction programme.

a. Maximum utilisation of village resources

The maximum use of the skills of management, construction and planning available at village level is one of the most important facets of these projects. Instigation, planning and construction are all carried out at village level. The only outside assistance has been in the form of construction materials supply and technical advice in the form of standard designs and occasional site visits. Most technical supervision has been supplied by a village chang (technician). The high degree of intuitive engineering skill in the NE at village level is evident in the ingenuity of some tradtitional irrigation systems (common in the north of Thailand) that have been built.

b. Projects have material costs less than US$5000

The vast majority of projects are small in size, much smaller in scale than anything the major technical agencies are attempting at present. The projects are selected to be within the managerial capacities of the villagers.

c. All labour is provided free

With a few minor exceptions all projects were constructed by the villagers themselves free of charge. This is considered one of the most important aspects of the SSWRP. Each project undertaken is initiated by the villagers and is based on a specific need for that particular project, not on a need for employment (cf. job creation schemes). The concept of free labour plays a vital part in creating a sense of village ownership and village responsibility for operation.

d. Construction supervision using village technicians

Where possible SSWRP has had its projects supervised by trained village technicians at the construction stage. These technicians are local farmers with some practical background in technical skills at the most basic level. Weekly visits by project personnel are normally sufficient to provide the necessary technical back-up. Training of village technicians was through close supervision by SSWRP personnel for the first few construction projects.

4. LESSONS

The project has helped illustrate the following points regarding small scale development in the NE, Khon Kaen province particularly.

a. Local skills are available and can be upgraded

There is a large and untapped reservoir of skilled and capable manpower already at village level which has been seriously underutilised in present water resource development programmes. The technical information required to implement the projects must be supplied in a way that villagers can understand and use. Training programmes should take place in the village in the situation it will be used. They should introduce one design and teach one skill at a time. They should involve little or no formal teaching as in the classroom situation, and emphasise on-site and practical demonstrations. It should be timed so that the lessons learned are soon applied to an actual project. For example, an irrigation weir training programme would be timed for December and January, for the construction season of January - May. The courses should be based round a suitable village level construction manual. The presentation of technical information in the form of manuals requires careful thought and research. Manuals should present only a limited amount of information at one time; too much and too detailed information tends to discourage its use by villagers with a limited level of education. A minimum of reliance on the written word is vital: facts should if possible be presented in a visual form, through models, films, slides, videos, etc.

b. Existing technical programmes are not truly small scale

There is no major technical agency in Thailand seriously involved in truly small scale development projects. At the level of individual projects involving farmers' groups or groups of villagers with projects less than US$4,500, there is little provision for technical help from a specific person assigned to small scale projects. At best it is 'loaned' from an agency which has responsibilities in other areas. There is a great need for technical assistance to be provided at village level. A new position of village technician within the government service is required to help implement village level development projects at present being undertaken by a number of government agencies.

c. Local free labour is available and worthwhile

The NE farmer is quite prepared to contribute towards his own economic improvement without being paid to do so, provided the following conditions apply:

i. He has a real need for that particular project.

ii. He is confident it is going to be a success and there is no risk involved.

iii. He has been consulted and has been involved in the projects initiation and planning.

Free labour is most important for small scale projects for three reasons: to ensure the project is acceptable to the village and is felt to be its responsibility; to reduce costs; and to reduce administrative work.

In the very few projects in which a fee (10 per cent of materials costs) was paid over for a labour contract, there was a good deal more administrative work involving village leaders, as well as project personnel. The rationale behind these paid labour contracts was that these projects were considered too big to expect the villagers to provide free labour. Hindsight seems to suggest that this was the wrong decision in almost all cases.

At the initiation and planning stage of small scale projects, the level of acceptance of the fact that no money will be paid for labour is often a very important indicator of the degree of need and interest existing for the project among its initiators. In some of the proposed SSWRP projects (involving a normally acceptable level of labour input in village terms) interest quickly died once it was learned no money is to be paid for labour.

By contrast, if a farmer or a villager is convinced of the merit of a project he may even be prepared to pay a significant amount towards its construction. Certainly, we have found farmers willing to work for nothing on a weir they felt would work even if they had been involved in previous paid, failed attempts.

d. Small scale schemes can promote agricultural development

There is a very high potential in the NE for agricultural development, particularly in the provision of supplementary irrigation for wet season rice through the construction of small scale irrigation weirs. This kind of development can be achieved with minimal social disruption and can be achieved at very low rates of investment.

5. INSTITUTIONAL REQUIREMENTS FOR SMALL SCALE DEVELOPMENTS

In Khon Kaen province alone, where there are over 200,000 households living in over 1,600 villages, each with their own particular requirements in terms of water resources, it would stretch even the largest technical line agency to provide for the need of all areas. The only way to promote village development is to give rural areas the responsibility to do most of the work themselves with the necessary technical and material back-up supplied by a suitable organisation.

This poses problems of management manpower and attitudes. The government has therefore embarked on a retraining programme and the academic staff at KKU have run reorientation courses and seminars for government officials and local government staff on technical and managerial aspects of small scale water development. Another training component is for engineering students. During their holidays they normally assist in supervision of the small projects, mainly to give them practical experience in engineering in a rural environment. The third training component, at village level,has already been described. Excluding the university students, over 1100 people benefitted from the courses.

A second essential part of any small scale development programme is a well structured monitoring programme to enable the development team to assess the performance of its projects from year to year. This has been considered one of the most important aspects of SSWRP. Contact was made, at regular intervals, with villagers who had been operating projects to assess what improvements could be made for the following years' construction programme. A monitoring programme has enabled SSWRP to maintain a very low technical failure rate in its project and this has helped to build up a high degree of credibility in the rural areas where projects have been constructed. This credibility is essential in projects which depend on contributions (in the form of time and labour) to be given without remuneration. The ultimate aim is to produce a project which requires little or no maintenance or, at worst, one that can be repaired by the villagers themselves with their own resources.

The SSWRP over the last five years has established that truly small scale development strategy can work successfully provided a few essential policies are followed. While answering questions on what kind and number of projects can be built at village level and how these projects can be managed, it has also raised a number of questions, questions that cannot be answered until some work is done in research as to the effects and benefits of small scale development at village level, and how this benefit can be increased. There is a need for more research work to be done on such questions as the self-financing of village level development projects, the need for a socio-economic study on the project, the potential for further agricultural and fishery developments, and for help from formal and non-formal education experts, as well as further classification of the important principles in small scale development.

Locally based training, monitoring and research, for small scale programmes should ideally be carried out by a team of personnel in an institution which is locally rooted and which can therefore develop a continuing relationship with the surrounding villages. A nearby university, as at Khon Kaen, can provide an excellent base. Other possible institutional bases are the local or provincial government, or an NGO, such as a church, with a local territorial base. The need for a continuous relationship, and for a flexible response to varying village needs, probably rules out a centralised bureaucracy, if its personnel are subject both to national transfer and to inflexible procedures. Comments are invited from Network members on suitable institutions to provide technical assistance to village-level projects in the countries best known to them.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 9f APRIL 1984

BENEFITS AND PROBLEMS WITH UNCONVENTIONAL DESIGN

edited by Mary Tiffen

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A. FIXED VERSUS ADJUSTABLE STRUCTURES

Comments by J Gowing and J L Merriam

Professor Horst's Network Paper 7c, Alternative Design Concepts for Irrigation Systems (April 1983) continues to provoke discussion. *John Gowing*, Engineer with Sir Malcolm McDonald and Partners, accepts that engineers have to be careful not to design over-complicated operational systems in countries where such systems have been seen to result in low efficiencies due to maloperation. In his opinion, designers and planners should be aware of possible operational difficulties with the 'conventional' systems described by Professor Horst, but should not be too hasty in abandoning the use of adjustable discharge structures where they have advantages. He draws parallels with the arguments over the optimum solution for rural water supplies:

> "The VLOM (Village Level Operation and Maintenance) concept is based on the premise that user involvement in O & M is essential and technology must therefore be simple. The alternative approach attempts to 'design out' any maintenance requirement and accepts higher initial cost and more sophisticated technology."

Similarly, in irrigation:

> "If the fault does indeed lie in the inability of operational staff to manage conventional systems, then three alternative solutions can be proposed:
>
> (i) more sophisticated systems with automatic control devices and on-demand irrigation;
>
> (ii) less sophisticated 'fixed proportional' or 'open/closed' systems;
>
> (iii) mixed supply/demand systems with buffer storage at the interface between project control and farmer control."

He goes on to discuss the advantages and disadvantages of the first two. On (i) he comments:

> "The on-demand system provides flexibility without needing extensive management intervention but, because of the need to provide sophisticated hydraulic control structures and greater canal capacities, results in a very high capital

cost. In some circumstances management intervention may still be required to deal with inadequate water availability."

On (ii), Gowing agrues with Horst that open/closed or fixed proportion systems have apparent advantages. However, while Horst went no further than saying that adjustable structures might occasionally have to be set at the main intake at the head of the secondary canal (Network Paper 7c, p.10), Gowing feels there are quite frequently circumstances that make them essential. There are many systems needing less than 50% of peak flow for 3-6 months in each year:

"If canals designed to carry peak requirements are operated at low discharges then conveyance losses increase dramatically - perhaps from 20% to 50% of head discharge. The normal solution would be to operate canals on a rotation schedule, but this requires that offtakes and regulators have gates (or at least stoplogs)."

Gowing also points out that in flat terrain, with canal slopes of 50-150 cm per km, it is important to minimise design head loss:

"A regulator incorporating a Butcher-type weir would be designed for a head loss of 20cm or 30cm ... However, simple fixed weirs would normally... require a greater head loss. To some extent the problem could be solved by using longer fixed weirs, but even a duckbill weir becomes impractical for high discharges."

Gowing agrees with Horst that proportional division systems are inefficient when different crops, or crops at different growing stages, are grown in different tertairy blocks. The 'conventional' system is able to provide the necessary flexibility of water distribution in this case. He concludes:

"This is not an attempt to refute Professor Horst's arguments. There is much sense in what he says and designers would be well advised to consider his arguments carefully. All design models (concepts) have their limitations and there is a need to evaluate all alternatives in the light of particular local circumstances. There is clearly scope for innovatory designs and subtle mixes of the various design models."

Not everyone would agree with the idea of designing systems to meet observed conditions of inefficiency or corruption. The issue is also discussed in the debate on design recorded in Network Paper 9b. *Bottrall* advocates investment in improved management, with design based on realistic assessment of improved management capabilities in the future (Network Paper 9b, p.19). *John Merriam* feels it is important for systems to be designed so that

> "...as conditions change - crops, farm sizes, farmer capabilities, water supply, economics, energy costs, etc - the physical system and its operation capabilities is upgradable. Staged construction, revision of structures, converting from canals to pipelines, installing reservoirs, etc. must not be made impossible by present design and construction, as they may become very practical as changes occur."

However, designing so as not to limit the future may have a cost, as some networkers point out in Paper 9b.

Merriam goes on to discuss the desirability of flexibility in frequency of water supply, rate of flow and duration of flow. The imposition of rigidity on any of these has negative effects at farm level, although there may be economic trade-offs. To make reasonable trade-offs, the various combinations in flexibility and rigidity of frequency, rate and duration have to be considered. These are set out in a table on water scheduling constraints, with a standard terminology accepted by the American Society of Agricultural Engineers.[1] Networkers who would like a copy should write to the Secretary of the Irrigation Management Network at ODI.

As fully automated on-demand systems are an alternative method of giving the farmer control over his water supply, in situations where land shortage makes the buffer reservoirs advocated by Horst impractical, it is interesting to have Merriam's account of problems and benefits from his Sri Lankan experiment with an on-demand system for inexperienced farmers. Merriam contends that the incremental capital cost of an automated system is soon repaid. The experiment highlights once again the need for communication between engineers and those responsible for agricultural extension, which in an irrigated farming system has to include extension on water management.

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1. In a paper by Replogle, John L. and Merriam, John L. 1980, Scheduling and Management of Irrigation Water Delivery Systems, Proc. ASAE, Second National Irrigation Symposium, U.S.A.

B. THE DEMAND IRRIGATION PILOT PROJECT IN SRI LANKA

John L Merriam

1. THE PROJECT CONCEPT AND PROBLEMS IN ITS EVALUATION

The concept of this project and its anticipated benefits and problems is presented in a report, Demand Irrigation Schedule Concrete Pipeline Pilot Project, Sri Lanka, August 1980. An evaluation of the third season with comments on the preceeding two is covered in the Third Interim Report, August 1983. A limited supply of these reports is kept by the Chairman, Mahaweli Engineering and Construction Agency (formerly Mahaweli Development Board), P O Box 1667, Colombo, Sri Lanka.

The pilot project covers about 360 acres[2] in the lower part of the D-1 distributory canal and is served by low pressure tongue and groove mortar joint concrete pipe delivering water to each individual 2.5 acre farm. The outlet is a small screw-valve which can deliver up to 0.5 to 0.7 cusec[3]. The farmer can take water at any frequency, for any rate up to the above-mentioned limit, and for any duration - a Limited Rate Demand Schedule. (Network Paper 8c, section B, has more details.) The upper 490 acres of the D-1 command are under the conventional earth ditch rotation schedule.

The pilot project aimed to test the economics of an automated system, and also to see whether farmers with an on-demand system would use less water than in a conventional system because they would be certain of water when they needed it. The evaluation of the pilot project over the first three operational seasons has been complicated by four factors:

(a) Flows from the branch canal supplying the D channel have not always been adequately co-ordinated. Information as to days when the water would be on or off was frequently not made available to the farmers so that they often took water when it was not needed to be sure they were not short. A new water management engineer has been appointed so this problem should be overcome.

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2. 2.47 acres = 1 hectare.

3. The flow rate of 0.25 cusec mentioned in Network Paper 8c, section B, is incorrect. (cusec = 1 cu ft/sec)

(b) The first season ran out of water during the last month with a resulting crop failure.

(c) There were correctable water losses due to problems with equipment. Most of these have now been overcome.

(i) To get an early start, the project used lightly reinforced 2m culvert pipe with a dry pack collar joint, which was available, instead of the specified unreinforced concrete pipe widely used in the USA. Many problems, including appreciable leakage, occurred. The unreinforced pipe is now being produced locally and an 800m section was laid in September 1982 with no observable leaks.

(ii) The Harris float valves used to break downhill static pressure were not jammed open by farmers (*Gunston* in Network Paper 8c), as they could already take wnat they wanted by opening their own valves. They were occasionally prevented from completely closing by floating material by-passing poorly constructed pipe inlet screens. This has now been corrected.

(d) Most important of all, new water management practices that it was assumed would be explained to the farmers, were either not explained, or inadequately explained. This fact was not realised until Merriam's last visit in December 1983, which was his first opportunity to be on the project during the irrigation season.

2. ECONOMIC EVALUATION

The layout, which is essentially fully automated as far as distribution is concerned, cost about US $735 per hectare. The conventional layout costs between $300 and $400 per ha. The incremental cost for the automated pipeline system is between $345 and $435 per hectare ($140 to $175 per acre) for a distributory channel area.

The necessary right-of-way is reduced 5-7%. The reduced cost of maintenance for a properly installed system is not known, but can be very appreciable. Yield increases of paddy have ranged from 6% to 15% depending on units compared and methods of measurement. For this third season, which was nearly normal, the cut yield was officially reported as 135 bushels per acre (7080 kg/ha). At a price of Rs 70 per bushel ($3.50/bushel), 6% yield increase, 5% right-of-way decrease, and \$175/acre incremental cost, the repayment period is

$$\$175/135 \times (0.06 + 0.05)\ 3.50 = 3.37 \text{ seasons}$$

or less than two years. Taking the other extreme values of 15% yield increase, 7% right-of-way saving, and \$140 incremental cost, the repayment period becomes

$$\$140/135 \times (0.15 + 0.07)\ 3.50 = 1.3 \text{ seasons.}$$

Whatever conditions are chosen, the repayment is quite fast. The right-of-way saving alone is impressive.

The reduction in maintenance and management, and greatly increased farmer satisfaction and reduction of contention are additional plus items. In a recent questionnaire, farmers indicated they would be willing to pay an annual rent of \$100 for a 2.5 acre farm within the project rather than outside. The land preparation was 100% done at the end of the second week whereas only 70% was done under the rotation schedule. Crop planting was 88% done at the end of the fourth week whereas only 54% was done under rotation.

3. REASONS FOR LESS THAN EXPECTED WATER SAVINGS

While crop yields show definite increments on the pilot project, the fact that actual water deliveries are larger than to the conventional earth ditch rotation delivery areas, and even when compensated for correctable losses, are not yet less than such deliveries, is the principal point for scepticism of the Demand concept.

Water usage varies appreciably between farmer groups on field pipelines. The groups vary from 4 to 16 farmers. Six of the FPL have totalising meters for evaluation purposes. The discharge from the re-regulating tank serving 230 acres is measured. Water use in the first two seasons was greater than on the surrounding area deliveries, but is difficult to compare. The first season involved all the land grading as well as crop planting and included water losses due to poorly installed pipelines.[4] The water delivered amounted to 86 inches. The adjacent conventional area received 70 inches. This was the season that ran out of water. However, of the 35 farms that did produce over 80 bushels/acre out of the 483 farms in the checked area, 27 were on the pilot project which included only 92 farms.

During the second season (dry season) 106 inches was supplied, but reduced for estimated correctable losses, this

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4. *See p.5 para (c)(i)*

becomes about 78 inches. The average cut rate yield was 102 bushels/acre. There was no comparable area to compare yields. However, for the preceding year the conventional areas ranged from 74 to 98 bushels/acre, averaging 84 bushels/acre.

During the third season (rainy season) the delivery was 67 inches which, again allowing for correctable losses, becomes about 56 inches. (Most of the pipeline losses from the previous seasons had been corrected. The losses during this season were mainly from a canal leak into an undercrossing of about 1.0 cusec for over a month, Harris float valves overflowing on several pipelines[5] and numerous small pipeline leaks which are impractical to fix but which would not occur on properly laid lines as was done in the September 1982 demonstration. All of these are correctable losses.) The 56 inches was comparable to deliveries in conventional areas.

During all three seasons frequent irrigations and considerable run-off had been reported. The local staff had not connected this with a failure to get the farmers to carry out new recommendations on water management which had been envisaged as an integral part of the pilot project.

The normal water issue schedule in the System H area of Mahaweli is based on a theoretical requirement of 5 inches in the first week, 2 inches in the second week, and 2½ inches per week in the vegetative period, as described by J Jayewardene, *Resident Project Manager, in a recent paper.*

The programme envisaged for paddy growing was to raise the water table to the surface during the land preparation and planting period. This occurs normally from canal seepage, rainfall, excess water application in the initial period and was shown on the pilot project to happen even though less water was used than under the conventional programme.

Subsequent to raising the water table, a continuously flooded intermittently irrigated programme was to be used. The water depth was to fluctuate from about 4 inches when the basins were full and overflowing down to about 1 inch when water would be applied. This programme permits economical weed control, transplanting, rainfall conservation and optimum crop production. The utilization of transplanting shortens the irrigation season and increases yields. The flooding reduces weed control problems and eliminates the need for foreign exchange to purchase weedicides. Water is applied only when needed, and surface run-off could be nearly eliminated from irrigation and from typical rainfall occurrences.

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5. See p.5 para (c)(ii)

The discouraging discovery, during the fourth season, was that farmers, instead of operating in the 4 down to 1 inch range, were operating as was done under the rotational deliveries providing only about 2.5 inches of water in a range of 2 down to 1 inch. This small 1 inch fluctuation required three times as frequent irrigations, probably more than three times as much run-off and very little storage for rainfall. The correction needed is to persuade farmers of the benefits of raising their weirs to 4 or 5 inches. I am encouraged to think our water usage and rainfall conservation can be greatly improved - but after four seasons!

Merriam is not sure whether the agricultural officer at block level attempted to establish the 4 inch depth, or attempted but failed. He himself tried to establish it in initial meetings with farmer groups, but does not know how effectively he was translated. He feels, with hindsight, that although he mentioned the system in several places in his first interim report, he should have stressed it more. The situation was not helped by changes in staff.

The pilot project was assigned a full-time Agricultural Officer to do extension work and supervise the demonstration farm. Both he and his successor stayed only a short time and were transferred. The demonstration farm got into fair operation in November 1983 under the third Agricultural Officer. He was not aware of the need for the 1-4 inch fluctuating depth and had eliminated all paddy production on the demonstration farm.

Farmers in the recent questionnaire said they approved of levying fines for having surface run-off water, and 40 out of 41 said they could grow a bigger crop with less water under the demand schedule.

The value of the potential water and rainfall conservation in paddy is not yet accepted since it is not yet 'proven' by the pilot project as a whole. I feel that the pilot project has shown how to accomplish the saving and has done so on part of the area, and so it should be used on paddy land as well as dry-foot crop areas.

We know all the things needed to make the Limited Rate Demand schedule function - we need to apply the lessons learned to new areas. The concrete pipe can be successfully made in the new plant, and it can be laid rapidly and not leak. Satisfactory gates and valves can be imported and adequate screens and structures can be constructed. The farmers are very desirous of having the system and, with adequate extension advice, can properly use the system. The extra costs can be quickly repaid. Water conservation can be accomplished as proven on portions of the field pipelines, and it can be done on all of them.

C. TOPICS FOR THE FUTURE :

THE MANAGEMENT ALTERNATIVE AND DESIGN FOR EASY MAINTENANCE

Jayantha Jawardene, *in a recently received paper, agrees that the main reason for shortcomings in the implementation of proposed plans and programmes is that while there was interdisciplinary co-ordination at project level, the lines of command then went straight down to separate Agriculture and Water Management staff. There was no single officer responsible for all staff at lower levels of management. A more unitary system of management was adopted in System H from Janaury 1981, combined with training programmes. This represents an alternative method of improving performance, by improving management structure and training. Is this cheaper or more effective than designing out problem areas, as suggested in different ways by* Horst *and* Merriam? *It is hoped we may have an evaluation of the costs and benefits of this system, and of the successes and problems involved in implementing it, in a forthcoming issue.*

Ian Rule, *from Zimbabwe, has sent a note on the need to design for ease of maintenance as well as ease of operation. This will be published in the next set of Network Papers. If other networkers are interested in this subject I will send them a copy of the paper immediately, so that they can add comments.*

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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER 10a November 1984

1. NETWORK PAPERS

a. The Current Issue

This issue primarily addresses the theme of farmers' associations in water management. The desirability of farmer participation is emphasised increasingly in reports based on experiences in parts of Africa, South Asia and elsewhere. This applies both to small-scale and large-scale schemes. In the former participation is said to be more easily promoted and some would advocate minimal external involvement with farmers evolving their own structure. Large-scale schemes are more problematic: there is a tendency for schemes to be organised so that project managers control distribution and decision-making, and even where distribution at tertiary level is left to farmers they have often failed to cooperate to allocate water equitably. In such schemes the linkages between project managers and farmers may be weak and contribute to inefficient operation and neglect of maintenance. In this context the papers in 10c are especially relevant. Two papers discuss large-scale schemes in Sri Lanka's dry zone. The Gal Oya Irrigation Scheme was operating since the early 1950s but had deteriorated in large part due to lack of farmer involvement in operation and maintenance. There were typical head- and tail-ender conflicts and mistrust between farmers and project officers. The paper by *Widanapathirana* discusses institutional innovations which are a major part of the scheme's rehabilitation. Farmer groups have been organised at field channel level by catalyst agents known as Institutional Organisers (IOs). Early evidence suggests a relatively good response from farmers who involve themselves in maintenance work and organise water allocation more equitably leading to fewer conflicts. Problems remain: high turnover of IOs results from the impermanent nature of their role. It might be hoped that other farmers will now organise themselves but this cannot be assumed; the formal commitment of higher authorities to restructuring based on farmers' groups also remains in doubt.

The second Sri Lanka paper discusses developments in System 'H' of the huge Mahaweli Ganga Development Project. Settlement began in System 'H' in 1975 and households organised into 'turnout groups' covering 12-20 ha. They were expected to manage equitable water distribution themselves but early evaluation showed this was not happening: social inequalities emerged surprisingly quickly. Recognition of this process led to the initiatives in farmer organisation and restructuring of project management described in *Jayewardene's* paper. Management was converted into a unitary system and decentralised to ensure more efficient cooperation between farmers and project officers. The value of regular evaluations with a link to project implementation is emphasised by these developments. It would be premature to claim 'success' for these schemes - particularly if conditions of stress arise - but they do strengthen the already convincing arguments in favour of participation to improve efficiency and equity.

The third paper in this collection by *Kathpalia* continues the theme, discussing rehabilitation of the Nong Wai Irrigation Project in Northern Thailand. Water users' groups have been set up with functions mostly limited to chak level although a committee comprising elected representatives of the groups has also been established. Such wider groups seem to be desirable within large schemes: even where intra-chak distribution is improved the scheme-wide inequalities which can arise during periods of water shortage may be better averted if there are links between project managers and farmers' representatives. Beyond crisis management such a structure of farmer participation should promote a continuous process of improving design and operation.

It remains to be seen to what extent project authorities will act on farmers' suggestions about operations above tertiary level. Holding meetings with farmers is one matter, taking decisions based on those meetings rather than handing down decisions already made may be quite another. One recent study observed in Sri Lanka how cultivation meetings of farmers in two large schemes (including Gal Oya) were largely pre-empted, although the restructuring within Gal Oya may have improved processes of consultation. (Formal and Informal Water Management Systems: Cultivation Meetings and Water Deliveries in Two Sri Lankan Irrigation Schemes by *Hammond Murray-Rust* and *Mick Moore*, Cornell Studies in Irrigation No. 2). More information on various management structures allowing for real rather than token consultation (a distinction drawn by *Rod Ryman* in correspondence) would be of interest.

Farmers' associations may not emerge voluntarily within small-scale schemes. In Africa there are many cases of schemes initiated by public authorities to which farmers feel little attachment and therefore undertake minimal cooperative work. In parts of South Asia farmers' associations have been seen as appropriate to facilitate development of smallholder agriculture but where significant inequalities in landholding and social structure exist farmer groups may be more likely to fail. Currently in Bangladesh much debate centres on suitable forms of organisation and choices of technology to develop extensive groundwater resources. Paper 10b by *Nick Chisholm* can be set in the context of this debate. It summarises results of a five year follow up study of a few farmer 'groups' operating deep tubewells in Northwest Bangladesh. The study intended in part to assess the effects of inequalities - 'social dominance' - on management and performance. There appears to be a tendency for individuals to control operations and for this to make mismanagement possible, although less so if farmers have some sanction against this which may include supporting a rival as manager. Broader farmer participation is probably preferable for dynamic improvements in operation and maintenance.

These developments were part of a public tubewell programme. Current policy favouring privatisation of the irrigation sector has substantial advantages for increasing the growth rate of output and reducing Government expenditures. Yet there are concerns about the effects of privatisation for smaller farmers whose access to irrigation water may be jeopardised if development is monopolised by larger landholders. The local-level framework for agricultural development is important in this context as is the proposition that problems of equity associated with social structures cannot be resolved by choosing 'appropriate' technologies.

Farmer involvement in irrigation management was also the theme of a recent conference held in Indonesia, on which more below. The other papers in this issue cover different topics. Paper 10d by *Ian Rule* is concerned with engineering design and construction to allow ease of maintenance. His examples from one region of Zimbabwe show how maintenance can be made more costly and complex by lack of forethought at design and construction stages. Such inefficiencies could be reduced in future projects provided mechanisms exist to feed back the lessons of operational experience to designers. Engineers (or others) in the Network may wish to provide their own examples.

Paper 10e is concerned with tank irrigation systems which have long been significant in regions as in South India where rainfall is relatively unreliable and where topographical conditions permit. Inadequate discharge common to these systems may increase water conflicts or enforce farmer cooperation: both conditions are known. Old tanks are now physically deteriorating and need rehabilitation and introduction of improved practices to increase output. The first paper by *Palanisami and Easter* discusses physical and management problems in tank irrigation in South India and NE Thailand where tanks are relatively new. They conclude that tackling physical problems may be highest priority in old tanks whereas in newer ones problems of organisation below the outlet may be more serious. Physical deterioration is likely to worsen conflicts between head- and tail-enders as the paper by *Sivanappan*, a case study in Tamil Nadu, relates. Both papers suggest ways of overcoming physical and socio-economic problems. Where possible water shortages may be eased by conjunctive use of tank and groundwater, and significant losses and waste can be reduced by improved design and management.

The final paper comprises comments on papers in the last issue and introduces the themes of cost recovery and water pricing, as well as institutional arrangements for cost-efficient water management, which will hopefully be covered by contributions in the next issue. *Dr P K Rao*, in comments arising from *Hotes'* Paper 9d, points out that attempted full cost recovery (including capital costs) would imply hugely increased charges in some Indian schemes which probably could not be borne by farmers. The method of charging also affects farmers' responses and it would therefore be sensible to consider charges within the overall pricing framework (including input subsidies, minimum procurement prices etc.). Cost recovery is easier if operations are cost-efficient and technologies 'appropriate'. *Dr Rao* urges examination of institutional alternatives promoting cost reductions and equitable water distribution. This suggests direct farmer participation in management and maintenance etc, but *Anthony Bottrall*, commenting on *Bergmann's* Paper 9c, also points to the potential for third-party management provided the latter are themselves subject to financial disciplines or in other ways responsive to farmers' needs. There is a further point: that within schemes there is often considerable variation in farmers' ability to pay and across-the-board pricing policies may benefit wealthier farmers who don't need subsidies or, where subsidies are reduced, penalise poor farmers who do need them (at least at first). This is only one of a number of difficulties which emerge where farmers of highly unequal economic status are expected to cooperate to manage a resource.

b. Future Papers and Newsletters: Responses of Network Members

Once again the current set of Papers is large and some contributions were received which could not be included this time. There is evidently strong interest in communicating ideas and experiences which is a major function of the Network; your responses to the questions on editorial policy sent out with the last issue confirm the high degree of support for the Network.

We received 86 completed forms. Almost all of you want to receive copies of all papers automatically as at present, and 63 per cent prefer 3-4 papers in each issue (most of the rest want more). There were also many suggestions for contributed papers which should ensure continued flow of information and ideas in the future. This component of the Network is only one way of exchanging information. Some of you suggest that the Newsletter should provide news and interim findings on major or particularly interesting irrigation projects, and information on conferences/seminars well in advance. In the latter case we rely on organisers to inform us.

Thanks to those of you - quite a few - who are already well pleased with the current format. Thanks also for your suggestions of topics for discussions: there were 114 contributions which were sifted into 66 reasonably distinct titles. The broad category of greatest interest relates to socio-economic/ institutional aspects (37 per cent of contributions) followed by financial/economic topics (16 per cent) and engineering/ technical/design aspects (11 per cent). Other themes of almost equal interest amongst members are: management, public administration, systems/planning, knowledge/information, agronomic/ physical, and health/environmental.

The individual subjects of greatest interest concern farmer/ community participation in planning, management and O&M, these being subjects with which the current and recent issues have been particularly concerned. Small-scale irrigation and 'appropriate' technology are related and also of interest to many members. Presumably these interests reflect a strong awareness based on experience that greater farmer participation is often desirable and that some past failures have been closely connected to rigid and remote management structures. As the current set of Papers shows, however, promoting participation is not easy and requires close attention to local circumstances - although there are lessons to be learnt from different experiences. (In this connection it would be good to have examples from South American experience which have hitherto been conspicuously absent.)

The Network also aims to cover the many aspects involved in irrigation development from planning through to operation and impact. The diversity of contributions received reflects demand for this: members will not be able to specialise in everything but some understanding of other aspects is important and will hopefully promote improved interdisciplinary work. We still have to decide whether to continue the tendency of having a dominant theme to each set of Papers or to spread widely over the many topics that could be covered.

There were many other useful suggestions on the scope of the Newsletter which are being reviewed. It would be nice to be able to take all of them on board but current resource limitations do not allow this. Most of you (65 per cent) are happy with the current practice of referring to only a selection of annotated publications.

Turning to the immediate future we would particularly welcome papers for the next issue covering empirical experiences of irrigation water pricing and cost recovery. Paper 10f introduces many of the themes, for example: What are the most effective methods of charging? What institutional forms exist to encourage cost-efficient irrigation practices? What have been the distributional effects of various forms of charging or reduction of subsidies? Is full cost recovery feasible and/ or justifiable and what are the effects of scale? These are areas in which many members expressed interest so the issue should stimulate some good debate. Deadline for papers in this area is 1 March 1985.

Another topic we might be able to cover in the following issue is suggested by *Anthony Bottrall* (see last page of Paper 10b) who refers to the important debate in Bangladesh on implications of alternative pump technology and broader issues of groundwater planning and management. Groundwater presents complications because it has characteristics of a common property resource but it can be 'captured' by exclusive interests if institutional, technical and other factors allow. The extreme poverty and pressure on land in Bangladesh make choices in groundwater development particularly critical but similar factors operate elsewhere and it would be interesting to receive papers with examples which include discussion of the framework established to exploit groundwater, technologies used and the impact on farming communities. A recent edition of Agricultural Administration is in fact devoted to Groundwater Use and includes a broad survey of potentials and limitations in groundwater development by *Professor Carruthers* and a discussion of the Bangladesh case by *Dr Sadiqul Bhuiyan*. The latter suggests certain policy measures needed to guide development: privatisation need not mean laissez faire but in practice it may become so. The edition (Agricultural Administration 16,4 1984) has several challenging contributions and could complement a discussion through the Network.

Finally, the revised *Register of Members* has been held over to the next issue. We should be grateful if you could inform the Secretary of the Network of any recent changes of address or professional responsibilities to keep the Register up-to-date.

c. Future Plans

In co-operation with CEFIGRE (International Training Centre for Water-Resources Management) ODI is bringing out an experimental French language version of the Newsletter and Papers. If the reaction from the readers of the trial issue is positive, we will jointly seek funding for continuing a French edition and extending Network membership to many French-speaking persons professionally interested in irrigation management. CEFIGRE will arrange the translation from English to French, and ODI will translate into English comments and papers from francophone members. We think there will be great benefit from the interchange of experience, particularly in view of the strong but distinctive French contribution to irrigation design, best exemplified in some Northern countries of Africa.

CEFIGRE is a non-profit making organisation sponsored by the French Ministry of Environment. It has a Board of Directors made up of representatives of French ministries and institutions, which oversees its administration and finance, and an International Scientific Council composed of representatives of 23 states and several international organisations (UNEP, EEC, etc) to advise on its programme of activities. Irrigation and drainage is one of its four fields of interest within the area of water resource management. Its main function is running short training and refresher courses for senior personnel involved in water management. Irrigation is a relatively new addition to their courses, starting with one in 1983, but with four in each year in 1984 and 1985. So far these courses, unlike the ones they run in other aspects of water management, are only in French, but they plan to add English language Irrigation courses in 1986. Courses are often divided between France and a developing country and include field visits and discussions. Other functions of CEFIGRE include dissemination and exchange of information. Further information from Monsieur J P Aubrac, Head of Dept of Documentation and Information, CEFIGRE, Sophia Antipolis, BP 13, 06561 Valbonne Cedex, France.

2. NEWS FROM NETWORKERS

a. International Programmes

The *International Irrigation Management Institute* is developing its immediate and longer term programme. IIMI's overall objective is to enhance independent national capacity in managing irrigation systems. The components of its programme are broadly three-fold: multidisciplinary research, professional development and preparation and dissemination of materials for training and information exchange. Research and professional development will be linked within field activities, and research - involving collaborative field studies across a wide range of locations - will aim to identify ways of improving the performance of irrigation systems through management innovations. Management of water will receive primary focus but other influences on system performance - management of the design process, of people, of farm inputs and of financial resources to support development - will also be subjects of research.

International involvement in IIMI's activities will be conducted within a 'network-type model'. The branch in Pakistan should be established in 1985. Network research projects will be initiated in several interested countries. Two intended projects in 1985 will focus on, first, constraints to diversified cropping under irrigation and potential to remove these constraints by changes in irrigation management, and second, finding different ways to modify resources for irrigation, particularly financing O&M requirements. Professional development activities in 1985 will include initiating fellowship programmes and sponsoring at least two conferences. The first, jointly sponsored by Cornell University and the US Government, and scheduled for January, will consider new priorities for irrigation management research. The second will be a smaller workshop on rapid appraisal of irrigation performance to be held in April or May. No further details on dates or locations are currently available. IIMI's documentation and information centre will also be set up in 1985.

FAO is developing guidelines to evaluate performance (technical and management) of irrigation systems. The guidelines will be especially intended for professionals conducting field level evaluation and will initially be oriented to rapid surveys of bureaucratically controlled systems. More detailed evaluations and inclusion of farmer controlled systems will be developed later. The work was initiated by a meeting of specialists held at FAO, Rome in December 1983. Follow-up work by ISP preparing an outline for the guidelines is to be discussed at a meeting late this year.

b. Meetings and Seminars

The experience of farmers' associations and organisations in Asian rice growing areas was the main theme of the *Expert Consultation on Irrigation Water Management* held in Jogjakarta, Indonesia, 16-21 July, 1984. The meeting was jointly sponsored by FAO Land and Water Division,USAID and the Komite National

PBB Pertanian. Seven case studies were presented and are reproduced in the report. They address technical, social, institutional and economic aspects of the irrigation system at farm level and factors affecting performance. The case studies cover more extensively the same concerns as those addressed especially in Network Paper 10c (one case study discusses the Gal Oya system and another compares Gal Oya and a smaller Sri Lankan rehabilitation scheme at Minipe where emphasis was on improving water distribution by mobilising low-cost local resources. The 'pipe committees' in the Pochampad canal project in Andhra Pradesh, subject of Network Papers 7d and 8c, are also discussed). Examples from the Philippines, Indonesia (2) and China complete the report. The Indonesian studies discuss the official policy of promoting improvements through existing 'traditional' local organisations for small-scale irrigation. The technical level of production has been significantly raised by this approach which appears to reinforce rather than undermine local farmers' participation. The case study of Yucheng County in NE China particularly addresses the impact of the recently introduced 'production responsibility system' on irrigation water management. Developments here are likely to offer important insights in key areas of management, notably the problems of establishing incentives for efficient O&M and the relationship between users and a higher planning authority. While cooperative agriculture presented incentive problems and led to 'free riding', the responsibility system sets up problems where farmers attempt to optimise individual water use in canal and groundwater systems. Water managers at State and local level are now required to cover costs from their operations - in small-scale systems groups or households make contracts with farmers to supply water - while conflicts of use, decisions on well spacing, neglect of drainage systems and provision of technical advice, all of which have appeared as problems under the responsibility system, may require an irrigation authority to guide developments. There is some confidence amongst Chinese agricultural economists that 'economic associations' will be formed by farmers to optimise scale and efficiency of irrigation development (except for large-scale State schemes). The previous cooperative experience may help or hinder such a prospect: hopefully more information will be available in future on irrigation developments in China.

Irrigation in Africa is now coming under close scrutiny as it should in view of the deteriorating food supply condition of many African countries. The *African Symposium on Small Holder Irrigation* was held at the University of Zimbabwe, 5-7 September, 1984. Proceedings have been published by Hydraulics Research, Wallingford, England, who jointly organised the meeting with the University of Zimbabwe's Department of Land Management. Six general lectures were presented covering topics including appraisal techniques, role of NGOs, human resources (Mary Tiffen's paper emphasising the importance of motivating managers as well as farmers) and health implications of small scale projects. The technical sessions comprised case studies related particularly to design, evaluation and management, and the role of the farmers. The meeting was generally held to have been successful although, as one participant put it, it did not produce 'clear guidelines as to what to do where next and how'. Another participant observed that the meeting revealed a wide range of ideologies and policies particularly on the relative degree of independence of peasant producers from Government control. The same observer notes potential conflict in emphasising cash crop production over subsistence food crops with the possibility of declining nutritional levels (which due to a variety of causes is happening); and suggests that for this and other reasons conventional economic cost/benefit analyses are outdated for small scale irrigation.

A workshop on *Irrigation in Tropical Africa: Problems and Problem Solving* was held at the African Studies Centre, University of Cambridge in March 1983 and thirteen of the papers are now available in a monograph (obtainable from the Centre, price £5.50 including p & p). The meeting brought together practitioners and academic researchers and the result is wide-ranging discussion of problems experienced in irrigation schemes, especially but not exclusively in northern Nigeria. The importance - often ignored in conceptual design - of labour constraints is brought out in a number of the papers, and problems arising from not understanding complex 'traditional' cropping patterns and farmers' risk-aversion, from market failure and 'bureaucratic failure' - perhaps inherent in the 'public good' nature of irrigation schemes - are also revealed. Large-scale projects do not emerge well from the evidence, particularly when different socio-economic indices, downstream effects etc are considered. Strategies which involve farmers in improving rainfed farming and developing small-scale irrigation schemes seem to offer better prospects of success particularly given the critical capital and food supply constraints now experienced by many African economies. Where larger schemes are still envisaged the need for more detailed socio-economic appraisal is emphasised.

The papers of the second *Fadama Seminar* of the Bauchi State Agricultural Development Programme, held 6-8 March, 1984, are collected in a report. Contact Dr N Chapman, Bauchi State ADP, PMB 230, Azare, Bauchi State, Nigeria, or c/o BASRA, 28 Old Church Street, London SW3, UK. There has been rapid development of small scale irrigation in the fadama or flood plain areas of northern Nigeria, farmers investing in pumps especially for irrigated vegetable production. Returns are generally high. The papers present information on the progress of fadama development and constraints in technical, organisational and socio-economic areas.

A seminar on *Nong Wai Irrigation Management* was held at Khon Kaen, Thailand in June 1983. This was a component of the technical assistance to improve irrigation management in the Nong Wai Project as discussed in Kathpalia's Network Paper 10c (this issue).

The previous Newsletter mentioned the workshop on *Scheduling of Irrigation* held in November 1983 at the Water and Land Management Institute, Aurangabad, Maharashtra, India. Professor Goel of Roorkee University notes that interest was generated by a paper suggesting the warabandi system should be introduced in Maharashtra as currently practiced in Uttar Pradesh, ie water supplied proportional to holding size on fixed days and for fixed times. The rationale is that water supply in Maharashtra is always less than demand. The consensus of the workshop was that warabandi system would ease administrative tasks in Maharashtra's canal systems rather than maximising productivity in the command area. Night irrigation was also considered to reduce transit losses.

A seminar on *Water Management* sponsored by the Dept of Personnel and Administrative Reforms, Government of India, was held at the Centre for Management Studies, HCM RIPA, Jaipur, Rajasthan, India, 8-10 February, 1984. It was specifically designed for officers in various departments involved in water management, using presentations and group discussion to develop policy guidelines for effective irrigation developments and to evolve a system of continuous monitoring and evaluation. This is a component of the Government's project to develop institutions and human resources involved in management and use of irrigation water.

The *Gerald Lacey Memorial Lecture* of ICID will be given on 15 May, 1985 by Guy Le Moigne, Irrigation Adviser at The World Bank, on 'World Bank Involvement in Irrigation and Drainage'.

FAO's *Small-scale Irrigation in Africa* (SSIA) programme will be organising two workshops during 1985, the first in spring 1985 for French-speaking West African countries, followed by one for East African countries in autumn 1985. The first workshop in the programme is being held this month in Sierra Leone as mentioned in the previous newsletter. Contact Harry Underhill, FAO, 00100, Rome, Italy, for further details on these workshops.

c. Training Programmes

FAO and the Indonesian Government are developing a *water management training programme* to help improve farm-level practices. The programme being implemented by FAO's ISP is designed for extension specialists and water management officers at district level.

The Instituto Nacional de Recursos Hidraulicos (INDHRI) in the Dominican Republic organised and sponsored a three-week training course in early 1984 for staff responsible for operation and maintenance of irrigation schemes, partially assisted by FAO.

FAO's ISP and ILRI are collaborating to develop a series of textbooks and manuals suitable for courses on water management. The materials will provide basic information and knowledge of particular use for personnel working at farm-level: village-level extension agents and administrative staff in tertiary units. The manuals will come initially in the form of loose-leaf elements. The first was due to be issued in late 1984. Further details from ISP, Land and Water Development Division, FAO, 00100, Rome, Italy.

A course on *Computer-aided Irrigation Management in the Tropics* willbe held at the University of Edinburgh, Scotland, UK, 31 March - 10 April 1985. It is designed for practicing irrigation engineers and agriculturalists and will include extensive use of computing facilities. The course is restricted to 12 places. Further details from TROPAG Irrigation Management Course, 16 George Square, Edinburgh EH8 9LD, Scotland, UK.

Silsoe College, Bedford MK45 4DT, UK, will be holding several specialist short courses in 1985 including courses on Remote Sensing in Natural Resource Surveying on 7-10 January, Irrigation on 25-29 March, and Irrigation and Dams: Their Impact on Public Health during July. Further details from Mrs Pam Cook.

3. RECENT PUBLICATIONS, REPORTS, ETC

A number of recent reports and books concerned with water management and prospects for small-scale irrigation are reviewed here: they add usefully to our knowledge in those areas.

WMSII has produced Prospects for Small-scale Irrigation Development in the Sahel prepared by *Jon Moris, Derrick Thom and Ray Norman*. It includes a review of traditional and modern irrigation systems and examples of these in Mali and Niger, a detailed and hopefully salutary description of problems experienced in the Action Blé-Diré (a project in Mali intended to popularise small-scale pump irrigation which suffered from poor project communication, limited farmer involvement, faulty equipment, financial problems etc), and a sensitive summary of social aspects of Sahel irrigation which practitioners likely to be involved in projects in the region (and others) would do well to read. The authors call for 'real world, behavioural economics...shorn of unnecessary assumptions and...based upon actual costs and benefits derived from local research' as a basis for developing small-scale irrigation which does have great potential in many areas. Their concluding observation also deserves repeating here '...one comes away from the Sahel with the impression that time is running out. Human and animal populations continue to rise, yet few of the many plans formulated after the 1968-73 droughts have come to fruition, and the opportunities for taking action are slipping away.' There is an urgency about the African situation which makes thorough prior understanding of local conditions more not less necessary.

The report is available from Water Management Synthesis Project, Utah State University, Logan, Utah 84322, USA.

An FAO report covering some similar ground has been written by *Harry Underhill*: Small-scale Irrigation in Africa in the Context of Rural Development. In two parts, the first considers the role of small-scale irrigation in Africa, the second presents and discusses 'crucial questions' to be considered in the stages of developing a project. The first section points out that small-scale irrigation is already significant in Africa and provides an entry point to broader rural development. Irrigation has to be seen in the wider context of the total farming system - eg farmers may give rainfed crops priority where labour shortages exist - and developments are generally more likely to succeed if an incremental approach based on farmer participation is adopted. The areas of useful government intervention and the policy environment for development must be carefully framed to keep farmers motivated. Prospects for smallholder irrigation development are judged to be good if opportunities and problems are understood. This report like the WMS Sahel one notes the poor performance and high cost of many, perhaps most large-scale modern irrigation schemes in Africa: the resources needed to successfully develop large schemes are generally very scarce.

Two points raised above are the subject of recent journal articles worth a mention here. Many practitioners and academics are now proposing greater direct farmer participation in water management but there are areas of management where such participation would probably be inappropriate. *John Montgomery* discusses the issue in a paper in the Journal of Policy Analysis and Management 3, 1, 1983, ('When Local Participation Helps') but points out that evidence is inconclusive: the experience of decentralisation and participation is too recent in many cases to allow firm conclusions although the rationale of participation at least at tertiary level and in small schemes is obvious enough.

Another article of interest is written by *Chris Finney* on 'Least-cost Analysis and the O&M Problem' and appears in the journal Water Resources Development 2, 1, 1984. It addresses the question of what kind of projects should be developed given the current situation of many developing countries (which may however change) of having ready access to capital funds for projects through foreign aid but severe shortages of public funds and foreign exchange for O&M. Conventional economic analyses used in project selection discount capital and recurrent costs at the same opportunity cost of capital which may not reflect the actual relative availability of funds. The conventional approach using a high discount rate favours projects with low capital-high recurrent costs which may be undesirable. The suggested methodology to correct this problem uses different interest rates for types of expenditure where opportunity costs differ.

