



**WorldFish**

Supported by the CGIAR

**WORKING PAPER**

## **Aquaculture and Development**

Aquaculture is the farming of aquatic plants and animals. It is the fastest growing food production sector in the world today, currently accounting for half of global fish consumption, and is projected to grow substantially in response to the growing gap between supply and demand in fish products globally. As a vibrant economic sector aquaculture brings diverse business opportunities for millions of producers, processors and traders at multiple scales, ranging from the small farmer producing for local

consumption to large companies producing for export. Yet, despite this demand and opportunity, many public and private sector investors remain poorly informed of the potential of aquaculture or are unconvinced that it can have significant impact on poverty. Yet others believe that current trends of intensification of production methods and internationalization place unsustainable demands on environmental services and promote inequity and social exclusion.

## 1. WHY AQUACULTURE?

The farming of aquatic organisms that feed low in the food web, converting plant-based foodstuffs and agricultural by-products into high quality animal protein, is an inherently efficient means of producing increasingly scarce and nutritionally important foodstuffs. Aquaculture can utilize aquatic resources of marginal economic value, e.g. salinized ground waters, and increase aquatic productivity ('more crop per drop'), thereby reducing pressure on increasingly scarce freshwaters. Fish are a high value crop and farming of fish and shellfish can relieve pressure on overexploited wild stocks.

Aquaculture can also help the most vulnerable by promoting gender equality through increased access to, participation and control over, production resources. Through the provision of affordable, highly nutritious food it can improve child development and maternal health and help combat major diseases. Thus, aquaculture can contribute directly and significantly to reducing poverty and hunger in an environmentally sustainable way.

The poor can benefit directly from aquaculture throughout the value chain by:

- Diversifying crop and livestock-based farming activities to include a high value aquaculture cash crop, thereby raising incomes, improving food security and increasing resilience to external shocks such as drought or market fluctuations;
- Improving nutrient cycling within the farming system, reducing the need for external inputs, and improving crop production;
- Starting a Micro, Small or Medium Enterprise (MSME), such as a hatchery, feed, processing or transport operation;
- Employment in hatcheries, feed factories or commercial fish farms;
- Accessing improved supplies of fish at affordable prices.

Poor people may also benefit indirectly through increased economic activity generated by the adoption and spread of aquaculture.

However, adoption of aquaculture has been patchy and, depending upon how it is implemented, can adversely affect the environment to the detriment of other economic sectors (including by competing with other uses of coastal and aquatic commons, such as fisheries and wetland resource use) further disenfranchising the poor. Aquaculture must therefore adopt an ecosystem-based approach and be developed within specific local, national and regional contexts that take account of other sectors' goals and policies.

## 2. TYPES OF AQUACULTURE AND THEIR IMPACTS

Aquaculture can take a variety of forms. The most important are described below.

- **Pond aquaculture.** Integrated aquaculture-agriculture (IAA), in which waste on-farm materials are used as pond inputs, and nutrient-enriched pond muds and wastewater are used for agriculture, forms the basis of most aquaculture adopted by small-scale farmers. Many studies show greater recycling of on-farm wastes and increased income and better nutrition, especially for women and children. However, the degree of recycling must not be an end in itself and the lower the pond production the smaller the benefits and the lower the rate of sustained uptake. Connection to input and output markets, access to extension support and profitability are critical to sustained adoption.
- **Rice-fish culture.** Rice-fish farming is of some importance in India, China, Vietnam, Laos and Cambodia. While this low-cost, low-risk technology generally results in modest production of food fish, often largely for home consumption, rice fields incorporating hatcheries and nurseries, or which focus on higher value species such as freshwater prawn, help generate cash to purchase inputs, such as fertilizers and pesticides, for increasing the productivity of small-scale rice farming. Rice-fish farming has synergistic impacts on rice production and can reduce the need for pesticides, benefiting aquatic biodiversity. However, it also increases demands on water that can foster conflict.

Wide-scale adoption of IAA in Asia and Africa has had impacts on large numbers of poor farmers. In Bangladesh, for example nearly 150,000 poor and landless have converted at least a million ponds, ditches, seasonally-flooded fields, and other bodies of water into productive “fish factories”, doubling average fish yields and tripling fish production between 1990 and 2000. Among participating farmers in Malawi, aquaculture production increased by an average 22 percent per year from 1996 to 2001, and total farm income rose by 28%. By increasing nutrient recycling and water availability, IAA increased total farm productivity by 18% relative to terrestrial cropping.

Since 2003 WorldFish and partners (World Vision) have successfully run a low-labour IAA project in Malawi to help 1,200 women- and child-headed families affected by HIV/AIDS. The results show a 50% increase in farm income and a 150% increase in fish consumption among adopters, although with little increase in fish supplies to local markets.

