

The Role of Aquaculture in Rural Development

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Introduction

Rural development, the process of sustained growth of the rural economy and improvement of well-being of rural men, women and children, has various dimensions, but it is particularly the development of the agricultural sector, which is widely believed to provide the main impetus not only for reducing poverty and hunger but also for ensuring food security for all. Only if more rapid agricultural growth takes place in countries with impoverished rural populations, can rural farm and non-farm incomes rise sufficiently to enable the rural poor to become more food secure.

Various types of aquaculture form an important component within agricultural and farming systems development. These can contribute to the alleviation of food insecurity, malnutrition and poverty through the provision of food of high nutritional value, income and employment generation, decreased risk of monoculture production failure, improved access to water, enhanced aquatic resource management and increased farm sustainability (e.g. FAO 2000a, Prein and Ahmed 2000).

Global aquaculture is now the fastest growing food production sub-sector in many countries. The production of all cultured aquatic organisms reached almost 43 million metric tonnes (mmt) in 1999 (FAO 2001), and it is expected that this trend will continue despite several constraints, which may become more challenging in the future.

FAO supports this process by promoting sustainable aquaculture development in its member countries and aims to assist them in achieving an increased contribution of this sector to rural development.

The purpose of this paper is to analyse the role of aquaculture in rural development, through its relationship to food security and poverty alleviation, its contribution to rural development, and to indicate strategies that could increase this contribution. It covers both inland areas and coastal zones and has no distinct geographical focus. However, the overall emphasis is on developing countries, which are the source of over 80% of world aquaculture production and where almost 75% of the poor live in rural areas.

Food Security, Rural Development and Poverty Alleviation

Food security, rural development, and poverty alleviation are closely linked. The FAO State of Food Insecurity Report 2000 estimates that 792 million people in 98 developing nations are not getting enough food to lead normal, healthy and active lives. Even in industrialized nations and countries in transition (those in Eastern Europe and the former Soviet Union), the number of undernourished remains significant at 34 million children, women and men (FAO 2000b).

Food demand will continue to rise significantly. Expanding populations and changing eating habits will make a doubling of food output imperative within the next thirty years. The problem in the modern world is not the lack of a sufficient quantity of food but rather the disparities in global food availability and growing inequalities within and between regions. The recent report on the right to food by the Special Rapporteur of the Commission on Human Rights points out that the *“remarkable developments in agriculture and nutrition science over the last twenty years have clearly so far failed to reduce malnourishment and malnutrition for the poorest populations”*, and that *“a different model of development is needed, one that is focused on local-level food security”* (Ziegler 2001). There are several fundamental reasons why local food demand should be met by local food production to the greatest extent possible. These are:

- that agriculture is the foundation of rural development and the most important provider of gainful employment in rural areas,
- that local food production is the basis for sustaining and caring about landscapes and the environment,
- that food demand has not and cannot be met logistically from surpluses elsewhere, and
- that the availability of foreign exchange is expected to remain a major problem for most poor countries.

Rural development and, in particular, a prosperous smallholder agricultural economy, is widely regarded as the cornerstone in a multi-pronged strategy aimed at reducing poverty and hunger and ensuring food security for all.

Mainstream thinking anticipates no major obstacle to producing sufficient quantities of food for a growing world population for at least the next 25 years, but this does not address the issues of food security. In the words of the World Food Summit: *“Poverty is one of the major causes of food insecurity and sustainable progress in poverty alleviation is critical to improved access to food.”* Poverty is linked not only to poor national economic performance but also to political structures that render poor people powerless. Thus, appropriate policy, developed through good governance, is of overriding importance for food security.

Alleviation of poverty is central to the concept of rural development. Different emphases and approaches to rural development have been followed in the past thirty years, variously focussing on the provision of basic needs, a joint social and economic sector approach, and employment creation through establishment of small enterprises in rural areas. A general consensus emerged from this experience - whatever the sectoral emphasis, rural development requires greater participation of the rural population and involvement of the people in planning for their own development. People's participation and 'bottom-up' planning were identified as essential elements of the development process.

In the agricultural sector, increased participation of stakeholders in decision making and planning processes was reflected in the emergence and evolution of the Farming Systems Approach (FSA). Previously it had been assumed that agricultural scientists were the key actors in improving productivity and that technical innovation within research stations could solve the problems of rural hunger and poverty. Although the technology of the 'Green Revolution' made significant production increases possible (in Asia in particular), it was also recognised

that this technology had little impact on poorer farmers, especially in resource-poor environments. FSA attempted to reverse the research-development process by emphasising the need to start with careful analysis of the real conditions of small-scale farmers, to understand farms as complex integrated plant-animal-fish systems with multiple goals and multiple livelihoods, and to understand the links between external services and internal functions of the farm system.