Two reports have been published by the Cornell Irrigation Studies Group. The second by *Hammond Murray-Rust and Mick Moore* was discussed earlier (see discussion of this issue's Network papers), the first by *Randolph Barker et al* considers Irrigation Development in Asia: Past Trends and Future Directions. The report again notes that increased farmer involvement in large-scale irrigation development is desirable to reduce the central control associated partly with a view of irrigation development primarily as a technical engineering problem. The report points out that costs of new irrigation are rising, therefore a priority is better system performance through interaction between government and local communities implying development of small scale systems. There are good discussions of historical development of Asia's irrigated area and considerations in 'conceptual design' of projects. The reports are available from Cornell Irrigation Studies Group, 372 Caldwell Hall, Cornell University, Ithaca, NY 14853, USA.

Dr K Palanisami has written a book on Irrigation Water Management: The Determinants of Canal Water Distribution in India - A Micro Analysis. This is a detailed and interesting analysis based on his Ph.D research on the Lower Bhavani Project in Tamil Nadu. He considers two broad categories of determinants, system-dependent and farmer-dependent, and notes how absence of water users' associations creates institutional uncertainty in which farmers behave as cautious optimisers. If supplementary groundwater is available certainty is improved: then the issue is how to ensure that all farmers will benefit. The book also covers organisation and management and a discussion of water pricing. It is available from Agricole Publishing Academy, 208 Defence Colony Flyover, New Delhi 110 024, India, price Rs100 or US$20.

A few other recently received publications etc deserve brief mention. The East-West Center, Honolulu, Hawaii, has brought out Water Resources Management in Asia: A Selective Bibliography with Introductory Essays by *M C Cruz, N D Briones and M M Hufschmidt*. This is a well organised annotated bibliography in which material can be identified by author, country or subject. The major sections are prefaced by brief essays on the historical background, environmental issues, planning methodologies, and farmers' asssociations. Irrigation-related issues form a major part of the bibliography.

The final report of the Egypt Water Use and Management Project (EWUP) contains - generally positive - results and recommendations of EWUP which was a multidisciplinary project concerned with improving irrigation systems in Egypt's old lands. Contact Campus Project Director, EWUP, 22 El-Galaa St, Bulak, Cairo, Egypt.

The WMS project has brought out a Guide on Farmers' Participation, available in English, French and Spanish translations.

The first volume of a three-volume study by *E Goldsmith and N Hildyard* on The Social and Environmental Effects of Large Dams has been published and gives an ecological perspective (in 400 pages) on the issues including effects of irrigation on land and water use. The future volumes will contain case studies and an annotated bibliography. Contact E Goldsmith, The Wadebridge Ecological Centre, Worthyvale Manor Farm, Camelford, Cornwall PL32 9TT, UK.

The Journal of the Indian Water Resources Society, 4, 1, 1984 has several articles on various aspects of irrigation including scheduling, water pricing, rice production management under non-optimal water supply conditions, and impact of lift irrigation. The IWRS has its headquarters at the University of Roorkee, Roorkee, U.P. 247 667.

4. LUNCHTIME MEETINGS AT ODI

There has been a series of good lunchtime meetings at ODI during the year:

16 May 1984: Dr Thomas Wickham *The International Irrigation Management Institute (IIMI)*. (Dr Wickham is IIMI's first Director-General.)

13 June 1984: Professor John Merriam *Experiences with the demand irrigation pilot project, Mahaweli System H, Sri Lanka* (Professor John Merriam, 235 Chaplin Lane, San Luis Obispo, CA 93401, USA.) The project incorporates a flexible design allowing farmers to regulate their own water use. Photocopies of Professor Merriam's May 1984 paper on the project are available from the Secretary, Irrigation Management Newsletter, ODI, price £1.70.

9 August 1984: Dr Asit K Biswas *Evaluation of Bhima irrigation project in Maharashtra, India*. (Dr A K Biswas, 76 Woodstock

Close, Oxford OX2 6HP.)

19 September 1984: Professor Ian Carruthers *Is drainage now the highest priority? Some economic questions* (Ian Carruthers, School of Rural Economics and Related Studies, Wye College, Ashford, Kent TN25 5AH).

22 November 1984: Mick Moore *Farmers' participation and effective canal management in Taiwan: a sceptical view* (Mick Moore, IDS, University of Sussex, Brighton BN1 9RE.)

Mary Tiffen is away on a project in Zimbabwe until December 1984. This issue has been edited by Nick Chisholm.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 10b NOVEMBER 1984

GROUNDWATER DEVELOPMENT IN BANGLADESH - FARMER ORGANISATION AND CHOICE OF IRRIGATION TECHNOLOGY

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This paper discusses socio-economic factors related to development of groundwater irrigation in NW Bangladesh. Information was obtained by continuous monitoring of a few farmer groups within the project for five years. Social dynamics and constraints within the groups are associated partly with relative 'dominance' of certain farmers. Evidence is cited of gains in performance and distribution of benefits resulting from farmer 'participation' in management but the difficulties in ensuring this are not to be underestimated.

The last part of the paper addresses the important issue of privatisation of small-scale irrigation equipment, raising the question of what this implies for farmer cooperation and whether more fundamental institutional reforms are desirable for efficient and fairly equitable water use?

The paper may also raise questions on current practices in project implementation especially at appraisal and monitoring stages. The researchers in this particular study were well acquainted with specific social constraints but were not in a position to bring about improvement. Useful monitoring may require groups of 'action-researchers' attached to an agency with statutory powers and obligations in management. The broader issue of decentralised agricultural planning and administration is relevant here.

1. INTRODUCTION

This paper briefly summarizes results of a study initiated by the Swedish International Development Authority (SIDA)[1] which monitored socio-economic changes within an irrigation project aided partially by SIDA. Monitoring of aid projects has hitherto been rare amongst donors.

The project comprised sinking of 3,000 2-cusec deep tubewells (DTWs) in the NW region of Bangladesh. The project was appraised in 1969 but the war of liberation intervened; sinking of wells finally began in 1974 and was completed in 1981.

Estimates of project benefits were based on figures of the 1960 Agricultural Census. A hypothetical 'average' owner-operator with 4 acres was assumed to irrigate 2 acres within a typical 60-acre DTW scheme: at full development (after 7 years) farm production was expected to have tripled from the pre-project period, and average annual family incomes to have risen by 130 per cent. Farmer cooperation was taken to be a prerequisite for groundwater development due to the small size of most holdings and high degree of fragmentation. Irrigation groups were to be formed and extension advice, maintenance of equipment and inputs were to be provided through public agencies.

Early observations found low average levels of capacity utilisation and reports of social constraints (obstruction by large landowners) as well as technical problems and shortages of variable inputs. In 1978 SIDA decided to monitor performance at four DTW pumpgroups starting up in that year. Researchers from Rajshahi University and the Rural Development Academy, Bogra, were commissioned to set up and continue the study. Continuous data on performance of all participants in these groups were collected for the irrigation season for five successive years.

The four pumpgroups were selected in consultation with local field officers to represent relative dominance of landowners of different farm sizes. Two groups were 'big-farmer dominated' - in terms of social and economic power and land owned within the command area - and two 'small-farmer dominated'. In the latter groups no particular farmers exerted strong social power at the outset.

Questionnaires to collect relevant socio-economic data were designed by the researchers and filled in during the season by a local contact man in discussion with each farmer. The same man was employed every year. The research team made regular visits to all groups during the season to collect qualitative data on their operation, particularly focussing on 'management' problems related to (i) the technical necessity for landowners/operators with different socio-economic characteristics to cooperate: how did 'cooperation' turn out in practice, (ii) progress of pumpgroups over time in making farmer participation genuine, and any consequent improvements in technical efficiency of DTW operation.

No systematic data collection was made in an adjacent non-irrigated area, nor for performance of irrigating farmers in the non-irrigated season. The overall and proportionate change in farmers' incomes can therefore be only approximately estimated. But in-depth study of a few groups has value in revealing dynamics of socio-economic change and the degree of evolution in group organisation and management. The next section summarizes some findings on these subjects.

2. PERFORMANCE OF THE PUMPGROUPS

In one 'large-farmer dominated' group a single family (with local and national political connections) owned about half the land within the potential command area and in every year they left most of it fallow, giving about 10 acres to sharecroppers. (Their total landholding far exceeded the legal ceiling of 33 acres.) This family had full control of DTW operation and regularly denied water to land adjacent to their own: 'to keep us in poverty' according to farmers thus excluded. (Physical factors could not explain the restriction although the controlling family sometimes did offer such a reason.) There was no formal cooperative: the leading family made all decisions on timing and quantity of irrigations and followed a policy of minimum use. The family's objective was control, but not for maximising output. Complaints were fruitless due to the family's local political contacts. Acreage irrigated exceeded 30 acres in only one year and socially-determined uncertainty of water supply resulted in (a) some farmers withdrawing from the 'group' over the years, and (b) yields far below potential (on average about 37 maunds [2] per acre: the appraisal anticipated per acre yields of 50 maunds). Also one excluded 'medium farmer' tried to solve his own water supply problem by taking a bank loan to obtain a shallow tubewell (STW) for his own land. Continuous mechanical problems with the STW left him financially worse off than before, not least because he tried to 'go it alone' rather than cooperate with others denied full access to the DTW. This outcome may be compared with the early consequences of 'privatisation' of irrigation equipment, discussed in the final section.

There was very little change over the five years at this DTW (although a brief survey in the sixth year (1983) showed a trend to increased cultivation by the dominant family);tenancy conditions were basically unchanged except that the (subsidized) water charge was paid by the landlord (all other inputs by the tenant, output being shared equally as for non-irrigated crops).

The other 'large-farmer dominated' group bears interesting comparison. Again, one leading family controlled management of the group, the largest landowner filling the managing committee with his own appointees (mostly his relatives and other large landowners). Control of the DTW secured this man's position as village leader over a rival faction - his economic power within the village, based on land ownership, was less absolute than the family in the first group - but the DTW was in general efficiently (if not democratically) managed, increasingly so with time. In 1981, 68 acres were irrigated (including 12 acres of the leader's land which was always sharecropped). Membership of the group increased until the fifth year when two new DTWs were sunk nearby and attracted some members from the group. Yields increased steadily to a per-acre average of 48 maunds in 1982.

In this group the second year (1979) was a turning point in management. Severe drought and fuel shortages created difficult production conditions which the leader's appointee as 'manager' failed to cope with. Opposition to the leading man's dominance was roused and prompted him to reorganise management for increased efficiency and access to irrigation, although still not for participation of small farmers and tenants in management. (The social hierarchy existing in some communities makes any such prospect improbable - in the minds of those at both ends of the hierarchy.) Where social power - underpinned by economic dominance - is less than absolute (as where rival factions command loyality of farmers) the result can be pressure to ensure relatively efficient utilisation. Much seems to depend on arrangements - formal or otherwise - allowing dissatisfaction to be registered by farmers. Existing inequalities may be maintained or increased (always probable if land distribution is unchanged) but real incomes of all groups can rise to some extent. Whether incomes of lower income groups do so depends partly on their access to inputs and the terms on which these are received: in general (the first group was a partial exception) there was no significant difference in input use or prices between farm-size groups, although use of fertilizers and pesticides by smaller landowners and tenants was cut back as subsidies on these inputs were reduced in the last two years.

Tenancy conditions changed here: the dominant landowner shared non-labour input costs equally, and output equally with tenants. However, the duration of tenure was reduced to cover only the irrigated season. This has become a common pattern locally: fertilizer applied by tenants in the irrigated season suffices for the following monsoon paddy crop, yields of which have increased compared with a single-cropping regime. Landlords engage labour to cultivate this crop and gain the enhanced yield at low cost. (Cost-minimisation appears to be an important objective of many large landowners in the project area, but not due to lack of capital.)

In 1983 government policy to expand the rate of groundwater utilisation had brought four new DTWs to the area. The erstwhile leader above owned significant amounts of land in the command areas of three of them and was busy organising managing committees. Most farmers may regard his connections with local administration as an asset helping them gain greater - but not necessarily equal - access to scarce resources for the village.

The third pumpgroup was 'small-farmer dominated'. Management was in fact dominated by one intelligent and able 'middle farmer' (owning about three acres) who overcame challenges from a once-wealthy family whose economic status had declined. This family attempted to form a rival cooperative but failed to get support from most farmers who thought the manager ran the 'group' reasonably well. The manager gained social status and some economic improvement within a community of very small landowners (average area irrigated per person was below 0.5 acres in this group - and generally below one acre elsewhere, in contrast to the appraisal document's assumed 'average' farmer), and acreage irrigated and yields generally increased over time, reaching 38 acres and 49 maunds per acre respectively in 1982. (The low command area was partly due to sandy soils at this site and partly to the small average size of holdings and their fragmentation which prevented some very poor landholders from irrigating.) The number of participants also increased.

Nonetheless, even where there were no large landowners, management was concentrated. Some farmers may prefer this arrangement if the manager is capable and honest, but inefficiencies follow from (a) failure to realise the potential scale economies of cooperatives to supply inputs and credit, to market output, and for broader social programmes (literacy campaigns, etc.); (b) restricted flow of information within the group to improve production and water utilisation; and (c) maintenance of a social hierarchy where most poor farmers are reactive rather than assertive and potential for human resource development is thereby constrained. This hierarchy is far more pronounced where socio-economic conditions resemble those in the two groups discussed above.

In the other 'small-farmer dominated' group management was again taken on by one family of 'middle farmers'. Participation and acreage were quite high in the first year (104 farmers irrigated 48 acres) but prior to the next season the manager registered a cooperative limited to his <u>para</u> [3] which excluded the majority in the village. Many of these farmers refused to pay water charges and the manager, lacking funds to buy fuel, retaliated by restricting water supply. Only 30 acres were irrigated in that year.

In the third year a dramatic improvement in participants, acreage irrigated and yields took place. Early in the season farmers showed no interest in growing an irrigated crop and the manager, realising limitations in his position, was forced to agree to a sub-committee being set up to represent all four paras in the village. The potential command area was delimited and all farmers with land in this area were requested to cultivate or give their land to a tenant (who would bear all costs and take two-thirds of output). The sub-committee was to guarantee adequate water supply. In this year 135 participants irrigated 60 acres and obtained average per-acre yields of 49 maunds.

The cycle of conflict and conciliation, reflected in group performance, continued in the next two years, while in 1983 one rival <u>para</u> obtained its own DTW and could reduce production uncertainties. In general the manager's control could be checked by protest by many farmers but it was still enough to cause periodic inefficiencies and loss of output. Broad participation in management brought an obvious improvement but did not prevent recurrence of disputes.

3. LESSONS

Except for the first 'group', performance generally improved but not in a smooth progression as adoption studies often assume. The cooperative structure remained poorly developed and management was dominated by a few individuals. Meetings of general growers were rarely held. Extension services and supply of credit were limited and layout of channels was carried out by farmers without adequate technical advice (two of the DTW locations were probably sub-optimal and decided largely on 'political' grounds). Supply of fertilizers was at first deficient but was later satisfactory (in later years fertilizer supply has been the responsibility of private traders) but pesticides - supplied by private firms - were apparently adulterated. Maintenance services were generally adequate. Performance of public agencies was thus highly variable compared to original design of the project.

In the first group the dominance by one family appeared inevitable and confirmed the pre-existing social structure. In other groups where land ownership was less skewed 'static' efficiency was possible if farmers kept up informal group pressure on the managers. This system does not, however, guarantee a rapid rate of 'dynamic' efficiency in the sense of improvements over time in production techniques and utilisation of irrigation equipment (which, by lowering unit costs, could permit reduction of subsidies with less harmful impact on smallholders than their reduction prior to such improvements). This applies whether or not large landowners control operations.

Limited evidence did show that broad representation of farmers in DTW operation provides necessary security and improves effeciency, and is more likely to exist in the absence of a dominant landholder. It would require greater experience and commitment at local administrative level than currently exists to ensure such representation, especially given deepseated social and economic inequalities. (Administrative reform and local-level agricultural planning are currently being considered.) It is well known that such inequalities permeate administration as well but it is oversimplifying reality to assume total correspondence between dominant farmer interests and local bureaucratic interests. [4] Present 'privatisation' policy may, however, promote such a correspondence.

Current trends to privatisation of small-scale irrigation equipment - DTWs and STWs-represent a move away from participation in search of a more rapid growth in output, lower public (State) investment costs and increased reliance on market allocation of equipment and variable inputs priced at or near their 'real' costs. Available evidence (Hamid 1982) shows most STWs are being obtained by larger landowners with liberal bank credit for individual use and field reports indicate some wells are already drying up. Large landowners are enabled to avoid cooperation and are evidently obtaining 'innovators' rents from this expansion; they can probably afford to do so from privatisation of DTWs as well. (At one site monitored for only the final two years of this study one large landowner - the 'group's' chairman - took advantage of the DTW's breakdown to sink an STW inside the command area and sell water to needy farmers: or rather to those farmers able to pay his monopoly rate.) It seems likely that results for the majority of small farmers will be (a) reduced access to irrigation and/or (b) higher water charges (i.e. increased income inequalities); while potential benefits of cooperative 'dynamic efficiencies' discussed above will be lost. Given Bangladesh's current landholding structure with its high degree of fragmentation and high proportion of small and marginal farmers, it is hard to believe that current trends represent the long-term social optimum. The allocative mechanism of the market under conditions of resource scarcity will function according to existing imbalances in resource ownership and is more likely to strengthen than to offset such imbalances (evidence from the study shows 60 - 70 per cent of gross value of output goes to landowners in production or rent, 10 - 20 per cent to hired labour and 20 - 30 per cent to physical inputs and irrigation). Effective cooperation does, however, need at least administrative reform and strengthening of agricultural planning at local level. Privatisation is partly a response to past failures in these areas.

A purely technological approach does not substitute for institutional reforms, although the need for technological improvements - especially encouraging higher domestic content - is undeniable. The socially-optimal 'mix' of techniques in a given local setting needs more detailed consideration than current procedures allow. The structure of cooperatives also needs closer attention: small groups, which allow smallholders more control over their production and institutional conditions, seem more likely to overcome some existing deficiencies than the present structure and would lead to more flexible choice of irrigation technique (see Hunter's paper).

Finally, although restricted in number, these case studies suggest the value of monitoring aid projects. Similar work is desirable in future, conducted with a local research institute to strengthen feedback from monitoring into the further development of the project area itself. Such work should include greater consideration of physical and technical constraints although the SIDA study has merit in emphasising rather than playing down the influence of social dominance on performance.

REFERENCES

Hamid, M.A.et al., Shallow Tubewells under IDA Credit in North West Bangladesh: An Evaluation Study. Rural Development Studies, Series 10. Dept of Economics, Rajshahi University Bangladesh, 1982.

Hunter, G. A Hard Look at Directing Benefits to the Rural Poor and at 'Participation'. Agricultural Administration Network Discussion Paper 6. ODI, London, 1981.

NOTES

[1] A detailed report on the study is expected to be produced by SIDA, Stockholm, in 1984. Five annual reports, prepared by researchers from Rajshahi University and the Rural Development Academy, Bogra, have been previously circulated in mimeo by SIDA, Dhaka, Bangladesh. Acknowledgements are due to the local researchers involved.

[2] 1 maund = c. 37 kg

[3] A para is a location and normally kin-based unit within a village

[4] This and other related matters were discussed in Hunter's 1981 paper.

COMMENTS

Mick Howes comments on the originality of the SIDA research in its attempt "to explain variations in DTW performance in terms of the degree of control which individual interests are able to exercise over group management; and there are very few instances of any kind of work concerning small scale irrigation in Bangladesh, where reliable time series data have been assembled."

Howes notes that "The major finding arising from the investigation is that greater participation and efficiency of DTW operation tend to follow from situations where no one family or household is able to dominate the management of the group."

He suggests a logical extension of the work to explain "why a farmer who is able to dominate a group then chooses to act in a way which leads to a low level of utilisation. It is not sufficient to show that his political position empowers him to act in this way; one also needs to understand why he should regard it as being in his best interests to do so. In principle, there seems to be no reason why a person in a position of domination should not turn this to economic advantage by selling water to others who need it, but in practice this type of arrangement seems only to have appeared after DTW privatisation."

"Could it also be that dominant interests attempt to restrict the access of others to water as a means of maximising their own long-term prospects of acquiring land (and irrigated land in particular)? What alternative investments were open to the wealthy, why were these preferred to investment in irrigated agriculture, and what overall consequences for the future development (or under-development) of the area follow from this? What economic advantage, if any, was perceived by the powerful to follow from a situation where others were denied the opportunity of improving their living standards? All of this points to the general conclusion, apparent in retrospect from my own research also, that one can ultimately only really explain what is going on inside DTW groups by investigating some of the things going on outside them as well."

Howes adds the following critical postscript: "The importance or otherwise of the questions which have been raised rests ultimately on the proportion of groups falling into the centrally dominated category. Could some simple index of domination be devised which would then make it possible to determine quite rapidly how many groups in an area were of this kind, and thus to test more widely the effect of domination on efficiency? Finally, and critically, how will the patterns identified be affected by privatisation?"

Anthony Bottrall puts much of the above into context in his comment on Paper 9b (Jurriens' remarks on irrigation design and the following debate): "The debate is conducted with almost totally exclusive reference to surface irrigation systems. Many of the general comments on the design process apply equally to lift irrigation, whether dependent on surface or groundwater. However, the choice of design of pumps has extremely important implications for performance, organisation and management, the distribution of benefits, and the pattern of overall surface or groundwater exploitation. I hope the Network will be able to organise a discussion soon on this topic, as well as the broader topic of groundwater planning and management. These are both matters of lively concern within Bangladesh. Would people with experience in this field elsewhere be interested in joining such a discussion?"

Bangladesh continues to be a focus of massive efforts at groundwater development - now within an overall plan for conjunctive water use - and questions of ownership and organisation are particularly prescient there. Privatisation is one issue on which Chisholm raises points of concern; experiments giving ownership and operation of pumps to landless groups indicate the broad range of possibilities.

Comments on this paper and field experiences from elsewhere should start off the discussion called for by Bottrall, and a later issue of the Network can be devoted to contributions in the areas he suggests (see Future Papers in 10a).

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 10c NOVEMBER 1984

DEVELOPING THE ROLE OF FARMERS ASSOCIATIONS IN SRI LANKA AND NORTHERN THAILAND

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The first two papers here describe the evolution of farmers' associations in two major irrigation schemes in Sri Lanka. In both cases it was recognised, partly from empirical evidence, that effective water management and related developments would probably be impeded by either a highly bureaucratic structure or by a voluntaristic approach neglecting institution-building amongst farmers.

In both schemes farmer participation in water management was actively promoted by the project coordinators. In the Gal Oya scheme groups of Institutional Organisers (IOs) were to be catalyst agents to encourage emergence of effective farmers' groups. Widanapathirana's *paper describes the activities and achievements of the IOs and outlines some emerging problems which may constrain further development of farmer organisations at Gal Oya, including trying to establish a career structure for IOs whose uncertain status has led to a high turnover rate.*

Jayewardene *describes in detail the management system in System H of the large Mahaweli Project. Within System H inequalities and inefficient water use rapidly emerged in the absence of formal attempts to promote farmers' groups. These trends were revealed in early evaluations and led to the decision to organise farmers into groups based on the turnout area. Also important was cooperation between the farmers' groups and project officers, aided by restructuring the management system.* Jayewardene *notes that organisation of farmer groups has also been a spur to community development, much of it on a self-help basis, but more effectively after improved production was achieved.*

The issue of cost recovery is raised at the end of the paper. Current water charges cover only a fraction of O & M costs although farmer groups carry out maintenance of field channels themselves. It will be interesting to observe farmers' responses as water rates are progressively increased as proposed. (Also see paper 10f.)

The third article by Kathpalia *describes Water Users' Groups in the Nong Wai Irrigation Project in northern Thailand. Once again the background is of a project performing below potential partly due to lack of organisation amongst farmers.* Kathpalia *was closely involved in the process of establishing farmers' groups to improve water management and coordinate with various departments involved. Water distribution and maintenance have subsequently benefited from greater farmer involvement. Contact between farmers and other agencies was also aided by holding a seminar to exchange views and generate further ideas for improvement. Such a forum should be generally useful provided farmers' representatives have a real opportunity to air their views and are listened to, as seems to be the case in this project.*

A. FARMER PARTICIPATION FOR WATER MANAGEMENT: THE GAL OYA EXPERIMENT

The Gal Oya Irrigation Scheme was the largest constructed by the Sri Lankan Government in 1952. Through years of neglect of maintenance and repair work, the irrigation system was in a bad state; production was very low, income disparity was emerging and social problems were beginning to surface. As an attempt to remedy the above situation a scheme of rehabilitation was planned by the Sri Lanka Government with assistance from USAID in 1979. Two major objectives of the programme of rehabilitation are (a) physical renovation of the system, channel net work etc for better water control, and (b) institutional reorganisation to promote farmer participation for system design and water management.

Programme Strategy

To secure farmer participation for the above activities, the Agrarian Research and Training Institute (ARTI) was requested to initiate a programme of organising farmers in the project area. This involved development of a few models of farmer participation and testing them in the field.

The farmer organisation programme began with the fielding of a change agent designated IO in a pilot area of 5000 acres in the left bank of Gal Oya scheme. The IO is a university graduate in social sciences with a strong farming background and desire to work with farmers. A group of 30 IOs were selected on merit and after a training in leadership, group dynamics, farmer behaviour, agriculture, water management etc, were fielded along selected channels of the scheme in March 1981. The IO is expected to motivate and educate the farmer for better water management work through group action.

The IOs were fielded in small groups, each group being responsible for organisation work in a specific field channel area. For field work each IO was allowed to work independently from otherswhile discussing problems jointly. Each IO group has a Co-ordinator and 3-7 IOs.

The IO met all the farmers in his channel area and promoted group work such as channel clearing, meeting with officers etc. After a few such activities farmers themselves realised the benefits and necessity of working together. Subsequently it was observed that groups of farmers organised regular monthly meetings with officers and discussed their problems jointly. Farmer groups also assisted in the design of channels, structures etc, where farmers provided local hydrologic knowledge based on their experience to engineers who prepared the design work. After a series of such group activities, the farmers were seen organised into small groups along field channels in the area.

Each field channel organisation is based on a hydrological boundary rather than on a specific area boundary. The approximate area covered by each group ranges from 12 acres in the smallest group to 100 acres in the largest group. What is important is that all the farmers ie the colony farmers, the lessees, the mortgagees, the encroachers etc, are members of the field channel organisation. The smallest group has a membership of 3 farmers while the largest group has a membership of about 50 farmers (the size of the organisation depends on the command area served by each field channel since the average official size of plot is 4.0 acres).

Each farmer was allocated with only one block (plot) of land of size 4.0 acres along a particular field channel in the 1950s. Therefore theoretically each farmer can have only one plot along a field channel. However, because of many types of land transactions which have taken place since initial colonisation, some farmers have more than one plot of cultivable land. In effect therefore, one farmer belongs to several organisations whenever he cultivates several plots of land under commands of different field channels.

A representative is selected by consensus of all farmers to look after the interest of the farmer organisation at discussions, meetings etc, elsewhere.

Once the field channel organisations were formed, group activities were organised better. A regular system of monthly discussions was arranged with field level officers. All such meetings were attended by the IO who continued to play the motivator role.

Farmer Responses

Good response to organisational effort was evident. Field channel farmer groups undertook to carry out regular channel cleaning, desilting and earthwork for repairing bunds, channels etc, with their free labour. Some channels which have not been cleaned since inception of the scheme were cleaned. Farmer organisations also supervised work of private contractors involved with construction activities to ensure quality. Some other groups also undertook rehabilitation work such as channel deepening, main channel desilting etc, and employed members of the farmer organisation for those activities during the off season.

Field channel groups organised water rotations to distribute the amount of water entering a field channel equitably among all farmers. In lengthy channels the head farmers agreed to send water down so that the tail farmers could obtain it first within a particular water rotation adopted by the Irrigation Department. As a result of regular water rotations operated by farmers at field channel level, possible crop damage at tail of the channels was avoided. The survey done by the ARTI in April 1983 indicated a marked reduction in farmer disputes, water thefts and channel crossings etc, after the formation of farmer organisations. Protection of irrigation structures against theft was also reported by farmer organisations. Field channel groups also developed very close links with officers of government departments, which helped the latter's work.

Constraints

Several factors such as land tenure problems, lack of legal status of farmer organisations, bureaucratic procedures of departments, poor leadership of organisations and slow progress of rehabilitation have affected the successful operation of farmer organisations. Also, the heavy turnover of the change agent (IO) inhibited the performance of farmer organisations.

The IOs are appointed on contract basis initially for one year with possible extension thereafter. Because of the lack of job security with the programme, they attempt to get permanent appointments elsewhere. This has been the only reason for the turnover amongst IOs.

To illustrate the severity of the problem, it was originally thought that 20,000 acres of the project area could be covered by 70 IOs. However, the ARTI has recruited, trained and fielded a total of 120 IOs since March 1981, in order to cover the 20,000 acres. Yet only 42 IOs remain with the project at present. The IO exodus has been so severe that some of the areas of the scheme have never had IOs contrary to intentions in the project plan. In other channels as many as 3 different IOs have served within a period of one year when only one IO could attend to organisation work. In some channels the IO turnover occurred at a time when most of the farmers were yet to be met. This jeopardised organisation work and caused unnecessary delays in the formation of Farmer Organisations (FOs). Our original plan was to thin out the IO density gradually once the majority of FOs became active. However, the exodus of IOs has caused a natural thin out even before FOs formed in most of the channel areas.

We found that IOs should not cease to operate even after FOs have begun to function; a low density of perhaps one IO for each 3000 acres of paddy may be required after the formation of FOs. They can help strengthen the weaker FOs, motivate the federation of field channel organisations to distributory channel organisations (the distributory channel organisation is a collection of farmer representatives of all the field channels under one distributory channel) and continue to monitor the programme. Therefore, most of the IOs could be withdrawn at a stage when all FOs were functioning (however, the programme has not reached this stage due to frequent turnover of IOs).

There is need for a career structure for IOs similar to the cadre of Technical Assistant (TA) in existing irrigation schemes in Sri Lanka. Each TA has an area of 5000 acres of paddy whose responsibility is to take care of the technical problems related to water management. Our experiment proves that the socio-economic issues including institutional aspects have been neglected although they are at least as important as technical matters.

Benefits and Prospects

The programme has produced both tangible and intangible benefits. The FOs have saved water in the head area allowing an additional area to be brought under cultivation during the dry season in the tail parts of the project. There was also a reduction in government expenditure since FOs have done all of the field channel maintenance work. The value of these two benefits alone is about Rs 165 per acre. Since most of the benefits produced by FOs are intangible such as less conflicts for water, better farmer-officer relations, protection of irrigation structures, the social benefits resulting from delivering water to tail areas, better design plans produced by farmer consultation, reducing income inequalities by equitable distribution of water among field channels etc, the net benefits will certainly overweigh the cost of the FO programme (about Rs. 222 per acre). The increase in salary overheads attributable to the creating of a career structure for IOs, therefore can be estimated at well below the benefits that can be expected from such investment. Our experiment has also shown that a level of yield increase of only 3.3 bushels (72.6 lbs) of paddy per acre is sufficient to cover the total cost of investment in the programme. This level of yield increase has already been achieved in the project area. The programme therefore appears to be cost effective which can justify the creation of an institutional development division for water management under existing conditions in Sri Lanka.

The Gal Oya experiment indicates that farmers can effectively be organised for water management work based on field channels. However government recognition and incentives towards them appear as important variables affecting the sustenance of the farmer organisations.

B. A DEVELOPMENT PROGRAMME FOR THE POOR
(A case study from the Mahaweli Development Programme in Sri Lanka)

System 'H' is the first area to be settled under the Mahaweli Development Programme. The scheme started in 1975 with the settlement of approximately 500 families in the area. This programme of settlement was accelerated from 1978 by the present Government.

System 'H' is an irrigated settlement scheme where a total of 24,000 families will ultimately be settled. Most have already been brought to the area. The project area consists of a total of 108,000 acres, of which 72,000 acres will be taken up for settlement under the Accelerated Mahaweli Development Programme. The balance 36,000 acres are old colonisation schemes that come under the command area of System 'H'. The Mahaweli Authority is not involved in the total management of these old schemes, but assists some in specific functions like water management, marketing, etc.

Each settler is given an irrigation allotment of 2½ acres and a highland allotment of ½ acre. In instances where the settlers owned land within the 'H' area and which was taken over, they were given up to seven blocks in the initial stages but now a maximum of three holdings due to problems of labour etc. The new settlers however are entitled to only one allotment each.

The management system that the Mahaweli Development Board had for the settlement areas of System 'H', was based on range, region and project level administration. This system worked well in the initial stages of the project. With the Mahaweli authority of Sri Lanka taking over the management functions of System 'H', they adopted the unitary system of management. This was based on their experience gained in a pilot management project carried out in the H5 area. The organisational charts of the two management systems described above are attached (Annexures I & II).

In the Mahaweli Development Board's management system each range has a set of officers from each of the disciplines like land administration, agriculture, irrigation etc. These officers had a specific role to play. At the next level too, which was the region, there were a higher grade of officers for each of the operative disciplines. At the top or project level too there were Deputy Resident Project Managers for agriculture, water management, land administration, community development, marketing and credit. The senior staff were strengthened by an Accountant and an Administrative Officer. This was the staff that the Resident Project Manager had to assist him to run the project.

At the end of 1980 an evaluation was carried out to determine the impact of these development programmes. The evaluation was conducted mainly by requesting the officers and farmers attending training sessions to fill in a questionnaire. Interviews were also conducted in the field. It was found that not all the settlers were getting the full benefits of the development effort and some were not receiving all the inputs.

The reason for this state of affairs seemed to be that the farmers were not geared to receive these benefits and to make best use of them. These farmers did not have sufficient productive and management skills individually to receive the benefits of the services that were available to them. It was necessary to upgrade these skills in the farmers. It also seemed that effective servicing was only possible through group action. Group action was also necessary to get the community to participate in the planned programmes of the project. It has been found that communities do not continue to function effectively if they are organised only to benefit from social and welfare programmes of the project. It has been my experience that initially farmers are only interested in aspects of productivity, ie, agriculture, land and water. It is only after consolidation of these project benefits and successful cultivations that they become fully interested in social, cultural, religious and sports activities. It is only then that they participate together as a community in project activities or programmes in respect of environmental sanitation, community health, nutrition, clean drinking water, day care centres etc. Without community participation no social development programme can be successfully completed.

In System 'H', as in most other irrigation settlement projects, water is the key to the success of the project and in the eyes of the settlers the most valuable commodity. Since all attention is focussed on water and since the irrigation design was provided for a turnout area with groups of 12-20 farmers, it was decided that this should be the base of a farmer organisation. The irrigable area was ultimately broken up into lots of 30 - 60 acres of irrigable land where the water was given to these farmers in bulk. It was the hope of the planners that the farmers in this turnout area would be able to distribute this water equitably among themselves. This, in actual practice, did not happen. Farmers cannot form themselves into groups and co-operate in group activities without their skills in management and organisational ability being developed to an effective degree. Some farm plots received little or no irrigation water for successive cultivations. As a result, the damage to irrigation structures and channels was very high. As mentioned earlier the turnout group was then organised, initially for water management.

Each turnout group was asked to elect from among themselves two representatives to be trained in water management and in agriculture. These representatives so elected by their fellow farmers were then given a formal training by the officers not only in water management and agriculture but in community development, marketing and credit, land matters etc.

The responses of the farmers to the formation of turnout groups and the attendance of their two representatives at the bi-weekly training sessions were very heartening. Their attendance was regular, they paid close attention to the proceedings, they kept notes and records and also participated very keenly in the discussions etc. These two farmer leaders or representatives were in turn supposed to go back to the other farmers in their turnout group and disseminate the knowledge and training that they got at these fortnightly sessions.

With the organisation of the turnout groups and the election of their leaders for the purpose of training it was necessary to assess the training needs of these farmers. Training had to be relevant to the situation in the field: therefore initially discussions with the farmers themselves and the field officers were held to identify the problems that the farmers faced so that training would be designed to equip the farmers to solve these problems together with the project officers. As mentioned earlier the project management had all the different disciplines represented at different levels or tiers by the officers in the field. There were officers for water management, agriculture, community development etc, at project, regional and range level. All these levels had to be represented in the discussions as otherwise a full list of the problems facing the farmers could not be made out. Also the constraints that the project staff came up against at all levels would be revealed. It would be necessary first to find ways and means of eliminating the problems and constraints faced by the staff, if they were to be fully involved in the solution of the farmers' problems.

Another important aspect of farmer training was that, considering the number of farmer leaders involved, it would not be possible logistically for one group of trainers to train all the farmer leaders. It was therefore necessary to have a number of trainers, a group of whom could work regularly and continuously with a particular group of farmer leaders. In this context the best possible trainers would be the field level officers themselves. But now we had to consider the question of training the officers to be effective trainers. This too was organised soon after farmer training started in 1979. A Foundation Course was held, later a monthly two-day Follow-up course. The Foundation Courses and Follow-up course were organised by the project management. The Follow-up courses still continue with slight modifications. The farmer training was carried out initially by the range and region level officers and later by the block and unit level officers.

The main problems with regard to water management that were identified at these discussions were:

a. Poor and inequitable distribution of water by farmers amongst themselves in a turnout area.

b. Poor maintenance of field drains and ditches by farmers within a turnout area.

c. No solution to the problems in respect of land preparation, irrigation, etc.

As a result of there being no organised system of water distribution within the turnout area, there was a lot of water being wasted and the actual consumption levels of water for crop cultivation were far in excess of the projected levels. In some instances however water was not reaching the fields of some farmers at all.

It was acknowledged at these discussions that the field level officers could not solve these problems by themselves nor could the farmers without some sort of organisation within their turnout area. Cooperation between the officers and the farmers was necessary. It was equally clear that the participation of the farmers in this exercise would be confined to their turnout areas. In System 'H' where nearly 72,000 acres of new lands were being developed for 24,000 families, there were 1734 farmer turnout groups.

Studies conducted in previous settlement schemes have shown very clearly the importance of agricultural production for the success of these schemes. Both agricultural extension and the timely availability of agricultural inputs are important. It was found that relatively few resources were being devoted to agricultural inputs and some of these inputs like tractors and heavy machinery were not appropriate to the needs of the farmers. High costs of oil and spare parts had increased the need to use draught animals for farm power. The extension education pertaining to agricultural production was also weak.

There seemed to be very little coordination between the various project activities like agriculture, water management, community development etc. The little coordination was at the top - ie at project level, whereas it was equally important to have some cohesion and coordination closer to the grass roots. Also there was very little participation by the community in the implementation of these programmes. Community participation to my mind is not merely keeping the community informed of the development programmes but to get the community to actively participate in the implementation process. This also includes taking into consideration their views and satisfying their needs even though they may not be in the original plan that is being implemented. Unfortunately their views could not be obtained in the pre-planning stage.

One of the primary needs for agricultural settlement is to have the necessary infrastructure. Basically there are three types. The physical infrastructure was now almost complete, the buildings and irrigation channels etc, having been built. The administrative infrastructure was organised to facilitate the provision of advice, inputs and other services easily to farmers and may need certain changes if we decide to alter our operation methods. The social infrastructure - the building of communities - had as yet to be created. The social infrastructure is necessary to organise farmers to improve their production, living standards etc, through co-operatives and other organisations to implement women and children's programmes etc. The social infrastructure must be so designed that it does not merely give the farmer security over the life he lives or the land he owns, but it must also be capable of high productivity. The purpose of this development programme is to make the farmers increase production so as to enable them to raise their level of living and not merely to create more subsistence farmers.

In this respect, as much as training is needed for the officers, the farmers too need a training and education to increase production and to make best use of increased incomes.

The Mahaweli authorities have, as mentioned, placed a great deal of emphasis on community development and the participation of farmers in the operation of these programmes. This approach needs intensive training both because it is a departure from the normal bureaucratic approach of the past settlement schemes and because evaluations have shown shortcomings in the implementation of the proposed plans and programmes, especially in respect of farmers receiving the benefit directed to them.

One of the main reasons for these shortcomings was that there was no coordinated effort between the officers of the various disciplines at range or regional level. At project level the Resident Project Manager coordinated all work in the project. The line of command went straight down from the top with no coordination between (say) agriculture and water management. As a result it was not possible to have an integrated, inter-disciplinary programme. Planning such a programme at project level by the Resident Project Manager and his senior staff was no problem, but it could not easily be implemented in the field as there was no single officer responsible for all the staff at the range or regional level.

It now seemed very necessary that there should be some coordinator at a very low level of the management structure. Breaking the management system into too many small coordinated units too would have nullified the purpose in coordinating the managements' activities at the lowest level in the field. These groups had to be coordinated as close to the grass roots as possible but not to the extent that there would be almost as many coordinators as those coordinated.

In the meantime the settlement branch of the Mahaweli Authority of Sri Lanka, which was going to take over the settlement and post-settlement work in System 'H' and subsequently in all the Mahaweli settlement areas, was experimenting with a new management system in a pilot project in the H5 area. This unitary system of management was akin to the system obtaining in the tea and rubber plantations in Sri Lanka which has evolved over a hundred years. It was basically this system that was adopted in H5 where it seemed to be working well. It was decided that with certain modifications and with further experience that could be gained in operation it would be best to adopt this management system in the other settlement areas as well.

The settlement branch of the Mahaweli Authority of Sri Lanka took over the management functions in System 'H' from the Mahaweli Development Board on 1 January 1981. In April 1981 the unitary management system as shown in Annexure II was adopted. With the new system, unit and block level management (the former directly responsible to the latter) replaced range and regional level management. A community development officer is included in the block manager's team. The management system at project level remained almost the same. This, as a management system, has worked quite well. Intensive orientation and training programmes had to be conducted with the officers to enable them to carry out their duties and functions properly and effectively. The existing staff were redeployed to work within the new management system. Due to greater decentralisation there was even a slight reduction in the costs of management.

In development schemes such as this, it is essential that evaluations are made from time to time to ensure that the purposes and objectives of these programmes are being met, particularly when the development programmes are for the benefit of the people and are designed to improve their quality of life. Merely spending large amounts of money on a project does not necessarily guarantee its success. Constant evaluations must be carried out to ensure that this money is being utilised in the best possible way and that the target group has got maximum benefits from these efforts.

In a recent evaluation which I conducted the following points were observed. Here the evaluation was based mainly on personal interviews with a cross-section of farmers and my experiences in the field.

Agriculture

There is a trend of increasing paddy yields season by season and a noticeable increase in the use of fertilizer in paddy cultivation.

More and more farmers are taking to the cultivation of other field crops, especially chillies, during the Yala season encouraged by good prices and easy marketing facilities.

The acreage of paddy that is transplanted is increasing each year. Weed control is more effective. This shows that farmers are receptive to the advice of the agriculture extension officers.

Water Management

Over succeeding Maha and Yala seasons water consumed per acre for cultivation has decreased progressively.

Farmers are taking a greater interest in water management. They are cooperating in the distribution of water and in the maintenance of the irrigation system. Very little damage is done to the irrigation structures now, unlike in the past.

In the Yala season when water is limited farmers get together and cultivate in equal shares the limited land that can be cultivated according to the water available. This is a traditional custom known as a bethma cultivation.

This shows that the farmer training sessions, both in the field and in the classroom, have had a definite impact on the farmers. The first evaluation showed that the farmer leaders were not passing on the training messages effectively to the others in the group. The others in the group considered the leader an extension of the bureaucracy. In some cases too the leader could not be bothered spending more time disseminating his training knowledge. The other farmers in these turnouts got the message of extension only by the example that the leader set in doing his own cultivation. Now that we have moved to a great extent from the classroom to the field for training there is greater participation by the others in the group: the group is no longer entirely dependent on the leader for their training.

Community Development

By their attendance, and responses shown in many ways, it is obvious that the farmers have realised the benefits of farmer training and group action not only in the solution of their problems but also in carrying out their cultivation work.

The response of the farmers is exemplified by their participation in our programmes. We have over 350 Health Volunteers who serve in each of the hamlets entirely on a voluntary basis. They render first-aid, distribute anti-malaria tablets and distribute milk to children daily as a part of our nutrition programme. They maintain registers and records of the work that they do.

To allow farmers' wives to work as well, twenty five Day Care Centres for children have been started with UNICEF assistance and another fifteen will be opened in 1984. In most instances the affairs of these Day Care Centres are managed by the parents' association formed for each Day Care Centre.

Another matter brought up by the farmers was that the single well presently provided for every 20 families was not suitable and inconvenient to use. It was suggested that a smaller well to cater for six families be built. Here again the management, with UNICEF assistance, responded fast to the request of the farmers and already over 2800 wells have been completed. The actual excavation of the well is done by the six farmers who will benefit from that well.

As an added measure, to strengthen the turnout group organisations, I have requested my officers to give all contract work on maintenance and repairs of each turnout to that particular turnout group. Apart from working together and earning extra money, the farmers will ensure that the work is done to their satisfaction and no reports of poor quality work etc will come back to the management.

A water tax of Rs 75 per hectare was levied in 1980, but was discontinued due to a number of reasons. In 1984 it was decided to levy a sum of Rs 250 per hectare per annum as operation and maintenance costs. This figure will be increased annually by Rs 50 per hectare till it reaches Rs 500 per hectare. This money is collected by the project management and will be utilised for the operation and maintenance of the irrigation system. The rates collected now are however only a fraction of the actual costs incurred by the management. This levy is in respect of maintenance work above the turnout gate. Maintenance of all field channels has to be carried out by the farmers themselves as before. Turnout groups continue to get small scale maintenance contracts that they are capable of carrying out effectively.

After the first evaluation it was decided to get the active participation of the farmers and that a coordinated effort should be made by the officers in the various disciplines to integrate each of their programmes. Farmer and officer training was to be the key to this new approach. From the results of the subsequent evaluation it is quite obvious that the new approach has paid good dividends. This is mainly as a result of the active participation of the farmers in our programmes which was brought about by the management's quick and effective response to the needs and aspirations of the farmers as articulated by them.

The problems are certainly not over but much headway has been made. As long as we are alive to the changing needs of the farmers and our responses to them positive, we cannot be far wrong.

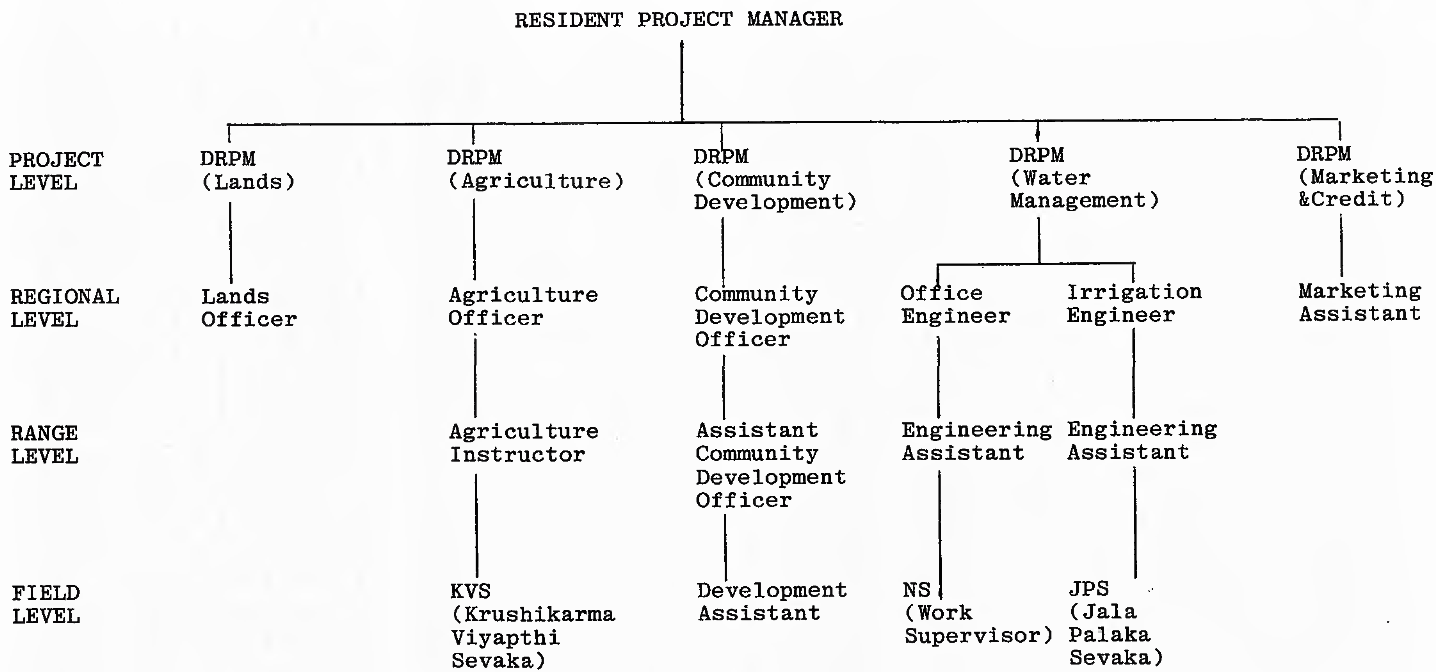
NOTES

Maha Season: is the period from September to March in which paddy is cultivated. The northeast monsoon occurs during this period and this rainfall is used for cultivation with supplementary irrigation.

