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SUSTAINABILITY OF DIVERSIFIED FARMS IN TAMBIRAPARANI RIVER COMMAND AREA, SOUTHERN INDIA

R. K. Theodore, D. David Rajasekar, G. Selvaraj and D. Jawahar

Abstract

India's efforts to increase food grain production have been achieved through promoting large-scale crop intensification by extending the area under irrigation. The expansion of irrigation has resulted in several undesirable environmental consequences and there is a growing need for a shift in strategy to foster greater environmental sustainability and still meet the economic demands of small producers. A micro-level study was undertaken in one of the important river irrigation systems of Southern India – the Tambiraparani River command area – with the objective of assessing and comparing the sustainability of diversified and non-diversified rice-based farming systems under assured irrigation. Diversified farms included systems based on rice + dairy, and rice + banana + dairy, whilst non-diversified farms were those planted to rice only, and those planted to rice + banana. To measure the sustainability level of these four different wetland farming systems a sustainability index was developed through the use of indicators for economic viability and ecological soundness. Data were collected by personally interviewing farmers in 30 villages along the river.

Research findings

- *The sustainability of diversified farms was found to be significantly higher than non-diversified farms (regardless of farm size) indicating the importance of dairy enterprise as an allied sector activity in the farming system.*
- *The economic viability of a farm is determined by the number of agricultural activities it possesses (i.e. the number of different crops and livestock).*

Policy Conclusions

- *The change in food consumption patterns, growing population, rapid urbanisation, rise in unemployment, need for stability in economic growth and liberalised policy measures at present are reasons in favour of farm diversification.*
- *Dairy is a suitable allied activity for small-scale producers, to augment their income and also to promote ecological soundness of farms along the river tract.*
- *The marginal farmers who form the most vulnerable group in the command area require the maximum extension support in order to improve their socio-economic status from subsistence farming.*

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Acronyms

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GCA	Gross Cropped Area
ha	hectares

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1 INTRODUCTION: THE EXPANSION OF IRRIGATION AND THE THREAT TO SUSTAINABILITY

With a population of 970 million, India is the second most populous nation in the world. In order to meet the food demands of the growing population, consecutive governments have allotted huge budgets for the development of major and minor irrigation projects in the country. The irrigation potential increased from 22.6 million hectares in 1950–1 to 89.4 million hectares by 1995–6 (Ministry of Finance, 1996). According to Rao (1997), the irrigation potential has increased so enormously that today India is rated second in the world for this component. Vast areas have been brought under irrigation to avoid famine and to meet the food demands created by the growing population, increased industrialisation and urbanisation. The Green Revolution was ushered in with the implementation of the High Yielding Varieties Programme during 1966–7 in the irrigated areas, boosting the morale and economy of the country by achieving significant upward shifts in crop production. Food grain production increased from 50.8 million tonnes in 1950–1 to 191 million tonnes by 1997–8 and is presently about 200 million tonnes. By increasing the irrigation potential, the country has attained self-sufficiency in food grain production and has managed to maintain this status for nearly two decades.

However, modern canal irrigation is closely connected with and directly related to a decline in environmental sustainability. The construction of huge dams across natural river courses and the laying of canal networks interfere with and even seriously alter existing ecosystems. Not only does India have one of the largest irrigation systems in the world but also probably one of the least efficient (Bansil, 1986). The waterlogged area of the country is estimated at six million hectares, and saline and alkaline soils (resulting from inadequate drainage associated with canal irrigation) are estimated at four million hectares (ha). It has been estimated that the Tungabhadra and Nagarjuna Sagar irrigation projects alone have resulted in 30,000 and 25,000 ha respectively of waterlogged and saline soils. Moreover, the construction of big dams has led to severe social problems as a result of resettlement (World Bank, 1984; Brown, 1989).

Indian agriculture is overwhelmingly dominated by small-scale producers: 78 per cent of holdings are marginal or small, each with an area of one or two hectares. The per capita land availability is 0.6 ha, one of the lowest in the world. Due to the massive biological and geo-physical changes brought about by bringing new and large areas under irrigation, the traditional production systems have been drastically altered through the promotion of modern agriculture. Assured irrigation has led to large-scale monocropping with rice and wheat crops throughout the land. According to 1994–5 statistics, rice occupied 21 million hectares and wheat 22 million hectares of the irrigated gross cropped area of 70 million hectares in the country. Crop specialisation and intensification have created imbalances in cropping patterns and reduced biodiversity. The areas under rice and wheat have continuously increased at the cost of coarse cereals, millets, pulses and allied sector activities. Monocropping has also led to further environmental problems: in the Punjab state of North India, continuous puddling in rice fields has led to the formation of an impervious layer of soil which prevents the uptake of water and nutrients from deeper layers, requiring increased fertiliser application (Singh, 1989). This has disturbed the nutrient balance in the soil and led to a deficiency in micronutrients.