Aquaculture development followed a similar pattern. Starting in the 70's there was substantial assistance for developing the sub-sector in Latin America, Asia and Africa. The tendency of these development initiatives was to focus overly on large infrastructure development, technical packages and technical training, without paying sufficient attention to the role of these, often new, production systems in the livelihood or farming system of the intended beneficiaries. All too often, the result was lack of adoption by one of the intended target groups – the rural poor. As a result of the apparent inability to impact the rural poor, donor support for aquaculture development has declined in the past 10 years. Paradoxically, the progress made in Asian aquaculture during this time saw a tremendous boom in commercial scale aquaculture by households with better resource bases, hand in hand with the economic expansion of the region, opening markets and increasing the flow of cash economies to rural areas.

Poverty is a complex phenomenon, which cannot be understood in purely sectoral terms. A series of consultations on small-scale rural aquaculture concluded that aquaculture should not be viewed as an isolated technology but be considered as one aspect of rural development and form part of a holistic approach to development (e.g. Martinez-Espinosa 1996, APFIC 2000). Interdisciplinary approaches were seen as an essential prerequisite.

More recently, there has been a re-evaluation of the role of small-scale aquaculture in rural livelihoods and its importance in poverty alleviation and household food security, particularly the mechanisms by which the rural poor can access and benefit from aquaculture. It is also increasingly realised that rural people do not depend for their livelihood on the agricultural sector alone, but rather on a range of livelihood options, which together offer their families food security and reduce vulnerability to conditions over which they have no control. Such options may be found in the diversification of activities in the agricultural sector, through the use of open access or common property resources in the natural environment and off-farm employment, whether close to home or far away in the cities. Different members of the family may be involved in each of these options, to varying degrees and at different times of the year. Rural poor people in resource poor environments tend to have a broader range of livelihood strategies, precisely because their situation is one of insecurity. A recent FAO/World Bank Farming Systems study noted the importance of five major household strategies for escaping poverty for 70 farming systems across the world: intensification, diversification, increased asset base, increased off-farm income, and exit from agriculture. Diversification, which includes aquaculture, was judged to be the single most promising source of farm poverty reduction in the coming years (Dixon *et al.* 2001).

The shift to a broader goal of improved livelihoods and greater household food security has led to the emergence of the concept of sustainable (rural) livelihoods as a framework for analysis of poverty, and possible interventions for its alleviation (Carney 1998). This framework sees the position of rural households depending on the availability of various capital assets, including natural, physical, human, financial, and social capital. These basic assets may be threatened by two sets of factors:

- 1) vulnerability to sudden shocks in the physical environment (drought, flood, or typhoons, or longer term trends in the economic environment or resource stocks, both of which can reduce the assets normally available to the household; and

- 2) the structures and processes in the institutional environment, which encompasses both public and private institutions. These include laws and policies which can work positively or negatively to affect access to capital and maintenance of it.

It is in response to their asset situation, in the context of the various vulnerability factors and the prevailing transforming structure and processes, that the livelihood strategies of the rural poor develop. The challenge for aquaculture is whether it can help strengthen the assets available to rural households, so that they are better able to withstand shocks, become less vulnerable to related losses, and are better able to influence the policy/institutional environment in their favour (Demaine 2001, STREAM 2001).

The Contribution of Aquaculture to Rural Development

Aquaculture comprises diverse systems of farming plants and animals in inland and coastal areas, many of which have relevance for the poor. FAO defines aquaculture for statistical purposes as the “*farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.. Farming also implies individual or corporate ownership of the stock being cultivated*” (FAO 2001). In the context of the rural poor, aquaculture often complements catches from traditional fisheries. The latter continue to play an important role and, in many areas, remain adequate to satisfy subsistence needs and provide a valuable source of cash income for farmers. In many cases, the capture or culture of aquatic species forms the basis for food security, enabling the use of livestock or cultured fish as a source of income generation. Aquaculture becomes an attractive and important component of rural livelihoods in situations where increasing population pressures, environmental degradation or loss of access, limit catches from wild fisheries (IIRR *et al.* 2001).

