odi

Natural Resource perspectives

Number 56, June 2000

AQUACULTURE, POVERTY IMPACTS AND LIVELIHOODS

Peter Edwards

Aquaculture is often viewed narrowly as intensive culture of salmon and shrimp to provide high value products for luxury markets and is often associated with environmental degradation. The promotion of aquaculture for rural development has had a poor record in many developing countries, especially in Africa. This paper shows that aquaculture does contribute to the livelihoods of the poor, particularly in areas of Asia where it is traditional practice, although a number of constraints prevent its expansion. Recent adoption of new technology suggests that, with adequate support, aquaculture could also contribute significantly to rural development in countries where it is neither a traditional nor widespread practice.

Policy conclusions

- Aquaculture comprises diverse systems of farming plants and animals in inland and coastal areas, many of which have relevance for the poor. Asia, in particular China, is dominant in global aquaculture production.
- Social, economic and institutional issues are the most important constraints to greater contributions by aquaculture to rural development, as generic technologies already exist. Land-based culture systems in inland areas have the greatest potential because aquaculture can be integrated with the existing agricultural practice of small-scale farming households Coastal aquaculture also has relevance to poverty alleviation.
- A new professionalism involving changes in values among development professionals and increasing use of participatory, farming systems approaches that empower the poor and local communities are required for aquaculture to contribute more fully to livelihoods.
- The poor need to be targeted and provided, at least initially, with public sector support although aquaculture has to function on a self-financing basis within the private sector for it to contribute sustainably to livelihoods.
- Government needs to address both the design and implementation of policy, with feedback mechanisms allowing the poor to influence development.

Introduction

The extent to which aquaculture can help in poverty reduction is a major policy question. Aquaculture is commonly equated with intensive culture of salmon in developed countries and culture of shrimp in developing countries; both are carried out mainly by better-off farmers to provide a high-value product for wealthy consumers, often with adverse environmental impact. Furthermore, conventional approaches to promoting aquaculture have failed to have a major impact on the poor, particularly in Africa (Harrison et al., 1994).

In parts of Asia, poor farmers farm fish where it is traditional practice; they consume or sell fish to generate income; have confidence in the technology; and have access to appropriate genetic material (fish 'seed'). The use of participatory rather than technology-driven approaches is leading to the adoption of aquaculture by new entrant poor farming households in Africa and Asia.

Aquaculture – definition, current status and potential

Aquaculture may be defined simply as farming fish and other aquatic organisms. Fish is used here generically to include all farmed aquatic organisms. Land-base systems are commonly integrated with agriculture by stocking fish in rice fields and ponds. Water-based systems involve stocking fish directly in enclosures or attaching them to substrates in water bodies such as rivers, lakes, reservoirs or bays. Water-based systems may provide an entry point for landless people and poor fishers to farm fish.

'Rural aquaculture' implies low-cost production with extensive and semi-intensive technologies most appropriate for the limited resource base of small-scale households (Edwards and Demaine, 1997). It is based on natural food for fish such as plankton, which is occasionally fertilised and/or supplemented by other feed. Fertiliser and feed may be derived from on-farm by-products, at least in the initial stage of intensification, although even here formulated and pelleted feed from agro-industry are increasingly used. By contrast, intensive systems invariably depend on relatively high-cost, nutritionally complete diets.

The annual growth of aquaculture has averaged some 11% for nearly two decades. Although salmon and shrimp receive most publicity, they comprise less than 10% of global aquaculture production by weight compared with 50% for carps and tilapias which contribute most to the domestic food supply in developing countries.

Aquaculture production is also skewed geographically with Asia producing over 90% of global products, dwarfing Africa and Latin America at less than 0.5% and 2%, respectively. In China, with 67% of global aquaculture production, inland aquaculture production has increased at least fivefold in the past decade; it has only doubled in the rest of the world, implying large potential in other developing countries if constraints to its expansion were removed.