Since modern rice and wheat varieties respond well to chemical fertilisers farmers have a tendency to apply excess doses of fertiliser, regardless of the recommendations. The predominant wheat–paddy rotation has created conditions congenial for pests and diseases to multiply and also led to heavy use of pesticides, in turn resulting in residual effects and posing health hazards. The ever-increasing dependency on fertilisers and pesticides has contaminated the streams and water tables, with serious hazards for the population (Sachs, 1987). Production of methane gas is another danger posed by lowland rice fields. In short, the future sustainability of one of India's most productive cropping systems – the rice–wheat system covering around 10 million hectares – is threatened by environmental degradation (Rao, 1997).

Although canal irrigation has proved a boon for increasing food production, it is a bane as far as environmental sustainability is concerned. The extensive irrigation network is in one way essential to meet the food demands of the burgeoning population. But at the same time the environmental hazards associated with canal irrigation cannot be ignored. Studies have shown that technical change to the production systems is warranted. Such a change must help to meet the economic requirements, yet at the same time it should also be environmentally safe. This paper suggests that the appropriate technical change would be to shift from pursuing an exploitative monocropping or specialised

Table 1 Predicted future demand for agricultural commodities in India, 1996–2007

Items	1996–7 million tonnes	2001–2 million tonnes	% increase over 1996–7	2006–7 million tonnes	% increase over 1996–7
Rice	81.2	89.8	+10.5	98.8	+21.7
Wheat	65.0	72.5	+11.5	80.7	+24.2
Coarse cereals	30.0	32.6	+8.7	34.4	+14.7
Total cereals	176.9	194.9	+10.8	213.9	+20.9
Pulses	15.9	18.2	+14.5	21.0	+32.1
Foodgrains	192.8	213.1	+10.5	234.9	+21.8
Edible oils	6.5	7.9	+21.5	9.5	+46.2
Sugar	14.5	16.8	+15.9	19.6	+35.2
Vegetables	77.3	91.7	+18.6	108.5	+40.4
Fruits	40.4	52.6	+30.2	69.1	+71.0
Cotton	2.0	2.4	+20.0	2.9	+45.0
Milk	72.4	93.4	+29.0	119.5	+65.1
Meat & Eggs	3.6	4.6	+27.8	6.0	+66.7
Fish	5.4	7.1	+31.5	9.3	+72.2

Source: Kumar and Mathur, 1997

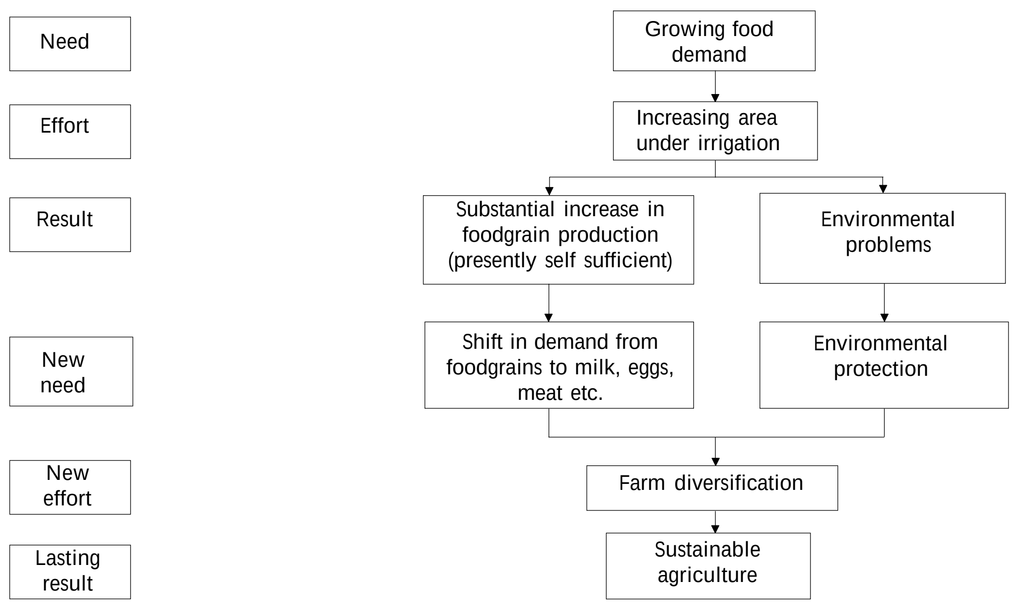
farming system to more diversified farming systems with complementary allied sector activities such as dairy which will fulfil both the economic demands of small-scale farmers and ecological demands for sustainability.