Yala Season: is the period from April to August in which paddy and other field crops are cultivated. Cultivation is mainly by irrigation.

<u>ANNEXURE I</u>

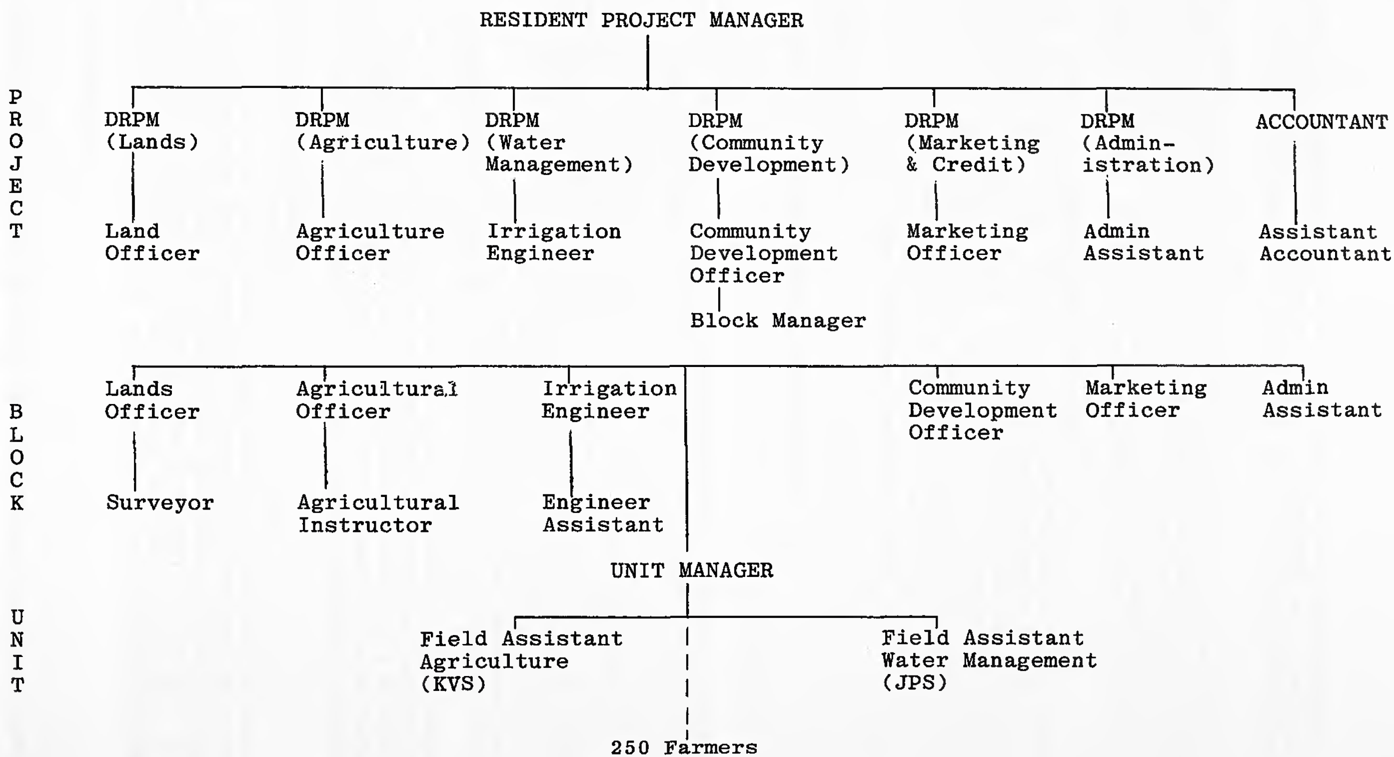
THE OLD MANAGEMENT STRUCTURE IN SYSTEM 'H'



DRPM = Deputy Resident Project Manager

ANNEXURE II

THE NEW MANAGEMENT STRUCTURE IN SYSTEM 'H'



DRPM = Deputy Resident Project Manager

C. WATER USERS' GROUP IN NONG WAI IRRIGATION PROJECT - THAILAND

1. INTRODUCTION

The farmers' group for water use have been active in Thailand for the past 700 years. These schemes generally belonged to one or two villages and irrigated areas of 100 to 300 ha. Each scheme had its own set of rules. The Government then gave some help in organising them under the People's Irrigation Act (1939). Some of these have been merged into associations as the water supply has been connected to a bigger irrigation project, managed by the government.

In the past ten years, consolidation of land was taken up and an act passed making the Cooperative Promotion Department (CPD) responsible to organise water users' groups and activate them through the cooperative in the project area or province. Besides the formation of the water users' group on chak basis of size about 80 ha and election of chak leaders, little activation was done due to lack of staff with the cooperatives. However, with the help of consultants and active cooperation of the Royal Irrigation Department (RID), CPD and Department of Agricultural Extension (DOAE) activation of these water users' groups has been done on a pilot basis in at least three projects, ie Meklong, Nong Wai and Lam Nam Oon with the financial assistance of the World Bank, Asian Development Bank and USAID, respectively.

The experience of Nong Wai project with which the author was connected as team leader of consultants for 21 months (1981-83) is discussed.

2. NONG WAI PIONEER AGRICULTURE PROJECT

2.1 Background

The Ubolratana multi-purpose dam was built across the Nam Pong river in 1965 by the Electricity Generating Authority of Thailand (EGAT). In 1966, the Royal Irrigation Department built an overflow type ogee weir 25 km downstream of the reservoir to divert water for irrigation on both sides of the Nam Pong river. The left main canal takes a maximum discharge of 35 cms with a command area of 29,760 ha, the right main canal a maximum discharge of 15.8 cms to serve a net command area of 10,840 ha in the Nong Wai Pioneer Agricultural Project.

The main canal and laterals in the Nong Wai area were completed in 1971. However, lack of terminal irrigation and drainage facilities, and the undulating topography in some parts of the project area, imposed serious limitations on water delivery and control. Construction was taken up in 1975-83 to overcome these constraints.

A technical assistance for Nong Wai Irrigation Management was implemented from November 1981 for a period of 18 months with the help of three consultants, to establish and demonstrate systematic water management in an area of 900 ha, besides improving operation of the main system, agricultural support services and training of staff.

2.2 Project

a. General Nong Wai Pioneer Agricultural Project is located in 45 villages in Khon Kaen province in Northeast Thailand, has a gross command area of 15,000 ha and net area of 10,840 ha. The project is served by the right main canal.

The climate in the project area is tropical. Annual rainfall is about 1,200 mm with pronounced seasonal distribution. More than 85 per cent of rainfall occurs in May to October and tropical storms are common in September, the month of maximum rainfall. In the dry season, adequate water is available for 80 per cent of years. During the wet season, there is normally no problem.

The soils in the project area are of alluvial origin, mainly heavy clay and sandy loam.

b. Water conveyance system The right main canal is concrete lined with a length of 47 km. It has a distribution system of 7 laterals and 8 sub-laterals from three of these laterals with a total length of 80 km. There are 8 regulators cum syphons on the main canal for crossing the natural drainage channels. From the main canal, laterals and sub-laterals, 248 irrigation ditches take off with mostly constant head orifices to regulate the discharges.

c. Canal capacity The irrigation system has been designed for 100 per cent cropping during the wet season and 80 per cent during the dry season. The canal capacity is sufficient for an average water duty of 1.438 l/sec/ha at the head of the canal for the wet season and 1.813 l/sec/ha in the dry season when a cropping pattern of 70 per cent rice and 10 per cent upland crops like peanuts, sweet corn and vegetables has been adopted.

d. On-farm development The chaks range from 15-200 ha. In the consolidated area the main ditch is lined with a constant head orifice to regulate discharges and sub-ditches have earthen section of generally 108-120 l/sec capacity with division boxes and checks. Farm inlets with 20 cm pipe have been provided to each plot (two pipes for bigger plots). The plots vary in size from 0.15-3 ha. In the ditch improvement area, the size of the chaks is generally smaller, but the size of the ditch is the same as consolidated area and the main ditch is generally not lined. In the consolidated area, every plot has been provided with a 20 cm drain pipe which drains the water into a tertiary drain linked to a secondary drain taking the water to the main natural drain thence to the Nam Pong or Nam Chi rivers. These types of drains are provided in the ditch improvement area also, although each plot is not always individually drained.

3. WATER USERS' GROUP

3.1 Background

In October 1981 the intensity of cropping during the dry season was 23 per cent. In the chaks of the technical assistance area of 900 ha, it was 50 per cent. A great deal of time was wasted in disputes among the farmers while distributing water. Some of the weaker farmers did not even attempt to sow any crop, as they were not sure of getting the water. During the dry season of 1982 and 1983, water supplies were made more reliable through the introduction of irrigation scheduling, and feedback information systems helped to operate the canals in a systematic manner. The farmers gained more confidence and cropping intensity increased to 80 and 95 per cent in 1982 and 1983 respectively, in the technical assistance area. The increase of intensity in 1983 was mainly due to the activation of the farmers through the water users' group (WUG) and extension work on water management and agricultural practices.

3.2 Activation of Water Users' Group

For efficient use of irrigation water, farmers' cooperation and active participation was essential. This required organisation skill and discipline. RID has the responsibility of distributing the water to groups of farmers organised in chaks. The responsibility was placed on the farmers for distributing the water and maintenance of all facilities within the chak (ie all action required with respect to irrigation and drainage).

3.3 Attitude

a. Officials Due to lack of sufficient will, action has been taken only to form the water users' group for each chak and elect the chak leader and other functionaries, but no action was taken to activate these groups. The staff was trained by the consultants to be persuasive and instructive and not have an authoritative attitude. Once farmers' confidence was gained through open and frank discussion by explaining the reasons for every suggestion and changes made, their cooperation was forthcoming. This process was slow but succeeded, more so than a directive approach.

b. Farmers The farmer had been used to plenty of water during the development period and therefore did not understand why it should be used efficiently,especially if it is to be given to other farmers far away. His natural inclination was to cooperate first with farmers who are in his sub-ditch and then in his ditch. To expand this process of cooperation, the value of water and necessity for discipline was explained to him.

i. Value of Water: The project aims to achieve an irrigation efficiency of 60 per cent or more, but at present during the dry season it is about 40 per cent. During the transition period till the above efficiency is achieved, the water supplied was a little short, but this helped to establish an appreciation of the value of water. However the tail portions of the lateral, sub-lateral and chaks were not allowed to suffer at the expense of farmers in the head reach. Equitable distribution of water was aimed for. Farmers' confidence and cooperative effort was obtained by reducing the supplies in a systematic manner after adequate explanation and also by introducing a system of rotation within the chak which ensured each farmer's due share at the proper time with less management effort. Confidence in the rotation system was obtained by ensuring steady supplies in the lateral system and irrigation ditch for the period of rotation, ie a week without fluctuations (within 10 per cent variation).

ii. Discipline. It is best to enforce discipline through group pressures. In a few cases, other sanctions like fines, cutting of water supply were imposed by the WUG. It is not possible to enforce discipline through law by the concerned government agency.

3.4 Responsibility of Cooperative Society

a. Formation of WUG Under the Land Consolidation Act, it is the responsibility of the CPD/NACS in coordination with RID, DOAE, and LCO to set up the water users' group in the scheme. 169 such groups of 60-80 ha (20-60 farmers) have been set up for 248 chaks with 5,500 members by a group organiser provided by CPD. The duties and functions were then explained and chak leader elected. Some of the smaller chaks have been combined and some farmers are members of two WUG as their plots are in two different chaks.

b. Relation between NACS and WUG In order to strengthen the cooperative it was recommended by the consultant that Nong Wai Agricultural Cooperative Society (NACS) would have a steering committee on WUG operations who would be elected by the 169 chak leaders. This committee shall decide all policy matters involving WUG and maintenance work. It is expected that all members of the WUGs would become members of the cooperative and that the organisational structure of the NACS incorporating WUG operations would be as given in the chart.

3.5 WUG Responsibility

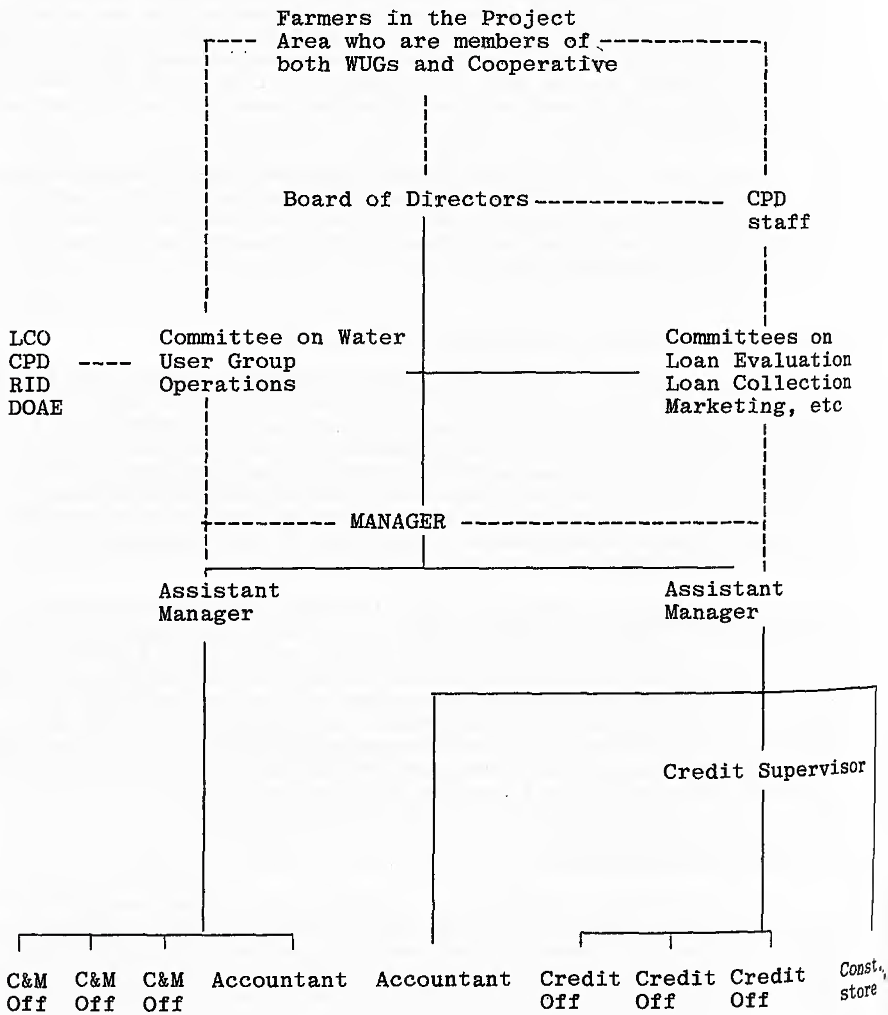
The WUG responsibility is to distribute water among the farmer members within the chak and to maintain discipline according to the rules framed. They are also responsible for the maintenance and repairs of irrigation and drainage ditches, farm roads, and all the structures located on them within the chak.

The distribution of water by the WUG is intimately connected with the supply of water in the main canal, laterals and sub-laterals being operated by RID. It was considered necessary for RID to take an interest and responsibility in activating the farmers within the WUG. In the technical assistance area, WUGs have been activated in 18 chaks by RID. A water distribution

Organisational Structure of NACS with Water User Group Operations

------ indirect supervision

——— direct supervision



plan on a weekly rotation within a chak was drawn up and explained in a number of meetings with the farmers. Some of the new features were:

i. Change in the size of the farm inlet pipe proportional to the area, ie 10, 15 and 20 cm, instead of 20 cm pipe only for all sizes of plots; and

ii. sub-groups were formed one for each sub-ditch or section of a ditch in which all farmers were to get water from farm inlets simultaneously.

Very useful suggestions with regard to location of farm inlets, checks, etc were given by the farmers. In some cases land levelling which had not been done properly was rectified so that there was no difficulty in distributing due share of water. The farmers were then trained in actual implementation of the rotation in the field. This whole process took almost one year.

Since water distribution cannot be carried out equitably and effectively without the cooperation of farmers, it was necessary to involve them fully. The chak leader did not get any remuneration for distribution work as every member of the WUG helps to reduce his burden. Similar work is planned to be taken up for other chaks over the next three years.

The maintenance work consisting of weed clearance in ditches and small repairs to structures has been carried out by the farmers in the 18 chaks of technical assistance area on their own under the guidance of the water master and special effort of an officer. Even then, some farmers did not contribute their labour. This effort to bring them together may not always be possible in the future for the whole project. To ensure proper maintenance a maintenance fee is collected by the NACS which places responsibility for this work on the chak leader of the WUG (it should be done at least two times in a year for about two days each time). For the labour component of the work, it was recommended that priority should be given to farmers of the chak to earn back part of their payment.

The coordination between various agencies like RID, CPD, DOAE was carried out through the Dry Season Cropping Committee under the chairmanship of the project manager O&M, RID.

4. EVALUATION

A farmers' seminar was held at the end of the dry season of 1983, to assess the functioning of the WUG and how it could be further improved. In this the chak leaders, group leaders of WUG of 18 chaks which had been activated and the contact farmers for extension service and the chairman and secretary of cooperative groups functioning in this area, were invited. Thus 100 farmers in two groups of 50 each were invited for two days each for exchange of views with the officers of RID, DOAE and CPD/NACS. They were happy with the activation of WUG and would like the zoneman to help them further in maintaining discipline and solving their problems. They liked the system of rotating water within the chak and making the farm inlet size proportional to the area for equitable distribution of water. The problems of agricultural extension and functioning of the Nong Wai Cooperative Society were also discussed and action taken to further help them in solving their problem with regard to pesticides, and recovery of loans.

It was generally recognised that the WUG should be utilised as the basis by all departments for their activities such as sharing of farm equipment, supply of farm input and pest control.

ANNEX 1

WATER USERS' GROUP ORGANISATION AND FUNCTION

1. MEMBERSHIP

A water users' group would consist of 20 to 60 farmers (all farmers using the water in the chak). Either the land owner or tenant can be a member, but the actual water user is preferred. If the chak consists of more than 10 farmers, then the WUG would be sub-divided into sub-groups for easy distribution of water. In case of smaller chaks, 2 or 3 chaks should be combined for weekly rotation to form one WUG.

2. ORGANISATION OF WUG

a. Each WUG shall be headed by a chak leader, and a group leader for each sub-group, elected every two years.

b. The chak leader shall be assisted by a working committee consisting of himself and the sub-group leaders.

c. Zoneman and KT would act as technical advisor and NACS official would be the supervisor.

c. The NACS Steering Committee on WUG would take all policy decisions

3. FUNCTION AND DUTY OF WATER USERS' GROUP

The WUG would perform the following functions:

<u>a. Water distribution</u>

Distribute the available water equitably among the members in accordance with the following:

i. Before the start of the crop season, the working committee shall discuss the irrigation schedule of their lateral and chak as intimated by the zoneman and give their suggestions and acceptance to him;

ii. With the help of the zoneman and water master, the working committee shall draw up an interim rotation schedule for their chak;

iii. Ensure no member wastes water into the drain, particularly during land preparation;

iv. All members would help the chak leader in water distribution.

b. Maintenance

Maintain and clean the irrigation ditches, drainage ditches, structures and roads within the chak. Drains at the boundary of two chaks shall be maintained by RID. If necessary new sub-ditches or structures would also be constructed for better distribution of water with the approval of RID. Each sub-group would be responsible for its own sub-ditch, sub-drain structures and the road portion along it. The main ditch would also be divided among the various sub-groups by allotting the portion of the main ditch processing the sub-ditch.

c. Maintenance fee

Each member shall pay a 'maintenance fee' as prescribed by NACS. The NACS will arrange the maintenance work through the chak leader. The farmers of the chak would be given priority for the labour component of the work.

d. Cropping pattern

Each chak should fix its own cropping pattern before the crop season particularly of upland crops during the dry season and also the variety of seed in the case of paddy. This can promote efficient use and management of water and other agricultural practices. The KT should provide technical advice to the WUG on suitable cropping patterns by attendance of meetings.

e. Discipline

To maintain discipline among the members. In case of default, the real reason for default should be established and if genuine it should be remedied, otherwise the farmer should be pressurised by members to fall within the prescribed discipline. In case of repeated default he should be fined as per the agreement, by the working committee in which the zoneman and NACS supervisor are present.

f. Coordination

i. To send genuine complaints, suggestions and requests of the members to RID, DOAE or CPD/NACS as the case may be, and obtain action by the responsible agency.

ii. To keep close contact with the zoneman, Kaset Tambon and credit supervisor of the area to obtain the latest information for better irrigated agriculture production and inform all the members.

iii. To report any damages to the crop in the chak due to floods or other natural causes to the zoneman and other officials concerned.

g. Meetings

For carrying out the above responsibilities, the WUG shall meet at least twice in a crop season, generally in April, August, October and February.

4. PROCEDURE FOR MAINTENANCE

a. Maintenance fee collection

The LCO would send out the notices one month before harvest to individual farmers in the project area about the amount they have to pay to the cooperative. With the assistance of the chak leader the NACS staff would collect the assessed amounts from the farmers (currently ฿60/rai and ฿44/rai from intensive and extensive areasrespectively including ฿10 for administration and payment to chak leader).

If a farmer does not pay on time, the chak leader should inform the cooperative about the reasons why the payment was not made. If the reasons are considered valid (eg crop failure, etc) the chak leader should recommend whether the payment could be postponed up to the next season. The NACS staff would then make appropriate recommendations to the WUG Steering Committee, in coordination with the KT and zoneman. If the farmer has not received water due to reasons beyond his control, he should not be required to pay the fees for that crop season.

b. Maintenance work

Each chak leader with the guidance of the zoneman would prepare an estimate for repair and maintenance in terms of material and labour required two months before the start of the crop season, ie in early April and October. This should be submitted to the Steering Committee for approval (who may delegate authority to the Assistant Manager). The amount should be generally limited to the maintenance fee collected from the chak and exceeded only in special circumstance. The maintenance work must be done at least one or two weeks before the start of the irrigation in early June and December. The C&M officer should make arrangements for the whole project and transport the material to the site of work. The work should be done by the farmers of the chak under the supervision of the chak leader and payment made to the farmers and chak leader by the C&M officer after completion.

5. RESPONSIBILITY OF CHAK LEADERS

i. To coordinate the work of all sub-group leaders.

ii. To maintain liaison with the zoneman, KT and credit supervisor and have an interchange of information.

iii. To ensure discipline and enforce the rules and report the fines to be collected to NACS.

iv. To decide the problems of water distribution and any other problems among the various sub-groups of the chak.

v. To get the estimate for maintenance and repairs prepared and collect the necessary funds from the NACS and get the work done at least twice a year in May and November and in between if necessary.

vi. To assist the NACS supervisor in collecting 'maintenance fee' from the members of WUG.

6. DOCUMENTS TO BE MAINTAINED FOR THE CHAK BY WUG

i. Register of members and plots owned by them.

ii. Map showing each plot on 1 : 4,000 scale.

iii. Summary record of meeting.

iv. List of written documents circulated by RID, DOAE and CPD/ NACS separately.

v. Account book showing receipts and expenditure.

vi. Register of lease of land to others by the owner.

vii. List of structures in the chak and the repairs carried out each year.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 10d NOVEMBER 1984

DESIGNING FOR EASY MAINTENANCE

Ian Rule*

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This paper departs from the themes of management and participation discussed in the other contributions. Ian Rule *uses his long experience superintending operations in one of Zimbabwe's Regional Water Authorities to indicate how system maintenance can be made easier with forethought at the design stage and appropriate construction. In some cases 'lack of forethought' may really stand for lack of information on what is required for operation and/or lack of accountability when faults are revealed (*Ian Rule *adds that in general the standard of design and construction in Zimbabwe is very high). What systems of organisation can minimise the need for maintenance due to inefficiencies at the design and construction stages?*

After some years of operating a number of large dams and lined canals in the south eastern lowveld of Zimbabwe it is possible to list a number of areas where improvements may be made at both the design and construction stages to assist the future operator. Some of the problems result from lack of operating appreciation and forethought whilst others are improvements suggested from experience.

As this article only deals with problems and their possible solution a biased impression could be given. It is stated at the outset the standard of design and construction in this country is of a very high standard and the points mentioned form a small part of the whole picture. From an operator's point of view a designer would be given three priorities - simplicity, ease of access and longevity.

Most dams, particularly in Africa, are in remote areas and emphasis must be given to the maximum of maintenance being handled by on-site staff or possibly a modular approach whereby a faulty or damaged item may be removed and dispatched for repair, in both cases avoiding the use of scarce and expensive contractors on site. Three of our local dams are equipped with Sorefame Hydraulics on the upstream emergency gates: these are excellent units but any repair can only be done on site by a specialist due to their complexity.

Ease of access would appear obvious but too often the end construction results in cramped conditions for inspection, maintenance and repair. It is understood that financial pressures dictate cost savings but this policy can result in overly expensive recurrent maintenance and is therefore short sighted.

It is at the construction stage that the maximum assistance can be given to the future operator but it requires a degree of forward projection by R.E. (resident engineer).

When building the dam the R.E. has at his disposal contractors and equipment for the construction but he should consider what difficulties will arise when undertaking normal maintenance etc. in the future once these aids have left the site. Two examples of this concern work done at one of the dams. The downstream sleeve discharge valves required inspection, servicing and painting. This task was considerably more difficult than need be due to a lack of slots and/or anchor points for the necessary scaffolding and cradle and when one of these valves had to be removed for repair an expensive mobile crane had to be brought to the site. The provision of lifting gear or anchor points could have reduced the cost. Later at the same site repairs to the spill mattress were required. The repair site was at least 75 metres from the nearest road causing problems in lowering down plant and material (which included a diesel powered dewatering pump, a concrete mixer and a compressor). The task could have been simplified considerably by the provision of an access ramp and winch point.

Whenever maintenance aids are built into a site they are seldom used in the original installation. Despite the delay it is considered that any aid should be tested under maintenance conditions, i.e. without the use of any construction aid, to ensure that it will do the work intended.

Check that any overhead gantry will lift directly over a valve/motor/pump and that it is feasible to then move the item directly on to a truck for removal i.e. is the entrance high and wide enough and does the roadway lead to the entrance.

Whilst these points appear obvious on one site the gantry was put in reverse and the operator had to stand on tip toe on a pipe manifold (a somewhat dangerous practice) in order to move the crane along the pump house and on another site the gantry would only travel one metre either because the bolts securing the beam rail were too long or because the carriage wheels were too large.

Some improvements are suggested from experience. On one site Avio Neyrpic Balancing Gates are used for discharge measurement. When originally installed the gates were shells and mass concrete was added to the floats to achieve a balance. It would have been preferable to have used a removable substance such as concrete bricks or the like to lighten the assembly for bearing replacement or if necessary, removal. The same comment applies to the counter balance on the automatic spill gates at another dam.

Two large pump stations on one system have been constructed of asbestos cladding which has proved to be very fragile. At each station two of the adjacent walls are "solid" thus inhibiting a through draft and necessitating the installation of fan cooling on the control panels as summer ambient temperatures are above 45°C. In addition the panels were sited about 300 mm too close to the wall causing unnecessary access and cleaning problems.

The discharge from one dam is from a surge chamber through a rock tunnel and thereafter into a canal. With time this tunnel has become blackened and very slippery underfoot due to algae. Anchor points set in the roof for safety ropes would have been most welcome especially at the lip of the surge chamber which slopes away without warning.

As the cost of fossil fuels increases all dam sites without access to the national electricity grid should be equipped with a turbine sufficient to supply domestic requirement (normally about 25kVa) provided the future flow conditions are favourable, i.e. fairly constant discharge.

New canals should, where possible, be designed for machine grass cutting with parallel drains having shallow cross section rather than a Vee. Tops of banks should either be wide enough for a tractor or slope at an angle compatible with tractor operation.

Design of a canal often calls for small weirs to be built across the base and these have a small pipe for drainage when the canal is emptied. As maintenance time is limited this drainage time was found to take too long. To speed up the process a gap +/- 400 mm wide was cut in the centre of each wall and then blocked using cheap bricks. These are then knocked out at the beginning of a close-down and rebuilt prior to re-establishing flow.

Whenever a sump or a stilling pool is built this should have a slight slope to one corner and in this corner should be a mini-sump approx 300 mm square by 400 mm deep. This mini-sump should contain a removeable plug, to avoid it filling with silt, and facilitates the complete drainage of the structure by pump for inspection etc.

Finally when siting labour housing it has been found useful to place them near and below canal siphons for raw water supply using siphon for both storage and pressure head. Where this has been unsuitable windmills are providing a limited but adequate supply.

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IRRIGATION MANAGEMENT NETWORK

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TANK IRRIGATION IN INDIA AND THAILAND: PROBLEMS AND PROSPECTS

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Tank irrigation contributes significantly to the total irrigated area in parts of South and Southeast Asia. Especially in South India and Sri Lanka tank irrigation has a long history and many currently used tanks were constructed in past centuries. Increasing physical problems - siltation, deterioration of channels, unreliability of rainfall etc - are reducing effective capacities of some tanks. As this happens conflicts between users and encroachment onto silting tank beds are more likely.

Where tanks have existed for a long time farmers have usually organised themselves to allocate water, but in many cases the results are still inefficient and inequitable. Where tanks are more recent, as in NE Thailand, farmer organisation is a problem sometimes more urgent than physical deterioration. As usual technical and socio-economic problems exist and are connected. On the technical side issues to consider include improved design for efficient water distribution and the potential for conjunctive use of surface and groundwater; socio-economic issues include conflicts over water allocation and the division of responsibility for maintaining the system. The economics of tank irrigation also require investigation of possible multi-purpose uses and potential for rehabilitation as against new construction.

As more attention turns to areas of unreliable rainfall to achieve sustained increases in output and incomes, improvement of tank irrigation systems is starting to receive high priority. An indication of this interest is shown in the Proceedings of the International Workshop on Modernisation of Tank Irrigation System: Problems and Issues *held at the Centre for Water Resources, Anna University, Madras-600 025 on 10-12 February, 1982. The Proceedings contain a number of highly informative and stimulating papers on tank irrigation mostly in South India but also in Sri Lanka and NE Thailand.*

The two pieces comprising paper 10e give a guide to problems and prospects associated with tank irrigation. The first paper by Palanisami and Easter *is a wide-ranging review of tank systems in South India and NE Thailand, revealing different nature of problems partly depending on how long tank irrigation has existed. The second paper by* Sivanappan *provides a case study from a district in Tamil Nadu. Both papers suggest that current farmer organisations are inadequate for system modernisation; the precise roles of external agents and farmers will now have to be defined in future developments based on the increasing information available on existing systems.*

A. TANK IRRIGATION IN INDIA AND THAILAND: PROBLEMS AND PROSPECTS

1. INTRODUCTION

An irrigation tank is a reservoir created by constructing an earthen wall across the slope of a valley to arrest and store rain water for the purposes of irrigation, domestic water supply, and livestock water. Tank irrigation systems are less capital intensive and havewider geological distribution than large projects. Tank irrigation systems also act as an alternative to pump projects, where energy availability, energy costs or ground water supplies are constraints for pumping water (12).

Tank irrigation systems are common in India (particularly in Southern India), Sri Lanka, and Thailand (particularly in Northeast Thailand), where the rainfall is highly variable and inadequate to produce a successful wet season rice crop in most years. The undulating topography further facilitates tank development in these countries. The mean annual rainfall is about 800 mm and 1200 mm for Southern India and Northeast Thailand, respectively. The coefficient of variation of rainfall is high in the wet season; 42 per cent for Southern India, and 51 per cent for Northeast Thailand (6, 8, 12, 18). Tank irrigation helps stabilize water supplies and rice yields.

There are as many obstacles to tank irrigation as there are benefits, due to their large numbers and the differences in water demand, managerial experiences, and investment for maintenance. Experiences from these tanks can be useful in evaluating present tank policies, as well as to extend tank irrigation to other suitable regions in the world. This paper examines the tanks of Southern India (particularly Tamil Nadu State) and Northeast Thailand and highlights their problems and prospects.

2. ORIGIN AND TYPES

South India

Most tanks in South India, particularly Tamil Nadu, are more than a century old and were build by the ruling kings, and subsequently by the zamindars and the State Governments to stabilize rice irrigation.* Approximately 39,000 tanks have been constructed in Tamil Nadu irrigating about 2.5 million acres. They account for about one third of total irrigated area. The area irrigated is based on the assumption that 1 million cubic meters (m.cm)

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* The zamindars mainly for tax collections, acted as intermediary between the kings and the farmers in the 16th and 17th century, and then between British rulers and the farmers from the 18th century to 1947. After independence, the state governments were directly responsible for tank construction and maintenance (12).

irrigates 212 acres of rice (12).

More than 90 per cent of the tanks are nonsystem tanks, where rainfall is the only source of water while less than 10 per cent are system tanks. System tanks obtain water from perennial water sources such as large reservoirs, rivers, etc. Tanks are also classified based on command area size: minor tanks are those with command areas less than 200 acres while major tanks serve more than 200 acres (3, 10). Minor tanks account for about 70 per cent of the tanks.

Northeast Thailand

Tanks in Northeast Thailand have been built since 1940s by the Royal Irrigation Department (RID), as a means to provide wet season supplementary irrigation for the rice crop as well as to meet the domestic and livestock water needs of the village. These tanks are also widely used for fish production and some provide dry season irrigation. By 1979, 544 tanks had been constructed and since then more have been constructed and planned (18). These (existing and future) tanks should irrigate about 0.75 million acres or benefit about 9 per cent of rural families in the Northeast.*

Most of the tanks (over 95 per cent) are non-system types. The tanks are normally classified based on the water storage capacity: small tanks (less than 1 million cubic meters), medium tanks (1-10 million cubic meters) and larger tanks (above 10 million cubic meters). The small tanks account for about 77 per cent of the total number of tanks, the medium tanks about 19 per cent and the larger tanks about 4 per cent (18). The small tanks are mostly used for domestic and livestock water needs, along with water for kitchen gardens and fish production. The medium and larger tanks are primarily for supplementary irrigation for wet season rice and some irrigation for dry season cropping. The number of acres to be irrigated by the tank is based on the assumption that 1 million cubic meters will provide 300 acres of wet season rice irrigation (1, 5).

3. MANAGEMENT AND WATER DISTRIBUTION

South India

The overall control of the tanks is vested with the Public Works Department (PWD) under the state government. Tanks above 100 acres of command area are under the direct control of the PWD and tanks below 100 acres are under the control of local village committees or local panchayat unions (the village level government body). PWD does the major maintenance works such as

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* This is almost equal to the irrigated area benefited by the two other major sources (big reservoirs and pumping from rivers) (1). Hence, tank irrigation can be considered a major source of irrigation for the region.

repairing tank bunds, tank sluices and breaches above the main canal outlet. Maintenance works below the main canal outlet are the responsibility of the farmers. Government funds for maintenance works are normally inadequate due to the large number of old tanks which are in need of repair.

Water distribution, in general, is vested with the local villagers or village committees. Although a waterman is generally appointed by the village to release water from the tank for irrigation, he does not schedule water releases to achieve efficient use of the water. For example, in many cases the sluices are not closed even when there is no apparent demand for water. Water conflicts between head and tail farmers also result in poor water distribution. In larger tanks, lascars appointed by the PWD are in charge of water releases. Water users organisations are present in some tanks and are in most cases informal. They appear to be an important factor in improving tank management and water distribution (11).

Northeast Thailand

The Royal Irrigation Department (RID) is the overall authority for operation and maintenance of most tanks. The tanks are generally administered directly from RID province (regional) headquarters, with only a small number of security and minor maintenance staff on-site. The RID only does the major repair works and the farmers are responsible for constructing and maintaining the distribution system. The funds for operation and maintenance are normally insufficient and much of the works cannot be done by RID (8).

The water is released by local people with little assistance from RID. Water distribution is very uneven since most of the tanks do not have complete distribution systems. Most of the tanks have water users associations. They are usually initiated by RID through the Center for Water Users Associations which helps to set up the first water users assembly in order to form the central committee. These associations help to organise a group of water users to repair and clean the canals, and in settling water disputes. However, the associations need better training on how to operate and manage small water systems which serve a number of farmers. Their poor financial status has also made them rather inactive (18).

4. WATER USE AND CROP PATTERN

South India

One short duration high yielding variety of rice such as IR20 is grown in the wet season (September-December). Dry season cropping (January-April) is generally not possible due to inadequate tank water although farms with wells irrigate small plots of vegetables, maize, groundnut, cotton, cholam and pulses. Normally in the wet season rain accounts for about 20 per cent of the water needs of the rice crop while about 80 per cent is met from tank and groundwater irrigation. The groundwater (mostly from privately dug wells) accounts for about one-fourth of the total irrigation water applied and is used in the latter part of the crop season after tank supplies are used up (12).

The method of irrigation varies from continuous flooding at the beginning of the season to rotations in the middle of the season when the tank water level is low. The topography of the rice fields is flat and water losses are high in the unlined channels (14). In many cases, water use efficiency has declined to as low as 25 to 35 per cent (13). Farmers at the top of the canal over-irrigate for fear of water shortages late in the season or to substitute water for weeding while farmers at the tail-end under-irrigate or supplement with well water. Water conflicts are common and are more easily solved when water user organisations are active.

The average rice yield varies from 1,000 to 1,200 kg per acre with adequate water supplies. Average net return ranges from \$30 to \$50 per acre (based on 1981-82 rice prices in the region).

Northeast Thailand

Glutinous long duration rice varieties are the main wet season crops (June-November) grown on the low lands. In a few cases the short duration Rice Division (RD) varieties such as RD1 and RD5 are also grown. The dry season (December-April) crops consist of rice, vegetables, maize, groundnut, cucumbers, etc. Kenaf and cassava are long duration, non-irrigated crops grown on the uplands. Rainfall in the wet season meets about 80 per cent of the rice crop's water needs with the rest supplied by tank irrigation. Although water is available in most tanks during the dry season, it is not fully utilised in majority of tanks due to inadequate water distribution systems, the lack of crop markets, labour shortages, etc. Hand watering of vegetable plots by buckets is common. In total, only about 15 to 20 per cent of the area is cropped in the dry season. Groundwater irrigation is not common partly due to high salinity.

The method of irrigation is continuous flow and there is little water control. The overall efficiency in water use is as low as 10 to 13 per cent (9). Poor land levelling as well as the random layout of fields inherited from pre-irrigation times makes it difficult to spread irrigation water particularly in the dry season. The average rice yields vary from 800-1,000 kg per acre with tank irrigation. The net return ranges from \$10 to \$30 per acre (based on 1981-82 rice prices in the region).

5. PERFORMANCE AND PROBLEMS

South India

Studies of crop profitability and economic feasibility suggest that tanks are performing well below their potential

(3, 12, 22). Several factors indicate that tank performance will likely continue to decline in the future. These factors include heavy tank siltation, encroachment on the tank storage area, poor functioning of the (upper) tank sluices, defective control structures and weak farmer organisations. Tank siltation has reduced the water storage capacity on average by 10 per cent although in selected tanks heavy siltation has almost eliminated the storage capacity. In conjunction with this siltation, farmers during the last two decades have slowly encroached on the tank storage area. Crops are cultivated in the storage area whenever the tank is not filled since the tank beds produce high crop yield due to heavy silt deposits. In many cases, the government issued rights to farmers for such unauthorised cultivation, resulting in about 30 per cent reduction in the storage capacity of the tanks. The encroachers also reduce the water level in the tanks by illegally opening the sluices to avoid submergence of their crop in the tank bed (2, 12).

The other important factor which affects the water storage and irrigated acreage is the rainfall. As the command area under each tank is based on the capacity of the tank times the number of fillings, variation in rainfall pattern influences quantity stored and area irrigated. Oppen, et al (22) observed that quantity of rainfall for South India has declined over the years. Thus, even if the tanks were in good condition, they would be receiving less rainfall and, therefore, able to irrigate fewer acres.

Absence of effective water users organisations to manage tanks and allocate the water among farmers is both a cause and effect of poor tank performance. Such organisations exist primarily where tanks have frequent water shortages and water management is critical for crop production. The existence of different castes within a community, different regional political parties, differences in economic status of the farmers, substantial variations in farm size and the absence of village leadership appear to make it difficult for water user groups to survive.

The PWD is responsible for tank maintenance but the Revenue Department collects the water fees from farmers so that there is no relationship between the water fees collection and amount spent for tank maintenance. On average, about one dollar per acre is allotted to PWD by the government for annual maintenance which is substantially lower than the estimated three dollars per acre required for maintenance. Hence, the PWD does only emergency repair work on the tanks and canal structures (12).

Northeast Thailand

The tanks were constructed mainly to spread the benefits of small scale irrigation throughout the northeast region in response to political pressures and concerns about political stability (18). Studies have shown that small tanks serving only domestic uses are economically inefficient while tanks providing water for both irrigation and domestic uses are able to cover project costs (18, 19).

Although many tanks used for irrigation and other uses (domestic, livestock and fishing) have benefits greater than project costs, they still have serious problems (15). Most of the existing tanks do not have a completed distribution system and a large percentage have no distribution facilities at all (20). The lack of maintenance, inadequate funds for maintenance, poor water control, inadequate storage capacities and competition for water between irrigation and other uses reduce the actual area irrigated to 16-43 per cent of the irrigable area (4).

Low adoption rate in the dry season (15 to 20 per cent) and poor cooperation among the water users further reduces tank performance. Undulating topography, distance of farms from the canal outlets and incomplete tertiary distribution systems have heavily reduced the water availability for dry season cropping for many farmers. The only alternative for many farmers is hand watering which is costly and cumbersome. The RID is authorised by law to construct tanks and to provide the main canals. The farmers are supposed to finish the rest of the distribution system. However, farmers do not have the appropriate equipment, technical assistance, or financial resources to complete the distribution network. The absence of markets for dry season crops and insufficient labour and money for cultivation are disincentives to dry season cropping and construction of a tertiary distribution system. Since farmers are not charged for water used, there are no fees which could be used to improve and maintain the systems.

6. FUTURE STRATEGIES AND POLICY ISSUES

South India

It is important to arrest the growing instability in tank irrigated acreage and rice yields, caused by uncertain and inadequate tank water supplies. Desilting tanks and reducing encroachment are potential long-term measures while short-term measures include increasing the number of dug wells at selected points in the command areas and lining the main canals to reduce seepage losses and provide better water control.

Where they do not already exist informal water users organisations should be encouraged through incentives. The incentives may be in the form of additional funds from government to meet emergency repair works, or added authority to raise fish in the tanks and market them without intervention by the Revenue Department. These incentives should also be available to existing water user organisations. Tank performance could also be improved by appointing a farmer-paid water regulator for each tank to release water according to demand rather than allowing water to flow continuously. The simple procedure of closing the sluices during rainy days has been shown to permit a 20 per cent larger command area at a 17 per cent lower risk of crop failure (23). Supervisors, at the rate of one person for every 100 tanks, could be used to help enforce minimal water regulation rules and provide technical assistance (21).

Changes in crops during years of low rainfall is another possibility for increasing output and income in tank irrigation areas. Tank irrigation in Tamil Nadu generally follows a four year cycle determined by rainfall - a good year (surplus), a satisfactory year, a bad year (inadequate water), and a very bad year (very little water). Hence, during bad and very bad years, irrigated dry crops could be grown successfully rather than rice. Based on the water duty concept (one cusec of tank water flow will irrigate 60 acres of rice or 120 acres of irrigated dry crops) farmers could grow twice as large an area of dry crops compared to rice. If these low rainfall years could be predicted, farmers could plant dry crops instead of incurring income losses by planting rice and then abandoning all or part of the area once they realise that the tank water supply is inadequate.

Oppen, et al (23) argue that whenever a tank has poor performance because of factors such as siltation, lack of runoff or unresolvable disputes over water rights, etc, it might be preferable to abandon the tank and use the fertile tank bottom for cultivation. Where hydrological and topographical features permit, irrigation could be provided from wells. In some cases where runoff is sufficient a watershed management project could incorporate operation of the irrigation tank and runoff collection for groundwater recharge and well irrigation. This would help reduce tank siltation and improve the conjunctive use of tank and well water.

Data limitation prevents a full analysis of tank irrigation. Tank level data should be collected on capacity of the tank, command area and the nature of tank fillings over time. This along with rainfall and other weather data is needed to help farmers predict water supplies and also help operate the tanks. For example, a weather-information management system is being proposed for development in nine South and Southeast Asian countries to reduce the impact of drought on food production. This system is primarily for predicting drought loss 30-60 days before harvest (17). In Tamil Nadu what is required is a system to predict drought 30-60 days before planting so that farmers can adjust cropping plans.

Northeast Thailand

The size factor should be considered while planning for new tanks. Tanks serving both irrigation and domestic needs should generally be given priority over single purpose tanks for only domestic uses which usually do not pass the economic efficiency test (19). This is partly because government agencies currently constructing small tanks do not clearly define how the stored water is to be used. For domestic water supply, only 2,700 to 21,600 M^3 is required per village. Small tanks storing 100,000 M^3 for only domestic uses are excessive and expensive for this purpose (1).

Many of the low performance tanks were designed improperly for the command area. In addition, there are cases of inappropriate site selection and poor soils as well as unsafe structures. It was RID's decision to go ahead with project construction in the early 1950s without adequate survey data (18). Now enough tanks have been constructed without adequate data to judge whether or not this is an appropriate policy for the future. It may now be more appropriate to construct new tanks based on reliable basic data on topography, runoff, catchment area, soil permeability, and location of cultivable area. It is also important to do <u>ex ante</u> project evaluations before making investments in new tanks. No such evaluation has been made for the tanks already constructed (18). Such analysis would help categorise the different expected benefits such as irrigation, domestic water use, livestock water use, etc and identify those with the highest potential payoff.

The overall performance of the tanks also depends on the dry season cropping intensity. Better water distribution systems, land consolidation, proper land levelling, effective water users organisation and credit and marketing facilities are needed if the tank water supplies are to be effectively used in the dry season. For example, land consolidation has been used in large projects to help provide a more efficient and controlled distribution of water. The same strategy should be considered for small scale systems.

Though glutinous rice varieties continue to dominate the wet season cropping system, the introduction of high yielding Rice Division (RD) varieties is also possible with the provision of increased extension services, and the greater use of fertilizer. A heavy extension input is needed to ensure that all farmers are aware of the problems and potentials associated with new varieties (4).

Improving the effectiveness of water user organisations at each tank is one of the short as well as long-run strategies for promoting better tank management and water control. Yet local participation in tank management cannot be fully successful without technical and financial assistance. RID is one possible source of both technical manpower and budgetary resources. Another source of finance might be the farmers themselves if a system for collecting fees could be implemented. If the farmers could see that the fees would be used to improve and maintain their system, collection might be possible. However, some outside assistance or incentive would probably be necessary to get the system started.

As with the Indian tanks, adequate and reliable statistics are important for proper evaluation of the tanks and for future planning. The RID should employ more staff on data collection and monitoring, as evidenced by one study which shows that RID overestimated the irrigated area by 50 per cent (16).

7. CONCLUSIONS

Tanks in South India are more than a century old and tank irrigation technology is well known to the farmers. Thus, many of the problems are above the outlet. Heavy tank siltation, encroachment and poor irrigation structures require a long-term government policy with an appropriate concern for the socio economic and political aspects of the problems. Since the scope for new tanks is limited due to the high cost of the remaining sites, rehabilitation of the existing tanks is the primary means for stabilising tank irrigation.

Tanks in Northeast Thailand were only started on a large scale in the 1950s. Thus, tank irrigation is a fairly recent technology for the Thai farmers and many of the problems are below the outlet. Improvements in the distribution systems, on-farm development activities and better incentives for dry season cropping appear to have the highest payoffs.