Aquaculture Production Intensity, Risks, and Benefits

Extensive to semi-intensive aquaculture systems still produce the bulk of aquaculture products. Extensive farming usually involves unsophisticated methods, relies on natural food and has a low input to output ratio. As production intensity increases, fish are deliberately stocked and the natural food supply is enhanced by using organic and inorganic fertilizers and low-cost supplemental feeds derived from agricultural by-products. The system found most frequently is the farming of fish in ponds, however rice-fish farming or the stocking of fish into natural or impounded water bodies are also included as aquaculture systems (FAO 2000a). It is extremely difficult to estimate the contribution of this type of aquaculture production, since small-scale and dispersed production data do not appear in official statistics and the produce is typically consumed or traded locally (STREAM 2001). Specific examples of aquaculture activities that have positive impacts on the rural poor include: fry nursing and the development of nursing networks, the integration of fish farming with rice crops in floodplains and the more remote mountainous areas in Asia, sustaining and restoring aquatic biodiversity through simple enhancement management methods. In coastal areas, the farming of mudcrabs, oysters, mussels, cockles, shrimps, fish and seaweeds provides employment for the rural poor, mainly for direct labour inputs, as well as seed and feed collection (Edwards 1999, Tacon 2001). Intensive aquaculture systems yield more output from a given production unit, using technology and a higher degree of management control. This, typically, involves facilities deliberately constructed for the purpose of aquaculture, which are operated with higher stocking densities and use compound manufactured feed and chemotherapeutant intervention on a regular basis. Intensive inland and coastal cage aquaculture of high-value salmonids has been encouraged and supported to develop remote rural areas in Europe and South and North America. Similar systems have emerged in Asia and Australia for warm-water piscivorous fish, such as groupers, yellowtail, snappers and sea bass. Coastal shrimp farming has raised particular interest throughout the tropics because of its high value and opportunities for export and earning foreign exchange.

Whilst increasing the cash economies of many coastal areas and stimulating local development, there have been wide ranging negative social and environmental impacts as a result of some forms of aquaculture development. This situation is under increased scrutiny for remediation.

The benefits of aquaculture in rural development relate to health and nutrition, employment, income, reduction of vulnerability and farm sustainability. Aquaculture in small farmer systems provides high quality animal protein and essential nutrients, especially for nutritionally vulnerable groups, such as pregnant and lactating women, infants and pre-school children. It also provides this protein at prices generally affordable to the poorer segments of the community. It creates 'own enterprise' employment, including jobs for women and children, and provides income through sale of what can be relatively high value products. Employment income opportunities are possible on larger farms, in seed supply networks, market chains and manufacture/repair supporting services. Indirect benefits include increased availability of fish in local rural and urban markets and possible increase in household income through sales of other income generating farm products, which will become available through increased local consumption of fish. Aquaculture can also benefit the landless from utilization of common resources, such as finfish cage culture, culture of molluscs and seaweeds, and fisheries enhancement in communal water bodies (Edwards 1999, IIRR *et al.* 2001, Tacon 2001).

An important, though often overlooked, benefit which is particularly relevant for integrated agriculture-aquaculture systems, is their contribution to increased farm efficiency and sustainability (FAO *et al.* 2001). Agricultural by-products, such as manure from livestock and crop residues, can serve as fertilizer and feed inputs for small-scale and commercial aquaculture. Fish farming in rice fields not only contributes to integrated pest management, but also management of vectors of human medical importance (Halwart 2001). Furthermore, ponds become important as on-farm water reservoirs for irrigation and livestock in areas where there are seasonal water shortages (Lovshin 2000).

In view of all these benefits, it is perhaps not surprising that aquaculture production has grown rapidly since the 1970s, and has been the fastest growing food production sector in many countries for nearly two decades; the sector exhibiting an overall growth rate of over 11.0% per year since 1984, compared with 3.1% for terrestrial farm animal meat production, and 0.8% for landings from capture fisheries (Tacon 2001). By 1999, the production of all cultured aquatic organisms reached 42.8 million mt (FAO 2001). A total of 262 fish, crustacean, and mollusc species, represent the most important animals used in aquaculture world-wide, are listed in a recent survey (Garibaldi 1996). Although not all aquatic organisms are suitable for culture, the variety of cultured species is still increasing. Freshwater finfish, particularly Chinese and Indian carp species, account for the greatest share of total aquaculture production in 1999. This is followed by molluscs and aquatic plants, mostly kelp, the majority of which come from China.