Roles and impacts on poverty

Aquaculture contributes to the livelihoods of the poor through improved food supply, employment and income (Box 1). Many small-scale farmers have small land holdings in areas of complex, diverse and risk prone agriculture in mainly rainfed and undulating land on the fringes of lowlands or in uplands. Construction of a pond on these frequently environmentally degraded farms may also provide a focal point for agricultural diversification and increased sustainability, by providing a source of water. The poor in well-endowed lowlands are often landless or near-landless; here, fish farming in common water bodies may help to reduce

DFID Department for International Development

This series is published by ODI, an independent non-profit policy research institute, with financial support from the Department for International Development (formerly the Overseas Development Administration). Opinions expressed do not necessarily reflect the views of either ODI or DFID.

poverty, provided that the poor can access them. Inland and coastal fishers are usually landless and are amongst the most impoverished; their opportunities lie mainly with water-based culture systems.

Although fish provide far less animal protein for global nutrition than livestock, people in major areas of Africa and Asia are highly dependent on fish as part of their daily diet: in 18 countries in Africa and Asia, nine on each continent, fish provide at least 40% of dietary animal protein. They also provide highly digestible energy, and are a rich source of fat and water soluble vitamins, minerals and fatty acids.

Aquaculture has contributed in the past towards poverty reduction in poor societies in the few areas of the world in which it is traditional practice, for example China, Indonesia and Vietnam, and it continues to do so today. Few projects have specifically targeted the poor and the impact of aquaculture on poverty has scarcely been assessed.

Recent experience in Asia and Africa indicates that poor farmers adopt aquaculture where certain predisposing conditions are met:

- Consumers (including farmers themselves) must perceive the value of fish and this must be reflected in market demand. This is most likely to be the case in areas where wild or farmed fish have traditionally been consumed. Early attempts to promote aquaculture often focused on household food security which may have contributed to the high rate of failed development initiatives, particularly in Africa. People-focused approaches are likely to be more appropriate.
- For the poor to become directly involved in aquaculture as a farming practice, they need to own or rent agricultural land for culture in rice fields or ponds, or if landless have access to a water body in which to stock fish.
- Another major requirement is knowledge of appropriate technology, e.g. many small-scale farmers failed to culture fish in northeast Thailand because they stocked too small fingerlings at too high a density in ponds that were neither fertilised nor fed; fish suffered high mortality; were consumed by residual populations of carnivorous wild fish, or simply did not grow (Edwards et al., 1996).
- A supply of seed is crucial and is often a major constraining factor for adoption of aquaculture.
- Institutional support is usually required for new entrant farmers in the form of extension advice or inputs, especially seed.

Box 1 Potential contribution of aquaculture to the livelihoods of the rural poor

Direct benefits

- Food of high nutritional value, especially for vulnerable groups such as pregnant and lactating women, infants and pre-school children.
- 'Own enterprise' employment, including for women and children.
- Income through sale of relatively high value produce.

Indirect benefits

- Increased availability of fish in local rural and urban markets, which may bring prices down.
- Employment on larger farms, in seed supply networks, market chains and manufacture/repair functions.
- Benefit from common pool resources, particularly the landless, through cage culture, culture of molluscs and seaweeds, and enhanced fisheries in communal water bodies.
- Increased farm sustainability through:
  - construction of ponds which also serve as small-scale, on-farm reservoirs
  - rice/fish culture as a component of integrated pest management.

Aquaculture has recently been adopted also by many new entrant farmers in specific areas in southern Africa where these conditions were met (van der Mheen, 1998).

Appropriate aquaculture technologies

Aquaculture comprises sequential stages of seed production, nursing and grow-out. In its early development in China and Vietnam, seed were either trapped from rivers or spawned by small-scale farmers at the household level. Bangladesh has dynamic, private sector involvement in production, nursing and distribution of seed, involving numerous stages to transport seed large distances by rail, vehicles and on foot. Although it is hierarchical with unequal power distribution between various 'actors', there is considerable employment of the poor as it is labour intensive.

However, many areas are characterised by inadequate seed supply, and donor funded hatcheries have often proved ineffective following withdrawal of financial support. Strategies to decentralise seed production and distribution have been developed recently in some parts of Africa and Asia. Small carps and tilapias can be bred simply without the need for expensive conventional hatcheries. Local seed production can enhance poverty reduction by reducing cost, improving quality of seed as long distance transportation of seed is not required, and providing employment and income generation at local level. Models for producing and nursing seed in small suspended cages at farm household level have been developed and field tested in Thailand (Little et al., 1991) and subsequently in Bangladesh, Cambodia and Lao PDR where they have a powerful multiplier effect. Seed production and distribution have the best prospects of sustainability where private sector involvement is strong, but these can also disseminate extension information, for instance via itinerant seed merchants.