2 FARM DIVERSIFICATION

An increasing demand for milk in both rural and urban areas suggests that the promotion of diversified agriculture through animal husbandry will raise the incomes of rural households. Such diversification is suitable for weaker sections of the rural communities and has a redistributive effect in favour of them. National Sample Survey data for 1977 and 1987 household consumption patterns clearly indicate that the annual per capita consumption of cereals declined from 193 to 180 kg in rural areas and from 147 to 139 kg in urban areas, whereas the per capita consumption of milk increased from 25 to 58 kg in rural areas and from 40 to 65 kg in urban areas during the same period.

The predicted future demand for agricultural commodities is illustrated by Table 1. Taking 1996–7 as the baseline year, by 2001–2 there is expected to be a 10.5 per cent increase in the demand for food grains, and by 2006–7 the increase is estimated to be 21.8 per cent. Similar figures for milk, meat, eggs and fish, in contrast, are forecast to be about 30 per cent for 2001–2 and between 65 and 70 per cent by 2006–7. This indicates the need for rapid development in the dairy, poultry and fishery sectors rather than in the crop sector. A recent assessment of Indian agricultural prospects revealed that Indian agriculture is beginning to appear globally competitive (Ministry of Finance, 1996). This welcome change seems to have been made possible by two important policy reforms introduced during the liberated regime: (a) a reduction in the excessive protection earlier accorded to the manufacturing sector, which in turn improved the relative profitability of agriculture; and (b) an appropriate increase in the relative price of major farm products,

Figure 1 Flow chart showing the need for farm diversification



ensuring market-oriented prices to the farming community, resulting in more equitable terms of trade for the agricultural sector.

There are several studies to support the view that diversification through crop and animal enterprises will help to conserve natural resources and promote sustainable agriculture. Swaminathan (1988) has illustrated that intensive crop and animal husbandry techniques practised on an ecologically sustainable basis are essential for the rehabilitation of degraded lands and to conserve our rich genetic heritage. Farm diversification helps to conserve natural resources and protect the environment (FAO, 1991). The disregard of biochemical and ecological feedback mechanisms of agro-ecosystems results in a decline in soil organic matter content and soil activity, the elimination of pest-predator insects, and the degradation of the animal auto-immune systems by prolonged use of antibiotics (Van and Verkly, 1991). These effects can be reversed by basing the farm system on diversification and optimum use of internal inputs. According to Petit and Barghouti (1996) agricultural diversification offers an approach for stemming further environmental degradation through the establishment of multi-commodity production systems that are not only economically profitable but also environmentally sound.

The future environmental sustainability of irrigated areas can be significantly enhanced by farm diversification with allied sector activities. Figure 1 illustrates the need for farm diversification to achieve sustainable agriculture.

For an empirical assessment of this issue, a micro-level study was undertaken in one of the important river irrigation systems of Southern India – the Tambiraparani river command area. The study was carried out with the objective of assessing and comparing the sustainability of diversified and non-diversified rice based farming systems under assured irrigation.

3 THE FARMING SYSTEMS OF THE TAMBIRAPARANI RIVER COMMAND AREA

The Tambiraparani irrigation system is one of the oldest irrigation systems in the state of Tamil Nadu. The river originates in Tirunelveli District and flows into the Bay of Bengal in Thoothukudi District, traversing a length of about 120 km. Run-off occurs during both the southwest monsoon (June–September) and northeast monsoon (October–December/January), thus making it a perennial river. The irrigation development dates back several centuries, and eight dams have been constructed across the main river to date. These eight dams serve a total of eleven channels with an authorized command area of about 34,443 ha of which about 47 per cent is within the direct command area and 53 per cent is indirectly fed through canals. The average withdrawal of irrigation water by the eleven channels of the irrigation project is 844 million cubic metres per year.