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B. A CASE STUDY IN CHINGLEPUT DISTRICT, INDIA

1. INTRODUCTION

The Chingleput District is one among the 16 districts in Tamil Nadu, India, with an area of 3155 sq miles or 8760 sq km. The net cultivable area is about 42 per cent. The main soils are red, river alluvium, sandy and a small portion of black soil. The soil in general contains low amountsof organic matter. The average annual rainfall of Chingleput is 1210 mm and the rainfall during summer, southwest and northeast seasons are 125.16 mm, 421.85 mm and 663.81 mm respectively. The rainfall pattern is almost the same throughout the district and hence there is great possibility of taking two crops even in dry land tracts. The intensity of cropping is 127 per cent compared to the State's average of 120 per cent.

2. IRRIGATION

Irrigation in the district is by canal, tank and well. The area under canal irrigation is 2.68 per cent of the total irrigated area. There are 80949 wells in the district irrigating about 87056 ha. Well irrigation alone is found in some areas and in others wells are constructed in the tank command area as a supplementary source of irrigation for the tank fed lands. The percentage of well irrigated area is 26.89 per cent.

Tanks - both system and non-system - are the principal source of irrigation in this district. There are 3548 tanks in the district irrigating about 156,492 ha which is 48.34 per cent of the total irrigated area. This will clearly indicate the importance of tank irrigation in the district.

3. CROPS AND CROPPING SEASONS

The main crops grown in the district are paddy, groundnut, ragi and pulses.

Sornavari season commences in April and the crops grown are paddy and groundnut under irrigated conditions mostly by lift irrigation from wells or from the tank if water is available. The other season is _samba_ which has a long duration (July to December). This season depends upon both monsoons. The crop is cultivated either as semi dry or wet depending upon water available in the tanks. The main crop grown in the season is paddy. Semi-dry paddy is raised by broadcasting or by using seed drill. It is maintained as a rainfed crop and thereafter with the receipt of good rain and water supply in the tank, the crop is grown under irrigation as wet crop. _Navarai_ season starts in December and ends in April. This season commences towards the end of northeast monsoon with the availability of water in tanks and wells. Paddy, groundnut and ragi are the other crops grown during this season.

4. *TANKS AND IRRIGATION SYSTEMS*

The tanks are classified as major and minor tanks. The major tanks are under the PWD and minor tanks are under the control of village/union. About one fourth are major and the rest minor. Large tanks have 7 to 10 sluices and medium and small tanks 2 to 4. The sluices are opened and closed by '<u>Neerkatti</u>' who are appointed by the villager/farmers. If the <u>ayacut</u> - the area irrigated from any one tank - is spread over many villages there will be many Neerkattis, one representing each village. If sufficient water is available during normal years, water will be distributed by them without any difficulties, otherwise there are great problems. The sluices are normally opened during the day and night. Hence the control and distribution of water becomes difficult during night and water is wasted. In addition there are double crop area, single crop area, high level sluice, low level sluice, different crop stage and cropping pattern, farmers with wells and without wells - all these have to be accommodated while delivering water to the fields. Since it is so complicated the system is not operated with high efficiency.

5. PROBLEMS IN TANK IRRIGATION

The sluices and channels are not adequately maintained; the latter are badly silted up and encroached. The Neerkatti opens the sluices without knowing the exact requirements of crops. He often lets out excess water which breaches the channels and floods the adjacent fields. This is also the case in the field channel area since all are unlined earthen channels, there is considerable seepage. The channel's cross section and gradient are not maintained to carry the designed capacity since it was constructed long ago.

Many major tanks are irrigating more than one village. Due to lack of cooperation between the different villagers, many farmers are involved in delivering water with resultant conflicts in its allocation. Since the sill level of the different sluices is not the same, the discharge varies and hence the availability of water differs between the farmers under different sluices.

6. PROBLEMS DUE TO SOCIO-ECONOMIC CONDITION IN TANK IRRIGATION

The time lag between the head farmer and the tail end farmer in land preparation and transplanting varies from 30 to

45 days even for a tank having an ayacut of around 1000 acres. The influential farmers are able to get the required quantity of water, whereas the small/poor farmers are not able to get water for a long time. The length of main canal from the sluice adds to the problem. The seepage losses in the channels are more than 50 per cent and therefore the time allotted to the tail ender is not sufficient to irrigate his land. There is no separate drainage channel to remove the excess water during the rainy season. Field to field irrigation is practiced for want of separate irrigation channels and this affects the crop growth resulting in appreciable loss of water by over-flooding.

Farmers in the tank ayacut area are forced to grow only paddy since the water is delivered without any control and seepage is so high: it is not possible to go for other crops like groundnut although it is very profitable to the farmer. Overflow of water from field to field causes heavy loss of fertile top soils which results in silting of the channels. Farmers are in some cases not able to prepare the land and transplant in time which adds further to the wastage of water.

7. WHAT IS TO BE DONE TO INCREASE EFFICIENCY

The following measures may be taken to increase water use efficiency in tank irrigated areas in this district.

a. The tank bunds, sluices, channels should be maintained as per the standard. Arrangements may be made to measure the water released from the sluices accurately. This is the pre-requisite for any water management practice.

b. The main channel/sub channel leading from the sluice may be lined or otherwise prevented from seepage.

c. As far as possible, the sluice should be opened only from 6 am to 6 pm.

d. The sluice opening or discharge should be based on the actual crop requirements which can be calculated and issued taking into account the area, stage of the crop, climate etc.

e. Land preparation/transplanting may be staggered and should be completed within 10-15 days time in the ayacut below the sluice.

f. There should be a sluice committee to operate the sluice. The various sluice committee chairmen should decide their allocation of water for each sluice.

g. On-farm development works should be taken up for all tanks and may include lining of main channel, forming irrigation and drainage channels, control structures, levelling the fields, etc.

h. Incentives should be given for using ground water which will help overcome the drainage problem and save water.

i. To use rain water effectively it should be allocated based on the areas, seepage loss in the channel, location of the field etc.

j. Extension staff and farmers should be taught in water management practices.

If the above suggestions/methods are followed it will be possible to increase the water use efficiency of the tank system and increase productivity and profit to the farming community.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 10f

NOVEMBER 1984

INTRODUCTION TO DISCUSSION ON WATER RATES

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Two papers in the last IMN issue brought forth rather detailed comments from Dr P K Rao *and* Anthony Bottrall. *Their responses concentrate on the important issues of irrigation water pricing and cost recovery, and appropriate organisational structures which inter alia encourage efficiency and financial discipline. Since the next IMN issue is intended to cover this theme in more detail these comments are reproduced here as a paper, both for their own merit and to stimulate more contributions.*

Dr Rao *addresses statements made on principles and practice of cost recovery by* Hotes *in Paper 9d. There may be general agreement that farmers should be charged for irrigation water, but how and how much? Different methods and levels of pricing will also cause farmers to respond differently in terms of intensity of input use, cropping pattern etc.* Hotes *pointed out that 'cost recovery is not an end in itself' but* Rao *also emphasises operational difficulties including inflated cost estimates and wasteful O&M if carried out by a body not including farmer representatives.*

The latter point raises the critical issue of institutional alternatives for water distribution and system maintenance which is also central to Bottrall's *contribution, commenting on* Bergmann's *Paper 9c, 'Management Structures in Mediterranean Irrigation'.* Bottrall *points out that* Bergmann's *conclusions 'do not do justice to his theme'. His descriptions of different organisational structures do suggest that their effectiveness at least partly depends on the structure of management which determines accountability - and on methods used for water pricing. As* Rao *points out though, more consideration needs to be given to the total pricing and subsidy environment faced by farmers. Not only the financial details of cost recovery are involved: the issue of incentives to encourage efficient use also needs to be considered both for managers/suppliers of water and for water users (if they differ).* Bottrall *points out that an alternative exists in irrigation management from bureaucratic agencies or farmers: management by some third party is possible and may be most cost-efficient in some cases. He cites Irrigation Associations in Taiwan and landless groups in Bangladesh as examples of this form (the latter has broader aims: see* Wood *1984); another recent example would appear to be village-level irrigation 'companies' in China which make contracts with farmers to supply water under a form of the 'responsibility system'. Third-party management may be an alternative or complement to more direct farmer participation; at any rate it opens up the range of institutional possibilities which have perhaps not been adequately considered in project preparation to date.*

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A. REMARKS ON COST RECOVERY AND IRRIGATION WATER PRICING

Mr F L Hotes in his paper (IMN 9d) "World Bank Irrigation Experience" stated:

> "The Bank has always maintained that farmers should be charged for their irrigation water because this has many beneficial effects: it keeps farmers aware that the water is not a free good but has been provided at high cost and must not be wasted; it is a way of reducing somewhat the inequality of income distribution between irrigated and rainfed areas, by recapturing some of the benefits from those for whom the investment was made; and it provides some funds which, if specifically set aside, can be used for essential maintenance work on the irrigation systems. Most serious studies of irrigation water charges seem to come to similar conclusions."

It was also stated:

> "Unfortunately, public lending agencies have tended to have a poor cost recovery discipline for irrigation projects, with predictable results - poor O&M, poor project performance, and continuing deterioration of the system. However, cost recovery is not an end in itself. The true benefits of enlightened cost recovery policies are those already mentioned - fiscal viability of the project to help ensure good O&M, fiscal viability of the farmers, improvement of water efficiency; equity and public savings which can be used to provide future benefits."

To a substantial extent, there is no disagreement on the view-points expressed by Mr Hotes. However, some of the operational aspects relevant for most situations in developing countries need to be highlighted. These also point to the major limitations of operationalising principles for cost recovery and evolving guidelines for irrigation water pricing.

The officially reported cost estimates are over-estimates of real costs incurred in project development and maintenance due to significant leakages, corruption and inefficiencies commencing with cost escalation in executing project works. The leakages are generally estimated to be around one-third of the official estimates. The accounting methods result in under utilisation of potential being reflected in the rest of the irrigated area leading to over estimated cost of providing water at the farm level. As a whole, it appears that only about half of the magnitude of officially estimated costs should be taken as real costs and pricing formula evolved on this basis. It is clear that even if this method is accepted, the water rate (based on cost recovery method) would work out to about Rs 1,000 per ha. in India, which implies over a dozen-fold increase in water rates in many States. Realising that such steep hikes upset farm budgets drastically and also may not be politically acceptable, an appreciation of the magnitude of gap between normative price and actual price suggests a more gradual approach which may be acceptable in the farm system.

As indicated by L E Small (Investment Decisions for the Development and Utilisation of Irrigation Resources in Southeast Asia, Report No 26, ADC, New York, 1982) farmers are more likely to pay specific fees for specific purposes rather than general water fees. This suggests a strategy of local collection and utilisation of these revenues. It may be desirable to institute project specific management organisations vested with powers to decide on pricing of water, coordinating with other agricultural inputs, maintenance and improvement of irrigation works and scheduling water releases etc. Instead of State directed operations regarding the above, the feasibilities of organising regional management boards (with farmers representation and control) for improved irrigated agricultural management need to be explored further. Examples and experiences in other countries like France need to be carefully analysed.

It is often argued that operations and maintenance expenditure along with at least some part of the capital deployed in irrigation projects be recovered through appropriate water pricing. This argument is also constrained and needs to be reviewed in the light of the following: (a) the reported expenditures on operations and maintenance might not be on the relevant type and magnitude, from the agricultural production viewpoint; in other words, the unproductive, irrelevant and extravagant expenditure that might be incurred on this account cannot be expected to be paid for by the users; (b) institutional alternatives, especially those involving farmers in part of maintenance works and management of water distribution below the main channels or some other suitable level, could be envisaged so as to reduce O&M costs as well as improve the discipline in water releases conforming to some equity principles. The cost implications of alternative institutional settings involving farmers do not seem to have been worked out in any irrigation project, at least from the project appraisal reports that one comes across.

The implicit and explicit levies from the farmers in addition to water charges need to be carefully assessed and compared with implicit and explicit subsidies in respect of all the agricultural inputs in a given region/irrigation project. Only then one may be in a position to argue about the relevant range over which the water rates could be determined, in contrast to simplistic and misleading application of thumb rules on recovery on administratively defined costs of irrigation projects. The practical difficulty in the application of the above suggestion is rather obvious. It emanates from the fact that whenever credit lending institutions like the World Bank are to effect changes in water pricing, the entire gamut of pricing of inputs and outputs cannot be reviewed for a variety of political and administrative reasons. This does not automatically imply that one could straight proceed to application of simplistic and sometimes irrational principles of water pricing. Evidently, a lot more debate is called for from a cross section of disciplines and expertise so as to evolve a broad concensus in respect of this area of concern. It is quite likely that the parameters relevant under the broad framework would be rather common to most of the developing countries and hence the need for greater attention to this issue.

B. ON 'MANAGEMENT STRUCTURES IN MEDITERRANEAN IRRIGATION'

Bergmann's paper (9c) contains some interesting observations on the performance of irrigation schemes in the Mediterranean region under different forms of organisation. However, his concluding paragraphs do not do justice to his theme. He appears to have convincing evidence that in the cases studied the formal structure of the organisations did not have a significant effect on scheme performance. He then goes on to suggest that the key factor on successful schemes has been 'the spirit of the managers and employees responsible' and their willingness to cooperate with farmers. But what have been the underlying reasons behind this responsiveness to farmers' needs? Have they had nothing to do with questions of organisational structure? Surely they have.

The key difference between the French Sociétés d'économie mixte and the Italian Consorzi di Bonifica is not the presence or absence of farmers on their boards but (as is suggested in the introductory para to Network Paper 9c) the location of management responsibilities and the provenance of the financial resources required for the performance of those responsibilities. Whereas the Consorzi are heavily dependent on outside agencies for 'all final decisions on financial and technical matters' (p 10) and are consequently 'pseudo-democratic' organisations with limited powers, the Sociétés 'have to cover all financial and operational costs from their own revenues' (p 12) - a factor which obliges them to be responsive to the needs of their clients, even though the latter have no direct management responsibilities. In other words, the Italian schemes are in effect managed by a state-supported centralised bureaucracy which is not obliged to be responsive to clients' needs either for financial reasons (as in the case of the Sociétés) or because their decisions are subject to 'democratic' control by the Consorzi.

The TOEV cooperatives in Greece, which have been found to be relatively successful representative users' organisations, differ from the Consorzi and are similar to the Sociétés in that they are given major management responsibilities and are required to raise their own finance in order to carry them out (p 13).

The main reason, then, why the Sociétés and TOEVs are more responsive and better managers than the Consorzi is not the fact that key decisions are taken by water users' representatives or by others, nor is it some independently fostered 'cooperative spirit'; it is the need for the managers (whoever they may be) to provide a satisfactory service to their clients in order to ensure a sufficient financial return to cover those service costs.

On schemes managed by state bureaucracies, either directly or, in the case of the Italian schemes, with the additional presence of 'water users' organisations' with limited financial or executive powers, there is much less incentive to respond to clients' needs because the major source of finance is the government budget; and if, as in many cases, water users' payments go into general government revenue rather than into the hands of a local organisation with immediate responsibilities for managing the scheme on which they depend, their incentives to pay will also be less (see Bottrall 1981, section 7.3: Problems of incentive in public service institutions).

An important by-product of the 'financially independent, decentralised' approach is its capacity and tendency to encourage continuity of locally-recruited technical staff whose rewards (salaries, promotions etc) are related to their own and the scheme's performance (see the footnote on p 6 of Hotes's Network Paper 9d). By contrast, it is a common characteristic of bureaucratically managed schemes that staff are frequently transferred to other jobs and are rewarded according to paper qualifications and length of service rather than performance.

To people primarily concerned with the performance and management of irrigation schemes in developing countries, many of whom have tended to assume that there are only two management alternatives - by bureaucracies or by farmers - Bergmann's paper is a valuable reminder that there may be a further option, viz. management by a third party which might be a private or state-assisted company. There are few well-known examples of the use of such an approach in developing countries, apart from the Irrigation Associations of Taiwan. These have sometimes been rather misleadingly portrayed as 'water users' associations'; but they have not always had elected representatives on their boards and even at times when they have had such people present it is questionable how 'representative' they were of the local water users as a whole. An interesting variant on the 'third party' approach has been the acquisition and management of small ($^3/_4$ - 2 cusec) lift irrigation devices in Bangladesh by groups of landless people, who provide farmers with water and irrigation services for an agreed fee (Wood 1983).

Bergmann's conclusion from the cases he cites is that quality of scheme performance is not much affected by who takes the decisions on a scheme under decentralised management so long as their financial relationship with their clients obliges them to be responsive to the latter's needs; and a further implication is that it does not matter too much whether the decision-makers concerned are farmers' representatives, managers of private companies, or whatever. The latter conclusion would be wrong, however. If the managers of a scheme are able to make it into a profitable business, the resulting benefits will be distributed differently depending on whether they are urbanised entrepreneurs, large or small farmers, or landless labourers.

Another point not considered by Bergmann is that the administrative costs of different forms of decentralised management are likely to vary according to particular circumstances and that this may be an important determinant of appropriate choice of institution. For example, one might hypothesise that where irrigation schemes are large, require specialised management skills, and/or have good communications with urban areas (as in Southern France?), a third party approach may be most cost-effective: if farmers have the option of transferring scheme management responsibilities to a competent third party, why would one assume that they would see many attractions in a more 'participative' approach?

(participation is not costless; and how many of us who are consumers of urban water supplies and other services, for example, have a burning desire to participate directly in the management of those services?) On the other hand, where schemes are smaller, of relatively simple design, widely scattered, and/or in rather remote rural areas (as in Greece?), the third party option may be less viable (unless the landless are brought into consideration) and the water users themselves may be the people best fitted to developing and implementing an effective management system.

It should not be concluded from Bergmann's paper or from these comments that the performance of centralised, bureaucratically-managed irrigation schemes is always necessarily bad. In developing countries, where bureaucratic management tends to predominate, particularly on larger schemes which are heavily dependent on public money for their construction, performance varies widely from good (see, eg Malhotra et al 1984) to deplorable. Reasons for the wide variation are numerous and include quality of system design, quality of management procedures, norms of bureaucratic behaviour and scope for interaction between bureaucracy and farmers. Where systems are poorly managed, there is often scope for substantially improved performance without radical changes in the basic organisational structure - through new procedures, technical and management training and so on.

Increased participation by farmers in decision-making is currently seen by many as a vital key to improved management and performance on such schemes. So it may be, provided form is not confused with substance (water users' associations on paper only should not be allowed to fool anybody) and farmers are given a real opportunity to influence decisions relating to the management of all parts of a scheme and not only the secondary and tertiary networks (cf. TOEV/GOEV in Greece, pp 12 - 13 of Bergmann's paper). So long as governments are not prepared to consider replacing bureaucratic management systems by decentralised, would-be self-financing systems, the strengthening of representative users' organisations within those bureaucratic systems is likely to be an important component of any strategy designed to improve scheme performance. But willingness to experiment with decentralised management (whether through water users or a third party) could open up a whole new range of possibilities. Attempts to introduce such experiments (eg by changing the destination of farmers payments from general revenue to local operating agency) have, as far as I know, been rare. Initially, they are bound to meet with resistance from vested interests, but it could well be worth giving more serious thought to promoting this strategy as an alternative - or complement - to the strengthening of water users' organisations.

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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER 11a MAY 1985

1. NETWORK PAPERS

a. The Current Issue

Professor **Tushaar Shah** of the Institute of Rural Management, Anand, India, has contributed an extremely interesting paper (11d) on the way farmers recoup part of *their groundwater investment costs by the sale of water.* As mentioned in Newsletter 10a, groundwater was the theme of a recent issue of Agricultural Administration, 16,4 1984 and in an article in this issue, Ian Carruthers remarked:

> "There is at present an economic barrier at around 5 horsepower ... which means that small farmers have either to join potentially troublesome machinery co-operatives owning mobile engines, or own expensive excess capacity, or do without pumping power"

The sale of water, either for cash, or by share-cropping arrangements, can give the poorer farmer access to his neighbour's spare capacity. Shah's paper shows how governments can, at least in the case of electric pumps influence the well/pump owners' water pricing policy, either in the direction of encouraging them to sell small quantities at high prices, or to sell large quantities at the marginal pumping cost, the alternative which benefits the poor. Shah also considers the circumstances in which well owners get monopoly powers. He notes that refusing official credit for digging wells within a certain distance of another disadvantages those needing to borrow without preventing over-exploitation of the groundwater resource by the rich. In Jordan the Natural Resources Agency issues or refuses permits for all wells, and may refuse one if the planned water abstraction is likely to prejudice reasonable conservation of groundwater resources. There is a traditional Moslem concept of *'harim'* or an area of bordering land within which it is forbidden to dig a new well so as not to affect an old one. (D A Caponera, Water Laws in Moslem Countries, FAO Irrigation and Drainage Paper 20/1). Some such legislation covering all would-be exploiters of groundwater, and not simply those who require credit, is probably needed in more countries now that pump and well technology is becoming relatively cheaper and within reach of more farmers.

Paper 11b by **M K Lowdermilk**, a USAID water management specialist with long experience in the large systems of Pakistan and India, summarises very well the arguments for involving farmers in planning, construction, operation and maintenance, and so makes a useful follow on to the case studies we had in Issue 10. Lowdermilk points out that the government cannot and should not bear all the costs and carry out all the operations involved in water distribution; below a certain level this should be a farmer responsibility. *In India there is on average one staff* operator servicing 10 gated outlets at the 40 ha level (ie 400 ha).

If the irrigation service took responsibility down to an 8 ha chak level, this would increase the number of gates and field men by a factor of 5 (with 1 operator per 80 ha). What country, Lowdermilk asks, can afford so much in recurring administrative costs? It is a question which planners and operators of sub-Saharan African schemes should seriously ask themselves, since their schemes may have 1 staff per 50 ha, or even 1 staff per 10 ha. This is partly because it is believed Africans need to be directed in irrigation activities for many years, but once government concerns itself at too low a level, it finds it difficult to withdraw, either because this involves dismissing staff, or because farmers have become accustomed to having things done for them. Lowdermilk quotes the homely wisdom of a farmer to illustrate the importance of seeing the first step is taken by the farmers, not officials. This does not exclude, of course, the necessity for advice and encouragement, but the responsibility for action must lie with farmers, who learn by doing. In Zimbabwe recently I asked one farmers' committee on a government scheme to contemplate the possibility they would have to pay for their diesel fuel. If they ran their scheme themselves, could they economise on water use? A committee member replied 'If we had to do it, we would learn. If people just come and talk about it, we forget.

Paper 11e continues the discussion on water rates initiated by P K Rao in Paper 10f. It invites further papers, particularly those describing schemes where farmers do make adequate contributions, and maintenance is being adequately financed.

The first paper in this set, 11b, discusses water management in rice irrigation. Seckler thinks a policy of minimum intervention should be pursued, since padi schemes are largely self-regulating. The paper was circulated to a few people in 1984, most of whom agreed with many of his points, while thinking he had oversimplified. We welcome occasional brief papers raising theoretical issues that can be circulated for comment, although our policy remains to publish mainly studies of particular schemes that seem to offer practical lessons that can be adapted elsewhere.

b. Future themes for discussion

It is perhaps time that our more technically orientated members joined in the discussion of how to maintain effectively at lower cost. I noticed that in a seminar held last year at the Rajasthan State Institute of Public Administration one paper reported that submerged aquatic weeds were reducing flow capacity by up to 80 per cent. And in a survey of African irrigation by Moris and Thom they note 'An unexpected finding has been that control of weeds, terrestial as well as aquatic, is a major difficulty within African irrigation.' Korten, in her comment on the Seckler paper, notes weed growth as a major maintenance difficulty in the humid tropics. Has anyone examples to share of recent changes in the technique of weed control that have reduced costs and/or improved the supply of water?

While it is true that changes in management style can be a very low cost method of improving the productivity of irrigated agriculture, they are not necessarily easy to achieve, because of bureaucratic inertia, and political considerations. We should not therefore neglect the possibilities of introducing better technologies within existing management systems, particularly as regards maintenance. The contribution of good maintenance to productivity is rarely measured. For example, while economists in the Sudan are looking at the undoubted stimulus the new method of payment for water (see 11e) has given to cotton yields, no-one has assessed the effect of the simultaneous effort to catch up on silt and weed clearance. Papers by members on effective methods of scheduling and monitoring maintenance routines (including the maintenance of the machines that do the maintenance) will be welcome.

A more glamorous topic is the possibility of introducing sprinkler and drip irrigation. Professor Sivanappan of the Water Technology Centre, Tamil Nadu Agricultural University, points out these systems have seeming advantages where water is scarce or expensive. He also suggests they have been used successfully in India by small fruit and vegetable farmers - which immediately limits them to a minority who have good access to the right type of market. The one small scheme I saw in Zimbabwe using sprinklers did not inspire confidence in the ability of communal/state ownership to take the necessary care in moving/maintaining the pipes and fittings. We should be interested in occasional papers sharing experience in introducing either technology to <u>small</u> farmers, in maintaining the equipment and recovering costs, and in the type of cropping and agricultural regime that proved acceptable and profitable.

However, most small farmers, most places will continue to depend on gravity systems, with perhaps conjunctive use of groundwater, and our main focus should continue to be on increasing the efficiency of such systems.

c. Future plans

In July I shall be meeting Dr Tom Wickham at IIMI to discuss collaboration between the Network and the Institute.

ODI has been investigating over the last few months its computer needs and deciding on which systems to purchase.

This has, unfortunately, delayed again the promised new Register of Members. With a membership now over 800 we badly need to be able to retrieve quickly information on the location and interests of members. We also hope in the next year to begin computerising our library. This would theoretically enable us to answer more quickly and efficiently requests for information. Unfortunately, a computer is not enough in itself; we shall also need financial resources for additional staff and associated costs. ODI is celebrating its 25th anniversary this year, and making an appeal for additional core funding, with the library as one of our central concerns. There will be more information in the November issue; in the meantime, members who feel they have a particular debt of gratitude to ODI might like to fill out Section D of Enclosure 1, which will bring you information on ways you can contribute.

The main objective of Enclosure 1 is to enquire:

a) what computer systems members use or have access to,
b) what other irrigation literature they normally read.

We would be most grateful if you could take the trouble to fill these in as it will help us in planning future services.

There have been some difficulties and delays over the projected French translation and trial issue. We still hope we may eventually bridge this language barrier.

d. ODI's irrigation research

At the request of the Overseas Development Administration, (ODA) Nick Chisholm and I are now reviewing the results of recent evaluation studies completed for ODA, the World Bank, IFAD, USAID, and other donors, to produce a check list of those social, economic and institutional issues that have most frequently caused problems. We are confining ourselves to schemes that were evaluated at least five years after construction, when initial teething problems might be assumed to be overcome. In at least five cases we hope then to be able to refer to the initial feasibility studies, to see if and how these problems were identified at that stage. Finally, we hope to provide amplified guidelines for the socio-economic and institutional investigations at feasibility stage, which may become the base document for a workshop, perhaps in association with FAO, which is particularly interested in the check list.

The other research programme is more field and action orientated. Hydraulics Research, Wallingford, England, long known for their measurement studies, invited me to design complementary socio-economic investigations for two of their programmes. The first of these centred on the operation of minor canals in the Gezira, where HR (Wallingford) were collaborating with the Hydraulics Research Station, Ministry of Irrigation, Wad Medani, Sudan, in measuring and diagnosing actual water flows on a minor, with a view to proposing alternative management methods that might improve productivity and equity, and which could be tried out on 2 similar, neighbouring minors. With the rehabilitation of the Gezira under active preparation, various organisations in its headquarters town were already actively considering research needs, the Ford Foundation providing a grant for local costs. As a follow on to my visit in February/March, ODI and Hydraulics Research Wallingford will co-operate with others in three additional related projects. The first will be an attitudinal survey to obtain information on farmers' perception of crop water needs, their current irrigation methods, and their degree of satisfaction with the existing water supply, (main researcher, Dr Abdel Gadir Mohamed Ahmed, Department of Economics and Rural Development, University of Gezira). This will be complemented by a longer anthropological study, focusing on farmers' knowledge, and farmer/farmer, farmer/bureaucrat relationships at the water-course and minor levels. Details of this are still being worked out, but Dr Abdullahi Osman El Tom of the same Department will be involved. The Sudan Gezira Board will be continuing into 1985/6 a study of farm management and water use begun by Hashim el Obeid in 1984/5, when, owing to water shortage, only two of the normal three crops were grown. These studies are all focused on the minors for which the Hydraulics Research teams are taking physical measurements. The research is designed both to be of immediate utility to the rehabilitation programme and to explore ways of better integrating socio-economic and physical data, and to test findings from quick surveys against longer, more in depth studies.

2. NEWS FROM NETWORKERS

a. International programmes

The International Irrigation Management Institute (IIMI) initiated its programme with a workshop on Research Priorities for Irrigation Management in Asia in January 1985 held jointly with USAID's Water Management Synthesis Program II. Much of the discussion during the workshop focused on needs for applied field research. While many topics were discussed, the one general area which dominated the discussion involved the human and institutional dimension of management. A variety of behavioural, organisational and administrative issues on which research is needed were discussed.

In addition to applied field research issues, there were considerable discussion on the needs for developing improved research methodologies, and for improving the conceptual basis for understanding the forces which affect the general character of management and performance in irrigation systems, and their evolution over time.

A summary report is being prepared, including research status summaries for nine Asian nations, and will be available upon request from IIMI, Digana Village, Via Kandy, Sri Lanka.

IIMI also ran jointly with the World Bank's Economic Development Institute a course on Planning and Management of Irrigation Projects in Asia from 17 April to 31 May 1985. It was attended by about 26 senior officials from ten Asian nations working in institutions concerned with planning, appraising, managing or financing irrigation projects. The course related to (1) the supply, use and disposal of water as an input into agricultural production; (2) the choice of technologies; and (3) the promotion of institutional framework for irrigation projects to benefit production.

IIMI is having a further workshop 15 to 19 July 1985 to discuss papers which various participants have prepared on Rapid Appraisal Methodology, Managing the Rehabilitation Process; Managing Main System Water Distribution; Improving Management Institutions and Staff-Farmer Relationships. The aim is to further refine research directions.

IIMI's contribution to the current research programmes on cost recovery and water tariffs is outlined in Paper 11e.

The International Centre for Agricultural Research in the Dry Areas (ICARDA) is starting a water management programme based on supplementary irrigation for rainfed farming. Further information from Peter Cooper, Head of Farming Systems programme, ICARDA, Aleppo, Syria.

FAO is sponsoring a number of studies and conferences on the food emergency in Africa, and its linkages to agricultural development, including irrigation. The Land and Water Division is organising a meeting with CILSS (Club du Sahel) countries on planning irrigation training programmes in Niamey, Niger, September 1985.

It is also preparing for a Pan African government consultation on irrigation in sub-Saharan Africa in April 1986. The meeting will be policy and strategy orientated, with an analysis of the present contribution of irrigation to food production in Africa, whether it is justifiable to develop irrigation further, and if yes, the means of so doing. In the meantime, FAO is commissioning studies for consideration at the meeting. Information from Mr P D Dieleman, FAO, Rome. One of the studies is being co-ordinated by the FAO World Bank Co-operative Programme, FAO, Rome. They have been holding discussions with the African Development Bank and various French development agencies, on the results of irrigation experience so far, and are preparing a draft report on the lessons to be learnt by those preparing investment proposals, concentrating particularly on economic aspects. While intended for the April 1986 conference, it is hoped it will be generally useful. For details, write to Simon Hocombe, FAO/World Bank, Co-operative Programme, FAO, Rome.

Currently 228 African projects for rehabilitation of agriculture, including irrigation, are being discussed with FAO and interested donors.

USAID's Africa Bureau has underway three projects which review irrigation performance in Africa, one on land tenure aspects, a second working on river basin development (with particular attention to the Juba, Niger, Gambia and Senegal Rivers), and a third an overview of technical issues. The Water Management Synthesis Project has dealt with this latter aspect, under a study organised by Utah State University (Moris, Thom) but drawing in working papers from a number of other contributors, including Tiffen (ODI), Sperling and Podmore (CSU), Weber, Stern and Humpal (DAI). The main output will be an annotated bibliography on English and French sources, as well as a review of issues and performance of African irrigation generally. A working draft of the report was discussed at a two day workshop in Washington (18-19 April, 1985) and the final report should be available from the WMS II Project at Utah by July.

Information on activities of the Cornell University Irrigation Studies Group within WMS II arrived just too late for the last Newsletter. Activities during 1984 show a strong emphasis on finding institutional ways to extend farmers participation in large- and small-scale schemes. These included hill irrigation in Himachel Pradesh, the farmer participation programmes in the Gal Oya scheme in Sri Lanka (see also section b. below), and small-scale systems in Nepal, Indonesia and Niger. Ongoing and planned activities include two special studies, one on indirect investment strategies for small-scale irrigation development and a second on irrigation and rural employment.

b. Meetings and Seminars

A seminar on Water Management for Rajasthan Canal Areas sponsored by the Dept of Personnel and Administrative Reforms, Government of India, was held at Bikaner, the headquarters of CAD Authority for the Canal, 21-23 August, 1984.

It was designed mainly for senior officers in the CAD Authority to provide training on improved water management techniques. A duplicated report of the seminar may be obtained from Prof Yogeshwar Sharma at the HCM Rajasthan State Institute of Public Administration, Jaipur 302017, Rajasthan, India.

Network Paper 10c included a description of the programme of promoting farmers' organisations in the Gal Oya irrigation scheme, Sri Lanka. The programme was initiated by the Agrarian Research and Training Institute (ARTI). Further progress is being made by the farmers and ARTI as shown in two meetings held in late 1984. On 14 October the farmers themselves organised a convention of Farmer Organisations, attended by over 400 farmers and two invited Ministries. One purpose was to press for legal recognition of the groups, lack of which is hampering their effectiveness. On 16-17 December a seminar on Irrigation Management was held at ARTI. The main purpose was to give farmers a chance to discuss problems related to irrigation management directly with policy makers.

FAO organised a Workshop on Small-Scale Swamp Development held in Freetown, Sierra Leone, 26-30 November 1984. The workshop was organised mainly for the five anglophone West African countries - Gambia, Ghana, Liberia, Nigeria and Sierra Leone - covering various aspects of swamp development. A Workshop report has been prepared. Further information from The International Support Programme for Irrigation Water Management, Land and Water Development Division, FAO, 00100 Rome, Italy.

The third workshop of the study on Options and Investment Priorities in Irrigation Development, promoted by the Agricultural and Rural Development Department of the World Bank and co-financed by the Bank, UNDP and the Government of France was held on 14-16 May 1985 in Washington. Methodological issues were discussed arising from five case studies of Morocco, Mali, Sudan, Peru and Thailand. The studies include health issues.

A conference on Water and Water Policy in World Food Supplies was held at Texas A & M University, 26-30 May 1985.

The German Association for Water Resources and Land Improvement held a Symposium on Traditional Irrigation Systems and Potential for their Improvement during the Kongress Wasser Berlin, April 1985. The papers have already been published as DVWK Bulletin 9, edited by Josef Mock, Verlag Paul Parey, Hamburg/Berlin.

The Fellowship of Engineers, Britain, held a meeting on 13 March 1985 to receive the report of a Working Party set up to outline the desirable content of a national research and development programme on irrigation, with emphasis on support for British firms working on overseas projects. Four priority areas were identified. These included the assessment of existing projects to provide feedback for rehabilitation and design of new projects, and design, management, operation and maintenance as related to small-scale systems. There is already a considerable amount of irrigation related research in Britain but the meeting felt it should be more co-ordinated and inter-disciplinary. Discussions are proceeding as to how to secure this. British interest and skills in overseas irrigation were also demonstrated at a meeting of the Royal Society, which had a Discussion Meeting on Scientific Aspects of Irrigation Schemes at 6 Carlton House Terrace, London, SW1Y 5AG on 1-2 May. Proceedings will be published.

We have had notices of some 1986 and 1987 conferences.

The Second International Conference on Hydraulic Design in Water Resources Engineering: Land Drainage will be held on 16-18 April 1986 at the University of Southampton, UK. Three main areas of interest which the conference intends to address are designs of main drainage systems, installation and O&M of land drainage systems, and environmental factors. Abstracts for papers should be submitted by 30 June 1985. Further information is available from Dr K V H Smith, Department of Civil Engineering, The University, Southampton, SO9 5NH, UK.

The theme of the September 1987 13th Congress of the International Commission on Irrigation and Drainage, to be held at Rabat, Morocco, will be Improving Water Management in Developing Countries, Synopses of papers have already been vetted by the different national committees.

c. Training programmes

A course on The Management of Irrigation Projects organised by the Commonwealth Secretariat was held 6-31 May 1985 at the Mananga Agricultural Management Centre, Swaziland. The course was aimed at senior and middle level managers and planners involved in irrigated agriculture, to develop their abilities to make more effective use of available human, financial and material resources.

The Project Planning Centre, University of Bradford is collaborating with the Research and Training Unit, Ministry of Finance and Planning, Sri Lanka, in running a six week course on Irrigation and Rural Aspects during May-June 1985. The course will cover both planning and management of irrigation development.

A course on Human Welfare Implications of Irrigation Development is being run by the Working Group on Water and Human Welfare at Rutgers University, New Jersey, USA, on 3-14 June 1985. The course, primarily for graduate students and staff of development agencies, is intended to develop a holistic approach to irrigation development to include human welfare impacts, for example related to health and domestic water supply. *Further information from* Prof Robert W Roundy, Coordinator, Working Group on Water and Human Welfare, International Agricultural and Food Programme Office, Cook College, Rutgers University, PO Box 231, New Jersey, USA.

Silsoe College, Silsoe, Bedford MK45 4DT, UK, is giving a short course on Irrigation and Dams, their Impact on Public Health, 16-19 December, 1985. Details from Mrs Pam Cook.

Apparatus developed by Silsoe for field teaching and practical irrigation and drainage studies is described in a brochure available from Armfield Technical Education Co Ltd, Bridge House, West Street, Ringwood, Hants, BH24 1DY, England.

From 1986 the MSc course in Irrigation Engineering at the Institute of Irrigation Studies, Southampton University, will be divided into two streams, one for Planning and Design, and one for Management and Operation. M A Burton has been appointed lecturer in Management, Operation and Rehabilitation.

3. RECENT PUBLICATIONS, REPORTS, ETC

The AAU Occasional Paper series is used for authoritative summaries of the results of considerable research programmes. We are glad to bring out now Occasional Paper No.5 by A Bottrall: Managing Large Irrigation Systems: A Problem of Political Economy. It brings together papers now somewhat difficult of access but which we feel deserve wide currency. They would be particularly useful to teachers and trainers. Consultants and researchers will also value Bottrall's summary of his methodology and conclusions in his comparative case studies of 4 Asian schemes, and appreciate the way these raised the issues we are still debating today (including water tariffs etc). The Paper includes his checklist 'Evaluating Irrigation Management: Guidelines for Analysis' originally published as an Appendix to his World Bank Staff Working Paper No. 458, 1981. Other papers included in the set are 'Irrigation Management and the Organisation of Support Services' and 'Farmer Motivation and Co-operation'. The first paper, 'Water, Land and Conflict Management' discusses the political issues which gives the Paper its sub-title.

ODI also has a Working Paper series, used for more preliminary findings. Working Paper 16, by **Mary Tiffen** is entitled Land Tenure Issues in Irrigation Planning, Design and Management in Sub-Saharan Africa. This was originally written for Utah State University in connection with the African Irrigation review undertaken under the Water Management Synthesis Project. It is based on a literature search for references to land tenure. Little directly on the subject was found, so the report synthesises the scattered references, and brings out the important issues involved. Irrigation in Africa has frequently been designed on a "settlement" model, in which the land is taken over by government and the irrigators are tenants subject to strict management control of their cropping patterns, cultural practices, etc. It is perhaps surprising that the advantages and disadvantages of this model have never been seriously analysed. The paper begins with a summary of some of the main authorities on African land tenure and water rights. It does not pretend to be comprehensive but is offered as a starting point to other researchers.

Recurrent Costs and Agricultural Development was the subject of an AAU international workshop in 1983. The main papers have now been edited by **John Howell** and details and order forms will be found on the yellow enclosure. It includes a discussion of the prospects for greater cost recovery on the Muda scheme, Malaysia, by L J Fredericks. Most papers deal with Africa, and general agricultural and veterinary services. If you would like to order it, please enclose the completed yellow form in an envelope to ODI Publications.

The order form for the Working Paper and Occasional Paper is on Enclosure One.

On the theme of new technology, a thorough investigation of small scale solar pumping systems was commissioned by the World Bank as part of a UNDP project. The ensuing report is bulky, but any one wishing to do serious work on the technical and economic alternatives should refer to it. The report finds that although solar-powered systems are relatively expensive, they are becoming cheaper with technical advances. As yet, however, they are generally more feasible for domestic and livestock purposes than for irrigation. The main report is entitled Small-Scale Solar Powered Pumping Systems: The Technology, its Economics and Advancement from Sir William Halcrow and Partners, Energy Studies Unit, Burderop Park, Swindon, Wilts SN4 OQD, UK. The technology is summarised and a more specifically socio-economic assessment is contained in a report Solar Pumping in the Future from Halcrow Fox and Associates, Shortlands, London W6 8BT.

Dr N M Awan has analysed data from the SCARP No. 1 in Pakistan and presents results in the ICID Bulletin, Jan 1984, 'Some Technical and Social Aspects of Water Management in Salinity Control and Reclamation Project No 1, Pakistan'. The results show declining performance of public tubewells and limited ability to reclaim waterlogged and saline land as intended. There was however an expansion in use of private tubewells, repeating a pattern observed in parts of India, but small farmers owned very few wells. Dr Awan notes that public tubewells - meant to augment canal supplies - were a focus of many disputes over water allocation which a smaller capacity might avoid. On the problem of small farmer access he suggests diverting government funds from costly subsidy of inefficient public wells to provision of low interest loans to small farmer associations enabling them to buy smaller wells for joint use.

Similar issues are discussed for Bangladesh in a report by Nick Chisholm, 'Whose Rural Development? Socio-Economic Change in 4 DTW Pumpgrounds in Bogra District, NW Bangladesh', available from SIDA, Stockholm. Results were summarised in Network Paper 10b. The report raises doubts about the alternative now being emphasised, private shallow tubewell development, for its likely output and equity effects, concluding that a more coherent strategy encouraging a mix of techniques and forms of social organisation is preferable.

A recent World Bank Staff Working Paper discusses institutional issues in relation to conjunctive use of surface and groundwater: Issues in the Efficient Use of Surface and Groundwater in Irrigation by Gerald O'Mara (W.B. Staff Working Paper No 707, Dec 1984). The Paper discusses different institutional arrangements made or attempted to solve the externality problems of stream-aquifer systems, with reference to examples in California, the Indus Basin in Pakistan, and the North China Plain. It also discusses more sophisticated modelling techniques being developed to manage efficient conjunctive use.

The conjunctive use of wells and tanks (which affect groundwater levels) in South India is well documented by Thomas Engelhardt, Economics of Traditional Smallholder Irrigation Systems in the Semi Arid Tropics of South India, for which field work was done at ICRISAT. It is available as a published dissertation from the University of Hohenheim, W Germany, July 1984, and is a good example of a combination of hydrological and socio-economic data.

Agricultural Administration 17,4 1984 is another special issue, devoted to organising the distribution and use of irrigation water. It contains several articles referred to in the accompanying Paper 11e, and also a good study by

Robert Wade of the methods used to manage a drought situation on a South Indian system. This shows how changes in the distribution system and management of conflict amongst farmers reduced the impact on output of water shortage. Another article by Wade in Agricultural Administration 18,4 1985 has a critical look at Indian statistics on irrigated acres. The handicap of an inaccurate picture of the area irrigated undoubtedly also applies elsewhere; it is always important when talking of either development costs, recurrent costs, or yields, to be clear whether this refers to the developed area (the area originally intended to be irrigated), the irrigated area (the area actually receiving water in at least one season) or the cropped area (which may be larger if there is double or treble cropping). This question of what we are measuring and why is basic to good research and planning, and is considered by C L Abernethy in Methodology for Studies of Irrigation Water Management, Report OD/TNG, Oct 1984, Hydraulics Research Ltd, Wallingford, Oxon OX10 8BA, England. He makes a determined effort to bring together socio-economic and engineering considerations in investigating equity and productivity. He criticises engineers for the implicit design assumption that farmers will receive an average water supply instead of attempting to define the distribution curve, but as an engineer himself, politely does not call attention to the equally unjustified use of averages by other disciplines in the planning situation.

Hydraulics Research Ltd has also produced a Summary Report of the Irrigation Water Management Study at Kaudulla, Sri Lanka, carried out over 5 Maha seasons. The report provides results on current operating practices particularly related to physical rather than socio-economic factors. It showed the possibility of saving water by more control structures permitting effective use of rain, by earlier land preparation and by higher bunds in the fields. The latter (also recommended by Merriam in Paper 9f) met with obstacles, as it required considerably more work by farmers for no obvious return.

Robert Chambers is currently writing a book on irrigation which sums up his South Asian experience. He is anxious for examples of actions taken by farmers above the outlet to secure adequate water supplies; knowledge on these actions will be useful to formalise joint management of canal systems between canal staff and farmers as a way of improving system performance. Any Network members with relevant examples from their own experience could write to Robert Chambers at IDS, Univ of Sussex, Brighton BN1 9RE, UK.

Chambers' November 1984 paper Improving Canal Irrigation Management: No Need to Wait is available from the

Ford Foundation, 55 Lodi Estate, New Delhi, India. It suggests actions which irrigation system managers can take now to improve performance without more resources. Three specific areas of activity are considered: scheduling water distribution, communications, and farmer participation.

The broader issues involved in promoting participation in small-scale schemes are discussed in Report 27 of the WMS II Project: Improving Policies and Programs for the Development of Small-Scale Irrigation Systems, prepared by Walt Coward and available from Cornell Studies in Irrigation, 372 Caldwell Hall, Cornell Univeristy, Ithaca, NY 14833, USA. The report draws on existing experience and discusses four key components of development programmes for small scale systems: processes of investment, design, local organisation and agency involvement.

The participation theme is also prominent in a book on Water Policies in Africa: Agricultural Development and Farmers Participation, which contains about 60 contributions of varying quality from a wide range of countries and disciplines. It is available from Economica, 49 rue Hericart, Paris 75015, price fr 290. Most papers are in French.

The Winchmore Irrigation Research Station has produced a User's Manual for the Farm Irrigation Systems Analysis (FISA). The FISA procedure is designed as a planning tool to determine projected operation of an irrigation system on a given farm. The manual describes the computer model which includes climatic, farm layout and management factors and irrigation systems information. Available from Winchmore Irrigation Research Station, Agricultural Research Division, Ministry of Agriculture and Fisheries, Private Bag, Ashburton, New Zealand. Technical Report 18, 1984.

4. LUNCHTIME MEETINGS AT ODI

One meeting has been held so far this year:

Robert Chambers spoke on 'Rapid Appraisal for Improving Existing Canal Irrigation Systems: In Search of Methods' on 29 March.

30 May 1985 Mary Tiffen

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 11b MAY 1985

THE MANAGEMENT OF PADI IRRIGATION SYSTEMS - A DEBATE

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** Agricultural Administration Unit, ODI

INTRODUCTION

Nick Chisholm

The first paper is a thought-provoking piece by David Seckler, who has had extensive experience with irrigation system development in India and, currently, Indonesia, working for USAID. He circulated it to a few people in 1984.

Seckler's main proposition is that certain padi irrigation systems, unlike those for other crops, are basically self-regulating in allocating water between farmers and therefore do not require active management to ration water at field level. This self-regulating property follows from unique physical characteristics of irrigated padi production.

The implication of Seckler's theory is that, in these cases the considerable resources now being put into promoting improved management at tertiary level are being wasted and should be deployed elsewhere: farmers should be 'left to themselves' since intervention will rarely bring about a <u>net</u> improvement in the system.

Seckler's paper stimulated a lively response and edited versions of some of those comments form the latter part of this Network Paper. The commentators, while agreeing with much of Seckler's description of the physical properties of irrigated padi and 'other crop' systems, still point to the need for management to perform certain tasks such as system management and water rationing during periods of 'crisis'. It is noted that within many padi systems farmers already organise for these purposes indicating their own recognition of the importance of these functions.

It may be that Seckler's naturally functioning, laissez-faire system is a special and rather limited case. His paper is still particularly valuable in pointing to:

(a) the need to understand physical properties of the system before proposing a specific management form,

(b) within existing systems to understand what farmers already do to manage their part of the system, and

(c) as Svendsen puts it ... 'to be very clear about <u>why</u> we want to improve management'.

It is hoped that the debate around Seckler's paper will be continued by Network members.