- **Cage aquaculture.** Cage aquaculture has been widely used as a means of directly helping people with minimum social, economic or natural capital (e.g. landless poor in Bangladesh and those displaced by the creation of reservoirs in Indonesia and Laos). However, a strong and well-informed policy environment is essential to ensure sustainable and equitable benefits.

- **Mariculture.** Mariculture offers opportunities to increase the resilience of fisheries-based livelihoods in coastal and island areas suffering from over-fishing. In the Pacific, production of juvenile sea cucumbers in abandoned shrimp ponds has not only helped redress environmental damage but has also provided jobs and increased incomes among the coastal poor. Sandfish, a commercially valuable sea cucumber species, fetches close to US\$75 per kilogram but was depleted under conditions of conflict and poverty; with new pro-poor rearing technology, thousands have been re-seeded in the Solomon Islands. Small-scale farming of crabs in mangrove systems, seaweed culture and small-scale fish culture have all provided sustainable opportunities for livelihoods diversification in the Philippines and elsewhere. As a key component of a Sustainable Coastal Livelihoods Framework, aquaculture is supporting the post-tsunami economic recovery of Aceh Province, Indonesia.

Sea level rises anticipated as a result of climate change will increase the extent of salinized groundwater in coastal areas, limiting the range of crops that may be grown but offering new opportunities for the production of high value salt-water-tolerant aquatic species.

### 3. EXPANDING OPPORTUNITIES FOR AQUACULTURE

- **Micro, Small and Medium aquaculture Enterprises (MSMEs).** While adopters of small-scale cage aquaculture, IAA and rice-fish culture are more resilient to external shocks such as climate change and market fluctuations, they secure limited economic benefits. Some small-scale aquaculturists choose to specialize in fish farming and make the transition from household-based economies to MSMEs; others do so by specializing in hatcheries, feed production and trading. The proportion of small-scale farmers that take this route remains comparatively small however, and the rate of adoption is slow and dependent on long-term support.
- **Private Public Partnerships.** PPPs are increasingly viewed as an effective means of conducting research, developing new technologies and deploying new products for the benefit of small-scale producers. For example, access of Vietnamese river catfish farming MSMEs to European markets was initially facilitated by public sector support of a PPP between farmers, an organic certification scheme and importers. In a decade this has developed into a million tonne export-oriented industry.
- **Export-oriented aquaculture.** Where large volume, low-cost export commodities, such as tilapia (Lake Kariba) or river catfish (Vietnam), are being produced benefits to the poor are largely through limited employment opportunities and greater availability of affordable food. Recent studies have shown that the poor can derive benefits by engaging in the aquaculture of high value species such as grouper and shrimp, but there are nonetheless considerable barriers, particularly in terms of accessing export markets. Food safety, traceability and certification are increasingly important but few schemes provide equitable benefits. As sub-sectors mature, intensification, consolidation and a top-down approach to certification and the costs of compliance tend to exclude the poorest, other than in terms of low-wage employment.

### 4. TOOLS FOR DEVELOPING AND MANAGING AQUACULTURE PROJECTS AND PROGRAMS

Several approaches can be used to help assess when aquaculture may be an effective means of poverty reduction or wealth creation. Poverty mapping tools help identify target groups. Using participatory approaches, Sustainable Livelihoods Analysis (SLA) provides a holistic, people-centred view of the circumstances of the target group and potentially affected groups, clarifying income streams and social (including gender-related) and natural capital, identifying risks and vulnerabilities. A participatory approach should be used in establishing development objectives which nonetheless should be sufficiently broadly framed to allow alternative or complementary interventions to be considered. Analysis of markets, both

present and future, for what are highly perishable goods is essential. Novel, spatially-related, decision-support tools that employ Geographical Information Systems (GIS), such as Recommendation Domains, and post-hoc analysis that identifies aquaculture hot-spots can help determine where aquaculture is most likely to prove effective.

Logistical Frameworks and Impact Pathway Models help identify causal links, key interventions and partnerships, and direct activities towards specific outputs and outcomes. These project and programme design and management tools also establish milestones and deliverables, facilitating adaptive management and helping secure funding streams.