Water is released by June 1st every year into the Tambiraparani command area for irrigation. The upper reaches of the command area receive the water during June itself, while the lower reach receives water only by September. The upper reach and most of the middle reach is irrigated directly through canals, whereas in the lower reach the irrigation is mainly through system tanks. Water from the river has to fill the tanks first and then in turn the tank water will be let out for irrigating the fields. In other words, the river water has first to irrigate the fields in the upper and middle reaches and then travel to the tanks in the lower reach, fill them, and then be let out for irrigating the fields. Due to the delay in the filling of the tanks in the lower reach, the crop rotation displays slight seasonal variations, as described below.

Cropping pattern

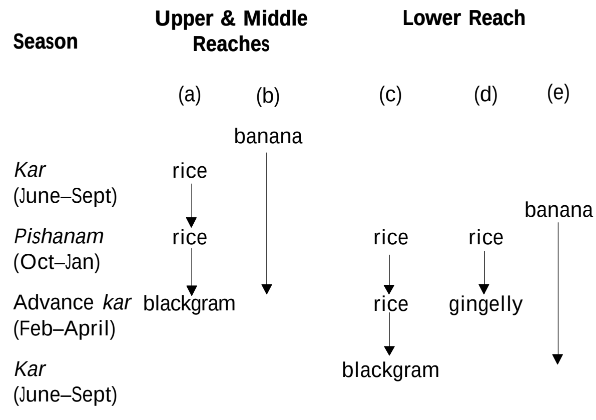
Rice (*Oryza sativa*) is the major food crop in the Tambiraparani command area followed by banana (*Musa spp*), blackgram (Vigna mungo) and sesame (*Sesamum indicum*, locally known as 'gingelly') in that order. In 1995–6, rice occupied 44.1 per cent of the gross cropped area (GCA) in Tirunelveli District, followed by blackgram (7.2 per cent), banana (3.4 per cent) and sesame (1.4 per cent). As regards Thoothukudi District, the share of rice to GCA was 11.9 per cent, followed by blackgram (10.1 per cent), banana (5.0 per cent) and sesame (1.6 per cent) during the same period.

Crop rotation

The cropping sequence prevailing in the Tambiraparani tract is more or less uniform throughout the upper and middle reaches, with a slight variation in the lower reach due to the delay in irrigation. The seasonal crop rotations of the upper/middle reaches and of the lower reach are illustrated in Figure 2. There are three main agricultural seasons locally known as *kar* (Hindi: *kharif*), *pishanam* (Hindi: *rabi)* and advance *kar*. The latter more or less coincides with the summer season (February – May); *kar* coincides with the southwest monsoon (June – September); and the *pishanam* coincides with the northeast monsoon (October – January).

Water is released into the canals at the beginning of June, irrigating the upper and middle reaches of the command area at the start of the *kar* season. With this a double crop of rice is grown, followed by blackgram,

Figure 2 Seasonal crop rotations of the Tambiraparani River command area



which is raised as a rice fallow pulse crop utilizing the residual moisture (column a in Figure 2). Banana is grown as a pure crop, normally planted during February, March or April (column b).

In the lower reach of the river, the delay in irrigation caused by filling the system tanks prevents a first season crop during *kar*. Hence, the crops are planted slightly later.

In double crop wetlands of the lower reach, rice is grown in *pishanam*, which is followed immediately by another crop of rice from March/April to June/July (column c in Figure 2). With the available water in the tanks and residual moisture in the field after the *pishanam* season, the second crop is raised as advance *kar*. Whenever the water in the tanks is insufficient after the *pishanam* season (which is quite common in the lower reaches of the tank command areas), a single crop of rice is raised during *pishanam* and it is followed by sesame or blackgram (column d). Banana is raised as a sole crop as in other reaches (column e). A 'two year crop rotation' is practised, in which rice and banana are generally grown interchangeably in the entire command area. In the middle and lower reaches of the command area where water for irrigation is scarce during the summer, farmers abstain from growing banana.

Livestock

Cattle and buffalo are distributed throughout the two districts, whereas sheep and goats are predominantly found in drylands outside the river command area. In 1998, the cattle and buffalo population in Tiruneveli District was approximately 430,000 head, followed by sheep (331,000 head) and goats (219,000 head). In Thoothukudi District, sheep (248,000 head) dominated over cattle and buffalo (230,000 head), and the goat population was 201,000 head (Directorate of Economics and Statistics, 1998).