THE MANAGEMENT OF PADI IRRIGATION SYSTEMS: A LAISSEZ-FAIRE, SUPPLY SIDE THEORY

David Seckler

1. INTRODUCTION

Peter F Drucker, one of the pioneers of management science, urges managers to continually ask themselves: 'What is our business? And what should it be?' These questions are basic to the specification of objectives, assignment of tasks, and monitoring the results of effective management systems. As Wickham and Valera correctly observe,

> 'While it is generally agreed that better water management is needed, it is not clear what is required to achieve it. What do we really mean by improved water management, and how can it be attained?' (IRRI, p61)

An example is the management of padi irrigation systems. There is a strong *propensity* to apply theories of irrigation management developed for other irrigated crops - like maize, wheat, sugar cane, etc. - to padi, as though the two were the same. But if there is one certainty in this field it is that <u>padi irrigation is fundamentally different from that of other crops</u>.

Padi irrigation is different in at least two basis <u>physical</u> parameters that substantially affect the design and operation of irrigation management systems.

First, in padi, water is primarily stored on and drained from the <u>surface</u> of fields, whereas in other crops, water storage and drainage is in the <u>sub-surface</u> profile of the root zone.

Second, at least in the HYVs, padi yields are <u>ultra-sensitive</u> to water stress compared to other crops. For all practical purposes the padi production function is like a binary switch - either 'on', with no water stress and high yield; or 'off', with water stress and drastically reduced yield.

The theory to be advanced here is that because of these two physical parameters, padi irrigation systems have a <u>self-regulating</u> property that leads to a reasonably <u>optimal</u> allocation of water supply between farmers. Thus, in complete contrast to other crops, it is doubtful if management improvements in the form of rationing and rotation of water supply to farmers would result in cost-effective improvements over the allocation achieved by naturally functioning, <u>laissez-faire</u> systems.

For the purposes of this discussion, this theory is restricted to the small (less than 1,000 ha), riverine padi irrigation systems characteristic of S E Asia, and to the HYVs of padi. Large systems in flat, alluvial plains differ mainly with respect to drainage effects, as discussed below. The deep-rooted, more drought-resistent 'local' varieties of padi form something of an intermediary case between the HYVs of padi and other crops. These cases are not discussed further in this paper.

Of course, these conclusions regarding the allocative effectiveness of laissez-faire padi irrigation systems should not be interpreted as denying the need for well designed, constructed, maintained and operated headworks and canal systems. However, it does appear that once water is delivered to something like a 10-15 ha block, the net returns to terminal systems, over field-to-field irrigation, may be negative. Hence the 'supply-side' part of the theory. Instead of expending resources on 'improved management' and terminal systems, it is likely to be more cost-effective to build more and better main systems.

If this theory is correct it will help explain why the few empirical studies of 'improved management' in padi irrigation systems generally show such poor results (see the review by Lazaro, Taylor and Wickham).

2. DIFFERENCES IN THE IRRIGATION PRODUCTION FUNCTION AND RELATED MANAGEMENT FUNCTIONS BETWEEN PADI AND OTHER CROPS

Figure 1 illustrates a hypothetical production function for 'other crops'. The point of maximum water use efficiency (E), in terms of yield per unit of water, is defined by the tangency between the vector and the production function. The essential feature here is that E lies considerably below the point of maximum yield (M). Therefore, a major task of irrigation management in other crops is to ration irrigation water supplies to each and every user in the system so that they will produce at E rather than at M.

By inducing farmers to produce at E, both the objectives of efficient water use and a more equitable distribution of water are served. In the case of Figure 1, for example, if one set of farmers (A) change production activities from M to E through rationing, the amount of water saved is Wm-We. The cost of the change to them, in terms of yield is Ym-Ye. The amount of water saved by rationing can then be reallocated to another set of farmers (B) - who, it is assumed, had no water, or production before. Figure 1 has been drawn, for simplicity, so that Wm-We = ½Wm. Thus the gain to B will be We amount of water, with a yield of Ye. The net efficiency gain in the system is 2Ye-(Ym-Ye) - or, hypothetically, about 170%. In addition, the number of beneficiaries in the system has doubled. In many cases, farmers may even use water beyond M, to R - the point where yields are reduced due to water-logging and/or salinity - or even beyond R. In this case, the benefits of rationing

Figure 1: A Hypothetical Production Function for Other Crops

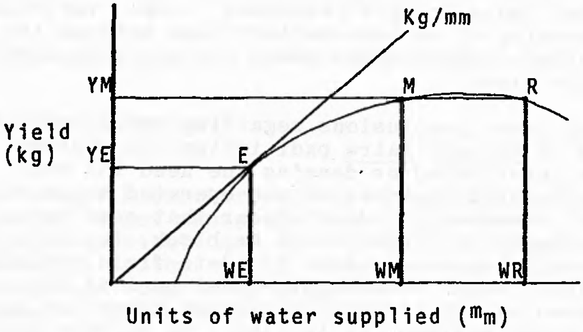
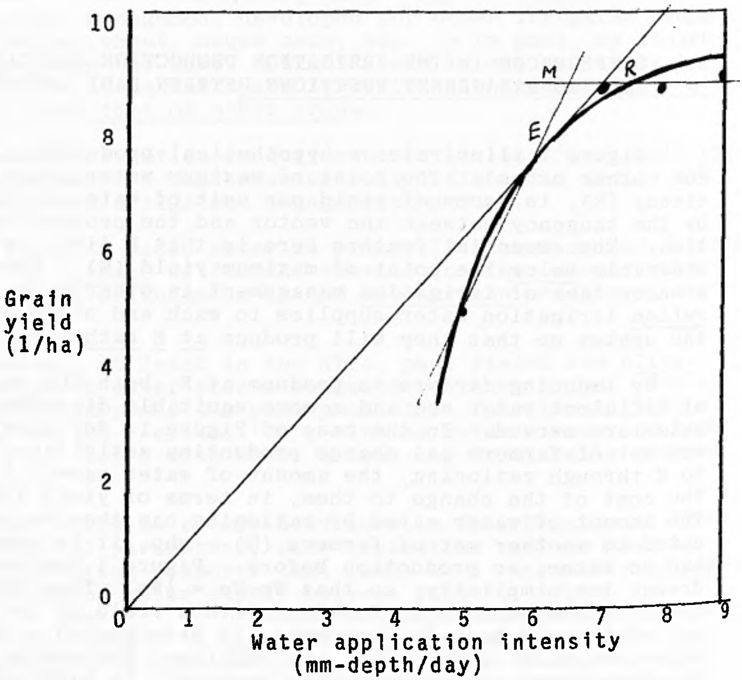


Figure 2: Yield response of IR8 to treatments of varied water applications intensity, IRRI, 1969 dry season



water (to A) and reallocation (to B) are even greater than shown above. Such are the enormous potential gains of improved irrigation management in 'other crop' conditions.

Of course, it is very difficult to ration water use from M, or R, to E in such cases. It is in the private economic interest of farmers at the head of the system to produce at M so long as the private marginal cost of water is zero. Rationing irrigation water requires a tightly managed and highly 'disciplined' irrigation management system, backed by the legal powers of the State. This is why so few irrigation systems are well managed. But at least in 'other crop' conditions the objectives are clear, even if the practise is muddled. In padi irrigation systems it appears, oddly enough, that the situation may be reversed. The objectives of would-be managers may be muddled, but the results of actual practises in naturally functioning padi systems may be as good as could reasonably be expected in an imperfect world.

Figure 2 (IRRI, p21) shows a characteristic production function for padi. The point of interest here is not in the specific values, which will of course vary from place to place, but in the shape of the function.

For all practical purposes, this function divides into three linear segments. From 0 to 4 mm per day (pd) there is no yield response. Between 4-5 mm pd, yield jumps to 4.5 T/ha. Between 5-7 mm pd, yield increases linearly to 9 T/ha. After 7 mm there is no yield response to increased water application.

The essential point is that the point of maximum water use efficiency (E) coincides, for all practical purposes, with the point of maximum yield (M). Thus in padi irrigation, unlike for other crops, the management system does not have to ration water below M. At most it only has to ration the 'surplus' water from R to M. Thus in principle, the rationing task in padi is much easier than in 'other crop' conditions because it does not adversely affect the economic interest of the farmer.

The theoretical property that E = M in padi irrigation, has been empirically corroborated in a study by Wickham and Valera, shown in Table 1. With no stress, at the maximum yield, kg/mm of water applied was maximized.

Table 1: Water use and grain yield of IR20 under four water treatments. IRRI, 1972 dry season.

Water Treatment[a]	Days Drained (no)	Average yield (t/ha)	Water use[b] (mm)	Yield productivity of water (kg/mm)
No stress	0	6.2	773	8.1
Early stress	38	4.4	788	5.6
Late stress	39	2.0	806	2.5
Late stress to harvest	54	0.5	338	1.5

[a] No stress = flooded throughout crop growth; early stress = no irrigation from 43 to 81 days after seeding; late stress = no irrigation from 63 to 102 days after seeding; late stress to harvest = no irrigation from 63 days after seeding to harvest.

[b] From transplanting to about a week before harvest. Includes all rainfall.

Since E = M the most that a padi irrigation management system would have to do is prevent 'over-irrigation' - the application of 'surplus' water which has no value to farmers. But here a rather obvious question arises. If the management objective in padi irrigation is only to ration 'surplus' water from R to M, why would farmers have R in the first place? The answer, of course, is that this water is only 'surplus' in the static case, in terms of a point in time. In the dynamic case, over time, it is of value as reserve for <u>future</u> water supply. But if this is so, then the water is not truly 'surplus': reducing water supply will increase the <u>risk</u> of a future loss to the user. This subject is addressed in the next section.

3. 'OVER-IRRIGATION' IN 'OTHER CROPS' AND PADI

In 'other crop' conditions the definition of 'over-irrigation' is quite straight-forward. It means application of water beyond field capacity, (net of leaching requirements), with consequent deep percolation losses below the root zone of the crop. Unless this deep percolation water is subsequently recaptured by pumping or downstream recharge, it is lost to beneficial use. In padi irrigation, however, 'over-irrigation' is extremely difficult to define.

The reason, is because once there is <u>some</u> standing water in a padi field, neither percolation nor evaporation losses are significantly affected by <u>additional</u> depth of water in the field. If a farmer applies more water than he needs in the present, it will simply remain there for use in the future. Thus in padi, unlike 'other crops' there is no <u>physical loss of water due to high rates of water application</u>.

The only loss is a possible <u>economic</u> loss due to excessive saving of water for <u>future use</u>. This economic loss can only be established by showing that the <u>future</u> value of water to a given farmer is significantly <u>less</u> than the value of the <u>present</u> use of water to <u>other</u> farmers. These trade-offs <u>between</u> future and <u>present values</u> form the rationale for rotational water delivery programs. However, the case for rotational programs is not easy to establish in padi irrigation, as the following discussion shows.

A commonly perceived problem in padi irrigation is high water depth in padi fields at the heads of the system, while tailenders are subject to water stress. First, it should be noted, that while this perception is taken as the basis of the following analysis, in at least some cases the perception itself is erroneous. Wickham and Valera (IRRI, p63), for example, found no difference in the incidence of stress days between the heads and the tails of the systems they studied. As they note, this is probably because the tails are at lower elevations, and thus gain from surface and subsurface drainage what they lose from direct irrigation inputs - a subject discussed in the next section.

Second, it must be realized that in any well designed irrigation system there must necessarily be 'tailender' phenomena <u>somewhere</u> in the system. Since water supply and demand <u>conditions</u> vary, <u>some</u> area must be available to absorb the variation - <u>to act</u> as a kind of 'surge tank'. This area will prosper in times of plenty and suffer in times of lean. This area need not be at the tails of the system but it may be, in 'other crops', on the land each farmer is able to irrigate - as in the Warabandi system of India (Malhotra, Rahaja and Seckler). But in any well-designed irrigation system a <u>tail must be there</u> - the only question is the <u>equitable distribution</u> of the tail.

Third, in considering the extent of possible over-irrigation, padi differs from 'other crops' in that there are both physical and economic constraints on the maximum depth of water in the field. With 'other crops' in well drained soils, there are no practical limits to over-irrigation. Also, in padi, the amount of over-irrigation can be directly observed by the farmer as field water depth, whereas in 'other crops' over-irrigation is invisible, below the root-zone of the plant.

The physical constraint on over-irrigation in padi is the fact that the HYVs are subject to excessive submergence losses. The limit varies from about 5cm depth shortly after transplanting to about 15cm for a mature crop. A farmer would not rationally choose to go much beyond these limits, even with free and limitless water availability.

The economic constraint on over-irrigation is the labour and land cost of building and maintaining dikes for water storage. This cost increases with the square of height. Thus, farmers would be induced to store no more water than they perceive they need under conditions of risk of future water supply.

While farmers may under- or over-estimate their need for field storage it is not at all clear that a 'management group' could do better (especially given the quality of soil, terrain and climatological data available to them in most cases). For these reasons one can hypothesize that the distribution of heights of dikes in a padi irrigation system reasonably corresponds to an optimum allocation of field water storage facilities - at least from the private point-of-view of the farmers themselves. If so, then rationing - rotation programs to redistribute storage capacity will entail a private loss which can only be justified by greater social gain.

Assume, for example, an extreme case where the command area is evenly divided between headenders and tailenders and that, without a rotation program, the head would have the maximum of 15 cm of water in the field while the tail would have 5 cm. With rotation 5 cm would be taken from the former and given to the latter, so that everybody has 10cm total, or 8cm net water storage. With a 6mm pd requirement during a drought everybody would have about 13 days supply. If the drought lasted no more than 13 days or so, the returns to the rotation program would be very high - half of the total crop, that of the tailenders, would have been saved from water stress. However, if the drought lasted much more than 13 days, the results of the rotation program could be catastrophic - all of the crop, instead of only one-half, would be lost.

Thus the returns to rotation programs in padi irrigation are highly sensitive to the ability to predict the duration of drought periods. It should be emphasised that in padi, rationing water supply through rotation does not create additional supplies of water which would otherwise be lost to beneficial use, as in 'other crop' conditions, it only changes the time of beneficial use of a given supply of water and, hence, is sensitive to the accuracy of predictions regarding present vs: future needs. In the above example it is doubtful if the return to rotation would justify the risk under reasonable assumptions regarding predictive ability.

Of course, these observations on rationing and rotation at the level of individual farmers should not be interpreted as denying the desirability of rotation in the main system among minor-canals. Rotation is necessary to economise on the size of conveyance systems. It may also be necessary to provide a better distribution of water to groups of farmers between the heads and the tails of the systems. However, unless there is malicious obstruction of water flows toward the tail (and thus less total water supply in the system), or real drainage losses, rotation between groups will not generally improve the efficiency of water-use - only the possible equity of water distribution. And even with respect to equity, there is the problem that with a given supply of water, more water to the tail of the primary canal will simply create more tailenders toward the head. In padi, the effective command area can be either lengthened or widened by rotation but not, unfortunately, both.

4. A NOTE ON THE RE-USE OF WATER IN PADI IRRIGATION SYSTEMS

The performance of the small, riverine padi systems characteristic of S E Asia can only be appraised in terms of the system as a whole - in terms of the use and re-use of water through an entire river basin. Drainage and percolation "losses" from one part of the system are commonly re-used for irrigation in adjacent fields or by downstream systems. Thus, improving the efficiency of any particular part of the system, for example by minimising drainage losses, may simply reduce the productivity of another, unobserved, part that depended on drainage for irrigation. Of course, some percolation and drainage losses are true losses of water to deep aquifers, or to the sea. But perhaps the best solution to these losses is more re-use downstream - more projects, rather than attempts to improve the management of existing projects.

5. CONCLUSION

The sub-title of this paper stems from a famous dialogue between the eighteenth century Minister of France, Jacques Colbert and some Parisian businessmen. Colbert asked, 'What can I do for you?' The businessmen replied, 'Laissez-faire passer' - roughly, 'You can leave us alone!'.

The laissez-faire philosophy, at least in its more enlightened form, depends on what is called 'the presumption of the market'. This means, that it is presumed that people pursuing their own interest (which is likely to include the interests of others) will reach a reasonably satisfactory state of affairs without intervention by the state or any collective entity - other than those collectives which they voluntarily choose to form. This presumption is quite often wrong. There are many instances of externalities, collective goods, monopolistic powers and failure to assure basic needs, which justify collective intervention in naturally functioning, laissez-faire systems. However, the burden of proof is on the interventionist. Unless there are good grounds for believing that intervention will result in a net improvement over the previous state, the system should be left alone. Such appears to be the case in the management of padi irrigation systems.

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THE DISCUSSION

Korten points out that, although routine rationing is not a major management task in padi irrigation systems, rationing during 'crises' is important and widely practiced. System maintenance and conflict resolution are other important tasks.

I agree that in wet rice cultivation rationing is not the principal irrigation management task. Does this imply that on systems under 1,000 hectares we do not need to be concerned with developing community management capacity?

The answer is obviously no, since farmers in so many different circumstances in South East Asia have banded together to construct, operate and maintain (padi) irrigation systems - spending as much as 30 days per farmer per year managing that system. They are occupied in:

1. Maintaining the system In the humid tropics even more than in the drier climes, maintenance is a major problem. Weeds quickly choke canals, canals wash out easily during floods, even dams wash out if not constructed of permanent materials. Without constant management effort an irrigation system shrinks, canals disappear beneath mud and foliage. Just getting the water to where it is needed is a major task requiring both routine activities (for cleaning) and quick response to emergencies such as washouts.

2. Allocating the water While rationing in the sense you have used the term is not the key issue, there are important water allocation issues.

a. Minimizing head enders overuse. You dismiss the problem of headenders overuse because you focus on the problem of headenders storing extra water. I think most Southeast Asian farmers would agree that is not the problem. The problem is when headenders allow water to continually flow through their field and into the drainage canals. It is true that sometimes the water that flows into drainage canals is simply used by other farmers. But other times it may flow through a sandy area, or into a marshy area, or into an uncultivated area or eventually into the sea. Particularly in the uneven topography characteristic of the smaller systems, drainage canals are often at too low an elevation for use by other farmers in the system and the water in them may be subject to 'real' loss.

b. Rationing the water in a 'water crisis'. While routine rationing is generally not found on wet rice systems, some form of rationing is common during periods of 'water crisis', when water levels dip below the expected flow. Particularly on small run-of-the-river systems, water availability may vary considerably even in the wet season. During periods of water crisis, a well managed system tries to get the available water to the plants in greatest need of water. Rice does not need the same amount of water at all stages of its growth. During some stages (eg. tillering) it is much more susceptible to damage from water stress than during other stages. Since generally the rice in an area is not all at the same growth stage, a well managed system gets the water to the plants most in need of it during a crisis. This requires detailed knowledge of the growth stages of the plants in the area and a decision making system for supplying water to those most in need.

c. <u>Rotation</u>. You correctly note that rotation does not create additional supplies of water that would other-wise be lost to beneficial use. But farmers themselves often resort to rotation during periods of water crisis. The usual approach is to allocate certain days to certain segments of the system - Monday and Tuesday for Sector A; Wednesday and Thursday for Sector B; Friday and Saturday for Sector C etc. Why do the farmers do this? Rice can generally withstand up to four days without standing water in the field before yields decrease. By rotating the water, everyone can keep their rice plants reasonably wet during the 'crisis'. Without rotation, all of the water would be used by the headenders and with 10 to 12 days of 'drought' the tailenders would suffer substantial yield losses. The rotation then ensures proportional allocation of water throughout the system, minimizing the stress throughout.

Svendsen underlines the rather limited number of actual systems fitting Seckler's conditions, and recasts the description of physical properties in energy terms. The task of irrigation design and management is then to control the rate of energy loss down the watershed. He agrees with Seckler that the case for management must first be established and balance be sought between investments in control systems and the existing human systems.

Your line of argument applies only in certain conditions. First, reservoir-based systems, which are the dominant type of system in many parts of the Asia region, are clearly outside the scope of your discussion as you state on page 3. One principal reason for this is that the ability to store water saved gives it a much higher time-dependent value than 'fugitive water'. Storage enables careful water management to result in a second or third crop, which might not otherwise be possible, as it permits rainfall during the wet season to be substituted for more valuable stored water which can then be used to support the additional crop. The result is that no longer are we simply moving back and forth on the flat right-hand position of a rice production curve (your figure 2) but are 'creating' a new crop and starting from zero on a second production curve, again moving up through the very steep initial limb of the curve. This same type of effect can occur in response to organised water management in a non-reservoir run-of-the-river system, as I will point out later.

Second, you assume that a system is either all rice or all upland (or palawija) crops. In many small irrigation systems, the cropping patterns are mixed - particularly during the second and third crops. Thus some form of water management is required to deliver measured amounts of water to the higher upland fields and larger volumes to the rice lower down.

Third, your argument applies to situations where no water escapes to the sea, or where no additional land is available that could have been irrigated and cultivated with the water. One very important property that water possesses when it is in the upper reaches of a watershed is energy. This store of potential energy is what makes gravity flow irrigation 'free'. As water moves downward through the watershed, it loses this energy, but the rate at which it is lost ie. within particular irrigation systems, is of vital concern to irrigation system designers and managers, be they farmers or professional engineers. The designing of an irrigation system, in fact, is basically a matter of predicting and controlling the rate at which this energy is lost. In these terms, the argument you are quite rightly making is that if water reaches the sea, or if it does but no irrigable land was left uncultivated, then the rates of energy loss within particular irrigation systems can be relatively rapid (making water management easier or unnecessary) without incurring significant costs or reducing benefits.

Such avoidable or controllable energy losses occur principally when water makes its way into drainageways, rivers, and streams more quickly than it would have to. This loss of water to drains, and not the storage of excess water in upper-system paddies, is the principal negative result of larger than necessary water withdrawals by upstream users. Drainageways always lie at elevations lower than adjacent fields. Once water reaches them, it must be pumped (at substantial cost) or taken off by a second headwork structure (constructed at some cost) and used lower down in that system to be reused. (This adds the constraint that the land must be at least moderately sloping or reuse by 'free' gravity flow may not be possible at all.)

Finally, your argument, even in run-of-the-river systems, would seem to apply only in situations where a single crop of rice (and nothing else) is grown. There are critically important seasonal timing issues to be addressed in a co-ordinated and collective way, by groups of farmer/irrigators in a multi-crop situation. For example, rice fields are typically drained before harvest. Before being prepared for the subsequent crop, however, they must be rewetted. At the same time, the relatively large amounts of labour required for the harvest demand a certain temporal spreading out of the harvesting operation. The problems involved in rapidly sequencing nearly simultaneous harvest and land preparation and planting activities throughout a system without co-ordination and careful water control must be immediately obvious, even where a well-developed channel network exists. Where paddy-to-paddy flow predominates, the difficulties are enormous.

I conclude that the scenario you sketch out has some interesting implications for water management and system design, but only in certain carefully circumscribed situations.

The subset of applicable situations is considerably smaller than you suggest and needs some empirical work to usefully define its 'ballpark' as I have tried to suggest. (One thing that this may tell us is that our information base on irrigation, even in Java, is terribly weak.) In addition, to dispense with irrigation management (as opposed to strictly water management) entirely, one would have to demonstrate that the other management tasks described by Korten were either adequately dealt with or unimportant.

Your reasoning does suggest, however, that under conditions as limited above, where water is abundant and land limited, investments in sophisticated water control systems (both hardware and software) would be misguided and wasteful. It is quite true that there is no intrinsic virtue to saving water. We have to be very clear about why we want to improve management and to balance carefully our investments in control capability, and the human systems which exercise control.

Coward points out that most management tasks are performed for dry season crops including padi, and it is the dry season that is the main focus of expansion of irrigated production in South and Southeast Asia. This gives grounds for expecting that tertiary-level management will become more widespread in future.

Your discussion does not explicitly recognize that many irrigation systems in Southeast Asia also support other crops and/or that they produce padi during a water deficit period - the dry season (or do both). Thus while tertiary canals might not be important for wet season padi they may be quite important for dry season production of either padi or other crops. The same can be said about the utility of rotational water distribution. In fact, most traditional systems that we have studied in Southeast Asia do not employ rotational practices in the wet season (unless the rainfall pattern is unusual that year) but do use elaborate rotational procedures in the dry season. Similarly, those traditional systems supporting dry season production typically have elaborate tertiary-level facilities. I think it is significant that in such systems farmers themselves have made the decision to invest in these facilities and these 'management systems' without government prodding or assistance.

So, while I do not disagree with many of the points made in the paper regarding the limited need for water management - I think it very important to be clear that this assertion applies to the production of padi in the wet season period but not to the production of either padi or other crops in the dry season. And, it is this movement of production activities into the dry season that is one of the most general processes of irrigation development that has been underway in Southeast Asia for the past decade or more.

Bhuiyan cites IRRI's extensive experience to suggest that farmers do follow practices disturbing the self-regulating properties an ideal system might have. Where these practices are wasteful and/or impose losses on other users a case for management exists on social and often economic grounds.

I offer the following comments:

1. Title I remained somewhat unclear what you really meant by 'Padi irrigation systems'. The 1st and 2nd paragraphs of p.3 seem to mean two different things to me. In the 1st, your system definition seems to mean small (<1,000 ha) irrigation schemes as whole, whereas in the next paragraph the unit of focus is the 10 - 15 ha block. In my understanding, all of your analyses and conclusions later related to the 10-15 ha block focus, not the whole systems. The Lazaro, Taylor and Wickham reference cited in p.3 also argues in favour of management emphasis on main system but against the farm-level or terminal level emphasis.

2. Figure 2 and p.5 Figure 2 actually shows an extreme case of the expected shape of the curve in which up to 4 mm/day water application did not produce any yield. The 1969 season, being very dry, could not sustain the crop up to 4 mm/day watering rate, hence no yield. In reality, rice is grown in many parts of the world with less than fully saturated soil or ponded water conditions.

3. Page 7, paragraph 1 I fully agree with your analysis of over-irrigation in rice fields. In practice, however, over-irrigation is often more associated with excess water drainage than excessive ponding in the paddies. Farmers with easy supply of (or access to) irrigation water like to maintain a small flow into the drainage ditch - a practice sometimes referred to as 'flowing irrigation'. This practice is advantageous in places where the plant body temperature can rise very high which can induce sterility of the flowers because flowing water helps to keep the plant body temperature lower. But the threshold temperature value of 35°C to induce significant sterility is not reached in most situations in South and Southeast Asian rice-growing regions. As you recognised in the paper, excess water drainage is a loss to the system.

Another related farmer practice noticed in the Philippines is that farmers with easy supply of (or access to) irrigation water maintain no or very low spillway in the paddies and thus allow almost all rainfall to drain, which is a wastage. Tailend farmers, on the other hand are found to maintain higher spillways.

4. Page 8, paragraph 4 The argument at the end of the paragraph ('... if drought lasted much more ...) seems to me to be somewhat academic given the fact that we are dealing with an irrigation system which does not normally become dry or droughtprone in the same way as a rainfed situation. In reality, during lean years, an irrigation system would know how low is the water supply at the beginning of a dry season when the pay-off from spreading the water to a bigger area by adopting an improved management system model would be socially (and perhaps also economically) desirable.

5. Page 8, last paragraph I fully agree with the contention here. An additional advantage of rotation between the groups that should be recognised is that, as Figure 2 will indicate, the improved equity can also increase the total production from use of the given amount of water. For example, by supplying about 67% of the potential requirement (eg. 6 mm/day rather than 9 mm/day), close to 90% of the potential yield could be achieved. Thus the productivity of the water (kg of grain per mm of water applied) would be higher.

Tom Wickham comments that:

1. Your thesis is completely correct in respect of the farm level, but I would not extend it to the main system. .... We found no difference between heads and tails at the watercouse level, ie. at increasing distances away from distributaries. But head-tail differences along the distributaries were striking.

2. I think you are too strong in dismissing over-irrigation in rice. You are correct that in general there is no yield loss at all, but there is usually a loss of water - not to increased percolation, but to surface drainage. Although that may be picked up for reuse later on, it usually isn't, and reuse requires investment.

3. The concept of rotation irrigation, an ideology for rice comparable to warabandi in India, represents the antithesis of your laissez-faire.

4. Regarding the yield response curve, I agree in principle with the all-or-nothing shape, but it is much more complicated when one recognizes that water is not supplied in exactly 6 or 7 mm/day. There are periods of excess followed by periods of insufficiency, and the yield response then takes on a appearance much closer to that of 'other crops'.

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IRRIGATION MANAGEMENT NETWORK

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IMPROVED IRRIGATION MANAGEMENT: WHY INVOLVE FARMERS?

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INTRODUCTION

The most underrated and misunderstood dimension of irrigation development today is that of the individual and collective irrigation behaviour of farmers. Government officials and donors are slowly realising the high economic, social and political costs involved when farmer end users or beneficiaries play only a passive spectator role in irrigation projects and programmes which affect them directly. The purpose of this paper is to examine only three basic questions which are increasingly raised by concerned officials and donor agencies:

- Why involve farmers in irrigation development and improvements anyway?

- Why don't farmers cooperate with irrigation authorities more effectively?

- What are some useful lessons about farmer involvement which may have relevance for India?

A. WHY INVOLVE FARMERS ANYWAY?

This question is intentionally phrased to indicate the doubt and skeptism which still exist in many quarters. Historically, farmers around the world have planned, built and operated their own private systems or parts of public systems. Without active participation of farmers, irrigation systems can never be efficient or cost effective. There are many things governments cannot do effectively for farmers. Farmers need a countervailing power and a voice to assure that their needs are met by those who should be more accountable to them.

<u>1. Historically farmers have been involved</u>

If irrigation is for the purpose of agricultural production then it is axiomatic that farmers be viewed as the key building blocks and central actors in irrigation systems. It is the farmer who when facing great risks and uncertainties must manage the water and all other inputs to produce food and fiber.

Historically, in India and other countries, farmers have probably played a much greater role in irrigation development in the past than they do today. Today in India, there are communal systems, and tanks serving significant areas of land which are owned and operated by farmers. For example, in the state of Himachal Pradesh about 70,000 hectares from a total of about 100,000 hectares are irrigated by private or communal systems known as <u>khuls</u>. In Tamil

Nadu state in South India there are about 40,000 tanks irrigating about one million hectares. Of these an estimated 50 per cent are private or communal tanks (Palanisami and Easter, 1983, pp. 9). In North India the famous warabandi system is probably one of the most successful water distribution and allocation systems in the world for large public gravity systems where water supplies are scarce. It has been wrongly concluded that no organisation is involved in the warabandi system. To the contrary farmers and irrigation authorities work together to establish a system of continuous supplies of water provided on a systematic and regular turn system of units of time per unit of land holdings on fixed rotations. The warabandi system has its own norms where the responsibilities of farmers and irrigation authorities are clearly defined. Coward (1980) in his volume Irrigation and Agricultural Development in Asia: Prospectives from the Social Sciences, describes several communal systems in southeast Asia. He finds that the indigenous private water user's organisations (mostly informal) have three basic characteristics. These are: accountable leadership, organisations divided into many functional subunits, and channel based organisational forms rather than village-based. Water users associations in Korea, Taiwan, and Japan play a major role in irrigation development. Though somewhat different in structure, farmers are usually responsible for construction, improvement, operation and maintenance of irrigation and drainage facilities; prevention and relief of damage to irrigation and drainage facilities; financing the association and staff; coordination with government policies on land, agriculture, industry and rural development (Asian Productivity Organisation), 1980, pp. 76-99 and Lin Chun-Huei, 1976). In these systems governments usually provide policies, loans, and technical assistance as incentives for creating and strengthening associations.

2. Farmer involvement is cost effective

Experience indicates that active farmer involvement is cost effective. First, farmers can and should pay for some of the costs of operation and maintenance and a share of the improvement costs. They can provide resources in cash or kind; labour for construction and regular maintenance; contribute land for right of ways or provide a combination of these. In a large $42 million effort for rehabilitation of the chaks in Pakistan, farmer labour alone amounted to about $7.6 million. In a recent World Bank Project in Pakistan, farmers are providing an estimated 30 per cent of project costs in labour and cost recoveries for improvement activities.

Second, with farmer cooperation there is a large saving in the time required for implementing projects.

Third, farmers' local wisdom and experience are resources often neglected in irrigation rehabilitation and management improvement programmes. At the planning and design stage farmers can contribute knowledge about topography, soil types, depth of soils, location of outlets, and information about possible social problems resulting from certain actions. Often engineers collect data and develop designs without any useful information from farmers. This often results in faulty designs and systems which are not maintained by farmers. The common response of farmers is, "The Government built the system without us, let them also maintain it without us". To by-pass farmer leadership, local wisdom and potential farmer contributions can be costly in both the short and long runs. Fourthly, it has been found that where farmers are organised and have a sense of ownership in the system, they will not only maintain the system but also assure that structures and facilities are not damaged.

Improved irrigation efficiency resulting from improved management and operations by farmers should lead to higher crop production, equity and conservation of soil and water resources. There is much indirect confirmation of this from the Philippines, Taiwan, Korea, and Japan where rice yields per hectare range from over two to six tons.

3. What governments cannot do effectively for farmers

It is obvious that there are many things in irrigation development which farmers simply cannot do or cannot provide for themselves. They are not planners, policy makers, designers or engineers. They require much more technical assistance and a continuous stream of services to create improved production possibilities. Seldom do engineers and planners stop to think about the other side of the coin of what the Government cannot effectively do for farmers in irrigation improvement. For example, governments seldom can bear the complete costs of irrigation projects without contributions from farmers. Neither can they effectively distribute water below the outlets, do regular maintenance below the outlet, settle disputes and resolve conflicts, supervise collective decision making, punish offenders, enforce cropping decisions, select the leadership, form effective associations from top down, monitor farm systems regularly and a host of other things. Without active farmer participation irrigation efficiencies will never be increased.

There are practical reasons for this. One is that of a 168 hour week irrigation field staff are at best present in the chaks (area below the outlet) only about 20 to 25 hours of a 40 hour work week. It is not realistic to think that irrigation field staff can be continuously at their posts. Also consider the costs. Assume that by the year 2000 there are 50 million hectares in India with gated outlets at the 40 hectare level with one field man servicing about 10 outlets. Such an arrangement requires 125,000 field men for the 2,500,000 gates to be operated plus thousands of extra supervisors. If there were gated outlets at the 8 hectare chak level, the number of gates and field men would increase by a factor of five. What country can afford so much in recurring administrative costs? A serious question seldom raised about India's irrigation sector is: Is the Government presently attempting to do <u>too much for farmers</u> in irrigation <u>development and</u> <u>improvements?</u>

Chambers (1977, pp 340-363) has suggested the following guidelines for determining the degree of adequate government intervention.

> "In general government should unambiguously avoid doing that which communities can do for themselves in their own interest, but should intervene when exceptional problems are beyond a community's power to overcome."

4. Farmers need a countervailing power and a voice

Farmers not only have a right to take part in most of the decisions that affect their lives directly, such as at the outlet level, they also need an organised means to make their needs known. Especially on government controlled gravity systems farmers seldom have a voice in the projects and programmes designed for them. Unlike most gravity systems in South Asia, farmers in some countries through federated farmer organisations have developed a strong voice and countervailing power to make irrigation and agricultural authorities accountable (Maass and Anderson, 1978, pp 22-25).

Farmers in India as a result of the Panchayat Raj and over 35 years of grass roots democracy and rural educational programmes are now becoming more aware of their rights. They are becoming more vocal regarding irrigation needs, agricultural price policies and other decisions which affect them directly. The time is almost here where engineers and other professionals will have to become more accountable to the clients they serve.

Takase (1982) predicts that the 1980s is a period of irrigation development where the emphasis will not be on the construction of large dams and canals. Instead he sees a growing widespread interest evolving in the institutional aspects of the whole system; human management issues such as farmer organisations, training of professionals and farmers, and ways to improve project design, implementation and management.

B. WHY ARE FARMERS AND IRRIGATION AUTHORITIES NOT COOPERATING MORE EFFECTIVELY?

Experience in many countries indicate that there are several common priority constraints in attempting to gain more farmer participation.

1. Most public gravity systems don't work well for farmers

Much of the non-cooperation and even destruction of structures by farmers is their response to a system which is not dependable. When systems do not work, farmers naturally will attempt to modify them to obtain water by any means. Hashim Ali (1981) in a survey of irrigation systems serving 232 villages, documented over 557 defects in system design and operation. In Gujurat at the Mahi Kadana Project farmers were willing to pay over six times the cost of canal water for private tubewell water because the public system was not dependable nor could it provide water control.

2. Large bureaucracies and response to local needs

It must be realised that irrigation management and farmer organisation are the most indigenous aspect of irrigation systems. No single model or method can be applied universally even in the same state or region. The most efficient systems known are those where decentralised process approaches are used to diagnose and solve problems at the project and farmer levels of the system.

It is not known how much centralised planning and inflexible procedures result in long delays in project completion. A recent review of 67 irrigation projects in India shows that 66 were not completed at the time planned or within the budget. The range and median years of delay were respectively two to twenty-two with a median of seven years (Economic Intelligence Services, Sept 1982). Also a Public Accounts Committee (1982-83) report to the Lok Sabha on 11 April, 1983 shows that there are 8 major irrigation projects 15 to 20 years behind schedule. This study also identified 42 major projects with cost over-runs of 500 per cent.

Another problem is the pressure donor agencies often bring to bear on host country irrigation bureaucracies. Under such situations farmer involvement and management issues are usually left marginal or ignored due to the inordinate pressure to move too much money too quickly.

Another set of problems of large bureaucracies related to those procedures, norms and attitudes which become standard and frozen over time. Irrigation system design especially in the areas of water delivery and distribution is often very traditional and inflexible (Murty, 1982). In much of India there are rolling landscapes and very small farms with highly fragmented fields which are operated under complex land tenure systems. Design and the procedures for design have build-in assumptions which are often strongly held. Once implemented in the project the limits are virtually set in terms of what optional management systems and modes of farmer involvement can be best used. After a system has been constructed and found not to work well, a frantic search for a management mode begins. Rather than the typical blueprint type designs where everything is specified, there is need for much more flexibility in design to provide for a learning process for evolving the most appropriate mode of management. This often can be established prior to the design process by studies on new systems by including field experiments early in the life of the project which provide feedback for improved design. The inflexible blueprint approach in designing the management mode seldom works well in actual practice though most design is still done this way.

There are a number of common beliefs and sentiments which often work against effective farmer involvement. First, is the frequent view that social and organisational factors are not really very important for irrigation improvement. Second, there is a rather widespread view that farmers must be commanded or put under great compulsion in order to force cooperation. Such a top down legal approach which provides no incentives for farmers will not work in a free society like India.

Third, there is a view that if only the right technology can be found we can by-pass farmers' problems and not have to worry about sticky farmer organisation. This is merely a half truth and as such is dangerous. There are some technologies such as the warabundi in North India, small chak sizes, and underground conveyence systems which can help reduce farmer conflicts. There is, however, no technology which completely rules out the need for farmer organisation of some type and at some level.

A final problem facing most large irrigation establishments is the lack of communication between users and irrigation authorities. Even a one way flow of information to users from irrigation authorities is greatly inadequate. In recent studies in Pakistan (Lowdermilk et al, 1978), Gujurat (Mahi Kandana Project) and Rajasthan (Ganberi Project) states in India, it was found that about 70 per cent of the farmers reported that they did not usually receive information about the closure of systems for maintenance and repairs or even opening dates. In a similar study in Pakistan, Lowdermilk and others (1978) found that over 83 per cent of 389 farmers did not know the published date for canal closures.

C. MAJOR LESSONS LEARNED ABOUT FARMER INVOLVEMENT

There are a number of major lessons learned in Asia which may have much relevance to India. These lessons have been field tested in several countries of the region.

1. No model as blueprint exists for gaining effective farmer involvement

No single model exists that can be transferred to India or within India to resolve the farmer participation problem. A major lesson is that the development of a management mode involving farmers is a process which must be evolved in each site specific cultural setting. This requires a built-in learning mode for each project. Much more action research is needed in India which places a strong focus on farmer involvement.

2. Farmers do respond to adequate incentives and interventions

The major disincentives to farmers participating more positively in irrigation systems seem to be in the malfunctioning systems themselves and the lack of adequate technical assistance and a continuing flow of essential services.

3. Government policies which provide incentives and authority for farmer organisation

There is much agreement that farmers' organisations are most effective where there are incentives for them to organise. These incentives include a predictable water supply, inputs and services for improved production possibilities and flexible attitudes of irrigation authorities (Lowdermilk et al, 1978; Easter and Welsch, 1983; Bagadion and Korten, 1983). Government policies should provide for the clear authority of the water user group and specify the roles and responsibilities of the group and the irrigation authorities. A major problem in India is the lack of clarity in the roles of irrigation authorities, agricultural workers, and farmers.

4. Initiate farmer organisation where a predictable water supply and local commitment can be generated

As discussed earlier, it is important to be able to provide a predictable water supply or the assurance of such a water supply. Equally important is the careful selection of the initial sites where local commitment exists or can be generated. In the Pakistan and Egypt Water Management Improvement Projects, the chaks selected had to meet certain physical and social criteria before improvement activities began. These criteria were:

- Chaks where the majority of the farms were small;
- Where a predictable water supply could be provided and were irrigation efficiencies, yields and cropping intensities had a real potential for improvement; and
- Where the farmers agreed to do the following:
  - provide all labour for earth work and lining;
  - provide some of the cash for small water-course structures;
  - settle disputes over land, water and other significant problem areas;
  - supervise local improvements;
  - provide masons;
  - clear right of ways and resolve all conflicts;
  - provide part of the cost of land leveling;
  - form an informal or a formal organisation for the project activities such as a water users association; and
  - set-up a method for regular operations and maintenance of the systems and improvements. (Lowdermilk, 1981, pp.19)

The successful programme in the Philippines experience of farmer organisation for irrigation management found that it was important for costs involved. The amount required in cash was 10 percent of the construction costs and a regular fee of about $61 per hectare for on-going operation and maintenance expenses (Bagadion and Korten, 1983, pp.35 and 38). In a study of 36 small farmer development projects around the world, it was found that the two factors which were most important for success were involvement of farmers in decision making and commitment of labour and cash to the project (Morss et al, 1976, pp.203).

It is important that irrigators develop a sense of ownership in their project. A Punjabi farmer years ago confided to the author how rural people often trick government workers into taking the first crucial steps in development projects. He stood up in a walking position and demonstrated how the first step a person takes, creates an imbalance, therefore, a second, third, fourth, etc. step has to be taken with the result that all is done by the Government authorities. The farmer stated that if you want to evolve successful projects with us get us to take the first step and provide some support. This local wisdom is important. Where irrigators will not take the first steps, it is often better to by-pass them for other chaks. Government organisations may find this difficult; however it is based on the well known fact that not all groups are prepared or ready at the same time for development activities.

5. Build upon local forms of organisation and begin with small units

It has been found that farmers often have developed informal organisations which can serve as the basis for building stronger organisations. Local leadership and existing organisational forms should not be ignored (Bagadion and Korten, 1983, pp.37). Some general strategies which seem to work include the following:

- Work within the cultural context in selecting leaders and help them improve their skills in organising farmers, making decisions and resolving conflicts;
- Identify and assess local informal organisations, and where appropriate build upon these;
- Do not by-pass group leaders and leaders of factions;
- Allow leaders to organise committees their own way to manage or supervise labour, materials, and equipment; to settle disputes; and to operate and maintain the system;
- Use much caution in attempting to introduce new organisational forms. Where there is doubt about a particular organisational mode, first try to use the local form of organisation;
- Use local organisations to reach and involve individual farmers;
- Where possible, keep organisations small so members deal in face-to-face relationships with each other and farmers; and
- Find ways to reward local leadership.
(Lowdermilk and Lattimore, 1981, pp.21 ff.)

It has also been found that small chak groups with face-to-face and daily interactions should form the basic building blocks for organisation. Until much experience is gained about how to best federate irrigators' groups, it probably should not be attempted. In most cases this hydrological unit should be used for irrigator organisations instead of the village or administrative unit, (Coward, 1980, pp.223-237; Bottrall, 1981; Hutopea et al, 1979, pp.167-174). In Indonesia Hutopea et al found that where the hydrological units coincide with village units, irrigation systems are easier to manage because conflicts are less likely. Where irrigation groups have federated up to the main canal or system level, much time and learning was required. Federated groups to be effective must be based on strong local units.

6. Build up the capacity of the implementing agencies

Time is also required to achieve a reorientation of the methods and approaches of personnel who work with farmers. Without changes in attitudes, procedures, and skills of the implementing agencies little can be accomplished in mobilisation of farmers. To achieve this a strong policy with incentives to staff for working closely with irrigators is needed.

First, engineers and social scientists need to learn to work together to diagnosis systems to identify the physical and social constraints and how these interface. Along with learning new skills for diagnosing and monitoring systems, engineers also require some skills about how to work effectively with farmer groups. Nowhere in present engineering training are there opportunities to acquire this knowledge.

Some of the changes needed for engineering staff include:

- Flexibility in working with farmers and farmer groups;
- Willingness to learn from farmers and incoporate local wisdom in planning and design;
- Willingness to use the trial and error method of learning such as experiments;
- Willingness to let farmers make their own decisions about matters that impact them directly;
- Acceptance of the fact that the local organisation actually belongs to the members and not to the Government;
- Overcoming the disease of paternalism and viewing irrigators as members of the team; and
- Showing appreciation and respect for rural people. (Uphoff, 1982, pp. 13-14)

The experiences in the Philippines and in Sri Lanka suggest that as farmers organise for irrigation more positive ties are developed with the irrigation authorities. In the Philippines the personnel who do the social-organising work are employed by the irrigation agency. In Sri Lanka a separate agency is used for organising farmers. It is not yet known which is the most effective approach. It appears that under one authority the technical and organisational activities are more complimentary and it is easier to involve farmers in planning, design, implementation, management and operations.

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IRRIGATION MANAGEMENT NETWORK

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TRANSFORMING GROUND WATER MARKETS INTO POWERFUL INSTRUMENTS OF SMALL FARMER DEVELOPMENT: LESSONS FROM THE PUNJAB, UTTAR PRADESH AND GUJARAT

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1. DISTRIBUTION AND EXTERNALITY ASPECTS OF PRIVATE EXPLOITATION OF GROUND WATER

This paper has three purposes: first, to initiate a discussion on the working of ground water markets in India; second, to analyse such information as is available to highlight the salient features of ground water markets in Gujarat, Uttar Pradesh (UP) and the Punjab; and lastly, to analyse policies that can *transform* ground water markets into powerful instruments of promoting agricultural growth in general and the interests of the rural poor - the small and marginal farmers, and the landless - in particular.

Ground water is a common property resource to which, in theory, all members of a community have equal right to access. Private exploitation of ground water, however, limits effective access to ground water only to those who can invest in Water Extraction Mechanisms (WEMs). There is bound to be a substantial scale bias in the ownership of modern WEMs (ie tubewells or dug wells mounted with electric or diesel pumpsets) which involve chunky investments beyond the resources of small holders. This implies that in areas where ground water is the only source of irrigation, only the large and affluent farmers who own WEMs would be able to adopt the lucrative HYV technology - crop enterprise options made possible by irrigation, in the absence of efficient ground water markets.

In areas where land holdings are highly fragmented, absence of efficient ground water markets will limit the actual areas irrigated to a small fraction of the minor irrigation potential created by private investment in WEMs. Typically, a farmer will instal WEM in the largest or the best one or two of the 6-8 parcels over which his land holding is distributed. Therefore, unless he has the option of buying water from other private WEM owners to irrigate his other parcels, he will have to rest satisfied with irrigated farming on only those of his parcels where his own WEMs are located. On the other hand, since his own modern WEM would, in most cases, be capable of irrigating more than the parcel on which it is located, its capacity will remain under-utilised until he has the option of selling ground water to the neighbouring farms.

Further, private exploitation of ground water has several externality effects which raise important questions of equity and social justice and to which public policy needs to be addressed:

a. In majority of the cases barring those where private WEMs are located in the centre of large holdings, private exploiters of ground water enjoy monopoly access to much more than their equal share in the ground water resources of the community. Thus under the existing institutional arrangements, the private exploiters of ground water enjoy a substantial external economy for which they are not required to pay the community.

b. The establishment of a deeper WEM which becomes viable only at high discharge, is likely to cause a decline in the water output of less deep WEMS in the locality. Owners of deep WEMs thus impose dis-economies on owners of less deep WEMs in 4-125 hectares of surrounding lands.

c. In order to protect the water yields of existing WEMs, public sector financial institutions insist on certain minimum spacing between existing and new wells to be financed. Such insistence on their part gives rise to a new inequity: the affluent late comers who can self finance their investments in WEMs are not touched by such spacing requirements since there are no formal laws specifying property rights on ground water and thereby impose a dis-economy on the neighbouring WEMs; on the other hand, the resource poor late comers who are dependant on institutional finance forefeit their right to extract ground water from their own land.

d. In areas where ground water resources are fast depleting, early exploiters who enjoyed high water tables and low extraction costs impose an external dis-economy on the late comers in the form of low water table and high extraction cost.