## 5. PRINCIPLES FOR INVESTMENT IN AQUACULTURE

- i. Design investments to target the specific opportunities and overcome the constraints of each location. Although the role that aquaculture can play in alleviating poverty and creating wealth is increasingly understood, actions must nonetheless be location and context specific.
- ii. Adopt a sustainable livelihoods approach (SLA) to identify livelihood opportunities and key constraints, and to identify and manage risks, especially with regard to the abilities of users to operate and sustain aquaculture. Decision support tools and post-hoc analysis of aquaculture hot-spots complement SLAs in identifying opportunities for aquaculture to improve resilience and create wealth.
- iii. Pursue technologies that increase productivity, protect environmental flows and minimize the consumption of environmental services. For aquaculture to be sustainable it must adopt an ecosystem approach and be mainstreamed into coastal zone and watershed management planning. Codes of Conduct and Best Management Practices must be promoted.
- iv. Conduct market analysis to identify current and future opportunities and understand that markets can evolve rapidly. Securing access to input and output markets is essential for sustained uptake and benefits. Access of poor aquaculturists to export markets can be limited because of low food safety standards and because prevailing traceability and certification schemes are top-down and favor larger businesses.
- v. Understand the roles of services, facilities and support infrastructure and the policy environment. Where there is weak governance and an unfavourable enabling environment it may be necessary to build compensatory strengths in the community, civil society, private sector, NGOs etc., in order to maximize sustainable and equitable benefits. Public-Private Partnerships may provide a cost effective and efficient means to address market deficiencies.

## 6. FURTHER READING

- ADB. 2005a. [An Evaluation of Small-Scale Freshwater Rural Aquaculture Development for Poverty Reduction](#). Asian Development Bank, Manila, Philippines. <http://www.adb.org/Publications>
- ADB. 2005b. [An Impact Evaluation of the Development of Genetically Improved Farmed Tilapia and Their Dissemination in Selected Countries](#). Asian Development Bank, Manila, Philippines. <http://www.adb.org/Publications>
- Dey, M.M., P. Kambewa, M. Prein, D. Jamu, F.J. Paraguas, D.E. Pemsil and R.M. Briones. 2007. [Impact of the development and dissemination of integrated aquaculture – agriculture technologies in Malawi](#). In: *International Research on Natural Resource Management* (H. Waibel & D. Zilberman, eds.) pp. 118-146. FAO and CAB International.
- FAO. 2007. [The State of Fisheries and Aquaculture 2006](#). Food and Agriculture Organization, Rome. <http://www.fao.org/docrep/009/A0699e/A0699e00.htm>
- Halwart, M. and M.V. Gupta (eds). 2004. [Culture of Fish in Rice Fields](#). FAO, Rome, and The WorldFish Center, Penang. 83 pp.
- Karim, M., M. Ahmed, R.K. Talukder, M.A. Taslim and H.Z. Rahman. 2006. [Dynamic Agri-business-focused Aquaculture for Poverty Reduction and Economic Growth in Bangladesh](#). WorldFish Center Discussion Series 1, The WorldFish Center, Penang, Malaysia.
- Muir, J.F., N. Gitonga, I. Omar, V. Pouomogne and I. Radwan. 2005. [Hidden Harvests: Unlocking the Potential of Aquaculture in Africa](#). Technical Review Paper – Aquaculture; prepared for the NEPAD–Fish for All Summit, 22-25 August 2005, Abuja, Nigeria.
- Ponzoni, R.W., B.O. Acosta and A.G. Ponniah. 2006. [Development of Aquatic Animal Genetic Improvement and Dissemination Programs: Current Status and Action Plans](#). The WorldFish Center, Penang, Malaysia.
- Ponzoni, R.W., H.N. Nguyen and H.L. Khaw. 2007. [Investment appraisal of genetic improvement programs in Nile tilapia \(\*Oreochromis niloticus\*\)](#). *Aquaculture*, 269, 187-199.
- Soto, D., J. Aguillar-Manjarrez and N. Hishamunda. 2007. [Building and Consolidating a Framework for an Ecosystem Approach to Aquaculture – Initial Steps towards Guidelines](#). *FAN*, 37, 8-11. <ftp://ftp.fao.org/docrep/fao/010/a1246e/a1246e00.pdf>.
- The WorldFish Center. 2007a. [Fisheries and Aquaculture Can Provide Solutions to Cope with Climate Change](#). Policy Brief 1701. The WorldFish Center, Penang.
- The WorldFish Center. 2007b. [Priority Technologies and National Strategies to Develop and Manage Fisheries and Aquaculture](#). Policy Brief 1702. The WorldFish Center, Penang.
- The WorldFish Center. 2007c. [Development Strategies and Options for Fisheries and Aquaculture in Asia](#). Policy Brief 1703. The WorldFish Center, Penang.
- World Bank. 2006. [Aquaculture: Changing the Face of the Waters. Meeting the Promise and Challenge of Sustainable Aquaculture](#). Report 36622. World Bank, Washington. 126 pp.
- Yang, N. et al. 2007. [http://www.worldfishcenter.org/fishnetcms\\_d01/resource\\_centre/RD-Asia\\_China-Henan.pdf](http://www.worldfishcenter.org/fishnetcms_d01/resource_centre/RD-Asia_China-Henan.pdf).