Diversification

Rice production is the main agricultural activity in the command area and farm diversification is fairly limited. Dairy forms the main allied sector activity, which is maintained along with crop activities as part of a mixed farming system. Dairy animals are maintained to provide milk for family consumption as well as for sale, and dung is used as manure for crops. Draught animals are used for ploughing and threshing operations and for the transport of inputs and produce. Other activities such as fishing or rearing of sheep, goats, poultry or ducks were hardly found to exist in the command area on a commercial scale.

As such, the four rice-based farming systems observed in the command area are:

i) rice only;
ii) rice + banana;
iii) rice + dairy animals; and
iv) rice + banana + dairy animals.

For the purpose of the study, these four systems were grouped as diversified farms ('rice + dairy' and 'rice + banana + dairy') and non-diversified farms ('rice only' and 'rice + banana'). A quantitative survey was conducted in 30 villages distributed uniformly in the upper, middle and lower reaches of the Tambiraparani River command area. Data were collected by personally interviewing farmers representing each of the four farming systems.

4 SUSTAINABILITY INDEX

A sustainability index was developed to measure the sustainability level of the wetland farming systems.

Box 1 Economic viability indicators

Production efficiency. The non-weighted average of the yield for each activity on a farm expressed as a percentage of the average yield of that activity in the region.

Net return. The non-weighted average of the rate of return (net return divided by variable cost) of each activity on a farm.

Cultivated land utilisation index. The total days land is occupied during the year, expressed as a percentage of full (365-day) utlisation.

Technology use level. The non-weighted average score for the adoption of recommended practices for each activity.

Low-cost technology use level. The non-weighted average score for the proportion of recommended 'low-cost' technologies used for each activity. (These technologies include: appropriate season, recommended variety, seed treatment, use of bio-fertilisers, integrated pest management practices, and certain dairy management practices.)

Employment generation capacity. The non-weighted average of labour time for each activity as a proportion of a standard labour requirement for that activity.

Farm family employment level. The proportion of total available farm family labour days spent working on the farm.

Self-reliant level. A score that measures the degree to which farmers were self-reliant with respect to capital, farm implements, farmyard manure, labour, and information on cultivation practices, processing and market knowledge.

Self-sufficiency level. A score that measures the degree to which the farm household was self-sufficient in food, fodder and fuel.

Box 2 Ecological soundness indicators

Eco-friendly technology use level. The non-weighted average scores for the adoption of eco-friendly activities for each activity. The technologies included suitable variety, use of biofertilisers, application of organic manure, and integrated pest management.

Organic recycling level. The non-weighted average (for all recycled products on the farm) of the proportion of the total product produced that is recycled.

Low-external input use level. The non-weighted average of the results of dividing the recommended level for each external input by the actual level (i.e., the further below the recommended level the higher the index).

Soil health. A score based on measures of organic matter, nutrients, electrical conductivity and pH for farm soil samples.

Box 3 Calculating the sustainability index

Economic viability. The average of the nine economic viability scores.

Ecological soundness. The average of the four ecological soundness scores.

Sustainability index. The average of the economic viability and ecological soundness scores.

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Economic viability and ecological soundness were the two dimensions of sustainable agriculture adopted in constructing the index. Economic viability refers to the level of adoption of economic principles in the management of farm activities and the extent to which the farm output is considered to be economically efficient. Similarly, ecological soundness refers to the level of adoption of ecological principles and the extent to which the farm was considered to be ecologically efficient. Economic viability was measured using nine indicators (Box 1), and four indicators were selected to measure ecological soundness (Box 2). The sustainability index was constructed by considering both sets of indicators (Box 3).

5 LEVELS OF SUSTAINABILITY

Indicator measurements relating to the economic viability of diversified and non-diversified farms are presented in Table 2. The results show that – with the exception of cultivated land utilisation – all indicator measurements for diversified farms were significantly higher than those for non-diversified farms. The uniformity in cropping patterns throughout the command area, be it diversified or non-diversified farms, resulted in similar levels of cultivated land utilisation. The overall economic viability of diversified farms was significantly higher than non-diversified farms.

Indicator measurements for ecological soundness of both diversified and non-diversified farms are presented in Table 3.