FAO's latest studies on future demand for, and supply of, fish and fishery products predict a sizeable increase in demand for fish (FAO 2000c). The majority of this increase will result from expected economic development, population growth, and changes in eating habits. Fish supply from capture fisheries in most countries is expected to remain constant, or decline, since catches have either reached, or are close to, maximum sustainable yield.

Inland fisheries may yet be able to yield more fish as effort increases, but the increased effort required will become increasingly challenging. Inland fisheries are also vulnerable to environmental impacts, such as watershed degradation, development of water control structures and pollution. All features of the changing rural environment. Thus, aquaculture has an important role to play in meeting the increasing demand for fish. Indeed, the growth of global aquaculture is forecasted to continue for some time (FAO 2000c).

Aquaculture Intensification and Expansion

The current trend of increased production can be maintained, either through intensification or expansion of areas under aquaculture production. Generic technologies for intensification of existing production systems are in place, and it is mainly socio-economic and institutional issues that will be the most important constraints for a greater contribution by aquaculture to rural development. The expansion of land-based culture systems in inland areas has the greatest potential because aquaculture can be integrated with agriculture on current agricultural land in smallholder and commercial farms (Edwards 1999). Considerable potential lies in the integration of aquaculture and irrigation systems (e.g. Fernando & Halwart 2000, Moehl *et al.* 2001), and aquaculture can make also use of land that is unsuitable for agriculture, such as swamps or saline marsh areas. In addition, there is a wide diversity of inland and coastal aquatic resources including rivers, floodplains, lakes, reservoirs, rice fields, estuaries, lagoons, coral reefs, mangroves, and mudflats, that provide opportunity for the integration of well-controlled, sustainable aquaculture, enhancement or other form of aquatic animal management, into rural development (IIRR *et al.* 2001).

Increasing yields through intensified production requires increased use of feeds and/or fertilizers, which may be derived from on- or off-farm sources, or a combination of the two. Development of infrastructure can reduce external costs, such as feed and fertilizers, allowing farmers to intensify production. Since this requires increased investment in the production system, other enabling features include the development of markets and access to finance. As mentioned previously, many of the technical aspects of aquaculture are relatively well developed, however there is a knowledge gap between what is known globally and what is available to farmers. Weak rural extension systems and a lack of local examples of intensified aquaculture limit farmers' ability and willingness to risk intensification.

Biotechnology in aquaculture represents a range of opportunities to increase the growth rate in farmed species, improve nutritional value of aquafeeds, improve fish health management, restore and protect environments, extend the range of aquatic species and to improve the management and conservation of wild stocks.

There is significant potential to improve production through genetic improvement programmes. Selective breeding programmes have yielded significant and consistent gains of 5-20% per generation in species of *inter alia* Atlantic salmon, catfish, and tilapia. Improved breeding capabilities, larval nutrition, and advances in genetic technologies now permit a wide range of genetic manipulations to be performed on aquatic species. The restocking of natural water bodies with indigenous and/or endangered species is another example of a situation where attention must be paid to the genetic aspects of the breeding programme.

Due to the high cost of modern biotechnological development, most biotechnological innovations are developed for farming systems with high inputs of feed, labour, and husbandry. Many biotechnologies could also be directed at low-input systems, farming systems in marginal areas, or to meet other needs specific to a given rural community, however, the requirement for recouping development costs of biotechnology generally puts this approach to aquaculture out of reach of most aqua-farmers. Furthermore, the application of biotechnologies often also requires a certain level of scientific support capacity and resources.

Small hatchery operations increase the local supply of fingerlings and can enable farmers to enter aquaculture as an activity. Such hatcheries are essential for the development of rural aquaculture but often have limited pond areas or water availability, hence may be unable to maintain the genetic quality of their broodstock and over a period of time lose genetic quality and performance. In such situations, intervention by government hatcheries or larger scale commercial hatcheries, are required. In each case, consideration must be given to the specific

stage of rural development in a given area, extension programmes and how to integrate such activities within prevailing livelihood strategies.

The introduction of exotic species is another strategy used to increase value from farming systems in rural areas, for example, tilapia production is much higher in Asia than in its native Africa. Introduced species often are genetically improved or domesticated species, to some extent, and share many of the same opportunities and risks.

Strategies for an Increased Contribution by Aquaculture to Rural Development

In a contribution to the FAO 1999 State of Food and Agriculture on the integration of fisheries with agriculture, approaches to enhanced integration at different levels of development have been considered, as outlined below (Willmann *et al.* 1999).