Land based systems

Farmers have always caught wild fish in lowland rice fields but integrated rice/fish culture has never been common. Capture and culture of fish in rice fields have both been adversely affected by the introduction of high yielding rice varieties (HYVs) because of the short growing season and pesticide use. In addition, it may be difficult to manage water to meet both crop and fish requirements, and theft of fish may increase, particularly where rice field fish are considered a common pool resource. Nevertheless, there is considerable potential for increased involvement of poor farming households in rice/fish culture in both rainfed and irrigated rice as indicated by successful examples from such widely separated areas as Bangladesh, Madagascar and Thailand. Strategies to culture fish with HYVs contribute towards integrated pest management (IPM) as farmers invariably reduce pesticide use to safeguard stocked fish. The potential of rice/fish culture is more likely to be realised where there is a market for the relatively small-sized fish harvested from fields. Most rice/fish culture in China and Indonesia is to produce fingerlings to stock more intensive culture systems.

Most rural aquaculture occurs in household ponds. These are widespread on floodplains, where earth is often extracted to raise the ground level of farm buildings. Various on-farm fertilisers and supplementary feeds are used as nutritional inputs. Night-soil is used in a few countries such as China, Indonesia and Vietnam but is socially acceptable in only few societies; and public health concerns argue against its wider recommendation. Although pigs and poultry may be housed over or adjacent to ponds, livestock on most small-scale farms scavenge for their feed which constrains the use of manure. Scaled-down integration of intensive feedlot livestock with fish has often been introduced but such systems invariably

collapse following withdrawal of external support because of input supply and marketing problems (Edwards et al., 1996). Wild or farmed, terrestrial and aquatic vegetation may be used as manure or fodder for herbivorous fish, but use is constrained by high fibre and moisture contents, high labour requirements, and limited area available on small farms to cultivate it. Most crop by-products have high opportunity cost. Box 2 outlines the characteristics of semi-intensive culture systems, which appear to offer the best prospects for small producers in most areas.

Water-based systems

Water-based systems such as cage and pen culture, enhanced fisheries in large communal water bodies, and farming molluscs and seaweeds in coastal waters may be the only options for aquaculture for the landless and for underemployed fishers. Major constraints include insecure access to water bodies, and the high cost of production of most cage culture. The NGO CARE attempted to involve groups of women in cage farming in Bangladesh but after its withdrawal activities ceased within six months as the women lost access to the water bodies. CARE is currently reassessing whether local NGOs can maintain access to water bodies after the withdrawal of project support. In parts of Asia, there are small-scale farmers and fishers culturing fish in cages. For example, in Vietnam grass carp are cultured in wood and bamboo cages in rivers and reservoirs, using grass, maize stalks, and cassava leaves and roots as feed. Chinese carps are cultured in Nepal with minimal supplementary feed in nylon net cages with bamboo floats and frames in eutrophic lakes with abundant plankton. However, in Indonesia where cage culture developed rapidly to resettle farming households displaced by dam construction, the rural poor gained mainly from trickle-down benefits from labouring in the industry rather than controlling it, as it was taken over by the urban élites. A major constraint is overcrowding of cages in confined waters causing pollution and fish kills.

Common pool, small water bodies are invariably fished by the poor, but are usually overfished. As governments stock water bodies with fingerlings and restrict access, poor people are unlikely to bid successfully for fishing leases. However, in some areas governments have made a commitment to long-term security of tenure for poor fishers: in the oxbow lakes of western Bangladesh, for instance the conditions are in place for self-managed groups of poor fishers to benefit from increased yields through stocking carps (Box 3).

Coastal aquaculture

Aquaculture may be one of the few options for technical improvement for poor households in coastal communities, which are among the most impoverished. Poor fishers culture molluscs and seaweeds in Southeast Asia, particularly in Indonesia and the Philippines. More controversial is shrimp culture which is often controlled by the better-off or by private companies. However, small-scale farmers dominate shrimp farming in Thailand, a majority of whom were previously either rice farmers or fishers, indicating that shrimp culture has contributed to the welfare of the poor directly as well as indirectly through diversification of employment opportunities in coastal areas. Vietnam provides another example where shrimp are now produced on a sustainable basis by poor farming households on small holdings in some areas.