Table 3 shows that two out of the four indicator measurements for ecological soundness – eco-friendly technology use level and organic recycling level – were significantly higher for diversified farms. The other two indicators – low-external input use level and soil health – were found to be almost the same for both diversified and non-diversified farms. Since the cropping pattern for both categories of farms was uniform (either 'rice only' or 'rice + banana'), both displayed similar levels of low external input use. As the river tract is a contiguous area any difference in soil health between diversified and non-diversified farms was negligible. Overall, the ecological soundness of diversified farms was significantly higher than non-diversified farms.

The results of the sustainability analysis for diversified and non-diversified farms are presented in Table 4.

The sustainability level was calculated as the average of the economic viability and ecological soundness indicators. From Table 4 it is evident that the sustainability level of diversified farms was also significantly higher than non-diversified farms. The majority of diversified farms (80.0 %) was found to have a high level of sustainability, whereas the majority of non-diversified farms (68.3%) had a low sustainability level. The coefficient of variation of both types of farms was found to be low indicating that the sustainability level of both diversified and non-diversified farms was quite consistent.

The size-wise analysis indicated that the diversified small farms (less than one hectare) were more economically viable, ecologically sound and sustainable than non-diversified small farms. Likewise, the large diversified farms (greater than one hectare) were more economically viable, ecologically sound and sustainable than large non-diversified farms. In all the three reaches i.e., upper, middle and lower reaches of the Tambiraparani River system, the economic viability, ecological soundness and sustainability of diversified farms were significantly higher than non-diversified farms. This provides strong evidence that the diversified farms were more sustainable than non-diversified farms.

To probe deeper, an analysis of sustainability was carried out for each of the four farming systems. It was found that the economic viability of the 'rice + banana + dairy' system was the highest, followed by two systems – 'rice + dairy' and 'rice + banana' – with similar levels

Table 2 Economic viability indicators of diversified and non-diversified farms

	Indicators	Percentage Level: Diversified farms (n=60)	Percentage Level: Non-diversified farms (n=60)	't' value
1.	Production efficiency	96.6	87.9	2.2**
2.	Net return	122.1	103.7	2.3**
3.	Cultivated land utilisation index	73.8	71.1	0.9NS
4.	Technology use level	51.8	44.3	4.4**
5.	Low-cost technology use level	52.2	38.7	8.5**
6.	Employment generation capacity	79.2	71.8	3.3**
7.	Farm family employment level	42.5	34.7	2.1**
8.	Self-reliant level	41.5	35.1	2.7**
9.	Self-sufficiency level	47.4	24.4	8.0**
	Economic viability	67.4	56.9	6.6**

** Significant at 0.01 level of probability
NS=Non-significant

Table 3 Ecological soundness indicators for diversified and non-diversified farms

	Indicators	Percentage Level: Diversified farms (n=60)	Percentage Level: Non-diversified farms (n=60)	't' value
1.	Eco-friendly technology use level	53.7	44.6	5.4**
2.	Organic recycling level	91.6	67.5	6.4**
3.	Low-external input use level	67.5	66.9	0.2NS
4.	Soil health	59.3	59.7	0.5NS
	Ecological soundness	68.0	59.7	6.2**

** Significant at 0.01 level of probability
NS=Non-significant

Table 4 Levels of sustainability for diversified and non-diversified farms

Sustainability Levels	Diversified farm		Non-diversified farm	
	No. (n = 60)	Per cent	No. (n = 60)	Per cent
Low	8	13.3	41	68.3
Medium	4	6.7	6	10.0
High	48	80.0	13	21.7
Total	**60**	**100.0**	**60**	**100.0**
Mean	67.7		58.3	
Difference between Means		9.4		
't' value		7.9 **		
Coefficient of Variation %	8.3		12.5	

**Significant at 0.01 level of probability

of economic viability. The system with least economic viability was 'rice only'. Economic viability therefore appears to be based on the number of activities: the economic viability of the 'rice + banana + dairy' system (three activities) was found to be economically more viable than the systems with just two activities ('rice + banana' and 'rice + dairy'). As the 'rice only' system had only one activity, its economic viability was found to be the lowest. These findings bring to light the following points: the economic viability of a farm is determined by the number of activities it possesses; the contribution made by banana and dairy activities to the economic viability of wetland farms is significant; the contributions of banana and dairy activities to economic viability in wetland farms are similar; and dairy farming is not competitive but complementary to crop activities (i.e. rice and banana cultivation).