All these externality effects arising from private exploitation of ground water assume a more serious and unjust form because it is the resource poor who are usually the late comers and who thus bear the brunt of all these adverse effects.

All these adverse effects can be minimised if a public agency, assuming a monopoly position and treating ground water as a publicly held resource:

a. instals its WEMs at various locations in the village

b. sells ground water to all users, large and small, at a price equal to the marginal cost of extracting it if ground water resources are substantial

c. distributes the economic surplus so produced <u>equally</u> among <u>all</u> members of the community

d. in cases where ground water resources are limited, charges a premium (over the marginal cost) high enough to contain the rate of ground water use to the rate of ground water recharge

e. uses a part of the surplus so generated in augmenting the community's ground water resources.

In areas where there exist substantial ground water deposits, similar results can be obtained by facilitating the emergence of efficient and competitive markets. For, such efficient markets will create economic pressures which induce private WEM owners to expand their sale of water to neighbouring farmers until their selling price of water approximates the marginal cost of extracting and delivering water. The existence of such a competitive water market would ensure that:

a. those of the community members - mainly the resource poor - who can not afford WEMs would be able to buy ground water at a price close to what it would cost them if they had their own WEMs.

b. fuller utilisation of privately created minor irrigation potential takes place.

c. farmers are able to irrigate all or most of the parcels of their landholdings either with own or purchased water.

d. resource poor farmers are not denied access to the HYV technology and more profitable crop enterprises because of their inability to invest in WEMs.

e. total farm output of the community and the amount of land irrigated are higher than they would be without such markets.

f. the seriousness of all but the last of the external dis-economies arising from private exploitation of ground water resources is minimised. In areas where water table is declining because of over exploitation of the aquifer, the competitive market price of water will not be high enough to limit the rate of water use to the rate of water recharge and public intervention on that score will become necessary.

It is the basic thesis of our paper that it is possible to design fairly potent interventions to recast ground water markets into very effective instruments for equitable development of ground water potential. Our basic question, then, is: how can public policy be used to (a) facilitate the emergence of ground water markets and (b) to ensure that these markets become as efficient as possible. We can best examine this question by first understanding the factors that govern the behaviour of the potential buyers and sellers of ground water.

2. ECONOMICS OF THE DEMAND AND SUPPLY OF GROUND WATER

Demand for irrigation is a derived demand; therefore, the characteristics of the water demand function are determined by the role of irrigation in the farm production function. The demand for water will, therefore, depend upon the price of water and the price of the crop output, on the marginal product of fertiliser and water. When water is available at low prices, farmers will have considerable choice in terms of enterprises and technologies to be pursued; however, as water price increases, the choice tends to get limited to either rainfed farming or to irrigated farming of crops such as potatoes or peas for which the marginal value product of water is very high.

Now let us consider the factors that are likely to determine the behaviour of water sellers. Most WEM owners invest in WEMs because their own holdings can utilise a significant proportion of the capacity of WEMs. Once such investments have been made, rational behaviour on their part will preclude the consideration of fixed costs in their pricing of water and they would be guided mainly by the incremental (or marginal) cost of extracting and delivering water. In particular, they would set their selling price so as to maximise their profit function -

$$\pi = w.H - cH - Fc$$

where π = total profit
H = hrs of water sold
w = price of water (Rs/hr)
c = incremental cost/hr of water (Rs/hr)
Fc = fixed cost (Rs/yr)

define $e = \frac{w}{H} \cdot \frac{\partial H}{\partial w}$ = price elasticity of demand for water facing the WEM owner.

The profit maximising water price will be $(\frac{e}{e-1})$ times the incremental cost of extracting and delivering an hour of water and will be independent of the fixed costs. e is a rough index of the monopoly power enjoyed by the WEM owner. As the water market becomes increasingly competitive, e becomes larger and w tends to get closer to c; on the other hand, when the market becomes highly monopolistic, e becomes smaller and the premium charged by WEM owners over c increases. The value of e is a very important and useful indicator of the structure of water market and can be roughly estimated using the more easily observable values of w and c.

Low values of c and high values of e can produce low values of w, the sale price of ground water which, in turn, can have several highly desirable implications discussed in the preceding section. We believe that public policy can be used effectively to influence the values of e and c - and therefore, of w; the best way of understanding how this can be done is to compare such empirical evidence as is available across various states which pursue differing policies affecting the ground water markets.

3. WORKING OF GROUND WATER MARKETS IN UP, HARYANA AND THE PUNJAB: SOME INDICATIVE EVIDENCE

A good deal of micro-level empirical research and the informal enquiries made by this author indicate that ground water prices are quite low and that they are close to the incremental cost of water extraction and delivery in the Punjab, Haryana and UP. It also appears that owners of WEMs in these parts of the country sell a substantial proportion of their total water output to neighbouring farmers.

An early study (1969) conducted by S M Patel and K V Patel in four districts of UP provides some useful and important evidence about the working of ground water markets in UP. The WEM owners reported in this study sold as much as 40% of their output and irrigated nearly 70% more land owned by other farmers who realised 40-150% returns on their outlays on purchased water. On their part, the WEM owners also earned greater total surpluses from their WEMs by selling water than they would have if they had restricted their water sales by pegging their selling price at a much higher level. The fact that they have settled for a large volume - low price strategy hints at fairly competitive conditions prevailing in ground water markets. A more recent field study conducted by IRMA and reported in some detail in the next section showed that as recently as in 1983-84, ground water prices in UP ranged between Rs 5-8 per hour and that a substantial amount of land was irrigated with purchased ground water. The village in Meerut district where field research has been carried out had 200% cropping intensity and only 12 private WEMs and one state tube well. Ground water prices in the Punjab and Haryana seem to be even lower than they are in UP. In early 1984, ground water was reported to be sold at Rs 4-5/hour in relatively backward districts of Punjab such as Hoshiarpur, and at Rs 5-6/hour in relatively more advanced districts. In all these states, the difference in tube well irrigation cost is negligible between owners of WEMs and buyers of ground water; and, ground water is only marginally more expensive than canal water which is known to be by far the cheapest source of irrigation.

4. EFFECTS OF HIGH GROUND WATER PRICES: SOME EVIDENCE FROM GUJARAT

In relation to what they are in the Gangetic plains, ground water prices are extraordinarily high in Gujarat. As early as in 1965, Programme Evaluation Organisation recorded the private WEM owners' water prices to be Rs. 2.50 - 4.00/hour in Baroda district (Gujarat) and Rs 3.50-5.75/hour in Kheda district (Gujarat) when they were as low as Rs 1.25-2.00 in Bulandsahar district in UP. Another study by S M Patel and K V Patel in Gujarat (1969) showed that prevailing price of water was 20-50% higher than the average total cost and 2.0-3.5 times the average variable cost. Asopa and Tripathi recorded in 1975 that, "the irrigation charges levied by the owners of private tubewells (in Gujarat) are four to six times higher than canal irrigation charges and two to three times higher than state tube well charges... In general, this has contributed to income disparities and at times of scarcity, it has led to the exploitation of small and marginal farmers." In the last few years, the already high ground water prices in Gujarat have risen rapidly; informal field enquiries conducted by this author showed that water prices range between Rs 15 (for 5 hp diesel WEMs) to Rs 30-35 per hour (for 35 hp electric engines) in various parts. The outcome of these enquiries has been summarised, along with brief notes in the following table.

It is likely that, in most parts of Gujarat, cost of irrigation with purchased water exceeds 40% of the total cost and 60-70% of the cash cost of cultivation. In relation to the Gangetic plains, where cost of irrigation with purchased ground water is no higher than 20% of the total cost, these proportions are much too high in Gujarat and must produce powerful incentives to minimise irrigated farming with purchased ground water. Research by the author in Panchmahal District, Gujarat, showed the inefficient water market leaves the existing WEMs seriously under-utilised and, on the other hand, leaves large proportions of farm lands, especially, those belonging to the resource poor, unirrigated in spite of there technically being enough irrigation potential for all of the village's farm lands.

In this author's discussions with some farmers in the Charotar tract of Kheda district, it emerged that high ground water prices were driving even small farmers towards cash crop oriented cropping patterns since irrigation with purchased water is profitable only in cash crops such as tobacco and banana. Quite a few farmers found it safer to take irrigated cash crop (with purchased water) than unirrigated food grain crop. Presumably to reverse this trend, the state tubewells charge 2.5 times as high a water price for cash crops (Rs 40-45/hour) as for food crops (Rs 15-18/hour). However, instead of discouraging farmers from growing cash crops, this dual water pricing has increased the farmers' dependence on private tubewells and thus enhanced the latter's monopoly power.

5. TOWARDS AN EXPLANATION OF HIGH GROUND WATER PRICES IN GUJARAT

It seems that the high ground water prices in Gujarat are explained much better by the conceptual framework described towards the end of our section 2 than by its lower ground water potential. In relation to Punjab, Haryana and UP, the value of e is likely to be lower in Gujarat; more importantly, the pricing of electric power used by WEM owners in Punjab, Haryana and UP is done in such a way that c, the incremental cost of supplying water to them is close to zero; on the other hand, in Gujarat, power is priced in such a way that the bulk of the power cost becomes incremental cost.

An Array of Ground Water Prices in parts of Gujarat 1983-84

Region/ district/ taluka	Owner	Water price (Rs/hour)	Average fuel cost (RS/hour)	Type of WEM
Lunavada taluka of the Panch-mahals district	Private farmers	Rs 15-18	Rs 4.5-5.0	5 hp diesel pump sets mounted on shallow borewells
Chhota-Udepur taluka (a tribal belt) of Baroda district	Voluntary agency	Rs 16-20	Rs 8-10	7.5 hp diesel pumpsets mounted on shallow bore-wells on river banks
Balasinor taluka of Kheda dist.	Private owners	Rs 17-19	Rs 4.5-5.5	5 - 7.5 diesel pumpsets mounted on bore or dug wells
Anand-Borsad talukas of Kheda dist.	Priate owners	Rs 20-25	Rs 5.50-7.5	15-21 hp electric pumpsets on tube wells - 150'-200' deep
	Private owners	Rs 18-20	Rs 4.5-5.0	Diesel pumpsets mounted on canals to irrigate up-lying lands
	State tubewells	Rs 15-17 for food crops and Rs 35-45 for cash crops	Rs 10-14	35-55 hp electric pumpsets mounted on deep tubewells (250-300 meters)
Prantij taluka of Sabarkantha district	Private	Rs 23-30	Rs 8-12	12-35 hp electric pumpsets mounted on deep tubewells
Vijapur talu-ka of Mehsana District	Private	Rs 30-35	Rs 8-12	21-35 hp electric pumpsets mounted on deep tubewells

An Array of Ground Water Prices in Parts of Gujarat:1983-4 Cont.

Region/ district/ taluka	Remarks
Lunavada táluka of the Panch-mahals district	Water table is very high; herefore, virtually unlimited access to ground water. With over 50 borewells, only 15% of the village's land was double cropped because of high ground water prices.
Chhota-Udepur taluka (a tribal belt) of Baroda district	About 100 lift irrigation schemes established by the Agency exploit very shallow aquifers (10'-15') recharged by the seepage of the river water. Most diesel engines were very old, therefore, fuel costs was high.
Balasinor taluka of Kheda dist.	Pre-dominence of crop sharing arrangements between water buyers and WEM owners. Buyers contributes land, labour, seeds and manure; sellers contributes water, half the cost of fertiliser and claims 50% of output.
Anand-Borsad talukas of Kheda dist.	An acre of wheat requiring 35 hours of water over 7 irrigation costs Rs 850-900 by way of irrigation with purchased water. An acre of HYV paddy would cost 60-70% more. Differential pricing of state tubewell water for food and cash crops has caused a shift in the cropping pattern towards cash crops and intensified the private WEM owners' monopoly power
Prantij taluka of Sabarkantha district	An acre of HYV paddy involved Rs 1200-1500 towards cost of purchased water. Irrigation with purchased water is extremely limited.
Vijapur taluka of Mehsana District	Water table is very low and declining further; ground water co-op have come up in many parts. Similar condition prevail in Amreli dist.,Saurashtra.

There are enormous variations in the methods used by different states for pricing electricity for agricultural use. In the Punjab and Haryana (as also in UP for the last 10 years or so) electricity rates payable by owners of electric WEMs are related to the hp of WEMs and not with the amount of power actually used by them. Power cost thus becomes entirely fixed and the incremental cost of supplying water approximates zero. The WEM owners in these states have strong incentives to maximise sale of water - for, all the additional revenue so earned forms their net profit.

In Gujarat, power to agriculture is costlier than it is in the Punjab, Haryana and UP; moreover, power cost is more or less completely variable at around Rs 0.48 - 0.52 per unit. High incremental power cost in Gujarat thus has the effect of reducing the sale of water by WEM owners and increases water prices, causing low utilisation of WEMs and reducing the pace of agricultural development and the development of the resource poor who typically are the buyers of water. Such exceedingly high ground water prices in Gujarat are a relatively recent phenomenan, although they have, in general, always remained higher in Gujarat than in the Punjab, Haryana and UP. During the 60's when power rate was around Rs 0.15/unit, water prices in Kheda District, Gujarat were Rs 4-5/hour; in fact, till 1979, they were as low as Rs 8-10/hour. Between 1979-84, power rate has increased from Rs 0.25 to Rs 0.50 per unit and the water price has shot up from Rs 8-10 to Rs 20-25/hour. A fuel surcharge, first imposed in 1980 as a harmless mechanism to adjust variations in fuel costs incurred by power plants, had by 1984 risen to nearly Rs 0.25 per unit, and emerged as the major culprit for the doubling of the incremental power cost over these past five years.

It is also our belief that the value of e - the elasticity of demand for water facing a typical WEM owner - is lower in Gujarat than it is in the Gangetic plains and that this fact has further accentuated the effect of high incremental power cost on water prices. In the Gangetic plains, particularly in UP, public policy towards ground water development has been such as would increase the value of e. In UP, the state took early initiatives in establishing numerous state tubewells in direct competition with private WEMs. Further, the heavily subsidised state tubewell water has been sold at prices substantially lower than those charged by private tubewells. In spite of the fact that state tubewells have always faced significant problems in management and in timely delivery of adequate quantities of water, their presence has acted as a powerful check on the unfettered exercise of their monopoly power by private WEM owners - for water buyers would not tolerate exploitive premia charged by private WEM owners over the rates charged by state tubewells because they could always patronise the state tubewells in such an eventuality.

In Gujarat, on the contrary, public policy towards ground water development has served to enhance the monopoly power of private WEM owners. For a long time, the government of Gujarat left the exploitation of ground water resources to private initiative; as a result, the development of public tubewells remained scanty and concentrated in certain pockets. The monopoly of private WEM owners so created was strengthened by the dual pricing policy followed in pricing the water sold by the relatively few state tubewells that exist since, as we noted earlier, such dual pricing has only increased the dependence of water buyers on private WEM owners instead of encouraging them to increase food crop cultivation and decrease their emphasis on cash crops.

By far the most important aspect of public policy which serves to accentuate the monopoly power of privately owned WEMs in Gujarat, however, is the manner in which public sector financial institutions determine and implement the spacing requirements between existing WEMs and new ones proposed to them for financing. In most parts of Gujarat, a financial institution will refuse to finance a WEM within a radius of 180 meters of an existing dug well and 780 meters for a tubewell; in effect, this implies that once a tubewell (over 45 metres deep) has been dug, neighbouring farmers will be denied institutional finance to dig a tubewell within nearly 200 hectares of the surrounding land. Early exploiters thus become monopoly water sellers; and public sector financial institutions strengthen their monopoly power through their policies.

In Mehsana, where over exploitation of ground water has assumed a very serious form, the issuance of further licenses for private as well as state tubewells has been discontinued all together. In most other parts of the state, there is a restriction on the number of state tubewells to be established to no more than 10-12 over an area of 25 square kms. Such restrictions have, indeed, reduced the chances of over exploitation of ground water and the incidence of the dis-economy caused by falling water tables. However, they have simultaneously given rise to another diseconomy imposed by the early and rich late exploiters on the resource poor late exploiters and whose burden falls mainly on the resource poor.

There are, no doubt, very sound geological considerations involved in the fixing of spacing requirements and such other regulations which, in any case, are needed to prevent the mining of ground water. Our analysis, however, indicates that there is a set of socio-economic considerations too which need to be taken into account while formulating such policies. Present spacing requirements, for example, help the early exploiters to impose huge diseconomies on late exploiters; the seriousness of such diseconomies is heightened further by the fact that it is usually the resource poor who most often are the late exploiters. If policy makers become sensitive to such issues of equity and justice, they will no doubt search for alternative ways of maintaining the ground water balance. If, for example, uncontrolled private exploitation of ground water leads to lowering of water table, the public policy can be so designed as to require private exploiters of ground water to invest in such water recharging devices as would restore the ground water balance - for it is they who are the primary beneficiaries from private exploitaion of ground water.

6. IMPLICATIONS FOR PUBLIC POLICY

The exceedingly high ground water prices in Gujarat imply that the main benefits of irrigation accrue only to those who can invest in their own WEMs; that the resource-poor who do not possess their own WEMs are obliged to economise greatly on their use of purchased water and, more often, to resign themselves to entirely rainfed farming because (a) such high water prices reduce substantially the difference between the profitability of irrigated and rainfed farming (b) they require them to arrange for substantial amount of working capital (Rs 6-900 per acre) (c) most importantly, high outlays on purchased water increase their fixed charge liability and, thereby, substantially increase the operating risk in irrigated farming with purchased water. A major reduction in ground water prices by private WEM owners will, therefore, stimulate the demand for purchased water by reducing greatly the seriousness of all these three factors; and will increase the utilisation of minor irrigation potential already created.

If our earlier analysis is any guide, such major reduction in ground water prices can be achieved fairly easily by reducing the value of c, the incremental power cost of operating a WEM and by increasing the value of e, the price elasticity of demand facing a private WEM owner. While influencing e involves several complex and controversial issues as we discussed towards the end of the preceding section, nevertheless, substantial reduction in c can be achieved if the Gujarat Electricity Board replaces its existing policy of charging for power according to actual consumption by a fixed power tariff linked with the hp of a WEM. We have discussed earlier that a fixed power tariff will reduce c, the incremental power cost to zero and generate powerful incentives amongst WEM owners to maximise the utilisation of their WEMs by selling as much water as they can - even if, in the process, they are obliged to reduce water prices considerably, since all the increase in gross revenue so generated will form their profit.

Even if the GEB were to lose by switching over to the fixed tariff system, it appears that there are good reasons why the state should make good the losses to the GEB. Our analysis indicates that protecting GEB's profits from its sale of power to agriculture denies the resource-poor farmers of Gujarat the opportunity to increase their incomes by several times as much as the profits made by the GEB. It must be said in defence of the GEB that the electricity boards in UP, Haryana and the Punjab have settled for the fixed tariff system not so much to help the poor as to check the rather substantial pilferage of power and the corruption that inevitably attends consumption linked power pricing - both of which, the GEB has been able to contain very effectively. However, it is also equally true that the fixed tariff policy adopted by Haryana, UP and the Punjab has had, quite inadvertently, positive social and economic fall outs which far outweigh the administrative convenience that such policy was intended to effect.

An important and related aspect of making ground water extraction more cost effective has been highlighted in the last few years by the significant applied work done by the Institute of Co-operative Management, Ahmedabad under the guidance of Dr S M Patel in the area of energy efficiency of privately owned WEMs. In course of their work, they found that most private WEM owners did not have enough technical knowledge to choose an appropriate pumping plant for their WEMs and, therefore, ended up choosing motors of considerably higher hp than the loads actually contracted and pumping plants that are very wasteful in power use. The Institute has itself worked so far with over 1600 privately owned electric WEMs and effected improvements which have reduced power consumption by 20-50 per cent.

In so far as the actual power cost directly contributes to the formation of water price, a large scale programme to effect such economies in power consumption can help to reduce water price by reducing the value of o. Further, in a consumption linked power pricing regime, WEM owners are less likely to be careful in choosing an engine of appropriate hp than in the fixed power pricing regime where the power bill is linked to the hp of an engine. Dr Patel's work has also shown that WEM owners can effect 35% savings in capital costs and 50% savings in power costs just by choosing appropriate foot valve and pipes for suction and delivery system. Obviously, the public policy can play a very important role by following vigorously the lead established by ICM in this direction.

In this connection, it may be noted that, quite often, physical constraints in bringing water to distant farms may effectively limit the area that can potentially be irrigated by a WEM. Most private WEM owners do not invest in elaborate underground or surface water delivery system because their primary motive is to irrigate their own land and because such investment in pipes can be quite substantial. An extension programme to encourage WEM owners to increase their emphasis on selling surplus water to neighbouring farmers by investing in water delivery systems, to use rigid PVC pipes in place of iron pipes which are costlier and cause more friction, and perhaps, a subsidy on such pipes which will make investment in them attractive to private WEM owners will lessen the impact of physical barriers that limit a WEM owner's water sales to neighbouring farmers and will serve to increase the value of e. As we noted earlier, the greater the extent of overlapping in the command areas of various private WEMs, and of private and state tubewells, the more competitive will the water market become and the lower will be the price of ground water sold by the owners of electric WEMs.

Many public agencies - such as the agriculture department of the Gujarat government, Gujkomasol, GEDA, etc - and more importantly national institutions such as the NABARD and Energy Advisory Board have become increasingly aware of the need to improve the energy efficiency of the lift irrigation systems. Such efforts as are being put forth in this direction are to be welcome on the additional ground of the likely favourable effects that they would have on the behaviour of the private owners of electric WEMs as sellers of water in particular and on the overall working of ground water markets in general. If the UP experience is any guide, a fall in water prices of electric WEMs will precipitate a corresponding fall in diesel WEM water prices too, at leasts, in areas where both co-exist - although a market difference may develop and persist in the prices charged by them.

7. SUMMARY AND CONCLUSIONS

If water prices in Gujarat are to be reduced, water markets must be made more competitive and less monopolistic. This can be achieved by (a) the state taking up a more active role in ground water development through establishment of large numbers of public tubewells in direct competition with private WEMs (b) by minimising the restrictions in the establishment of private tubewells (c) by following a uniform water pricing policy for all crops and in general, by managing state tubewells as effective checks on the monopoly power of private WEM owners (d) by taxing private WEM owners to generate resources for water recharging schemes that will maintain the ground water balance. All these measures have complex and diverse ramifications.

A much simpler way of reducing ground water prices in Gujarat is by affecting the incremental cost to the WEM owners of supplying water - the bulk of which is the cost of power. The water buyers, mainly the resource-poor, will gain substantially from lower prices and greater supplies of ground water. Such a power pricing policy will also lead to fuller utilisation of privately created minor irrigation potential and help to establish a just and equitable system for ground water development.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 11e MAY 1985

COST RECOVERY AND WATER TARIFFS

A DISCUSSION

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1. RESEARCH ISSUES AND POLICY CONTRADICTIONS

This paper is intended simply to raise talking points and to stimulate people to send in information and comments, which can be forwarded to those conducting research projects on the issue. I have put together comments from some networkers on P K Rao's paper 10f, with news of these research activities, and with extracts from some recent writing on the issue, and have salted the mixture with a few comments of my own.

Ian Carruthers (Wye College, Ashford, Kent, UK) writes:

> With public sector financial pressures severely affecting irrigation departments as all other public services, (see Howell (ed) Recurrent Costs and Agricultural Development, 1985) aid agencies and Governments are turning again to the old intractable area of user fees and water tariffs. 'Get the prices right' is the current slogan in agricultural policy and it's now dawning that this means get the input prices right as well as the product prices. There is not much enthusiasm in irrigation departments for economic pricing policies, partly because economists and financial analysts can't agree on precisely what this means. However, the main problem is that any revenue is generally not retained by the irrigation department. Aid donors including USAID, World Bank, and ADB have all recently or are currently sponsoring studies to find new approaches to securing finance for O&M, with farmers contributing more than hitherto. Whether or not this is successful there is little doubt that irrigation departments will soon have to reassess the scope and purpose of their workload and possibly hand over some of their responsibilities to farmers. We see strange things happening at present when research reveals how beneficial a water extension service can be and aid agencies promote below outlet public sector investment but often other groups in the same donor agency are through policy dialogue urging withdrawal of public services to match the declining public sector financial resources available to irrigation. Interesting times; watch this space for further reports in the autumn.

The main problem lies in the large systems so it is on these that we should focus, looking at the farmer-operated systems mainly to learn lessons on the capabilities of farmers and local organisations. It is the large systems which generate the really terrifying levels of costs:
A S Widanapiranathan of ARTI, Sri Lanka, notes that by 1981 irrigation was accounting for 9.2 per cent of government expenses.

However, we should not concentrate only on problems. **F L Hotes** (formerly of the World Bank) hopes networkers will contribute

> information on projects which are being successfully operated and maintained, the water pricing structures, direct and indirect, which are in effect in those areas, and the management and organisation arrangements... Examples of successful projects, rather than detailed analyses of poorly operated projects, need to be brought to the attention of those who may have some influence in making the changes that will help accelerate the economic development of their nations.

We should be very glad of descriptions of large projects with fairly satisfactory water rate collection systems and fairly satisfactory maintenance. It is to be hoped that some of the current research projects, which are described by Leslie Small, now with IIMI at Digana Village via Kandy, Sri Lanka, will also produce this information. He writes:

> IIMI is just at the beginning of the development of a network research project (which)... involves studies in five countries which we are doing in collaboration with the Asian Development Bank. Part of this work with the ADB involves collaboration with the World Bank on studies that they have done in at least three countries. In addition USAID has ... two related studies. Ian Carruthers has major responsibility for one. The other was undertaken in four countries and involved a synthesis paper ... by Bill Easter of the University of Minnesota.

My own contribution to this discussion is to point out the importance of differentiating between:

a. operational and maintenance costs (O&M)
b. costs of minor works and small improvements
c. *major* investments, eg in reservoirs, deep tubewells, main canals, etc.

Am I right in thinking it is generally agreed that farmers should meet (a), even though they often do not in practice? There is certainly less agreement that they pay (b) and particularly (c). *Farmers* themselves make this distinction. Can we generalise and say they seem to think it fair they pay (a) if they know that costs are being managed economically; they are *willing* to bear (b) at least on systems or parts of systems which they manage themselves, and they make trouble over (c) - though there are instances of successful schemes recouping *even* these costs.

Lack of clarity as to the purpose of the payment was one of the problems with the *former* irrigation rate in Sri Lanka. Widanapathirana quotes the 1951 Ordinance which related the rate to the supply of water from major works 'in respect of the cost of, or incidental to, the construction or maintenance ...' The rate also suffered the defect noted by Carruthers of being paid into central treasury. Non-payment was not punished, so little was collected. However when the rate was raised in the 1960s to take account of the increased costs of the Mahaweli Scheme, it became a political issue, and was abolished by the new government in 1970.

One of the best summaries of issues requiring consideration before instituting or increasing water rates is in FAO's Irrigation and Drainage Paper 40, Organisation, operation and maintenance of irrigation schemes, Rome 1982, where J A Sagardoy writes:

> Increasing water fees is quite a delicate matter which requires a serious analysis before a decision is made. It will not be the first time that a substantial increase has been suggested in an irrigation scheme and failed because the farmers have refused to pay it. Some of the critical issues which need careful consideration in this analysis are:
>
> i. Is the existing public irrigation organisation of the project efficient? In other words, are all the existing manpower, equipment and administrative procedures really needed?
>
> ii. Are the funds collected through the water rates utilised on the same project? Very often the fees collected go to the central treasury and the recurrent funds made available to the project by the central administration for O&M bear no relation to the fees paid by the farmers. This kind of administrative procedure does not stimulate the farmers to pay since they do not see a direct relationship between their contribution and the services they receive.
>
> iii. Are the farmers informed about what they are paying for? Do they participate in any way in the determination of the water rates? In many instances the water fee represents for the farmer another tax that he has to pay. They are seldom aware what it is for and how it is used.
>
> iv. To what extent do water fees reduce the income arising from the production? In other words, what is the weight of the cost of the water in the total production costs? Obviously, in schemes where water fees are already a sizeable portion of total production costs, any increase would meet considerable resistance. A careful analysis of production costs and income from the main crops

produced in the irrigation scheme should precede any attempt to change water rates.

v. How large are the contributions made by the farmers, in terms of indirect taxes, to the irrigation development? Added value taxes on irrigated land are quite significant in many instances. Total repayment of the investment in these circumstances would not be justified because part of the investment is already paid through the taxes.

vi. Is there malpractice in the collection of fees? Some of the payment methods - especially the volumetric one - are more susceptible than others to malpractice in the collection of fees. This needs careful investigation. There have been schemes with low payment records and after investigation it was found that farmers paid constantly and regularly but a good part of the water fees collected never reached the central or project administration.

The only note one might add is that under iii. farmers should be told if they are paying development costs as well as O&M. While i. and ii. appear to relate to O&M, in v. Sagardoy appears to be thinking of costs of constructing the system.

Having decided there should be a contribution to a, b, or c, or to all three, the next issue for consideration is how to raise it, and the effect of different types of rate or tax on incentives. A good summary of types of payment is available in Easter, 1980.

3. PAYMENTS TO MEET O&M COSTS

Widanapathirana reports the introduction in January 1984 of a new "O&M" levy in Sri Lanka. This differs from the former rate because it is based on 50 per cent of average actual O&M costs in 1981; the rate will be increased to meet full costs in 1989. These contributions are being paid into special funds ear-marked to each scheme. Expenditure from these funds will be on priorities decided in consultation with the farmers. By September 1984 collections were markedly better than previously, but still not much more than 50 per cent in the best districts and negligeable in the worst. It is clear farmers still have to be convinced that they will get the benefit of their payments, and that non-payment will be penalised. We will look forward to hearing from Sri Lankan members on the progress of the new scheme, both as to improvements in collection, and as to improvements in the ability to finance essential maintenance.

In Zimbabwe also politicians during the independence struggle sometimes promised the abolition of the unpopular water rate on the small schemes in communal (African farmed) lands. It has since been reintroduced as a "maintenance fee" due to the high costs of the schemes, but the ability actually to collect it has varied from province to province. The highest of the three rates which may be charged, is around 15 per cent of average farm incomes, but has covered less than one fifth of the government's average O&M costs. The rate is not related to specific scheme costs, which are particularly high on diesel pump schemes, but varies according to whether water is supplied in one or two seasons, and whether it is reliable or variable. There are contrasts between schemes operated by farmers themselves, with maintenance fees of less than Zimbabwe $10/ha, supplemented by quite high inputs of voluntary work, and government schemes, where payments of Z$145/ha do not cover staffing and other costs. While the farmer-operated schemes could be criticised on the grounds that they did not raise enough for improvements they could have afforded, it was also clear that on the government schemes there were frequently too many staff doing work which farmers could do for themselves (and often did do, during the independence struggle). The importance of Sagardoy's point (i) is obvious.

Hotes raises the question as to whether farmers in developing countries, even if represented, have the capacity to judge what is needed for improvement:

> Regarding the question: Are all present costs justified? raised by Dr Rao ... Western USA farmers continually raise that question, but they usually get detailed and prompt responses from project leaders, since the leaders basically are employed by the farmers, and the farmers elected representatives make the final decisions on all capital and operating expenditures. The farmers are good at knowing whether or not too many people are employed. They also know that if they want improved service, it often means slightly increased costs to them. Unfortunately, most farmers in the developing nations have little to say, or even little basis to judge (at least initially), concerning appropriate staffing levels, equipment, and facilities ... Understaffing can be equally as bad as overstaffing, as far as water delivery results are concerned, but of course, at perhaps less cost.

There is also the issue of the basis of assessment. There are theoretical attractions in volumetric payments, ie. by volume of water used, but there are technical difficulties as well as those of malpractice which Sagardoy notes. Zimbabwe's rates for small farmers varied, as described above, according to the quality of the supply. In India, rates levied by the Revenue Department were traditionally based on type of crop. Malhotra, in an article in Wamana, January 1985, describes the "Warimetric" method started on a pilot basis in Haryana, and now extended, with World Bank support for research assessment, to 200,00 hectares. Under the Warabandi system each farmer receives a fixed time for irrigation, varying according to his size of holding, every so many days. The new charge is related to the number of his turns.

In much of the Middle East, O&M costs are traditionally paid on pumped schemes by a share of the crop and it is well known this system was adopted on the Gezira scheme. The advantage of this system is that the revenue of the provider of irrigation varies in accordance with the supply of water - low efficiency in water delivery = depressed yields = depressed income. By the 1970s it has become inefficient in the Gezira partly because it only applied to cotton, and not to the other two crops cultivated by the farmer. Under World Bank prompting, the Gezira switched in 1981/2 to a system of a land and water rate for all crops, and farmers are now charged for actual inputs on a per hectare basis, rather than as previously, an average sum on the basis of kg/cotton delivered. Cotton yields improved as a result; they must, however, also have been helped by a simultaneous drive to catch up on silt and weed clearance. Current research programmes in the Gezira are described in Newsletter 11a. Interestingly, some farmers are now talking of their 'right' to a certain number of irrigations per crop, because they have paid a water rate; this could be awkward for administrators!

4. PAYMENTS FOR MINOR WORKS AND IMPROVEMENTS

Malhotra's article reviews the historical policy in northern India by which government constructed canals, but left groups of farmers to construct at their own cost a watercourse of a few kilometres to bring water to their fields. Because this led to the canal potential not being fully realised, in the early 1970s government decided to reduce the length of farmers' watercourse by extending public canals to 8ha blocks instead of the previous 40ha (approx). This, as Lowdermilk notes in Paper 11c, has recurrent cost implications if government staff are employed to control water deliveries at these lower levels. This was associated with the institution of Command Area Development Authorities, CADAs, and efforts to co-ordinate credit, agricultural and water management, and to assist farmers' associations (see papers 7d by Syed Hashim Ali and 8c by K K Singh). Malhotra implies the CADAs have not achieved all that was hoped of them. It would be interesting to know if any work is being done on the relationships of increased recurrent costs under the CADA system (if any), the effect on farmers' own investments in water course construction and improvement, and any revenue effects to government through direct and indirect taxes on irrigated land.

Lining is another example of minor works to which farmers might be expected to contribute. There were several papers on this subject at a Seminar on Water Management organised by the Centre for Management Studies, Jaipur, at Bikaner in August 1984. Papers agreed that lining had improved efficiency of water utilisation and intensity of irrigation. The seminar recommended 20% of the command area (which was unsettled) should be auctioned to raise funds for lining. However, a paper by Shri Jai Singh Nirwan noted cultivators were avoiding their obligation to maintain the water courses once lined. David Groenfeldt adds some details about one village he studied near the beginning of the Rajasthan canal:

> All watercourses are lined; the work was done between five and two years ago by contractors paid by the Government, with World Bank assistance. The farmers are being charged over a 7 year period to recover some portion of the costs. Only a few have paid anything, and there is now an organised boycott of any further payments. Some of the reasons are:
>
> 1. Poor quality work (in the farmers' view) because most of the cement mortar was "eaten" by the contractor and the various irrigation officials, (cement was in very short supply at the time, and commanded a high black market price). Now parts of the watercourses are weak and deteriorating.
>
> 2. Delays in construction of up to two years, but loan charges (there is interest, even though subsidised) have been levied from the time the contract was signed, rather than from the time the watercourse was actually built. This is not a large financial issue, but it has caused widespread resentment.
>
> 3. Farmers in Haryana State, just 20 km away, have been excused from repaying their lining charges. Their Rajasthani kindred are waiting for their politicians to react in a similar manner to the farmer lobby.

I have been discussing construction, not repair, but the two are closely linked. The government constructed the watercourses and is now charging the farmers, who are complaining that they were not constructed properly, as is evidenced by present deterioration. Since the government did the construction, they are also expected to do the repairs. The farmers complain that they get no help from the irrigation department ... not even materials to patch breaches in the watercourse. The irrigation department claims it is the farmers' responsibility. A World Bank officer was himself uncertain as to whose responsibility it is. The farmers have so far done repairs on their own, but they patch with mud, not cement. The condition of the watercourses looked fine to me, though in the long run, there could be a problem.

The solution suggested by the farmers themselves was that they should have been given the chance to build the watercourses in the first place. If the government had supplied the bricks and cement (and presumably some technical advice) they could have done a better job. This is hindsight, of course, but it does seem to me that they have a point: a lesson for the future.

For the present: should farmers be expected to pay for their watercourses? Clearly some discounting is called for. Interest charges might be written off, and the principle reduced, but in general I consider it fair that they be charged something.

Dr V K Bagda, Chief Technical Officer, Rajasthan Land Development Corporation would say farmers are already paying something. He has done some calculations showing that the on farm development work in Rajasthan has increased intensity of cropping, and that revenue from Mandi (market) tax, sales tax and municipal tax on the increased production from 25,000 developed hectares was Rupees 2,534,000 ie, just over Rs. 100 per hectare (correspondence with ODI, 1984). Unfortunately, the correspondence does not show what the development costs were.

John Duewel has provided a study of two villages in central Java and the relationships between their water user associations (WUA) and the normal village administrative authorities in Agricultural Administration 17,4,1984. Both 'obtain water from multiple, primarily irrigation operated, weirs ... Major responsibility for managing water distribution, conducting maintenance and undertaking technological development, however, is assumed by the individual desa (village administration)'. While the boundary between the WUA and the desa varies in different villages, both have in phased fashion added technical improvements including lining, additional weirs, drop structures, etc. These tended to be financed by the local government, using a combination of annual central government grants to the desa and revenues from desa land.

The option of leaving small and medium scale development and/or improvement to local government is not everywhere available, because not every country has strong local government units. Indeed, the power, and revenues, of local government have often declined in recent years. Yet the local government is often aware of the spread of irrigation benefits to non-farmers in the locality through increased demand for other local services etc. Bell, Hazell and Slade calculated that in the Muda scheme, Malaysia, for every $1 generated in the paddy economy, another 83 cents of value were generated in other sectors of the regional economy. If the tax system allows local government bodies to benefit from this increase in local economic activity, as in the case Bagda cites, local bodies may be willing to finance improvements out of general revenues. Indeed, in California, Easter has noted city voters in local irrigation districts are sometimes more willing than rural voters to support irrigation investment.

In any study of the funding of minor improvements it is to be hoped the role of local government institutions, or possibly regional management boards with farmer representations, as suggested by P K Rao will be examined, along with that of central government and WUAs.

In regard to WUAs, it should not be assumed they always can and will contribute labour, as this will depend on the opportunity cost of their labour at different seasons and in different economic situations. One farmer managed scheme in Zimbabwe did not want to use voluntary labour for improvements (as opposed to maintenance), partly because the work was felt to be beyond farmer competence, and partly because farmers growing two crops a year had no spare time. They were willing to contemplate a kind of building society loan to finance improvements by a technically supervised contractor, but emphasised they would first want information on acutal costs, terms of repayment and date of final payment, so they could (a) make sure it was within their means and (b) be sure the payments did not become a permanent tax unattached to the completion of repayment for a particular item of work.

A final important point in regard to improvements relates to the question who benefits. If the objective of lining is to enable a farmer to irrigate 100 per cent instead of 75 per cent of his own land, he may be willing to pay. If the saved water is to benefit those at the tail, or on another system down river, he assuredly will not.

5. REPAYMENT OF MAJOR INVESTMENT IN INITIAL CONSTRUCTION ETC.

Historically costs of some major investments in dams, canal systems etc have been recovered - the Gezira is a case in point. The Sudan still expects, at least in theory, a return of 3 per cent on its irrigation investments. In Kenya, Mwea is an example of a scheme where farmers' payments do contribute towards amortisation of the initial investment as well as O&M.

It is not reasonable to suppose all present and future project investment costs can be similarly recovered. The cheaper sites have already been exploited, so irrigation development must necessarily depend on the more difficult, and expensive water sources, or take place in areas where costs are high for new transport infrastructure and where farm incomes are limited by distance from markets. It is also probably the case, as P K Rao suggested in 10f, that not all development costs are justified - there are leakages and inefficiencies. The way things are done nowadays, often involving high costs for foreign consultants, also differs from cheaper methods used by previous governments and/or commercial exploiters. P K Rao suggests it is unfair to expect farmers to pay all such costs. Indeed, on some new schemes it looks impossible for any feasible cropping pattern to yield enough for direct farmer charges to make any contribution to the initial investment, if farmers are to earn a reasonable income (Sagardoy's point iv.). In that case, we may have to estimate whether the necessary loans can be financed out of increased indirect taxes collected by government, both from production on the scheme and the multiplier effects on the rest of the economy. This is extremely difficult to quantify; however an educated guess has to be attempted, or poor governments will find themselves with increased loan charges to be met from inadequate revenue - the situation explored in John Howell (ed) Recurrent Costs and Agricultural Development. And in these cases, a final decision has to be made either not to go ahead with a scheme already expensively studied, or to finance it with an international aid grant on humanitarian grounds, provided that it can at least produce enough revenue for recurrent O&M costs.

These problems of water rates, contributions in cash or in labour, contributions from general revenues justified by the multiplier effect of irrigation schemes, humanitarian considerations, have all been considered before, probably whenever large scale irrigation has been undertaken. We have in our library an article by Michael Roberts, reviewing irrigation policy in British Ceylon during the nineteenth century, which shows most of the issues discussed in this article were considered at one time or another more than one hundred years ago!

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IRRIGATION MANAGEMENT NETWORK

NEWSLETTER 12a NOVEMBER 1985

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1. CHANGE OF ADDRESS

ODI is moving to more commodious quarters on 9 December 1985, at Regents College, Inner Circle, Regents Park, London, NW1 4NS, UK. A change of address card is included with this set of papers. Regents College is near Baker Street Underground Station, and quite easy to reach. We hope to see Network members there if they are in London.

2. NETWORK PAPERS

a. The Current Issue

Three papers in this set are linked by an institutional theme. The first is by Cedric Saldanha, who was recently appointed Institution Development Specialist at the Asian Development Bank. We are grateful to the Bank for permission to reproduce his working paper on the preparation of institutional aspects of projects, originally intended for Bank staff. He has used the design of a water management sub-project of an Irrigation Project as his example. His article deals not only with institutional theory and concepts but provides outline checklists for assessing the need for, and for designing, an ID component. (More detailed ones, specific to irrigation systems, have been provided by Anthony Bottrall in his work for the World Bank, reprinted in ODI's Agricultural Administration Unit's Occasional Paper 5 which, as stated in the last Newsletter, is available to Network members at a special price of £3.25, plus £0.50 for surface postage (£3.00 for air mail).)

Saldanha's paper recognises the difficulties inherent in institutional reform. Project design has to take account of existing capabilities and improvements in a realistic time frame. As he says, it is not enough simply to provide a training component if "the institution will not change in ways which match and support the application of the individual's new knowlege". Yet it may not be realistic to plan for dramatic changes in existing government departments.

Saldanha also recognises that methods of assessing and investigating large, complex government operated schemes will differ from those used to assess traditional small schemes whose institutions are deeply rooted in their sociocultural system. The main part of Paper 12c by Robert Yoder and Ed Martin is a questionnaire devised for the rehabilitation needs of existing small systems in the hills of Nepal. This is preceeded by a description of how these systems function. I used the questionnaire in modified form in Zimbabwe, for the rather different situation of small government schemes where it was desired that farmers play a greater role in management. Despite the change of scene, it proved a useful analytic tool. Another part of the Yoder and Martin questionnaire concerns the technical information needed to describe physical arrangements and to identify worthwhile improvements. It then returns to the important question of how farmers would like to organise to raise money and to implement these improvements.

Saldanha's paper for the general approach, Bottrall's guideline for analysing the functioning of government departments related to irrigation, and Yoder and Martin's questionnaire for communal schemes together make up a useful work kit for those involved in the management aspects of a rehabilitation programme.

Saldanha's note that socio-cultural factors are important in assessing how things do at present and might in future function is amply illustrated in Paper 12d by K S Park, a Korean irrigation consultant who describes the institutional arrangements in his own country. Korea has the great advantage of an effective provincial and county local government system which co-ordinates and supervises all government departments. Consequently, it has been possible to attain high rice yields by concerted planning of water improvements and agricultural research and extension. Irrigation systems are run by local managers, in theory elected by farmers, in fact centrally appointed. They depend on water rates raised within the scheme and the 98% collection record will seem enviable to many. However, as Park notes, they are probably under-spending on maintenance (with an implied over-spending on personnel and administration) and are not meeting their commitments on repayment of investment - a situation that may become worse as some of the older schemes require expensive modernisation. Despite quite tight administrative and political control of Korean farmers, they are able to respond to market forces, and Park shows how they have reverted to traditional rice varieties after finding HYVs met consumer resistance on grounds of quality.

Robert Wade, now with the Research Unit, Agricultural and Rural Development Dept, Operational Policy Staff, World Bank, Washington, USA, has written a Discussion Paper No. ARU3 <u>Managing Water Managers: Deterring Expropriation or Equity as a Control Mechanism</u>, which suggests that the Korean institutional structure also has the advantage of making corruption less attractive. Because construction is done by a national parastatal, the staff of the Irrigation Association "do not have their incentives constantly tipped towards construction, nor is their behaviour constantly shaped by the control mode appropriate to construction tasks". Wade's paper is well worth reading alongside K S Park's. (He has also produced a paper, No. 36 on reasons for variations in zeal in common property resources management including canal water in Indian villages, and No. 37 on the unreliability of collected statistics which makes it difficult to calculate efficiency and to determine if this is rising or falling.)

If you trust your statistics, Charles Bailey shows in 12e, how a spreadsheet programme can be used to determine period by period water requirements. As Table 2 shows, many members who have micro computers have a spreadsheet programme. Bailey used Supercalc, but the methodology used in the Gezira, Sudan, could be adapted to any similar software.

3. DISCUSSION ON PREVIOUS PAPERS AND NEWSLETTERS

a. Paper 11e Cost Recovery and Water Tariffs

One of the studies on this subject for USAID has been completed and K William Easter has produced a final draft summary of 4 case studies in Asia. Persons with good reason might be able to get a copy from Mark Svendsen, Office of Technical Resources, Bureau for Asia and the Near East, USAID, Washington DC 20523, USA. We will carry some more information when the other studies underway are also available.

M G Bos of the International Institute for Land Reclamation and Improvement, (ILRI) PO Box 45, 6700 AA, Wageningen, The Netherlands, calls attention to his findings, based on a questionnaire distributed through the International Commission on Irrigation and Drainage in 1971, and reported in M G Bos and J Nutgren On Irrigation Efficiencies, ILRI, reprinted 1982. Altogether, 29 national committees replied in respect of 91 irrigated areas. Information was gathered on the method of water charging, and the proportion of operation, maintenance, and capital costs recovered. Although there were large differences in the water charge within the same country, no direct relation appeared between the level of charges and tertiary unit efficiency in water use. There were no significant differencies in efficiency according to whether water was charged by volume, by cropped area or by farm area. "In those areas where relatively high charges can be levied because of good farm management and high productivity, water distribution and water control on farms is generally efficient". Consequently they concluded that the water charging system that best suited local conditions and was simple to administer should be adopted. However, Bos was talking of 'often low charges for irrigation water'. Certainly, when charges are high, as in pumping schemes, farmers react to higher fuel costs by changing cropping patterns or irrigation practices. This can be tested in any conversation with such a farmer, and is the underlying implication in Tushaar Shah's paper, 11d.

David Potten, of Huntings Technical Services, Boreham Wood, Herts WD6 1SB, UK notes that a summary of cost recovery indices in 5 Asian projects appeared in "Proceedings of the Expert Group Meeting on Water Pricing" Water Resources Series No. 55, ESCAP, UN, New York, 1981. This is still available. Incidentally, a South Korean project gave by far the best returns - see paper 12d! Potten also notes the method used in Burma - the compulsory purchase of a proportion of the crop at low prices. It apparently works there, due to a very firmly administered economic system. This suffers from rigidities - at times the Government may be paying more than a (falling) export price. Similar systems are used on African schemes where the project authorities control marketing; they have worked when the project was efficient and productive as in Semry, Cameroon, and failed when the scheme had low productivity, and low prices provided no farmer incentives. Which brings us back to Bos and Nutgren: high water charges are only feasible if there is high productivity.