Human resource development and institutional strengthening are widely held to be the principal requirements for improving integration at the level of individual farms and communities, in river basin and coastal area management, and at the level of sectoral and macroeconomic policies. At the farm level, attention needs to focus first on resource use efficiency and the economic or livelihood incentives that influence farmers decisions on cropping patterns, the use of water, feeds, fertilizer, chemical treatments and other inputs. Next, the emphasis should be on farmers' knowledge of available production and pest management options, as well as on their ability to apply these. Agriculture and aquaculture offer a large variety of cropping patterns under different climatic and soil conditions. If they have the right skills, together with access to the necessary inputs, farmers will adopt the farming or aquaculture system that is most suitable to their specific situation. Since farmer's management strategies are not based solely on economic criteria, but also include minimization of risk, cropping flexibility, cultural preference for species, time and labour requirements, extension and training. Farmer participation in these processes are crucial for informed decision-making. The presence of an enabling infrastructure, such as availability of inputs, markets and financial or credit facilities, are indispensable for optimal development and integration of farming and aquaculture systems.

Co-management and community-based management approaches to use of common property resources have received increasing attention in recent years because of assumed improved efficiency and prevention of undesired distributional implications. Factors that the users identify as important for successful resource management include: small group size (which facilitates the formulation, observance and monitoring of a collective agreement); social cohesion; resource characteristics that facilitate control of outsiders access; and visible signs of successful collective management. These factors could well apply to a number of fisheries in reservoirs and other small water bodies, where the potential for self-management, is not currently implemented. This is because responsibility is not delegated to the local level and collective rights are insufficiently protected. Similar favourable conditions exist in other situations, such as seasonal wetlands, swamps, flooded forests and mangrove forests where, again, the potential for effective management has yet to be realized. In addition to the recognition of common rights, community-based and co-management need support through extension and training services and solid scientific assessment of resource abundance. The capacity to deliver such support is lacking in most countries, as it requires significant modification of working practices to allow a more interactive, participatory approach to the management of collective resources, as well as access to requisite scientific expertise.

At the level of river basins and coastal areas, integration is aimed at managing sectoral components as parts of a functional whole, explicitly recognizing that management needs to focus on human behaviour, not just physical stocks of natural resources such as fish, land or

water. Integrated river basin and coastal area management employs a multi-sectoral strategic approach to the efficient allocation of scarce resources among competing users and the minimisation of unintended natural resource and environmental impacts. Land use planning and zoning, together with environmental impact assessment procedures, are vital tools for reducing or rationalizing the conflicts between resource users, minimizing negative environmental impacts and enhancing sustainable development. The effective participation of fisheries agencies in these planning activities is absolutely essential.

The participation of all resource users and other stakeholders at an early stage is indispensable for effective land use planning and zoning, not least because of their intimate knowledge of local socio-economic conditions and the state of natural resources. At the government level, the functions of the various agencies with regulatory and development mandates need to be well co-ordinated. Two broad distinctions can be made in the wide range of possible institutional arrangements for integrated river basin and coastal area management:

- 1 Multisectoral integration - involves co-ordinating the various agencies responsible for river basin and coastal management on the basis of a common policy, and bringing together the various government agencies concerned, as well as other stakeholders, so that they can work towards common goals by following mutually agreed strategies; and
- 2 Structural integration - an entirely new, integrated institutional structure is created by placing management, development and policy initiatives within a single institution.

Multi-sectoral co-ordination tends to be preferred, since line ministries are typically highly protective of their core responsibilities, which relate directly to their power base and funding. The establishment of an organization with broad administrative responsibilities overlapping the traditional jurisdictions of line ministries – as would be the case if management, policy and development functions were integrated within a single institution – is often likely to meet with resistance rather than co-operation.

However, experiences to date indicate that cross-sectoral planning and institutional coordination are often difficult to achieve and can entail significant costs. The difficulties and costs relate to the often cumbersome bureaucratic structures and procedures of government agencies; the complexity of the scientific, technical and economic issues involved; and the potentially large number of informed decisions that need to be taken. In addition to high administrative costs, the decision-making process could be protracted and may slow down economic development.

Many river basin and coastal management issues can be addressed through sound sectoral management, but must take into account the impacts of, and interdependencies with, other sectors and ecosystem processes, such as; the provision and enforcement of environmental legislation; the need for a transparent and consultative process of land use planning and siting; and the design of major infrastructure projects such as dams. The costs of a formal process for the preparation of a river basin or coastal area management plan are most likely to be justified in areas where intense multisectoral resource utilization either exists or is planned.