These findings suggest that to increase the economic viability of wetland farms the number of activities in the farm must be increased. In the Tambiraparani tract, small farms (less than one hectare) are predominant. Small-scale farmers mainly grow rice for the purposes of home consumption and the little surplus is sold in the market. Since, the 'rice only' system relies solely on one activity i.e. rice, it becomes the most vulnerable among all the wetland systems in terms of sustainability. As stated elsewhere, in certain pockets of the middle and lower reaches of the river tract, the lands situated at the end of the reaches faced water scarcity and thereby only one crop of rice is raised in those areas. The data revealed that the net return of rice was the lowest when compared to either banana or dairy activities. Under these circumstances, reliance on rice cropping alone cannot lead to economic viability of the farm.

Furthermore, the study indicated that even though there is a possibility for growing cash crops such as blackgram and sesame in fallow rice fields after the *pishanam* season, it is still a gamble with uncertain prospects. In the upper reaches of the river, it was observed that many farmers abstained from growing blackgram due to the menace of grazing cattle. Lack of rains at critical periods results in poor yields or no yield from the cash crops. Moreover, it has become a customary practice not to apply any fertilisers or undertake any plant protection measures for these two crops, which results in low yields when compared to the potential yields. Thus, dependence on cash crops as a guaranteed and a regular supplementary source of income is futile and will not help to achieve economic viability of the 'rice only' system.

The cultivation of a banana crop depends upon water availability during the summer (i.e. advance *kar*) and farm size, together with the annual income and socio-economic status of a farmer. Marginal farmers with an area of less than half a hectare have to decide between growing a rice crop for meeting the food requirement of the household and growing bananas for commercial purposes. Deciding between these two options and their trade-offs is extremely difficult for the farmer. As mentioned elsewhere, a paucity of water for irrigation in the summer tends to discourage farmers from raising banana. Hence, in the light of the above findings, dairy seems to be a better option for supplementing farm income.

With respect to ecological soundness, the system-wise analysis revealed that the ecological soundness of the 'rice + banana + dairy' system was the highest, followed by 'rice + dairy', 'rice + banana' and 'rice only' in that order. In any case, the diversified systems with a dairy component were more ecologically sound than the non-diversified systems.

6 STRATEGIES TO PROMOTE SUSTAINABLE AGRICULTURE

The diversified farming systems – especially the 'rice + banana + dairy' system – were found to be more economically viable and ecologically sound than the non-diversified systems. This implies that combining dairy activities along with crop activities has important dividends. There are four types of farmers in the command area, as follows:

i) farmers who have always had dairy;
ii) farmers who had dairy in the past but have discontinued in the present;
iii) farmers who have dairy on an on-off basis; and
iv) farmers who have never had dairy.

The characteristics of these four types of farmers and the strategies to be followed in promoting dairy activities are described in the paragraphs that follow.

Those farmers who have always undertaken dairy activities are the biggest farmers in the command area with very high incomes. They have the capacity to invest huge capital on dairy activities for purchasing cross-bred animals, constructing proper cattle sheds, and feeding balanced fodder, and they have hired labour to maintain the cattle. As such, this group is an elite group. Since they are very interested in maintaining milch animals and possess the means to do so, a deliberate strategy to promote dairy is not required for this group: left to themselves they are capable of performing at very high standards.

For those farmers who had dairy in the past but not at present, the reason for discontinuation is that they do not have anybody to take care of the animals. Dairy was previously a family enterprise, for which family members themselves provided the labour without the need to hire any external labour. As family members grew up and moved out of the home and village to seek higher education or employment or marriage, there was nobody left to maintain the animals. This group comprises both large- and small-scale farmers with high to moderate incomes. Their potential to invest in dairy is high but they cannot undertake dairy activities themselves due to the lack of labour. Since this group is quite stable, it is suggested that they can help those resource-poor farmers interested to maintain dairy by extending loans or on a profit-sharing basis.

Poor dairy management practices are the hallmark of those farmers who practise dairy farming on an on-off basis. They mostly own a non-descript breed of cows and lack proper shed and stall facilities. Since the milk yield of non-descript cows is less, the profit margin is also low. As a consequence, capital formation and subsequent investment in the dairy enterprise is affected and so whenever any animal dies, replacement with a new animal is not immediately possible. This group is quite unstable without a regular flow of income. Though very interested in dairy farming, this group comprises small-scale and mostly marginal farmers, with low incomes and low investment capacity. The strategy to promote dairy farming among this group would be firstly to convince them to cultivate bananas alongside their rice crop for the purpose of capital formation. Awareness campaigns need to be undertaken to promote graded animals instead of non-descript cows, as the graded animals are more remunerative than the non-descript ones. The defunct cooperatives can be revived by the local *panchayat* bodies that exist to help this group of farmers. (*Panchayat* is a three-tiered system of democratic self-government that forms a statutory part of Indian governance). The State Department of Animal Husbandry can create fodder banks during off-season in association with voluntary organisations. Model diversified farms can also be established in the villages to convince farmers of the benefits of dairy farming by allowing the farmers to see for themselves the possibilities for diversification in their own farms.