On a related topic, Ernest Thiessen, Cornell University, is working on the concept of allocating water shares to all participating in irrigation construction, as a means of spreading the benefits of new schemes beyond those owning land in the command area. The shares could then be transferred by cash sale or otherwise. This is being put into practice in the AHREP scheme, Nepal. Those interested can contact him at 14 Catherine St, Ithaca, NY 14850, USA.

b. Paper 11b The Management of Paddi Systems

Martin Burton, Institute of Irrigation Studies, Southampton University, SO9 5NH, UK, writes in strong disagreement with Seckler's view that "the best solution (to water over-use and loss upstream) is more re-use downstream - more projects, rather than attempts to improve the management of existing projects".

He feels it is essential to discriminate between considered use of drainage water to feed new projects or part of a project, and indiscriminate, ad hoc usage. The latter often arises within a scheme when the management system has deteriorated, so that farmers no longer receive adequate water as planned from a canal, but have resorted to building their own structures across a drain. This in turn can lead to local flooding and still further loss of management control, as it becomes almost impossible to determine where water is coming from and going to, which is a necessary basis for delivering controlled quantities to all parts of the system. Once a system reaches this stage, it requires a planned rehabilitation to bring back management control, to the benefit of the majority of users. From an operator's point of view it is best to supply water to fields via canals, and to drain excess water via drains, not to have an ill defined water route by way of main canal, farmers' fields, drains and back to farmers' fields.

c. Newsletter 11a

A S Widanapathirana notes that the farmer convention at Gal Oya was attended by 4,000, not 400 farmers as reported. This is a good indication of farmer interest in participation.

4. COMPUTER USE

Computer Use

Only 88 members have so far returned the form regarding computer use. Of these, 20 had no computer. Amongst the remaining 68, 34 makes were mentioned, the following more than once:

Table 1

Name	No. of mentions
IBM PC	12 (2 IBM compatibles)
IBM PC XT	3
IBM PC/ATE	2
Apple IIe	5
Apple II+	2
Apple II	4
BBC	6
Apricot	6
Hewlett Packard	3
Compaq	3
Epson	2
Rainbox	3
Osborne	2

Fifty-five types of software were mentioned, the following more than three times:

Table 2

Name	No. of mentions
Wordstar	29
D Base II	19
D Base III	8
Lotus 123	12
Supercalc	6
Microstat	5
Visicalc	3
Symphony	3

If you do like the occasional paper on computer applications, like 12e in this issue, perhaps you could retrieve the form from issue 11 and send it in. We have started with a Spreadsheet article since these seem generally available.

5. NEWS FROM NETWORKERS

a. International Programmes

As several international programmes have recently produced draft or final reports, they are reviewed in section 6.

b. Meetings and Seminars

i. Forthcoming meetings

The Centre of Excellence in Water Resource Engineering, University of Engineering and Technology, Lahore, Pakistan is hosting an International Symposium on Conjunctive Use of Surface and Groundwater for Agriculture in March 1987. The scope includes technical, economic and socio-political issues. Write to the organiser Dr N M Awan, for details. Abstracts of intended papers are required by 30 June 1986. Papers should be in English and contribute something original and of practical importance. The aim is to pool experience and knowledge, not only in regard to basic principles but also on actual results obtained in different countries.

Harry Tuvel, ASCE Headquarters, 345 East 47th St, New York 10017, USA, is the organiser of Water Forum '86 on World Water Issues in Evolution, August 4 - 6 1986 at Long Beach, California. One section will be on irrigation and drainage. Abstracts were wanted by 1 October, so this probably reaches you too late unless you simply would like to attend. It is intended for engineers.

A conference on Hydraulic Design in Water Resources Engineering: Land Drainage will be held at the University of Southampton, 16-18 April, 1986. The aim is to focus on the integrated design of land drainage system and there is a distinguished collection of international authors, on mainly technical topics (one small section on drainage economics). Details from Land Drainage Conference, Dept of Civil Engineering, The University, Southampton, SO9 5NH, UK. The fee is £225.

ii. Meetings in 1985

The Director, Monitoring and Evaluation Division, IFAD, Via del Serafico, Rome 00142, Italy, organised an Asian Regional Workshop on Monitoring and Evaluation of Irrigation Projects, November 1985. The aim was not only to exchange information but also to contribute to a handbook/manual which IFAD intends to work on during 1986.

The Royal Irrigation Department, Thailand, with the FAO Regional Office for Asia and the Pacific, are holding a workshop on Small Scale Irrigation Water Management in Bangkok, 17-20 December, focussing on identifying the factors that make for success, and methodologies for rapid appraisal of technical and institutional needs. The workshop is mainly for nationals concerned with the large small scale sector in Thailand, but with FAO support one or two international consultants are being invited (including Mary Tiffen of ODI).

A seminar on Irrigation Management Policy Issues was organised by the Indian Institute of Management, Bangalore, at Katmandu, Nepal in May 1985. It made recommendations on the planning process, maintenance and training, and manpower development.

c. Training, research and new publications

Ian Carruthers is trying to find a set of about six researchers to form a MPhil/PhD group to work on theses in the area of irrigation/drainage economics. The possibility of scholarships and/or part funding is being explored. Each researcher would undertake fieldwork in his home country with a period of course work before and a period of data analysis and writing afterwards at Wye College, University of London. It is hoped to launch the programme in the Autumn of 1986. Interested persons should write for details to Prof Ian Carruthers, Wye College, University of London, Ashford, Kent TN25 5AH, UK.

CEFIGRE is planning 4 courses of training in Irrigation Management in 1980 each of 5 weeks including 2 weeks of field visits. Three courses will be in French based on case studies in north and west Africa. The fourth course, in the last quarter of 1986, will be in English - details yet to be established. There will also be special 3 week courses in French, in September 1986, on technical, management and economic aspects of small scale schemes, and in November-December on drainage. Details from CEFIGRE, Centre de Formation Internationale à la Gestion des Ressources en Eau, Sophia Antipolis, BP13, 06561 Valbonne Cedex, France.

Short courses at Silsoe College, Bedford MK45 4DT, UK in 1986 with an orientation towards the needs of developing countries include Irrigation (7-11 April) and Soil

Conservation (14-18 April, 2-27 June). Details from Mrs Pam Cook, at the College.

A new journal Irrigation and Drainage Systems, to be edited by M G Bos, International Institute for Land Reclamation and Improvement, with Ian Carruthers of Wye College and Jack Keller, Dept of Agricultural and Irrigation Engineering, Utah State University, Utah, USA, as Associate Editors, and a distinguished international consulting editorial board, will be launched in 1986. It will cover technical, environmental, institutional and economic issues. Papers will undergo the usual academic review procedure. Details from the publishers, Martinus Nijhoff Publishers, PO Box 163, 3300 AD Dordrecht, The Netherlands or 190 Old Derby St, Hingham, MA 02043, USA, who will send a sample copy on request.

This journal should be of interest to many of our readers, particularly those engaged in research. The Irrigation Management Nework, meanwhile will continue to welcome from members a rather different type of paper. We like to receive:

a) reports of innovations, improvements, practical experience in management or planning, which have been successfully implemented in a particular area, and which may have lessons for people elsewhere.

b) short papers opening up new ideas or concepts, which may stimulate debate and new thinking amongst people at the hard end of irrigation management and design, whether in ministries, in the field, or in consultancy.

c. Requests for information

A S Widanapathirana is now working with the Ministry of Agricultural and Natural Resources, PO Box 50, El Fasher, Sudan, on a programme to improve water harvesting and water spreading techniques in seasonal wadis. During the last 15 years the wealthier farmers have learnt to build the necessary infrastructure (though this could be done more efficiently), but the fertile clay-dominant soil is difficult to work with hand tools. He is particularly interested in low cost technologies which might make the resources available to more farmers.

6. PROGRAMMES AND PUBLICATIONS

As several international and national programmes have recently produced draft or final reports, the normal section on their activities is being amalgamated with the review of literature received. One cluster of reports recently received is on African irrigation, another is on training, and we finish with a more miscellaneous group on topics that have been mentioned in previous newsletters or papers.

a. Africa

The most comprehensive study so far on irrigation in Sub-Saharan Africa is Irrigation in Africa South of the Sahara: A Study with Particular Reference to Food Production, FAO Investment Centre in co-operation with the FAO Land and Water Division, Rome, September 1985. For further information contact S Hocombe, FAO Investment Centre, Rome 00100, Italy. The report begins a very necessary process of data collection, analysis and differentiation. It identifies the 8 countries with greatest need to develop irrigation, having little or no land with a reliable rainfed growing period, and which have exceeded the carrying capacity of traditional types of agriculture. Most are small countries with less than 7 million people, and 5 are in francophone Sahel, but the largest is Kenya, with 18 million. Unfortunately the Sahel, and the latest Kenyan scheme, have the highest investment costs, leading to great problems of viability.

FAO tabulates the results of evaluations of 6 World Bank projects. On 5, totalling 275,000 ha, ERR was calculated at 17 - 33% at completion, and only one was negative (in Madagascar). However, a re-examination of a second Madagascar project 4 years later showed production had dropped and ERR had become negative. Disappointing production after completion also negatived an original positive ERR for the Gambian Agricultural Development Project, not listed with the major schemes but with a substantial component for small-scale irrigation.

An evaluation recently requested by the European Development Fund, and carried out by the International Institute for Land Reclamation and Improvement, PO Box 45, 6700 AA Wageningen, The Netherlands, showed that on a sample of 12 projects, the highest ERR was 12.6%, and at least 4 were negative. Eleven were medium-scale projects totalling 15,000 ha; the largest, Operation Microhydraulique in Madagascar, for 40,000 ha spread over 1,400 small units, was relatively successful. Eleven of the twelve projects were in francophone Sahel or Madagascar. Both areas have suffered political or economic constraints on development, with the Sahel also having a series of low rainfall years, which may indicate a change in climatic trends. The final report may soon be available from H Eggers, Evaluation Section, DG8, EEC Development Division, Rue de la Loi 200, 1049 Brussels, Belgium.

The FAO report also differentiates between full and partial water control, and between government and private sector development. It concludes the best investment options for the future lie with rehabilitation of existing large schemes, and the development of the smaller, informal sector, both with greater consideration of farmer requirements. An annex gives preliminary data on irrigation in SSA countries (unfortunately omitting the two with the largest formal irrigation sectors, the Sudan and Madagascar). A second annex suggests a simple economic analysis of project results under different crop yield possibilities, to assist in selecting feasible concepts early in the preparation stage.

The small-scale option, including run-off farming, swamp development, etc. as well as private pumps, are considered in Small Scale Irrigation Schemes in Sub-Saharan Africa: Options Paper, prepared by Silsoe College, Bedford MK45 4DT, UK, for IFAD, February 1985. This is one of several studies now underway to inform IFAD's policy decisions in this area. For information contact H Trupke, Project Controller, Africa Division, IFAD, Via del Serafico, 00142 Rome, Italy. They note the rapid increase in the informal irrigation sector in West Africa in the last 25 years (in Nigeria from 120,000 to 800,000 ha) contrasting with the slow pace and poor results of the formal sector. However, not all small-scale schemes are technically successful. An interesting discussion of factors leading to different rates of development shows the steepest curves are achieved when a replicable innovation is both technically and economically successful. The report also reviews the benefits and problems of channelling aid through NGOs. It is summarised in Outlook on Agriculture, 14,3 1985 (Pergamon Press, UK).

African Irrigation: An Overview: An Annotated Bibliography, containing 1500 items, has been published as WMS Report 37, available from Water Management Synthesis II Project, Agricultural and Irrigation Engineering, Utah State University, Logan, Utah 84322, USA, for $8.00. Utah State will also send details of the companion volume, just published, which contains the summary of USAID's overview on African Irrigation.

FAO Land and Water Division is preparing papers for an important Consultation on Irrigation in Africa in late April 1986, for the main policy makers on agriculture and irrigation in FAO member African countries. The meeting will discuss the present and future role of irrigated agriculture in food production and policy, and strategies and options to obtain irrigation development objectives. The results will feed into the next FAO African Regional Conference in Brazzaville, September 1986, which will focus on food production.

The Ford Foundation has made a grant to the University of Nairobi, Kenya, for a programme of research and workshops designed to lead to a book on irrigation and water management issues in eastern and southern Africa.

b. Training

The Government of India has identified two vital areas for the improvement of its existing irrigation: monitoring of performance, and training (T Edwin, in the Indian Journal of Training and Development, Oct-Mar 1984). Edwin quotes Robert Chambers on the course elements needed by senior, junior and middle level, and entry level operating staff. Edwin further distinguishes between in-service training courses, which can give quick results, and an interdisciplinary syllabus for graduate entrants who have specialised in agriculture or engineering, for longer term improvement. M N Venkatesan, a consultant reporting to USAID, India in March 1985, noted that two Universities (Roorkee in UP and Anna in Tamil Nadu) have established postgraduate courses in irrigation water management, but that these were as yet too classroom orientated for the needs of field professionals and for the staff of the State Training Institutes. The latter are responsible for junior and middle level professional training in irrigation management, under a Government of India programme assisted by the World Bank and USAID. The first group of faculty for the new institutes were therefore sent to Colorado State University. It is good to see evaluation being not only preached but practiced - Venkatesan's report reviews the trainees' evaluations on their return. Most felt that part of the course should be given in India, so that diagnostic analysis could be practiced in relevant circumstances. The report is available from Max Lowdermilk, Irrigation Management Division, USAID, American Embassy, New Delhi, 11021 India. Max Lowdermilk is keenly interested, and well experienced, in the process of transferring water management technology in two way communication between farmers and trainers. He has prepared papers on this which he would be glad to send to anyone wanting to exchange ideas, experience and information.

USAID, India, also produced in July 1985 a draft Irrinage Network Planning Training Manual, aimed at those responsible for running training workshops. The final version may now be available from Max Lowdermilk at the same address. Irrinage is a word coined to combine irrigation and drainage. The Manual contains some very good guidelines on the process of organising a training workshop, and on appropriate teaching methods for the professional people who will be the trainees. However, some of the material in it requires further thought; one hopes it may have already been improved. It is interesting to note that while the African reports quoted above argue in favour of simple developments to start with, phased over adequate time to allow for the build-up of experience, this manual condemns the way Indian schemes have evolved haphazardly, without adequate initial provision for drains and farm access roads. While it is indeed expensive to have to put these in at a later date, there may be neither money, skills nor incentive to put them in and maintain them at an earlier stage in irrigation development. After many years of irrigation development land has been parcelled out amongst heirs, sold off or bought in in irregular pieces, etc., the pattern of holdings is complex and irregular and population density has increased. The planning manual recognises that imposing a rectangular layout during improvement will run into difficulties in the reallotment of land. It recommends instead following the contours, which will indeed avoid topographical constraints, but may equally run across farm boundaries. In the circumstances, it seems strange that it is only at step 19 that the layout is discussed with farmers, before finalisation at step 20. Yem Othman, in Network Paper 6b, and Martin Adams in Paper 7b disucssed methods and advantages of bringing in farmers at a far earlier stage.

Water Resources Management Ltd, 39 Sandown Park, Tunbridge Wells, Kent TN2 4RU, UK, has produced a training manual Farm Water Management aimed at the lower level extension staff in actual contact with the farmers involved in on-farm water development programmes.

Martin Burton and Ian Smout gave a lunchtime meeting talk at ODI on in service training for the East Java irrigation rehabilitation programme. Their solution to the problem of relevance was a mobile training team that trained on site. We hope to have a paper in the next issue, March 1986.

The Ministry of Agriculture, Kenya have produced four practical manuals aimed at field staff responsible for assisting farmers in layout, constructing and running their own small scale schemes. They are rather bulky, and I am not sure how many have been printed and whether the NIB can spare copies, but those with good reason for wanting to see them can either look at the ODI copies or try writing to LDD/Irrigation and Drainage Branch, Ministry of Agriculture and Livestock Development, Nairobi, Kenya.

Another training manual available from USAID, India, is a Construction Quality Control Manaual listing tests and procedures. They have also compiled a list of the visual aids for Irrigation Water Management Training. For details of a set of slides on Water Delivery Control Methods prepared by Professors Charles Burt and Frank Coyos, write to the Dept of Agricultural Engineering, California Polytechnic State University, San Luis Obispo, California 93407, USA.

Not a training manual, but a useful refresher document for those engaged in irrigation planning is Guidelines: Land

Evaluation for Irrigated Agriculture, FAO soils bulletin 55, FAO, Rome, April 1985. This is far more comprehensive than the title suggests, for the authors, (B Eavis, Land Resources Development Centre, UK; R Struthers, formerly of the USBR and others) take land evaluation to be more than soil classification. They differentiate between the first stage of identifying areas as 'provisionally irrigable', provided water can be brought to them at acceptable cost, and the later stage of identifying 'irrigable' land, which takes account of the net benefit brought by the project and its acceptability to farmers. The check list provided for socio-economic data, which I can best evaluate, is good; the ones for agronomic considerations, water quantity in relation to need and supply, etc. etc. also look comprehensive. Critical management resources are perhaps the least well treated.

Soils bulletin 55 could be perhaps one of the textbooks for the inter-disciplinary post-graduate courses in irrigation which more universities are now establishing. New ones are at the University of the Gezira, Wad Medani, Sudan, (in the Faculty of Agriculture with contributions from the Faculty of Economics and Rural Development and some inputs from Hydraulics Research) and, from October 1986, at the University of Newcastle, (a joint course of Faculties of Engineering and Agriculture). Contact John Gowing, Dept of Agricultural Engineering, Porter Building, St Thomas St, Newcastle NE1 7RU, UK.

Another textbook aimed at graduate level personnel is Soil-Water Management, ed. A K Turner et al. Based on lectures originally given in Indonesia, it is available from the International Development Program of Australian Universities, GPO Box 2006, Canberra ACT 26001, Australia.

c. Other reports and programmes

The Final Report on the Demand Irrigation Schedule Concrete Pipeline Pilot Project by John L Merriam is now available from the Mahaweli Development Board, PO Box 1667, Colombo, Sri Lanka. Merriam was also giving a paper on it at the US ICID meeting in Reno, Nevada, USA, November 1985. Anyone contemplating the introduction of this system, which has certainly advantages for the farmer, should look at this report, which discusses the learning difficulties of farmers, operators and constructors, as well as the increased production resulting from it.

USAID/Jakarta, c/o US Embassy, 3 Jalan Medan, Merdeka Selatan, Jakarta, Indonesia, has been working with the Indonesian Government on a programme called High Performance Sederhana Irrigation Systems (HPSIS). Sederhana are small scale projects. The project is to test the idea that farmer participation can improve the quality of small scale government supported irrigation. David Robinson has produced two papers on findings to date from an analysis of 718 farmers in 12 systems. He notes it is important to ask if farmer participation increases the efficiency of irrigation, either by reducing management costs, or by increasing productivity. We have also to ask what the benefit is to farmers of participation in the various stages, (design, construction, maintenance). Participation always has a cost; the farmer must forego other more directly profitable or pleasurable activity to work or to attend meetings. One could assume farmers would be keenest to participate in design (once-off input, short commitment, long term benefit in a system operating as they desire); that they might be willing to participate in construction (also once-off, but longer commitment), if it brought them a desired improvement at lower cost; that they would participate in maintenance provided this could be fitted in incidentally to other activities, or in an off-season, but that otherwise they might prefer to pay someone else to supervise, manage and maintain the system if this means long commitments of time. However, even if they preferred to leave these things to A N Other, they might still be keen on formal annual meetings of a WUA to elect or sack him.

So far Robinson's results show that HPSIS have successfully involved farmers in design and construction. Other people may be interested to learn the approach HPSIS used in securing this, and may like to write direct to Robinson.

7. LUNCHTIME MEETINGS AT ODI

27 June 1985: Fred Kaul 'Water Resources Development Planning: A Case Study of Institutional Strengthening in a Developing Country'. (Fred Kaul, Binnies & Partners, Artillery House, Artillery Row, Westminster, London SW1P 1RX, UK.)

25 September 1985: Geoff Wood 'Provision of Irrigation Services by the Landless in Bangladesh'. (Geoff Wood, School of Humanities & Social Sciences, University of Bath, Claverton Down, Bath BA2 7AY, UK.)

10 October 1985: Martin Burton and Ian Smout 'Training Programmes for Irrigation Staff and Farmers - Two Examples from East Java, Indonesia'. (Martin Burton, Institute of Irrigation Studies, The University, Southampton SO9 5NH, UK; Ian Smout, Sir M MacDonald & Partners, Demeter House, Station Road, Cambridge CB1 2RS, UK.)

26 November 1985: Dr L Worth Fitzgerald 'USAID: African Irrigation Overview, Study and Follow Up'.
(Dr L Worth Fitzgerald, Office of Agriculture, Rm 408 SA-18, Bureau of Science and Technology, Agency for International Development, Washington DC 20523, USA.)

27 November 1985 Mary Tiffen

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 12b

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INSTITUTION DEVELOPMENT ISSUES IN RURAL PROJECTS

by

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INSTITUTION DEVELOPMENT ISSUES IN RURAL PROJECTS

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1. INTRODUCTION

Project performance audit reports of most multilateral financing institutions such as IBRD, ADB, and IADB, have consistently been attributing project success or failure to, among other reasons, the efficiency and effectiveness of executing and collaborating national and local institutions. In parallel, the strengthening of institutions to help support development investments has become an accepted and important strategy for economic development planners. Yet, while the role of institution development (ID) has been receiving increasing attention, there continues to exist a relative lack of consistency in the use of systematic methods and approaches to assess ID needs, develop ID strategies and monitor ID progress.

The purpose of this paper is to review some of the basic concepts of institution development, to describe some of the systematic approaches that are available for identifying ID needs and designing ID services into irrigation and rural development projects, and to develop an ID checklist which may be used as a guide during project design to help ensure important ID concerns are appropriately addressed. It is hoped that consequently, more time, attention and specialist assistance will be made available by external aid agencies and developing country governments during project design to identify and validate ID needs and to develop and implement required ID services.

2. DEFINITIONS AND BASIC CONCEPTS

a. Definitions

ID means many things to different people. To some it is primarily training of institutional staff for the enhacement of skills. To others, it deals with all "non-technical issues and human capacity".[1] The World Bank defines it as the "process of creating or strengthening the capability of institutions to make more effective use of available human,

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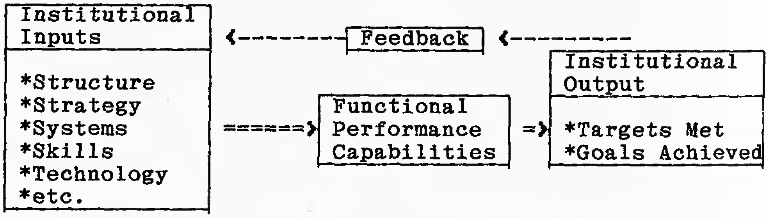
[1]Asian Agricultural Survey II, Supplementary Papers, Vol 1, p 124.

financial and other resources".[2]

An institution is essentially a group of individuals who work together to achieve preidentified goals and targets. To assist them achieve these goals and targets they create, develop and maintain specific institutional performance capabilities in various functional areas. These functional capabilities in turn are made possible with the help of various institutional inputs which include organisation structure, technology, systems and procedures, operating strategies, etc.



ID is, if we were to put it simply, the creation or strengthening of an institution's self-sustaining capabilities to help fulfil its functions and purposes. It therefore implies the enhancement of related institutional inputs as described above.

b. Types of institution development

At the first and most simple level, ID focuses on the productivity enhancement of the individuals in the organisation through education and training, reorientating management style, enhancing staff compensation and/or incentives, etc. This is the kind of ID most commonly built into externally aided development projects. The objective is to upgrade the quality and quantity of staff in areas such as project planning, maintenance, etc. Training is generally the preferred method since it is the most easily organised and implemented by, for example, sponsorships to attend university courses, on-the-job training, exposure-visits to other institutions, demonstration farms, etc.

At a second and more complex level, ID is often concerned with enhancing or modifying the technology of the

[2] The WB and Institutional Development Experience, 1980.

institution. This often implies change in the type of machinery and equipment used, modification in the flow, pace and arrangement of technical procedures, introduction of innovative methods and techniques, eg. the irrigation of diversified cropping systems, mechanised harvesting and post-harvesting methods, improving executing agency (EA) capability for environmental monitoring, etc.

In addition, ID is sometimes also concerned with reorganising institutional roles, structures and work processes. Institutional analysis often uncovers the need to rearrange work roles, reassign or transfer operational responsibilities, revise administrative procedures, develop innovative coordination mechanisms between various groups, agencies or departments, etc. This type of ID intervention is perhaps the most difficult to implement due to the very natural resistance of organisation groups to let go of roles, authority and influence, and change their set ways of administering their responsibilities. Aid agencies are aware of the difficulty in implementing such types of ID interventions and attempt such exercises only rarely and with great caution.

Since no institution exists in an environmental vacuum, the fourth area of concern for ID is to help enhance the institution's capacity to use more effectively its resources of staff, technology, processes, etc. to cope with changing external pressures and risks. This is done through a central operating strategy which, ideally, needs continuous updating in the context of the changing needs of the environment. Aid agencies often use technical assistance to help both national planning institutions, as well as sectoral executing agencies to review and examine national and sectoral needs and revise development and investment strategies accordingly.

In one sense, it is impossible to think of an institution as only a set of people, only a technology, only a structure and process, or only a strategic operation. Any problem in one part of the institution affects not only overall goal achievement, but also the performance and role of the other aspects of the institution. Correspondingly, any attempt to change one part of the institution (eg. enhance staff skills) must invariably affect other parts (eg. technology, processes, etc.). Unfortunately, much institution development tends to focus only on a part of the institution: efforts to change individuals (through training), efforts to revise technological processes (through new equipment, research) etc. For instance, research clearly indicates that training frequently fails to achieve results either because the institution's structures and processes are incongruent with the training imparted, or the institution will not change in ways which match and support the application of the individual's new knowledge.

Consequently, while it maybe relevant to initiate an ID intervention in only a part of the institution, all four approaches must be integrated, in a mutually supportive manner, in order to achieve a substantial and self-sustaining change in the institution.[3]

c. Types of institutions

The focus of ID efforts to help enhance economic development is, potentially, the whole spectrum of institutions who are involved in developing countries in various economic development and administrative functions. From an institution development perspective, these various institutions can generally be classified into two major categories:[4]

i. Government agencies responsible for economic development and administration; and

ii. Beneficiaries organisations who assist in the appropriate utilisation or management of the services or technologies offered to them, eg. water user associations, compact farmer groups, credit or marketing co-operatives, etc.

Government agencies with whom the Bank collaborates maybe further sub-categorised by function:

i. Planning agencies in the development planning and administration hierarchy who are responsible for formulating appropriate policy and strategy, and generally planning the allocation of resources among regions and target groups;

ii. Central executing agencies or public sector and autonomous bodies and participant organisations who implement specific programs and projects;

iii. Regional or provincial agencies who operate, maintain and regulate the delivery of services; and

iv. Local government who is directly responsible for catalysing and being responsible for constituency needs.

An indicative framework of the various functional capabilities of such government agencies is given in Appendix 1. It is these functional capabilities that are generally the focus of ID efforts.

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[3]Friedlander Frank, "Purpose and Values in CD", ASTD, 1976.

[4]Non-Governmental Organisations (NGOs) are also increasingly being recognised as major contributors to the development efforts.

In practice, because of the project-oriented nature of their operations, external aid agencies are generally and predominantly associated with national executing agencies and public sector service bodies in the agricultural sector. And in as much as this association primarily revolves around the functions of project identification, design and implementation, it is such institutional capabilities that are and generally have been the primary focus of their institutional development efforts and assistance. This does not, however, imply that they have not given ID assistance to national planning agencies, regional or provincial agencies, local government bodies or beneficiary organisations to help build capabilities such as policy formulation, sector planning, operation and maintenance, water management, etc. This has been done, though not to the extent perhaps as in areas directly related to project design and implementation.

3. INSTITUTIONAL ASSESSMENTS

a. Purposes of institutional assessments

An institutional assessment is, by far, the most critical part of an institution development exercise. It charts out the course for the design, implementation methodology and resource requirements of an ID exercise, be it in the form of technical assistance or as a project component. Institutional assessments should be as much a critical element of sectoral analyses or project feasibility studies, as economic, agronomic and engineering assessments. In fact, institutional assessments of executing agencies and beneficiary organisations can and should be used for any or all of the following reasons:

i. In respect of government bodies/executing agencies:

A. as criteria to decide on whether to postpone the approval of a project loan till appropriate institutional strengthening has been achieved;

B. to assist in identifying the institution's specific development needs, both project-related as well as long term, that need to be addressed;

C. to help ensure that the scope of the project and the technology it will use is tailored to the implementing agencies' capabilities and the socio-cultural context of the beneficiaries and the environment; and

D. to assist in arriving at appropriate project organisation and management arrangements.

ii. <u>In respect of beneficiary organisations</u>:

A. to help assess the extent to which beneficiary organisations are <u>capable of participating</u> in the design, construction, operation and maintenance of the project; and the <u>kind of assistance</u> they will require to enable them to do so; and

B. to help arrive at and implement appropriate <u>coordination arrangements</u> between beneficiary organisations, the local administrative authorities and the project for both construction as well as O&M purposes.

<u>b. Types of institutional assessments</u>

i. <u>Institutional assessments of government or public sector organisations</u> Various well-known techniques and methods are available to carry out comprehensive institutional assessments of formal institutions such as government or business organisations. Given below is a general outline of some of the more widely accepted methodologies.

A. <u>Institutional performance analysis</u> The performance analysis method utilises a framework of goals, performance indicators, targets, standards and comparator institutions to measure and compare an institution's performance, if any. These gaps in performance, identified in clear and tangible terms are the starting point for identifying an institution's requirements for development assistance. A diagnostic analysis is used to develop and empirically test causal linkages between negative performance variances and related deficient institutional inputs such as inadequate staff skills or motivation, inappropriate procedures, ineffective supervision, etc. Specific institutional capabilities that require upgrading are thereby pinpointed for immediate attention.

B. <u>Institutional profile assessment</u> Unlike the performance analysis method which is performance based, the institutional profile assessment method uses essentially an <u>a priori</u> approach to institutional assessment. A profile of the input-output ratios and relationships within the institution is developed. Key institutional inputs such as the operating processes, systems and procedures, financial and budgetary management capacity, type, quantity and quality of staff, etc. are assessed in terms of their adequacy to cope with the projected output required of the institution. Comparisons are made with an ideal situation and with appropriate comparator organisations. Consequent deficiencies are identified for ID assistance. Though in some ways incomplete by itself, this is the method most commonly used by aid agencies to assess prospective executing agencies.

C. Institutional financial audit The institutional financial audit concentrates on assessing the financial strength and stability of an institution. It thus examines finance-related aspects and performance indicators of the institution such as its profitability, liquidity, assets management, accounting practices, budgetary control, etc. While essential, especially for private and public sector bodies, such kinds of audits address only one aspect of an overall institutional assessment.

ii. Institutional assessments of beneficiary organisations Beneficiary organisations themselves can differ substantially from one to the other in terms of their purpose, size, complexity, and degree of organisation. At one end of the spectrum are beneficiary organisations such as the Irrigation Associations of Taiwan and the National Dairy Development Cooperatives of India which have evolved and grown into large, formal and rational bureaucracies. Assessments of such institutions will follow methodologies similar to those which have been described above as suited for assessing government bureaucracies.

At the other end of the spectrum are beneficiary organisations such as the Subaks of Bali, the village-based agro co-ops of India and Bangladesh, water-user associations of communal systems in Indonesia and the Philippines, etc. These are small organisations, with intricate and inalienable links to the local socio-cultural customs, traditions and value systems. Their rules, regulations, procedures, authority and role structures etc. are generally deeply anchored in custom and convention rather than in rational logic. Consequently, institutional assessment methods which are meant primarily for formal institutions and are predominantly performance-based are not totally suited for assessing such institutions. These methods have to be complemented with and carefully integrated into a wider socio-cultural-institutional enquiry which is more suited and capable of addressing such issues.

A. Socio-economic surveys Such surveys are often used to obtain a clearer picture and assessment of the social and economic status of the proposed beneficiaries primarily for project benefit monitoring and evaluation purposes. In the process, such surveys also offer scope for an assessment of the organisational and technical capacities of beneficiaries, their willingness to participate in a project and their financial ability to pay for some or all of the services to be rendered.

B. Socio-institutional investigations Experience, however, indicates that the conventional research methods adopted by formal socio-economic surveys using rigorous sampling, statistical analysis and numerical presentations of findings are _not_ the most effective method of assessing the dynamics of the socio-technical systems and institutions which govern village and rural life. They are consequently not the most appropriate to serve as a basis for developing ID interventions for village-based beneficiary organisations. It has been demonstrated that it is more effective and productive for the social scientist assessor to conduct socio-institutional investigations which utilise informal surveys, guided interviews, disciplined observation techniques, and require a substantial degree of intimate familiarity with village behaviour. Such investigations also present findings and assessments as narrative presentations rather than as static profiles, to allow adequate coverage of the social and cultural dynamics and nuances of village-based institutions.[5]

4. INSTITUTIONAL DEVELOPMENT SERVICES

ID services should _never_ be designed and planned for unless based on a prior institutional assessment exercise. In practice, though, this often does not happen. Training services, for example, are invariably built into a project primarily on an assumption that they are necessary and required. Provision is made for the establishment of Water User Associations often without substantive prior enquiry as to whether they exist at all, in what form, since when, etc.

As mentioned in Part II, b, various types of ID services can be designed into a project if demonstrated as necessary. Generally speaking, such services will fall into the following categories:

i. skill enhancement;
ii. increase in staff incentives;
iii. systems/standards/procedures revision or development;
iv. introduction of new or upgraded technology;
v. organisational structural changes, which may also include adjustments in coordination linkages;
vi. policy/strategy adjustments or changes; and
vii. enhancement of resources: adequate staffing, equipment, budget, etc.

While institutional assessments may demonstrate the need for specific ID services, the extent to which such services

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[5] Korten, David: "Community Organisation and Rural Development: A Learning Process Approach", Public Administration Review, Sept 1980.

should be undertaken and financed will depend on the following considerations:

i. the gravity and urgency of the deficiency to be addressed in relation to project success;
ii. the commitment of the institution (executing agency) concerned;
iii. the support available in the administrative environment surrounding the institution; and
iv. the availability of required resources such as time, finance, and expert assistance.

5. CHECKLISTS FOR PROJECT DESIGNERS

The following are checklists of actions that may be used as a reference by project designers in regard to the planning for, designing and monitoring of institution development activities related to the preparation and implementation of irrigation and rural development projects.

a. Checklist for institutional assessments

i. In regard to prospective Executing Agency's (EA's) capabilities vis-a-vis the project's design, construction and O&M

A. Has your agency had substantial dealings with the proposed EA?

If not - a thorough institutional assessment should be conducted at project preparatory stages.

If yes - a thorough enquiry with the help of your agency's records should be conducted to assess the relative strength of the EA based on its performance with past projects; and whether in-depth in-field assessment is merited. If the EA has a proven record for good performance, an in-depth assessment will not be necessary.

B. Is the project of a special nature (eg. innovative technology, complex organisational linkages, etc.) that may require specialised institutional assistance?

If no - institutional assessments may be dispensed with.

If yes - (1) assess the project's special requirements; (2) assess the EA's current capabilities in this regard; and (3) identify the specific types of institutional assistance that will be required.

ii. In regard to prospective beneficiary organisations

A. Does the project allow scope for beneficiary participation and involvement in design, construction and O&M?

If no - beneficiary investigations in the form of a socio-economic survey should suffice.

If yes - then enquiry should be made if the beneficiary institutions are currently organised.

If they are not currently organised - then a socio-cultural assessment should be made to identify the potential and the methods for organising them.

If they are currently organised - then an institutional assessment should be made of their capabilities to participate effectively; and if assistance is called for, appropriate ID assistance should be planned for and designed.

b. Checklist for designing an ID component of a project[6]

If an institutional assessment indicates the need for specific ID services, these should be built into the project and designed for, keeping in mind the following:

i. Describe the specific institutional capability/ies that will be developed or enhanced, ie. the objectives to be achieved by this component;

ii. summarise the empirical evidence that demonstrates that this capability is currently weak or non-existent. This will later serve as the performance indicator/s to assess the impact of this component;

iii. describe the specific and various methods that will be used to enhance this capability. These methods should preferably adopt a multi-pronged approach, ie. training, revision of procedures if necessary, appropriate staff incentives if called for, etc.;

iv. identify the type, extent (man-months), specific terms of reference and time schedule of consultant expertise that will be required. A balanced staff input should be provided for between technical expertise and the training and ID specialisations made available; and

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[6]More detailed guidelines are given in Appendix 2 using the example of a water-management component of an irrigation project.

v. develop an outline of a performance plan and work schedule with suitable performance indicators and milestone targets. This will be discussed with the Government for its acceptability and refined on the appointment of consultants and in collaboration with them.

Appendix 1

INDICATIVE FRAMEWORK OF FUNCTIONAL CAPABILITIES OF GOVERNMEMT INSTITUTIONS IN DEVELOPING PLANNING AND ADMINISTRATION

Key Institutional Functions	Key Institutional Capabilities
1.1 Policy, strategy and programme development	1.1.1 Economic & social research 1.1.2 Sectoral analysis 1.1.3 Policy analysis, formulation and review 1.1.4 Strategy and programme development 1.1.5 PBME and management information system
1.2 Project identification, design and evaluation	1.2.1 Technical capacities in engineering, agronomy, etc. 1.2.2 Economic and financial analysis 1.2.3 Institutional analysis and planning 1.2.4 Cost and schedule planning
1.3 Project implementation and management	1.3.1 Technical capacities in design, construction, etc. 1.3.2 Procurement and materials management 1.3.3 Budgeting and accounting 1.3.4 Overall project management
1.4 Management and administration of services, ie. O&M	1.4.1 Technical capacities in engineering, agronomy, etc. 1.4.2 Operation and management of services, eg. water delivery, credit co-operatives, agricultural input distribution etc. 1.4.3 Maintenance of infrastructure 1.4.4 Budgeting and financial management 1.4.5 Coordination with beneficiary groups and associated services.

1.5 Resources management and administration	1.5.1 Performance planning and monitoring 1.5.2 Funding coordination 1.5.3 Financial planning and management 1.5.4 Budgeting and accounting 1.5.5 Manpower planning and staffing 1.5.6 Personnel management

Appendix 2

A SPECIMEN INSTITUTION DEVELOPMENT INTERVENTION

Designing a Water-Management Sub-Project as a Component of an Irrigation Project

A major concern in regard to all irrigation projects is the task of ensuring that water is distributed efficiently and effectively through the main and on-farm systems once these have been constructed, and that the newly-constructed irrigation canals and structures are appropriately maintained. Lately external aid agencies have encouraged the use of a discrete water management component as part of their irrigation projects, to help achieve this important objective. This component generally takes the form of a Water-Management Sub-Project or a Water-Management Training Centre which have specific institution development objectives in regard to the enhancement of the O&M capabilities of the local irrigation administration and of the concerned farmer organisations. Such components have obtained allocations ranging from half a million dollars (ADB's Bali Sector Project - Indonesia) to almost $7 million (ADB's Second Irrigation Sector - Indonesia).

Guiding Principles

Experience with ongoing water management sub-projects indicates that it is advisable to adhere to the following principles when designing new water management sub-projects, and to monitor closely the observance of these principles during reviews of implementation:

(i) Sub-Project's Objectives: The key objectives of a water-management sub-project should not be to itself develop and implement effective water management and O&M systems, but to assist and enhance the capabilities of the local irrigation administration and the farmer-organisations in doing the same. The latter is a very different and far more difficult objective to the former. This developmental orientation should therefore be reflected in the sub-project's organisation structure, its operational emphasis, its type of activities and programmes and the type of staff that will be mobilised and used.

(ii) Sub-Project's Organisation Structure: It is critical that the local irrigation administration and other local authorities are both organisationally and operationally involved in the sub-project. This serves two purposes: (1) it assists in obtaining the active collaboration of the local irrigation authority in investigative work, and its co-operation in the implementation of the sub-project's recommendations; and (2) it helps ensure that the sub-project itself does not work in isolation of the local administration. From an organisation standpoint, this can be achieved by arranging for functionaries of the local irrigation administration to fulfil appropriate project supervision positions. From an operational standpoint, field investigations should be done hand-in-hand with the local irrigation authority.

(iii) Operational Emphasis: In the past, once the water management component becomes operational, it has been observed that the tendency is to adopt the blueprint approach. The project staff, working predominantly in isolation of the local authorities and/or the farmers, research and develop optimum water management systems. On development of what, in the sub-project's opinion, are optimum water management and O&M systems, an attempt is then made to persuade the local authorities and farmers to accept and implement the sub-project's recommendations. To assist this process of persuasion, the sub-project uses the formal classroom training approach. An operational distinction is thereby made between the research and development stage and the implementation stage. This operational strategy has met with limited success. The alternative approach being recommended here is what may be generally classified as the action-learning approach. Research of the new system is to be done hand-in-hand with operating personnel and with farmers and a substantial amount of time is spent in the field testing approaches, step by step, and keeping in contact with operating realities. The relationship between the research and development phase and the implementation phase is therefore more interactive; and training of the local administration and farmers is primarily on-the-job.

(iv) Sub-Project's Activities/Programmes: It is essential that a Performance Plan is developed for the sub-project which clearly spells out the sub-project's objectives, envisaged impact, key performance indicators, and the various programmes planned to help achieve specific performance targets. Each programme, in turn, should be clearly profiled in terms of its specific objectives, target group/s, implementation schedule, allocation of resources, etc. Indicative samples of a Performance Plan and a Programme Profile are shown in Annexures I & II. Such Performance Plans and Programme Profiles are especially important in such a software type of project to help monitor progress and assess impact.

(v) <u>Sub-Project and Consultant Staff:</u> A balanced staff input should be achieved between the technical expertise and the training and institution development specialisations made available. Water management is as much an organisational, managerial and social issue as it is a technical one. Technically optimum water distribution systems need not necessarily be organisationally practical or socially acceptable. The sub-project has, therefore, to develop and use a balanced and integrated approach to the achievement of its objectives.

Appendix 2
Annexure 1

FRAMEWORK FOR A PERFORMANCE PLAN FOR A WATER-MANAGEMENT COMPONENT OF AN IRRIGATION PROJECT

Ultimate Objectives	Project Objectives	Performance Indicators	Targets	Possible Programmes*
Increase in: - Yield - Production - Cropping Intensity - Cropping Extensiveness	I. Assist farmers in operating and monitoring the on-farm system efficiently and effectively	*Increase in yield & production *Increase in cropping intensity *Percentage of irrigation system used *Reduction in period of land preparation *Percentage of farmers' contributing to O&M *Number of inter-farmer conflicts	(To be decided by the project after detailed diagnostic assessments in the field)	(1) Pilot Tertiary Blocks (PTBs) (2) Demonstration Farms (3) Community Organiser Programme (4) Extension Programme
	II. Assist the local adminis- tration in operating and maintaining the main system efficiently & effectively	*Increase in irrigation area (especially in dry season) *Increase in yields and production *Actual water delivery versus schedule at Main, Secondary and Tertiary Turnouts *Reduction in period of land preparation per tertiary due to increased water supply *Percentage of area delayed for land preparation against schedule *No. of Canal kms maintained versus schedule *Number of illegal openings/ offtakes *Timeliness and accuracy of operational data reports	(To be decided by the project after detailed diagnostic assessments in the field)	1) Development & implementation of Water-Distribution Plan 2) Development & implementation of Maintenance Plan 3) Development & implementation of budgetary & accounting system 4) Development & implementation of reporting procedures and coordination mechanisms

* A detailed profile should be developed for each of these programme to include the programme sub-objectives, schedule, allocation of resources, etc.

Appendix 2
Annexure II

AN INDICATIVE PROGRAMME PROFILE[7]

1.	Name of Programme	Pilot Tertiary Blocks (PTB)
2.	Programme Objectives	Efficient and effective on-farm water management and O&M by the farmers.
3.	Specific Tasks	
	Task 1	To develop optimum and practical on-farm water-distribution and maintenance plans in collaboration with the farmers of the PTB.
	Task 2	To develop and test methods for assisting the farmers in preparing and organising themselves for implementing the water-distribution and maintenance plans.
	Task 3	Assist in actual implementation and monitor results.
	Task 4	Develop plans for wider application in collaboration with local administration and prepare local administration for this task.
4.	Scope of Programme	The PTB programme will be implemented using ___ PTBs of approximately ___ to ___ ha each, in ____ geographically discrete and strategic locations in the proposed project area. Criteria for choice of locations will be: (1) balanced geographical spread in the project area; (2) willingness of farmers to collaborate; and (3) preference of local O&M administration for whatever valid location-specific reasons.

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[7] An actual program profile should be normally developed in far more specific detail preferably at the time of appraisal.

5. Schedule	The programme will spread over ___ months beginning in the month of ___. The programme will be run concomitantly in all of the locations.
6. Staff Resources	One full time supervisor from the project will be assigned to the programme. He will be assisted by one field staff at each PTB location who will be assigned by the local administration. These field staff should be chosen with care keeping in mind that the tasks to be carried out require skill in interaction with the farmers.
7. Reporting	Inception report at the end of the first month. Progress reports at the end of each quarter.

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IRRIGATION MANAGEMENT NETWORK

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IDENTIFICATION AND UTILIZATION OF FARMER RESOURCES IN IRRIGATION DEVELOPMENT: A GUIDE FOR RAPID APPRAISAL

by

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and

Ed Martin

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Contents

Editor's Preface

This paper divides into two parts. The first describes how some Nepalese communal systems are organised, institutionally and technologically.

The second part is a question guide for obtaining this type of information, prior to designing any kind of intervention in the system.

I have found it can be adapted to very different situations from the one for which it was initially devised. By omitting some sections and modifying others it was useful in identifying the rehabilitation needs and institutional reorganisation requirements of small government-run schemes in Zimbabwe, where there was an intention to transfer increased responsibility to the existing farmers' management committees.

It is always important to avoid overburdening the informants. In some cases it may be possible to ask the questions over a period of time; when the visit to a system has to be brief but there are several interviewers (eg. an engineer, an agronomist, a sociologist) it may be possible for each to take some of the questions and interview separately different groups or persons. Some questions can be best answered by a local authority or village council, others by a group of farmers or an extension assistant, others by the committee, others by the responsible officer or employee of the sytem. Questions may have to be shuffled around from one section to another according to local circumstances, so as to group those best answered by particular classes of informant.

In some cases it may be possible to have a two stage intereview, to allow time for reflection. In Zimbabwe we were able to leave a letter with the Committee, asking them to arrange full discussion on the perceived needs for physical works, preferred future cropping patterns, and organisational, staffing and financial requirements if they were to manage the system themselves. Thanks to a good postal service, most committees were able to respond by the deadline they were given.

IDENTIFICATION AND UTILIZATION OF FARMER RESOURCES IN IRRIGATION DEVELOPMENT: A GUIDE FOR RAPID APPRAISAL

Robert Yoder
Ed Martin

1. INTRODUCTION

In most places in the hills of Nepal, and to a somewhat lesser extent in the Terai, wherever there is a reasonable potential of developing irrigation, the farmers have already made some effort to irrigate part of the potential command area. This means that the local farmers have some experience in diverting water, digging and maintaining canals, distributing water to the fields, and applying it to the various crops. To most effectively develop irrigation as quickly as possible over a wide area in Nepal, these local resources must be identified and utilized.

2. ORGANIZATION

Wherever there is some existing irrigation, there is also an organization to carry out the primary tasks of an irrigation system. These tasks include construction of the civil works to capture and convey water among the members, distribution of the water to the farms, maintenance of the system, and managing of conflicts. In order to carry out most of these tasks, the organization must have a means of mobilizing both human and financial resources.

The organization may be very informal, or it may exhibit a high degree of formality with scheduled meetings, elected officers, written rules, accounts, list of members and their water allocation, and members' attendance at work. The amount of organization required and the formality of the organization is, to a large degree, a function of how much labour must be mobilized to maintain the canal to deliver the available supply of water as needed. If little labour is required, the organization tends to be much less formal and vice versa. Although when one first observes a community irrigation system, it may appear that there is no organization and, depending on the time of year, that the system is in complete disrepair, if one asks the right questions of the right people some form of organization can always be identified. And what in the winter might look like a system in complete disrepair will look quite different at the beginning of the monsoon rice season after the annual cleaning and maintenance has been done.