At the macro level, economic policies, such as subsidies for production inputs and import and export duties, can have profound impacts on the characteristics and level of resource use, as well as on the occurrence of undesirable environmental effects. The advantages of subsidising chemical inputs, such as fertilizer and pesticides, need to be weighed against the potential harm they can do to aquatic environments and to fishery resources, which provide food for fishers and fish consumers alike.

The way forward

Recent meetings and consultations organized and supported by FAO and partner organizations (including *inter alia* Martinez-Espinosa (comp.), 1996; Edwards and Demaine, 1997; APFIC, 2000; FAO/NACA, 1999; FAO-RAF, 1999; FAO, 1999; DFID/FAO/NACA/GoB, 2000; FAO, 2000d; Haylor and Bland, 20001; Tacon, 2001) have reached a number of conclusions and recommendations aimed at increasing the sustainable contribution of aquaculture to rural development. 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 contributes to rural development by enabling diversification of subsistence fishery sectors. Differences between countries and regions, with regard to physical resources, norms and traditions, as well as economic conditions, are significant, hence the developmental status of aquaculture differs widely. The areas and means of intervention for more or less intense aquaculture development also need to be separated. The conclusions and recommendations listed below, therefore, need to be seen in the context that there is no single acceptable aquaculture development strategy for all.

In the past decades, there has been a move away from a predominantly top-down view, dominated by technical issues, to a more holistic perspective of improved livelihoods and greater household food security. Social, economic and institutional issues have been recognized to be the most important constraints to enhanced contributions by aquaculture to rural development. However, the impact of aquaculture on food security and poverty alleviation in rural areas is poorly documented and understood. There is a need to assess the impacts of aquaculture on sustainable livelihoods and for advocating products and benefits. Advocacy issues include:

- raising awareness amongst policy makers of the role of small-scale rural aquaculture and aquatic resource management in rural livelihoods, including actual contributions and unfulfilled potential of aquatic resource management, including aquaculture, to sustainable rural development;
- documenting indigenous aquaculture systems and farmer-proven examples of aquaculture;
- developing indicators for monitoring aquatic resource management and aquaculture impacts on food security and poverty alleviation ;
- encouraging and promoting consumption of aquaculture and inland fishery products; and
- publicising and promoting benefits of sustainable aquaculture enterprises, aquatic resource management and their products.

Governments should address the design and implementation of policy, ensuring feedback mechanisms to allow the poor to influence development. This may be done through the establishment of a multi-sectoral co-ordinating process both at sectoral policy formulation level and at the extension service level. Aquaculture development should complement or substitute wild fisheries, as needed. Negative impacts of aquaculture projects on the food supplies of the poor should be avoided. Other recommendations aimed at improved planning and policies include:

- Establishing national aquaculture development and inland fisheries management plans and policies in consultation with stakeholders; and
- Integrating aquaculture planning into water resource management planning for inland areas and into coastal management planning in coastal areas, as well as into other economic and food security interventions for rural areas.

Generic technologies for sound aquaculture production exist. Some of the indigenous systems require further study and more detailed documentation. More emphasis is needed to:

- favour systems which use readily available species and local materials;
- decentralized seed production and seed nursing and trading networks;
- improving culture systems for aquatic species feeding low in the food chain and that are preferred for local consumption; and
- adapt and improve these systems through farmer based learning, and promoting the results through participatory approaches.

Governments should aim to providing services and facilitate access to inputs. The rural poor need to be provided, at least initially, with public sector support, while commercial aquaculture requires less intervention. In the longer term, aquaculture has to function on a self-financing basis within the private sector. Necessary actions include:

- focussing limited public resources on strategic government infrastructure and flexible and efficient extension services that meet producers' needs;
- promoting and facilitating the private sector production of feed and seed;
- encouraging credit for medium- and large-scale producers;
- facilitating the formation of farmers' associations and encourage community production; and
- encouraging investment in building the institutional capacity and knowledge base concerning sustainable aquaculture practices to manage the sector.

Positive examples and case studies of traditional and other aquaculture systems that have proven to be sustainable should be promoted and disseminated. In doing so:

- Promote collaboration, co-ordination and information exchange between national and regional aquaculture institutions and agencies; and
- Develop strategies for an effective transfer of aquaculture know-how into areas and regions where it has no tradition.

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