Box 2 Favourable characteristics of semi-intensive culture systems for poor farming households

- can be developed by modifying a rice field or extensive pond system (previously used for trapping wild fish or for culture with no intentional nutritional inputs)
- nutritional inputs can be on-farm by-products such as manure and crop residues
- intensification can be through relatively cheap inorganic fertilisers
- produce can be marketed at relatively low cost and be affordable by poor consumers
- nutrients not removed by harvest of fish are largely immobilised in pond sediments, and so impact on the environment is near-neutral

Source: Edwards and Demaine, (1997).

Expansion versus intensification

Aquaculture has considerable potential for expansion of area: fish can be cultured on good agricultural land resulting in increased production and profit through the synergies of integrated farming practice. Potential also exists for use of irrigation systems and of land unsuitable for agriculture such as saline areas and swamps.

Intensification requires the introduction of off-farm nutrients, possibly in a 'balanced model' using both on- and off-farm inputs: small amounts of feed concentrates to raise fingerlings (Little et al., 1991); and inorganic fertilisers to 'green' ponds to produce plankton for fish for grow-out (Edwards et al., 1996).

Institutional aspects

Poverty elimination is primarily the responsibility of national governments which must be committed to, and provide an environment for, enabling poor people, who are socially excluded, vulnerable, and have limited access to productive assets and resources. The poor need to be specifically targeted with a package of support that includes training and microcredit as well as 'baskets' of choices of appropriate technology. Major national level constraints are the weak implementation of policy; insufficient knowledge relating to rural aquaculture at all levels and the limited capacity of national institutions to function as service providers. Even when governments have favourable pro-poor policy its implementation is often weak (FAO, 1999). For instance, legislation on the use of irrigation water may unjustifiably favour agriculture over aquaculture; policy may also prohibit conversion of rice fields to fish ponds due to misplaced emphasis on grain for food security.

Research and development

Unsurprisingly researcher-derived, on-station technologies have seldom fitted the diverse and resource-limited contexts of most poor farming households. Most aquaculture professionals and service providers currently have a technocratic and fisheries biology worldview which focuses on maximising biological yield rather than meeting local objectives, high-value species rather than low-cost food fish, and commodities rather than communities. More use is required of participatory, systems type approaches to identify poor farming households, to assess their needs and resources, to assess whether aquaculture is appropriate, and if so, to

Box 3 Factors required for the establishment of self-managed groups of poor fishers

- equitable access to the water body
- inclusion of enough fishers from around the lake to avoid mass poaching and to provide 'social fencing'
- incentives for group members through income sharing
- participatory decision-making
- checks by group members on leaders for efficient investment in stocking and harvesting
- commitment to the welfare of the local community

Source: Apu and Middendorp, (1997).

adapt technologies to local contexts through research with farmers (Edwards and Demaine, 1997). Various extension strategies will be required for diverse contexts, including increasing emphasis on farmer to farmer extension, and all driven by the need to provide options rather than fixed prescriptions. Overall, a multidisciplinary and holistic systems framework is required that considers social, economic and institutional contexts as well as technical aspects as the former influence the involvement of the poor in aquaculture more than the latter. There is a pressing need for awareness raising and for problem-based training supported by relevant formal and non-formal education, and for a conceptual framework, such as sustainable livelihoods, to place people and their assets, needs and opportunities at the centre of analysis.

As rural aquaculture is relatively new farming practice in most countries, a regional approach offers a cost-effective mechanism for sharing experiences and resources, and exploring potential in widely varying contexts within and between countries. Successful examples are ALCOM in southern Africa (van der Mheen, 1999) and AIT Aqua Outreach in northeast Thailand and Indochina (Edwards and Demaine, 1998). Partnerships are required between the poor and development professionals to carry out action-based programmes in a shared learning process, in particular where non-governmental and government organisations play complementary roles. Pilot projects should be established at local administrative level in the various resource systems having potential for poverty-focused aquaculture in inland and coastal areas of developing countries.

Strategic or adaptive research?

Although systems approaches to adapt known generic technologies to specific and local contexts will have the greatest short-term impact on poverty reduction, it would be unwise for donors to fund only adaptive research. Strategic research may be higher risk, but also has a potentially higher pay off in terms of the number of poor who may eventually benefit from the research over a wide area.