A broad diversity of organizations and means of carrying out the primary tasks of an irrigation system have been observed among community-operated systems in the hills of Nepal. What follows is a summary of observations of community irrigation systems in Gulmi, Palpa and Nawal Parasi Districts.

2.1 Construction

Local communities have constructed long canals (more than six kilometers) through jungle, hard rock, and along the face of cliffs. Often they have hired other villagers who are skilled in cutting canals and tunnels through hard rock. Flows of between 300 and 400 liters per second have been measured in canals constructed by local communities.

2.2 Water allocation

An irrigation system must somehow allocate entitlement or rights to the water among the farmers. Two basic principles by which this is done have been observed. The most common principle used is to divide the water in proportion to the land irrigated by each farmer in the command area. Thus, if a farmer has one-twentieth of the land area irrigated, he is entitled to one-twentieth of the water in the system.

Another principle of allocating water is by selling shares in the system to the members. In one system the total water supply is divided into 60 shares, and the 105 members own anywhere from one-eighth of a share to four shares. If one farmer has more water than he needs for his land and another has less than needed, the one can sell to the other. One year, ten additional shares in the system were sold for a total of Rs. 28,000, and that money was used to make improvements in the canal so that more water could be delivered to serve a larger area. The price of water shares has been set to somewhat reflect the resources that have been invested in the system over the years. Since there are about 40 hectares in the command area, one share of water can irrigate about two-thirds of a hectare, and the current price of a share is Rs. 4,000.[1]

2.3 Water distribution

In a well-functioning irrigation system, water is distributed to each farmer's fields in the amount that he

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[1]Napalese Rupee = $14.545 in 1983

has been allocated. Three methods of distributing the water among farmers for monsoon rice cultivation have been observed.

One method is through the use of saachos. A saacho is a horizontal weir made from a log with two or more notches of equal depth but varying widths cut into the top. It is installed in the canal so that all the water flows through the notches, causing the flow to be divided in proportion relative to the ratio of the width of the notches. The ratio of the water allocation of the land served by the distributary canals below the saacho is the same as the ratio of the widths of the notches. These saachos may be used only to divert a proportion of the flow from the main into secondary canals, or they may be used right down to the individual field level.

Another common method for distributing the water according to the allocation is by a timed rotation. Each farmer takes water from the canal for a specified length of time. The length of each farmer's turn is calculated to provide him the proportion of the flow to which he is entitled by the allocation.

The third method of distribution observed is by contract. The members of the organization pay one or more persons to deliver the water to all the fields. The contractors adjust the flow throughout the command area so that all fields are covered as adequately as possible. This method of distribution is especially suitable when the fields are a long distance from the village where most of the farmers live.

Water distribution for wheat and maize tends to be much less precisely regulated. Usually the farmers decide among themselves when each will irrigate his fields, and then each farmer will be allowed to take water until his fields are fully irrigated. Since water is relatively scarce at the time of maize planting, the mukhiya may be in charge of distributing so that all members are able to plant at least some of their maize at the optimal time.

2.4 Operation and maintenance

Nearly all of the community irrigation organizations have a mukhiya or adhyaksha, and many have a bahidar or sachiv. The mukhiya is responsible for organizing and supervising work on system, and the bahidar keeps the accounts, minutes of the organization's meetings, and a record of members' attendance at work.

The critical period for maintenance of most community irrigation systems is prior to and during the monsoon season. Most organizations have a meeting of the members in Jestha. Plans are made for the major annual maintenance which is done in mid-May to mid-July.

Generally the members all have to work to clean and repair the canal. Some organizations give a contract to one or more members for this work, and all the members have to contribute money to pay the contractor. Money may also be raised in this way to purchase tools and cement.

An important element in the operation of an irrigation system is a method for early detection of any problems at the intake, landslides that block the canal, and leaks in the canal. During the monsoon, usually two people patrol the canal every day. The members may do this turn by turn, or two people may be hired to do this on contract. The persons patrolling the canal do minor repairs and alert the rest of the members if more labour is required.

2.5 Resource mobilization

An irrigation organization must be able to mobilize resources, both labour and material, to be able to operate and maintain the system. The ability to mobilize resources in a timely fashion is the major factor distinguishing a well-operating irrigation system from an ineffective one. In community irrigation systems, these resources are contributed by the members in proportion to the benefits they receive from the system.

In the systems where water is allocated in proportion to the area irrigated, members are usually required to contribute labour and cash according to their land area which is served. For instance, in one system a person with 40 units of irrigated land is required to provide one labourer every day that ordinary maintenance work is done. A person with only 20 units has to supply one labourer every other day. In another system, cash was raised at the rate of Rs. 2 per unit to pay a contractor to do the maintenance.

Another basis for resource mobilization is in proportion to the productivity of the irrigated land. Each member's irrigated land is rated by measuring the yields of rice in local units and both labour and cash are contributed in proportion to the number of measures each person's land yields.

Community irrigation organizations which allocate water in proportion to purchased shares of water also mobilize labour and cash contributions on this basis. One labourer must be provided each day of ordinary maintenance for each share of water owned. This year, one organization raised cash at the rate of Rs. 250 per share for a total of Rs. 15,000 from sixty shares.

When emergency maintenance is necessary, most organizations require all members to work irrespective of the number of shares owned or the size of the land irrigated. At times work will continue at night by the light of kerosene lanterns and torches.

The amount of resources community irrigation organizations mobilize is considerable. Several systems with command areas of 30 to 50 hectares regularly mobilize more than 2,000 man-days of labour in a year. One organization with 55 members raised Rs. 70,000 in one month's time to install a pipe to cross a major river.

In order to mobilize these large amounts of resources, an irrigation organization must have means of enforcing its rules and assessments. Most organizations keep written records of members' attendance at work, and people are fined if they do not work as required. Fines are set at about the same level as the local daily wage rate. If a person refused to work or pay the fine, the organization can deny that person water. Several organizations have reported that when members have refused to pay, a group of the members has gone to that person's house, taken his pots and pans and threatened to sell them. The person then paid the fine, and all the members saw how serious the organization was about collecting fines.

2.6 Conflict management

An irrigation organization which must distribute a limited amount of water to many members and which requires the co-operation of the members for operation and maintenance will inevitably experience conflict. Some members may try to steal more than their allotted share of the water. Members, from time to time, will fail to contribute their required share of the labour and cash to maintain the system. To function well, irrigation organizations must have an effective way of managing conflicts when they arise.

As mentioned above, most organizations levy cash fines against members who are absent from work. Persons who are caught stealing water are also usually fined. One organization exacted a public confession from a member caught stealing water, and the signed confession was recorded in the organization's minute book. Since the enforcement of sanctions is in the hands of the members who benefit from the proper adherence to the rules and who control the distribution of water, there are both the incentives and the means to enforce the rules.

3. CONCLUSION

The above has been a brief review of the types of community irrigation organizations that have been observed and the different ways which they carry out the tasks of an irrigation system. A surprisingly broad diversity has been observed over a fairly small area. The purpose of this review has been to alert the reader as to what to look for in community irrigation organizations.

When one observes any irrigation, one should expect that there is some organization in existence for managing the system. Persistent questioning may be required to uncover information about how the organization is structured, how it mobilizes resources, and the way in which it carries out the primary tasks of irrigation. But learning about the organization and working with it can greatly facilitate further irrigation development through improvement and extension of the existing system.

The farmers in the organization are probably the best source of information concerning stream and canal flows. They can identify the problems in the existing system that need to be overcome through some construction inputs and can establish priorities concerning what is most urgent to be done first and what can wait if the budget is limited. The organization has experience in mobilizing and organizing construction labour, and the members are experienced in the use of local materials in construction and maintenance of the system. It can certainly manage the transport of materials to the site. Likely the organization has some experience in handling money raised from the members contributions and fines. If the organization is made responsible for accounting for the money used in a project, and if all the members are informed of how much money is dispersed and what it is to be used for, likely it will be managed more effectively than if a contractor is given the responsibility for implementing the project. The members have a strong incentive to ensure that the money is spent so as to accomplish as much work as possible on the system, and with all the members informed of how the money is to be spent, there are checks to prevent any individual from pocketing a part of it.

By working with existing community irrigation organizations and mobilizing the local resources represented in the organization, the limited resources of the government can be spread over a wider area bringing about more and better irrigation development.

QUESTION GUIDE FOR THE ASSESSMENT OF LOCAL RESOURCES FOR IRRIGATION DEVELOPMENT

SECTION I: General Information

Date__________________

Persons interviewed	Interviewers
________________________	________________________
________________________	________________________
________________________	________________________

A. **Location of the area**

1. Zone________________ 2. District____________
3. Panchayat____________ 4. Village_____________
5. Route and distance from:
   a. Nearest public transport
   b. District Center

B. **Physical Information**

1. Make a sketch of the community (from an air photo if possible) and show with names:
   a. Streams and rivers
   b. Paths and roads
   c. Location of village and housing clusters
   d. All irrigation canals with an outline of the command area served
2. Make a detailed sketch of the area that is proposed for irrigation development or improvement and include:
   a. Name of all water sources presently used or proposed to be developed
   b. Outline the command area and roughly show the ward boundries

c. Show all existing canals, housing clusters, drains, and gullies

C. **Population**

1. How many households are there in each ward of the panchayat?

2. How many landholders have their house more than one hour walk away from the command area?

D. **Ethnic Groups**

1. What ethnic/caste groups are represented and in what proportion?

2. Do they live in specific areas? What are these areas called? (include on the sketch of the area)

3. Which groups dominate the local politics? Economy?

E. **Land Holdings**

1. Are there many landless households?

2. How many households presently own irrigated land in the proposed command area?

3. How many additional households will receive irrigated land in the command area?

4. Who are the three largest land owners and where is their land in the command area? How much land does each own? Do they have special influence in the present irrigation system?

F. **Tenancy**

1. What forms of tenancy are there in the area?

2. How much of the land is farmed by tenants?

G. Agricultural Production

1. Cropping cycle and area

	Crop	J	F	M	A	M	J	J	A	S	O	N	D	Area
khet[2]														
irrigated bari[3]														
bari														

2. What percent of the area is irrigated in the wet season?

3. What percent of the area is irrigated in the dry season?

4. For each crop what are the varieties planted?

5. What are typical rates of fertilizer (compost and commercial) for each crop? Where is commercial fertilizer purchased? Is the supply of manure adequate?

6. When is the water supply for crops most critical? When is it in short supply, ie. when is it extremely important to use it most efficiently?

7. Constraints to increased agricultural production and cropping intensity

   a. Could you grow more crops than you are growing now? Would it not be better to grow 2 crops of paddy?

   b. Is fertility a problem? Is there not enough manure produced? Is it first allocated to other fields? Is the supply of commercial fertilizer insufficient or unreliable?

   c. Is uncontrolled grazing of animals a problem? Are there rules concerning grazing? Would it

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[2]Levelled and bunded terraces for growing flooded rice.

[3]Cultivated fields for non-rice crops, ie. may be terraced but not levelled for flooded rice.

be possible to stable animals and bring fodder to them? Is fodder a limitation on the number of animals you keep?

d. Is there a labour shortage due to low population density? Seasonal migration for employment?

e. Does the land ownership pattern inhibit increased cropping intensity, ie. is there a concentration of land ownership among a few people and do they dictate the cropping pattern?

f. Is there a problem of water? Is the supply insufficient for the area? Is the supply too unreliable making increased cropping intensity risky?

8. Changes in cropping patterns

a. What changes have there been in the cropping pattern? Probe with specific questions such as: When was wheat first grown? When was a second crop of paddy begun? When were new varieties introduced?

b. What caused the changes in cropping patterns?

1) Introduction of irrigation?

2) Improvements to the irrigation system?

3) Introduction of new varieties, inputs, knowledge?

9. If you had all the water you want when you want it, what changes would you make in your cropping patterns?

a. How much bari would you make into khet?

b. What crops would you grow on the khet?

c. Would you continue to cultivate bari? What crops would you grow on bari?

10. Food sufficiency

a. How many households have excess grain to sell?

b. How many households must purchase more grain than they sell?

H. Employment and Migration

1. What local employment opportunities are there? How many people are employed in each?

2. Is there much seasonal migration to find employment? When does it occur? Where do people go?

3. Has there been much permanent migration? Have people migrated because they could not produce enough food?

I. Market and Prices

1. Where is surplus production sold?

2. Where are food grains purchased?

3. Where are inputs purchased?

4. How much are transport costs? How long does it take to transport a porter load?

J. Institutions

1. Are the following institutions located in the community? If not, where is the nearest one? How good are the services? How well are the structures maintained?

   a. Sajha?[4]

   b. JT or JTA[5]. What is his name?

   c. Agricultural Assistant. What is his name?

   d. Agricultural Development Bank?

   e. Health Post?

   f. Panchayat house?

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[4]National cooperative for supplying credit and inputs to farmers.

[5]JT, JTA: Junior Technician and Junior Technical Assistant respectively referring to personnel in Nepal's agricultural extension system.

g. Schools - primary, middle, secondary?

h. Police station?

K. Development

1. What local development projects have been undertaken in the area? Who initiated them and how were they implemented? How much labour was voluntary? How much was paid labour? How and where was money raised?

2. What is the state of maintenance of these projects?

3. Who benefits from the projects?

SECTION II: Organization

Date ____________________

Persons interviewed | Interviewers

______________________ | ______________________

______________________ | ______________________

______________________ | ______________________

A. Membership

1. How many farmers are members of the organization?

2. Are all people who receive irrigation members of the organization? Is there a system of representation?

3. Is there a difference between those who have khet and those who only have bari which is irrigated?

4. Are non-cultivating (or absentee) land owners participating members?

5. What is the membership status of tenants?

6. Are there any members who do not have land in the system?

B. Social Composition

1. What ethnic/caste groups are present in the system?

2. Are any restricted from full participation in the organization? Is the organization dominated by one or a few individuals? Who?

3. Do women have a role in managing the system? Labour maintenance? Application of water?

C. Official positions or roles

1. List the official positions within the organization. Get the names of the current office holders. For each person named, what other positions in the community or other organizations does he currently hold?

2. How and when are they selected?

3. For how long do they hold a post? How long have the current officers been in office? Under what circumstances will they be replaced?

4. Do they represent specific areas within the system?

5. What is the remuneration for each position? Monetary and/or other benefits and privileges?

6. Are there recognized unofficial positions? How is the organization related to the Panchayat system? (ie. are officers in the Panchayat also leaders in the irrigation organization?)

D. Meetings

1. What regular meetings of the organization are there?

    a. What is the date and purpose of each of the meetings?

    b. Who attends?

    c. Who runs the meetings? Is there a highly respected person/persons in the meeting who contributes a lot but does not hold an official position?

    d. Are minutes kept of the meetings?

    e. Are there sanctions for not attending?

2. What meetings are there that are not regularly scheduled?

    a. For what purposes are they called?

    b. Who calls them? Who attends?

    c. Are there sanctions for not attending?

3. Are there any ritual ceremonies conducted related to the irrigation system?

    a. When are they conducted?

    b. Who participates in them?

    c. What is their purpose?

    d. What is the remuneration for those who conduct the ceremonies?

E. Water Allocation Principle

1. By purchased share?

2. By land holding size? How was this first measured? How are the newly developed land areas incorporated? Are there considerations for different soil types?

3. According to position along the system?

4. By rights of people who first developed the system?

F. Water distribution

1. How is the water distributed for rice?

   a. By timed rotation?

      1) How is the rotation initiated? How is the order of rotation determined?

      2) How does the rotation proceed (tail to head, head to tail, etc.)

      3) How is the rotation timed? Does the time period change with supply and demand changes? Who decides when and how to change the rotation?

   b. By proportioning weirs (keys)? To what level? What happens below this level?

   c. By contract?

      1) To whom is the contract given?

      2) What is the amount of the contract?

      3) What is the time period of the contract?

   d. Are there changes in the water distribution within a season for any reason? Is the distribution different within a season for any reason? Is the distribution different for land preparation? Are there times of stress when there are special rules?

2. Have the methods of distribution changed as the system has been improved or expanded? Has rotation been discontinued as the supply increased? Has rotation been introduced as the area has been expanded?

G. Conflicts

1. What conflicts related to water management are there? Water stealing? Rearranging rotation after flow has been interrupted by landslides?

   a. Are there conflicts among individual farmers or different sections of the system? (rotation area?)

   b. Do farmers have to closely guard the water during their turn? What happens if they do not, ie. how is water stolen? By breaking bunds to make illegal turn-outs? Obstructing keys?

2. Who does a farmer go to with a grievance? What is the process of resolving conflicts? What are the sanctions and how are they enforced?

H. Maintenance

1. Routine maintenance

   a. When is it initiated?

   b. What needs to be done?

   c. How is water delivered during maintenance or is it completely stopped until the maintenance has been completed?

   d. Who plans and organizes the work?

   e. How is labour mobilized? What are individual members' responsibilities? Are they based on area irrigated, crop grown, shares owned? How do they differ for khet and bari owners? Do women also work?

   f. How is cash raised for purchase of materials? What are individual members responsibilities? Is there a water fee? When is it collected? Who collects it? On what basis is it charged?

   g. Are there written records kept of individual member's payments and labour contributions?

   h. What are the sanctions for not fulfilling responsibilities?

   i. How are the sanctions enforced?

2. Emergency Maintenance

   a. What are methods of early warning of emergencies? Chowkidar, person living near the intake, etc.? How are they remunerated?

   b. What are common emergencies? How are they caused?

   c. How are people informed of the need for emergency maintenance?

   d. Who is responsible to respond? How many people? For how long? Do women work?

   e. Under what conditions will work continue at night?

   f. How do they decide what repairs (temporary or permanent) should be made? Is this by consensus or by recognized authority?

   g. What is the worst emergency that is recalled?

I. Conflict resolution

1. What are sources of conflict other than water stealing? Give examples of specific conflicts, eg. making unauthorized khet, uncontrolled grazing, refusing to work when they are supposed to, misappropriation of funds. What are the sanctions for each of the above? Who enforces the sanctions?

2. How are conflicts resolved? Give the process for the above mentioned conflicts.

J. Rules

Does the system have written rules or by-laws? How were they formulated and by whom? What is required to change the rules?

K. Organizational development

1. How was the organization (official officers, methods of raising money, membership, etc.) different long ago from now?

2. When did it change and why? Was it at times of expansion and improvement?

SECTION III: Historical development of existing irrigation system

Person interviewed | Interviewers

______________________ ______________________

______________________ ______________________

______________________ ______________________

Date______________

A. Original construction

1. When was the system constructed?

2. Who initiated and organized the initial construction?

3. How were the intake, layout of canals, and command area selected and designed? Who was responsible for that work (name, where from)?

4. How much did the original construction cost?

5. What resources were raised and how were they mobilized?

   a. Volunteer labour? How much? Who participated?

   b. Cash and materials? Who contributed? Loans?

   c. Technically skilled persons? From where? Names?

   d. Were any contracts given out? For what work? To whom? For how much?

   e. Government assistance? When the government was approached what was the procedure?

      1) Who from the system made the contacts?

      2) Whom did they contact first, where, and when?

      3) With whom were the subsequent contacts, where and when?

      4) Who came to look at the system? What did they do at the site?

5) When was the money/technical assistance actually given? Was it satisfactory?

6. What were the impacts of the improvements?

   a. Increased area irrigated? Were new members added to the organization? If new members have been added, do they have actual access to water? Do they participate as fully as those whose land is in the original command area?

   b. More reliable irrigation on basically the same area? Did cropping patterns change? What new crops were introduced?

   c. Less effort required for maintenance?

   d. Reduction in conflicts?

SECTION IV: Technical Information

Date________________

Persons interviewed	Interviewers
____________________	____________________
____________________	____________________
____________________	____________________

A. Water Source

1. Describe the main and all supplementary water sources.

   a. Type of source (spring, monsoon stream, spring, etc.)

   b. Extent of flow variation in litre/sec.

	In source	Diverted	Date
Measured			
Maximum			
Minimum			
Critical period			

(Maximum, minimum, and critical irrigation period flows expressed as a proportion of the measured flow using information locally available.)

2. What year was the last major flood? Work backward listing all the years of large floods.

3. When was the last drought? Work backwards and list all the years of drought?

4. Could more water be diverted, ie. if more water is available, what are the limitations in diverting more?

5. Estimated silt load (high, medium, low)?

6. Water quality for irrigation (good, poor)? Why?

7. Water rights

   a. Is there a water right for the water currently diverted?

b. In whose name is the right and for what quantity of water?

c. Are there other irrigation systems using this source? For each give: location (above, below), name, area served, number of households involved, whether or not they have a right to the water and to how much water?

d. If all the water would be diverted, how would it affect other downstream users?

B. Intake

1. Describe the intake arrangement and structure (sketch)

   a. How often is the diversion damaged? One or two times each year? Every few years? What is the current state of repair?

   b. What problems are faced in repairing the diversion structure-materials, high water, labour, etc.?

   c. Is there a flow limiting device?

   d. Is there an escape for excess flow?

   e. What is the arrangement for stopping the flow in the canal?

   f. What methods are used in removing silt? How frequently is desilting required?

   g. Would there be benefit in a more permanent intake structure?

C. Distribution system

1. What physical control devices are used?

   a. Temporary earth diversion?

   b. Permanent gates, keys (proportioning weirs)? If keys are used, sketch the branches and measure the respective key notches.

   c. When are these controls in operation?

   d. Who is responsible to construct them?

   e. Who maintains them?

2. Water delivery to the fields

   a. What percent of the irrigators must receive water via a neighbouring field?

   b. To what degree are there canals to each field that a farmer owns? Can the field be fed by two canals?

   c. Have there been recent changes in the alignment of field channels? Why?

D. **Soil types**

What are the soil types and how do they vary throughout the system?

E. **Other uses of water**

Are structures provided or special provisions made using the system for purposes other than crop production? Such as bathing, washing clothes, watering animals, running a turbine or water wheel?

F. **Physical constraints to increasing the irrigated area**

1. What are the limitations to increasing the irrigated area?

   a. No more land that can be irrigated?

   b. Source of water limited?

   c. Water delivery problems due to:

      1) Inadequate diversion structure

      2) Siltation

      3) Seepage from the canal

      4) Landslides

      5) Canal size

      6) Uncontrolled stream crossings

G. Identification of local priorities and resources

1. If you had access to Rs. 5,000, 10,000, 50,000 (use amount with respect to project needs) how would you use it? If you then had Rs.__________ more, how would you spend it?

2. Having identified the project, how could resources be raised?

   a. How would planning take place? By the organization? By a committee? By an individual? Who would appoint a committee or individual?

   b. How would money be raised?

      1) From current members? How would it be decided who contributes and how much?

      2) From potential new members? Would the organization accept new members?

      3) If you look outside the community for money, where would you look?

         a) Who would you contact first? Who would make the contact?

         b) Would you consider taking a loan from private individuals or a bank? Could a loan be paid back? In cash or kind (at harvest time)?

   c. How would you organize to implement the project?

      1) Would the present organization officers implement it, or would a separate committee be established?

      2) Would you use only volunteer labour of the members, or would labour be concentrated?

      3) Is there a special group of workers that would be hired?

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 12d

NOVEMBER 1985

INSTITUTIONAL ASPECTS OF OPERATION AND MAINTENANCE FOR IRRIGATED PADDY PRODUCTION IN KOREA

by

K S Park

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K S Park

INSTITUTIONAL ASPECTS OF OPERATION AND MAINTENANCE FOR IRRIGATED PADDY PRODUCTION IN KOREA

K S Park

1. KOREAN AGRICULTURE, ADMINISTRATION AND IRRIGATION

a. Agricultural conditions and yields

In Korea, only one irrigated paddy crop a year is climatically possible, due to cold winters. Most of the rainfall is concentrated in the growing season, so the amount of water that must be added by irrigation is relatively low. Irrigation is required because of the annual fluctuations in rainfall, as some years have bad droughts. Irrigation also encourages the use of much higher levels of fertiliser than would be feasible without it. One study of 15 new small-scale irrigation projects started in 1972 concluded that after irrigation paddy yields increased by 50 to 70% over rainfed paddy, holding seed variety constant; presumably much of the increase reflected higher fertiliser use. During the 1970s yields rose rapidly, due to the spread of HYVs and high levels of fertiliser use. By 1983, Korea had the highest average paddy yield in the world, with 6,220 kg/ha. Rice imports, high in the late 60s and 70s, have since 1978 been small or zero. In 1983, of the total cultivated area, 61% was under paddy and 39% was under upland crops. About a quarter of the area was double cropped, the climate being sufficiently mild in some areas for winter wheat or barley.

Irrigated paddy has a centuries old tradition in Korea but it was expanded during the Japanese occupation (1909-1945) to compensate for the growing Japanese rice deficit. The irrigation and land development component of a 15 year plan inaugurated in 1920 was implemented by national agencies of the Japanese government and by Irrigation Associations (196 by 1933) with huge government expenditure through subsidies, low interest loans, or direct investment. After independence land and water development projects continued to receive the largest share of government allocations to agriculture, and the irrigated component of the paddy area increased from 43% in 1963 to 71% in 1983.

b. Social and administrative setting

About 24% of the population is classed as rural. The two million farm households live in tightly nucleated villages, with an average holding of about 1 ha. A land reform in 1948-50 provided for a maximum holding of 3 ha, and most families now own the land they work. Beginning in 1964 the small, irregularly shaped plots were consolidated into larger, rectangular units, which was accompanied by an on-farm water development programme, including improvement of field channels and drainage ditches, the installation of on-farm water control structures, and building of farm access roads.

Most farm families grow most of their own food requirements, with rice providing over half the total agricultural income. Most labour is provided by the family, though wage labour is replacing labour exchange groups at peak times. Labour shortages have sharpened since the 1970s, particularly in transplanting and harvesting, where mechanisation has not made as much progress as in other agricultural operations.

The country is divided into 9 provinces and 139 counties, each with a county town. The lowest administrative units are the ri (a single village or group of hamlets) which is divided into ban, a grouping 14-20 neighbouring households.

The Ministry of Home Affairs supervises the provincial governors and appoints the county chiefs. It has administrative control over all other government agencies at provincial level and below. The county is the executive unit in rural development, but it has little room for autonomous decisions as 80% of its budget comes from the centre and all major iniatives come from Seoul. The Ministry of Agriculture and Fisheries (MAF), has responsibility for planning and supervising agricultural programmes. Implementation is by several agencies which include the Office of Rural Development (ORD), with responsibility for agricultural research and extension; the National Agricultural Co-operative Federation (NACF), the sole supplier of fertiliser and most agricultural chemicals, the sole source of institutional agricultural credit and the sole agent for government grain purchases; and the Agricultural Development Corporation (ADC), which plans, designs and constructs large and medium-scale irrigation and drainage projects (with service areas of greater than 50 hectares).

The ORD, the NACF and the ADC are organised into provincial units, each unit directly supervised by the provincial governor and each having considerable autonomy.

From the farmer's point of view, they have four organisations on which they depend and by which they are to some degree controlled, in addition to the county administration and its township arms; the ORD, the NACF, the Saemaul Movement (Farmers's movement for rural development).

2. INSTITUTIONS CONCERNED IN IRRIGATION AND DRAINAGE IMPROVEMENT, AGRICULTURAL DEVELOPMENT, AND OPERATION AND MAINTENANCE

a. Irrigation and drainage improvement

In 1970 the law on the Promotion of Rural Modernization was enacted and the Agricultural Development Corporation (ADC), which absorbed the Union of Farmland Improvement Association and the Groundwater Development Corporation, was established for the implementation of large-scale agriculture comprehensive development projects, medium-scale projects and small-scale schemes throughout the country

i. Large and medium-scale projects There have been large-scale agricultural development projects of many types, including forest and pasture development, farm mechanisation, improvement of the rural environment, etc. Amongst these have been 8 projects to expand irrigation (83,400 ha) with a further 6 projects for 91,211 ha under construction. Such large-scale irrigation projects are supervised and financed by central government and constructed by the ADC.

Medium-scale projects are initiated by Farmland Improvement Associations (FLIAs); but the feasibility studies, detailed designs and supervision of construction is carried out by the ADC after an agreement between the FLIA and the ADC. Between 1970 and 1979, 312 projects with an average area of 292 hectares each were completed. The provincial governor is responsible for the establishment of the FLIA, for financing, and supervision of the operation and maintenance facilities.

After completion of engineering works, both large and medium-scale projects are handed over to FLIAs for operation and maintenance.

ii. Small-scale schemes The planning, design and construction is by city and county authorities with farmers participating in building. They are then handed over to autonomous organisations of farmers, the Water Users' Associations (WUA), for maintenance and operation. Central and provincial governments subsidise about 70% of the construction costs with the rest being a long term loan repayable by the farmers.

All in all, there were 59,544 schemes run by FLIAs and WUAs at the end of 1983.

b. Agricultural development

As already stated, intensive investment to increase paddy production through large, medium and small irrigation and drainage improvement schemes took place in 1963-83. This was accompanied by complementary measures to increase agricultural production. The use of high yielding paddy varieties, fertiliser, control of pesticides and other modern practices are intensively taught to the farmers by the various levels of the Office of Rural Development (ORD). HYV paddy has been recommended since 1972, and the area under HYV reached 929,004 (76%), in 1978. This gradually declined to 418,522 ha (34%), by 1983, due to consumer preference for the older varieties. Pest and disease control are intensively implemented by machinery and helicopter. Fertiliser was sold to farmers by the NACF in amounts proportionate to their farm area till 1975; since then farmers have been allowed to buy any amount at any time from the district office of the NACF. Group mechanised disease and pest control is subsidised by the local government and FLIA in severe cases, but is normally done by the farmers themselves. Farmers have been trained in chemical fertiliser use, pesticide and weed control, on-farm water management and mechanisation of ploughing, puddling, transplanting and harvesting.

The price paid to farmers on average was above the world price, though it goes down during the harvest season and goes up during the spring and summer. This made it feasible to collect relatively high water charges from FLIA members.

The result of these efforts was the rise in yield to the world's highest, as already described, and the production of over two million tons of rice from the 458,463 ha covered by FLIAs in 1983.

c. The Farm Land Improvement Associations

FLIAs are established as legal public enterprises if they have the support of at least two thirds of the farmers, controlling at least 50% of the area. Their functions are to operate the water delivery system, to maintain the irrigation and drainage facilities, to disseminate modern agricultural practices, and to assess and collect annual water charges from the farmers. In 1983 they had 8,076 staff, including administrators, engineers, agronomists, assistants, skilled labourers and temporary employees, (ie. one employee per 57 ha).

Each FLIA has its own regulations, covering: purpose, name, address and jurisdiction, affiliation and registration of membership, organisation, staff and employees, assets, accounting, O&M, construction and project implementation, assessment and collection of water charge, annual income and revenue, meetings, general and special, and announcement methods.

The Chairman of the FLIA is in legal theory elected by the member farmers, but is actually appointed by the Minister of Agriculture and Fisheries and/or the Governor of the province on behalf of the Minister since 1965. The Chairman appoints the staff and established field offices throughout the command area. The staff are locally recruited and have salaries higher than the average farm income. They may be transferred to a bigger FLIA with promotion, but generally remain within the province and share a common interest with the farmers in developing local prosperity. Their salaries are paid entirely out of the local water charge.

Chief engineers are appointed on the 48 biggest FLIAs having over 3,000 ha of command. Water scheduling is worked out by the responsible engineers, during February. Member farmers are co-ordinated by the FLIAs field staff to establish nursery areas, and to carry out land preparation and transplanting at set times to make efficient use of the limited water supply. During the growing season a supplementary water supply is correctly implemented according to the initial water scheduling plan.

The Office of Rural Development (ORD) has county level offices responsible for agricultural extension to farmers within and without the FLIAs. The county officer of ORD give guidelines to the FLIA's agronomists on advanced farming practices from the paddy nursery to harvesting stage, including mechanisation. The FLIA agronomists make paddy yield estimates by random sampling and field plot checks for each village area for statistical purposes and to determine the water charge.

Water charges are locally established but may not exceed 50% of the increased paddy yield due to the project. The FLIA makes an annual budget for personnel expenses, O&M costs, construction costs, and repayment of long term loans. Water charges are then assessed and collected. For the fiscal year 1983, 67,735 million Won (US $80 million) was assessed and 66,556 million Won (US $78 million) was collected (98%). Table 1 summarises the financial statements of the 103 FLIAs in 1983.

Table 1: Income and expenditure of FLIAs, 1983

	Income in million Won		
1.	Earned revenues		70,831
	- water charges	65,713	
	- other	5,118	
2.	Other income		12,978
	- government subsidy	2,576	
	- other (water charges outside command area, rents and hiring FLIA property)	10,402	
3.	Special profit		2,778
	TOTAL		86,587
	Expenditure in million Won		
1.	Staff and other costs for revenue collection		38,392
2.	Administrative expenses		34,728
	- personnel expenses for O&M	21,663	
	- O&M costs	13,605	
3.	Loan repayment and interest		1,615
4.	Other costs		11,423
5.	Special loss		370
6.	Net earnings		59
	TOTAL		86,587

d. The Hungnong Gae (HNG)

The Hungnong Gae are farmers' clubs for promoting technically improved irrigated paddy. It is organised within each village of the FLIA's service area as the self-help organisation of farmers. They have an average membership of 58 farmers, covering 30 ha. The chairman of the HNG must in the first place see that the irrigation and drainage channels are adequately maintained, and that the main and secondary canals within his village area are cleaned at the start of the season by all HNG members. Secondly, he must disseminate the recommended modern agronomic practices on nurseries, HYVs, farm-level water management, control of pesticides and mechanisation. Thirdly, he must contact the water master of the FLIA about water problems within his area and persuade his own members not to waste water. Fourthly, he has to see his members pay their water charges promptly. Lastly, he must pass statistics and data to the FLIA through the water master, participate in paddy yield and compost making contests, and in other social activities amongst the HNGs within the FLIA.

The chairman received no salary, unlike the village chief, who is the lowest member of the government's administrative staff. Generally, the village chief recommends to the HNG member farmers the person they should elect by unanimous vote.

e. The Water Users' Associations (WUA)

As already stated, the WUAs normally have an average area of 15 to 20 ha with a single water resource outside an FLIA area. The chairman is elected by the member farmers. The regulations of the WUA cover the same functions as the FLIA. They must be approved by the general meeting of the WUA.

The annual budget is prepared by the chairman for approval at the general meeting. The greater part of the budget is concerned with the operation and maintenance of the WUA's facilities. The water charge is paid in cash or kind after the paddy is harvested. The chairman appoints the WUA staff, who may be paid or voluntary according to the local regulations. The chairmen of the WUAs are under the supervision of the county chief.

3. PROBLEMS AND PROSPECTS IN KOREAN IRRIGATION

a. Better adjustment of flows to crop water needs

Water should be supplied to supplement rainfall throughout the growing season, so flows should be adequately measured and adjusted by the engineering staff and watermasters of the FLIA. To increase water use efficiency, canals and the various control gates should be properly maintained before irrigation starts. The young engineers and agronomists of the FLIAs should be trained in crop water management practices. However, most of them are graduates from vocational schools located in the rural areas. Highly educated engineers and agricultural experts with university training are hard to employ.

b. <u>High water charges, high long-term debt and low maintenance expenditure</u>

In 1983 the average water charge per hectare was 156,270 Won (US $184), and with government price for rice at its then level, 98% was collected. Korea will soon face a surplus of rice and the rice price may not continue to be increased in line with other consumer prices. Even at present levels of water charge, the outstanding long-term loan was approximately US $227 million, or US $507 per ha. Table 1 shows that only 15% of the total budget of the 103 FLIAs in 1983 was spent on the operation and maintenance of the irrigation and drainage systems, and this is not enough for adequate maintenance.

c. <u>Improvement of rice varieties</u>

GNP per person in Korea reached US $2,110 in 1984. The consumption of rice has been declining every year since 1980 and the demand is for better quality rice. The yield of the HYVs is 15% higher than that of the preferred traditional varieties. The ORD needs to develop HYVs from the traditional varieties and to disseminate these to the FLIAs.

d. <u>Studies on the engineering, cost recovery and organisational aspects of rehabilitation of the FLIA systems</u>

Many existing systems, built in the 1920s and 1930s, have gone over their economic life. In the future the government will need to rehabilitate and modernise them, but the cost of doing so is increasing continually.

Studies need to be made not only of the engineering aspects of rehabilitation but also on the organisational side, including the numbers and quality of staff, and their functions for improved system operation. Operational principles have continued on the same basis for more than 60 years, with changes only in the names of FLIAs, titles of staff, and political control. Lack of good management is the primary reason why many projects fall short of their potential. Investment in management training for key staff would pay high dividends. As has been said, good managers can increase the productivity of even poorly designed systems.

A study on cost recovery is especially important in relation to long term loan repayments. Many projects have not allocated money to the repayment fund in their budgets because this would lead to a higher water charge for the farmers. The total long term loan for the 103 FLIAs was US $246 million at the end of 1983. US $19 million has been repaid, US $17 million during 1946-1982, and US $2 million in 1983. It is a serious thing that US $2.4 million of interest on the long term loans was outstanding at the end of 1983. The study would need to look into the increased repayment potential of measures to improve land productivity, increased paddy yields, and improve management of the FLIAs and individual farms.

At present member farmers have little role in establishing policy or in influencing the operation of the FLIAs, and paddy is the only irrigated crop to be grown. The government has a policy of decentralisation, which should lead in future to more power for the local governments, and also, the true election of the chairman of the FLIA to bring about more active farmer participation in the FLIA.

4. TRANSFERRING KOREAN EXPERIENCE ON O&M TO OTHER COUNTRIES

It is worth noting that Korea reached its present level of achievement in stages. There was a long standing irrigation tradition, followed in the 1920s and 30s by a large programme of new and rehabilitated schemes. This was followed in the 1950s by land reform and in the 1960s and 1970s by on-farm development and other improvements, with co-ordinated agricultural extension. Problems remain but there are probably some lessons for other countries. These cannot be transferred without modification to meet local conditions, for Korea has its own particular institutional culture with a tradition of centralised authority. It has also to be remembered that its irrigation has been developed to provide supplementary water during one season only. There are, however, three main lessons which can be learned from it. These are:

i. The utility of an agricultural research and extension programme closely co-ordinated with, and complementary to, on-farm water development and improvements in irrigation and drainage. Both these components are needed for high yields and should be included in the planning for new projects. In Korea, the fact that the provincial and county governments are the main supervisory and planning bodies has helped to co-ordinate agricultural and water development.

ii. The utility of locally-based irrigation organisations with legally recognised powers and duties, including the right to raise revenue and to employ their own irrigation and agricultural staff. While in Korea farmers do not participate much in the operation of schemes, they at least have mechanisms for requesting and jointly planning projects or improvements.

iii.The relationship between the price of the main agricultural product and the farmers' ablity to pay for O&M and some portion of investment costs.

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IRRIGATION MANAGEMENT NETWORK

NETWORK PAPER 12e

NOVEMBER 1985

AN APPLICATION OF SPREADSHEET SOFTWARE TO WATER MANAGEMENT

by

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Charles Bailey

AN APPLICATION OF SPREADSHEET SOFTWARE TO WATER MANAGEMENT

Charles Bailey

The simple, accurate and speedy calculation of crop water requirements using Penman or other methods is of increasing importance for the improved management of irrigation systems in many developing countries. This note describes the use of an electronic spreadsheet microcomputer program to determine period by period water requirements for crops grown in Sudan's state-managed Gezira Scheme.

1. SPREADSHEET SOFTWARE

Electronic spreadsheet programs (or ledgersheets as they are sometimes called) were introduced in the US in the late 70s and are widely believed to be responsible for the dramatic success of Apple and the rapid spread of microcomputers into many aspects of daily life. The particular spreadsheet used in the Gezira Scheme is SuperCalc on either an Apple IIe or KayPro II. Supercalc is a product of SORCIM, 2310 Lundy Avenue, San Jose, California, 95131, USA. Other software/hardware configurations are easily possible, but depend on the size and nature of the problem to be modelled.

The SuperCalc spreadsheet begins as an empty matrix of columns (designated by letters) and rows (designated by numbers) displayed on the computer terminal. Each cell in the matrix is defined by the intersection of a particular column and row, and identified by the appropriate letter and number. For example, the cell in the extreme northwest corner of the sheet is "A1". The cell at the intersection of the fourth column and fifth row is "D5", and so on. The entire spreadsheet contains 63 columns and 254 rows. This is too large to be viewed all at once on the terminal, so with simple commands the sheet can be made to "scroll" across the screen. Using other commands each cell can be filled with a word or phrase, a numeric value, or a formula relating the numeric contents of one cell to another cell or cells. Once the spreadsheet is built, a change in the value of any cell will cause the rapid recalculation of values in all other cells linked to it by a formula. This rapid recalculation ability is the heart of spreadsheet analysis since it permits quick updates to pre-existing information or "what if" (sensitivity) analysis.

2. THE GEZIRA SCHEME

The Gezira Scheme covers an area of about 2.1 million feddans lying between the Blue and the White Niles south of Khartoum (1 feddan = 0.42 ha). Its principle features are a level and nearly uniform topography of water-retentive clay soils, centralised control of farming operations by the Sudan Gezira Board (SGB), a narrow range of variation in farm size, and a regulated cropping pattern of cotton, groundnuts and sorghum in summer and wheat in winter. The arid climate necessitates irrigation of both summer and winter crops, which is done by diversion from the Blue Nile at Sennar Dam just south of the Scheme to feed a gravity system. The total length of the canal network down to the field water courses (Abu XXs) is 10,640 kms (for a fuller discussion of the Gezira see Gilbert Levine and Charles Bailey, "Water Management in the Gezira Scheme" in International Journal of Water Resource Management, forthcoming).

3. CALCULATING CROP WATER REQUIREMENTS

The Gezira spreadsheet is based on crop factors developed from the Penman equation and agro-climatological research at the Gezira Research Station by Drs Osman Fadl, Hussein Adam and Herbert Farbrother (Farbrother:1973). In the Gezira Scheme an irrigation "period" is one-third of a month, ie. 10-11 days. A crop factor is the number of cubic meters of water per feddan per day that the crop requires in each irrigation period. The period in which the crop is planted determines the vector of crop factors for that period and all subsequent ones to harvest.

The spreadsheet occupies a matrix of 28 columns and 65 rows. Twenty-two of the columns represent irrigation periods from June 1-10 through January 1-10. Thirty-nine of the rows represent crops planted in particular periods. The crop factors thus arrayed are used to calculate periodwise net water releases required at Sennar Dam to meet Gezira Scheme crop water requirements, taking into account rainfall and canal evaporative losses. Losses from deep percolation are ignored since they are negligible in the heavy Gezira clay soils. The data required are the number of feddans planted to each crop in each planting period and the rainfall (mms) in each period. Figure 1 shows the crop data entry portion of the spreadsheet before and after input of data on feddans planted in the 1983/84 season.

Figure 1 <u>Crop Data Entry Vector: Empty and Filled</u>

CROP	FEDDANS:	PERIOD:	CROP	FEDDANS:	PERIOD
ELS Cotton	....	Jul/III	ELS Cotton	108558	Jul/III
0	....	Aug/I	347422	205932	Aug/I
	....	Aug/II		32217	Aug/II
	....	Aug/III		715	Aug/III
Acala Cotton	....	Jul/II	Acala Coton	24634	Jul/II
0	....	Jul/III	153339	90744	Jul/III
	....	Aug/I		37239	Aug/I
	....	Aug/II		722	Aug/II
Groundnuts	....	Jun/I	Groundnuts	8068	Jun/I
0	....	Jun/II	136212	21653	Jun/II
	....	Jun/III		35238	Jun/III
	....	Jul/I		30360	Jul/I
	....	Jul/II		23751	Jul/II
	....	Jul/III		17142	Jul/III
Sorghum	....	Jun/I	Sorghum	3163	Jun/I
0	....	Jun/II	409239	26356	Jun/II
	....	Jun/III		49549	Jun/III
	....	Jul/I		89475	Jul/I
	....	Jul/II		82974	Jul/II
	....	Jul/III		76473	Jul/III
	....	Aug/I		38181	Aug/I
	....	Aug/II		27083	Aug/II
	....	Aug/III		15985	Aug/III
Wheat	....	Oct/II	Wheat	9997	Oct/II
0	....	Oct/III	263264	47573	Oct/III
	....	Nov/I		98173	Nov/I
	....	Nov/II		79433	Nov/II
	....	Nov/III		19572	Nov/III
	....	Dec/I		8516	Dec/I
Rot'l Gardens	....	Jun/I	Rot'l Gardens	2105	Jun/I
	....	Jun/II	35000	3029	Jun/II
	....	Jun/III		3954	Jun/III
	....	Jul/I		3759	Jul/I
	....	Jul/II		4102	Jul/II
	....	Jul/III		4447	Jul/III
	....	Aug/I		1956	Aug/I
	....	Aug/II		1957	Aug/II
	....	Aug/III		1957	Aug/III
	....	Sep/I		7734	Sep/I

(Notes: ELS = extra long staple cotton; Acala = medium staple cotton. Figures under each crop name are the total number of feddans planted to the crop in the season.)

Figure 2 shows the provision for entry of rainfall data and the final output: calculated water requirements for each crop, required Sennar diversions and feddans planted and irrigated. The values are for the agricultural situation in the Gezira Scheme in October 1983. (Values for the other months in the cropping season are not shown here for reasons of space.)

Figure 2. Gezira Scheme Crop Water Requirements: October 1983

PERIOD		October 1-10	October 11-20	October 21-31
Crop Water Requirements				
	COTTON	13346	14816	15255
	GROUNDNUTS	4147	3851	3466
('000 cu	SORGHUM	11592	10252	8615
meters	WHEAT	0	600	2988
per day)	ROT'L GARDENS	1201	1162	1130
	NON-ROT'L REQS	800	800	800
Total Crop Water Requirements		31086	31482	32254
TOTAL Rainfall/Period (mm)		.00	.00	.00
Required Diversion at Sennar ('ooo cu meters/day)		33046	33591	34802
TOTAL Feddans:	Planted in Period	0	9997	47573
For Season) 1344476)	Irrigated in Period	1078049	1061690	1059714

4. USES AND LIMITATIONS

The spreadsheet was originally developed as a pre-season administrative planning tool to enable the Sudan Gezira Board and the Ministry of Irrigation to quickly examine alternative planting schedules and avoid those whose water requirements exceeded canal capacity. It could equally well be used period-by-period within the season, with the operator entering data on rainfall as it occurred and adjusting planting schedules accordingly. The spreadsheet could also provide a post-season evaluation of circumstances which had led to water shortages. Perhaps the most promising application however is in direct performance monitoring in which the spreadsheet generates "target" deliveries against which actual deliveries can be compared. (For a fuller discussion see Charles Bailey and Roberto Lenton, "A Management Tool for the Gezira Irrigation System" in Water Distribution in Sudanese Irrigated Agriculture: Productivity and Equity, University of Gezira, Wad Medani, January 1984.)

As presently designed, the spreadsheet operates at the aggregate Scheme level. However, since the Scheme is over 150 kms north to south, spreading from the 200 mm to the 425 mm isohyet, single point crop factors and rainfall data can give a misleading picture. Unfortunately, at the present time reliable rainfall data and crop factors are only available for Wad Medani on the eastern edge of the Gezira irrigated area.

Disaggregated operation of the spreadsheet would be quite possible with local collection of rainfall data and some adjustments to the Wad Medani-based crop factors. Another spreadsheet program, "MultiPlan", allows up to seven separate linked matrices. In the present example, six could be used for the six irrigation divisions in Gezira with the seventh reserved for a macro or summary picture. As for the number of irrigation periods, the memory of the Apple and the KayPro limits the actual number of useable rows and columns to about the present matrix size. For this reason the spreadsheet ends with the January 1-10 period though the Gezira season extends to the end of March. This space limit has not been a problem since irrigation demand is low at the tail end of the season. However, for more crop planting periods or a greater number of irrigation periods a larger, probably 16- or 32-bit machine would be required.

In conclusion, spreadsheets on microcomputers are a quick, reliable and inexpensive water management tool especially useful where water balance or Penman calculations have a spatial or temporal aspect. Their flexibility and ease of construction should permit many applications even in situations far less structured than irrigation management in the Gezira Scheme.

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