Lastly, those farmers who have never practised dairy activities are the smallest farmers in the entire command area and have very low levels of income. They do not undertake dairy activities for the simple reason that they cannot afford to purchase and maintain the cows. Though interested in dairy activities, they lack the capital required for investment. They grow only rice and their life is one of hand-to-mouth existence. They do not have the space, either in the farm or in their homestead, to maintain milch cattle. This group is the most vulnerable in the command area: they have no extra income, and they suffer the most in times of adverse circumstances. As far as the extension system is concerned, these farmers have the most potential in that they will be prepared to take up fresh initiatives to give them some extra income. These farmers can be motivated to form self-help groups or cooperatives for the establishment of dairy enterprises. Such enterprises can be set up on farms where there is enough space for cattle, and the farmers providing the space can be duly compensated. The defunct cooperatives can also be revived by the relevant *panchayat* bodies that exist to help this group of farmers. Fodder banks and the establishment of model diversified farms are also necessary to motivate this group of farmers.

The above strategy can help to improve the socio-economic status of small-scale producers and also promote environmental sustainability in the region. It is

Table 5 Strategies for dairy promotion among four types of farmers

1. Farmers who always had dairy (elite group)
- biggest farmers
- can invest high capital on dairy and very interested
- cross-bred cattle
- proper cattle sheds
- enough fodder

Strategy: Not required

2. Farmers who discontinued dairy (stable group)
- big & small farmers
- high & moderate income
- can invest high capital on dairy but not interested
- nobody to maintain at present
- feel that hiring labour will not be profitable

Strategy: This group can be motivated to provide capital to other farmers for dairy enterprises at nominal rates of interest or on profit-sharing basis.

3. Farmers who practise dairy on and off (unstable group)
- small & marginal farmers
- less income
- can invest less capital on dairy but very interested
- unable to maintain cattle on permanent basis due to indebtedness, mortality of cattle and possession of non-descript cows, which yield less income
- have people to maintain

Strategy:
- to convince farmers to avoid mono-cropping and to raise rice + banana for capital formation
- to promote rearing of graded milch animals
- to create fodder banks during off-seasons
- to develop model diversified farms

4. Farmers who never had dairy (vulnerable group)
- smallest farmers
- very low income
- lack of capital to invest in dairy but interested
- raise only rice
- subsistence farming
- no place for cattle

Strategy: farmers can join to form self-help groups or cooperatives to:
- revive the defunct cooperatives
- create fodder banks during off-seasons
- develop model diversified farms

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possible for small-scale farmers to maintain dairy enterprises due to the relatively small space requirement, provided that there is an assured water supply either for drinking or washing and the availability of veterinary services such as vaccination, artificial insemination and treatment for disease. In addition, it is necessary that banks should extend subsidies linked to the Integrated Rural Development Programme loans to allow for the purchase of milch animals at low interest rates and with easy repayment schedules. Moreover, the dry fodder requirement can be met from the rice straw available in the farm, and green fodder is available for more than six months along the river course.

7 CONCLUSION

The sustainability of wetlands – especially the rice-based farming systems – is important both from an economic and ecological point of view. The farms that include rice, banana and dairy activities have been found to be more economically viable and ecologically sound than other wetland systems. Dairy activities contribute significantly to the sustainability of the wetland farms. Considering the predominance of small-scale producers in the Tambiraparani River command area and the suitability of dairy enterprise to the local area, appropriate support from the government in the form of technical and financial assistance can help in promoting dairy business in the region. Government bodies, local *panchayats*, voluntary organisations and farmer associations need to gear up their activities to promote dairy activity in the region in order to improve the socio-economic status of small producers and also to achieve sustainable agriculture of the river command area. To instill confidence in farmers to diversify their farms, model diversified farms based on scientific principles may be developed in the villages. It is also necessary for the research system to explore other possible options for locally appropriate diversification strategies.

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