The major gaps in knowledge include the social and environment/resource aspects of rural aquaculture; the actual and potential contribution of aquaculture to sustainable livelihoods of the poor; and the trade-offs between capture of wild fish and culture of farmed fish, and between agriculture and aquaculture, including the use of fish in IPM.

Strategic research is required on indigenous species, genetics, seed quality and disease. Research is required on potential new species for rural aquaculture, especially for areas where there are concerns that the introduction of exotic species might adversely affect local biodiversity. Breeds of farmed fish are mostly wild types in terms of genetic make-up. Potential gains through genetic research in aquaculture may be expected to parallel those of agriculture and animal husbandry, e.g. research has produced a new strain of Nile tilapia with a doubled growth rate in seven generations of selection that grows faster than most genotypes of the species found in many Asian environments (Eknath and Acosta, 1998). However, concerns have been raised over whether the introduction of improved strains that grow faster and are more marketable, may further marginalise the poor. The poor, especially women and children, might be disadvantaged if lower value local strains currently consumed in households and at village level markets are replaced by higher value, more marketable fish. Research is required in seed quality as many farmers now perceive that cultured fish have declined in performance. Disease also impacts poor farming households, e.g. outbreaks of epizootic ulcerative syndrome in South and Southeast Asia, and red spot disease of grass carp cultured in cages and ponds in Vietnam.

Conclusion

Aquaculture is a relatively new and underdeveloped farming practice compared to agriculture and animal husbandry, even in many parts of Asia. Its positive social and environmental attributes make it an attractive entry point to improve the livelihoods of the poor in rural development programmes. These include its exceptional nutritional characteristics to alleviate undernutrition, relatively high value and marketability to generate income, and the prospects it offers of agricultural diversification through construction of ponds as on-farm reservoirs. Some progress has been made in recent years through the use of people-centred approaches in research and development, even in areas in which aquaculture is not a traditional practice. There is a need to raise awareness of the large potential contribution of aquaculture as it is unappreciated and ignored by most agricultural and rural development professionals and policy makers. Only then would its potential to contribute more towards elimination of poverty have better prospects of being realised.

References

Apu, N.A., and Middendorp, H.A.J. (1998) 'Establishing fishers groups for self-management of enhanced fisheries in semi-closed water bodies in western Bangladesh'. The experience of the Oxbow Lakes small-scale fisherman project, in T. Petr (ed.) 'Inland fishery enhancements', paper 374, pp.393–406. Rome: FAO.

Edwards, P., and Demaine, H. (1997) Rural aquaculture: Overview and framework for country reviews. Bangkok: RAP/FAO.

Edwards, P., and Demaine, H. (1998) 'Completing the problem-solving cycle in aquaculture: The AIT Aqua Outreach'. *Aquaculture Asia*, 3(3): 10–17.

Edwards, P., Demaine, H., Innes-Taylor, N. and Turonguang, D. (1996) 'Sustainable aquaculture for small-scale farmers: Need for a balanced model'. *Outlook on Agriculture* 25(1): 19–26.

Eknath, A.E., and Acosra, B.O. (1998) Genetic improvement of farmed tilapias (GIFT) project. Final Report. Manila: ICLARM.

FAO (1999) 'Asia-Pacific Fishery Commission'. FAO Fisheries Report 610 of the Ad Hoc Working Group of Experts in Rural Aquaculture, Bangkok, pp.22. Rome: FAO.

Harrison, E., Stewart, J.A., Stirrat, R.L. and Muir, J. (1994) Fish farming in Africa – What's the catch? London: DFID.

Little, D.C., Innes-Taylor, N.L. Turongruang, D. and Komolmarl, S. (1991) 'Large seed for small-scale aquaculture'. *Aquabyte*, 4(2): 2–3.

Van der Mheen, H. (1998) Achievements of smallholder aquaculture development in southern Africa. Experiences from the ALCOM Aquaculture Programme. Harare: FAO.

Peter Edwards is a Professor of Aquaculture and Consultant at Aquaculture and Aquatic Resources Management, School of Environment, Resources and Development, Asian Institute of Technology (AIT), PO Box 4, Klong Luang, Pathumthani 12120, Thailand. *Email*: pedwards@ait.ac.th *Tel*: +66 (2) 524 5477 *Fax*: +66 (2) 524 6200.

ISSN: 1356–9228

See www.odi.org.uk/nrp/ for papers in this series.