

**POLICY WORKING PAPER:
DYNAMIC AGRIBUSINESS-FOCUSED
AQUACULTURE FOR POVERTY REDUCTION
AND ECONOMIC GROWTH
IN BANGLADESH**

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March 2006



**Ministry of Fisheries
and Livestock**



**Bangladesh Shrimp
and Fish Foundation**

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Policy Working Paper: Dynamic Agribusiness-focused Aquaculture for Poverty Reduction and Economic Growth in Bangladesh

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Foreword

There were times when fish were plenty in our rivers and open waters, and aquaculture was not a popular activity. However, we are now witnessing a dramatic change in fish production; our open water catches are no longer increasing and we have seen more than 10% annual growth in aquaculture over the last decade. This is happening in rural areas as a result of private sector investment and is a trend that we want to promote. My vision is to make aquaculture a medium-sized industry where millions of poor people find employment, earn income and obtain nutrition. As the income of poor people increases, so the demand for other goods and services grows. Hence aquaculture becomes an engine for rural economic growth and the reduction of poverty. To achieve this goal we need to promote multi-agency partnerships to ensure closer cooperation between the public and private sectors. For example, government and businesses must be committed to a carefully controlled and accredited breeding program to ensure that high quality seeds are delivered to nurseries and grow-out operators.

Community-based fish culture in floodplains will also be encouraged. A successful model for growing fish in floodplains has been developed in Daudkandi, Comilla. This model has shown good production for both rice and fish. We have 2.83 million hectares of floodplains in the country, which remain fallow for 5-6 months. My vision is to bring at least 1 million hectares of this land under fish production for community-based fish culture.

We need to increase our share of the global fish-export market. This can be achieved by improving processing quality, ensuring compliance with food safety regulations and creating more value-added products. The government is willing to support the development of the necessary infrastructure and encourage private sector investment, which will create employment for both men and women. We are also supporting aquaculture development as an alternative livelihood option for displaced fishers.

This Policy Working Paper is an outcome of the joint efforts of MoFL, Bangladesh Shrimp and Fish Foundation and The WorldFish Center. It was presented as a background document for the 'policy stakeholder consultation on dynamic agribusiness-focused aquaculture development for poverty reduction and economic growth in Bangladesh,' held on 14 August 2005. The authors have done an excellent job in succinctly summarizing and synthesizing the technical, institutional and policy constraints for developing a pro-poor agribusiness-focused aquaculture industry. I am pleased to see the reflection of the comments and suggestions made by representatives and members of government agencies, NGOs, private sector, academic and research communities, farmers and fisher groups in this working paper.

I take this opportunity to thank, in particular, Dr. Kamal Uddin Siddiqui, Principal Secretary to the Honorable Prime Minister; Mr. Dhirendranath Sha, M.P.; Dr. Salehuddin Ahmed, Governor, Bangladesh Bank; Mr. Siddiqur Rahman, Secretary, Ministry of Finance; Mr. Abdul Karim, Secretary, MoFL; Dr. Stephen J. Hall, Director General, The WorldFish Center; Mr. Syed Mahmudul Huq, Chairman, Bangladesh Shrimp and Fish Foundation; and Dr. Mahfuz Ahmed, Director, The WorldFish Center along with the officials of MoFL, WorldFish and BSFF for organizing and leading the policy stakeholder consultations. This cooperation will serve as a model for public-private-NGO partnership in the development of the fisheries and aquaculture sector for poverty reduction.



Abdullah Al Noman M.P.

Minister

Ministry of Fisheries & Livestock

**Govt. of the People's Republic of Bangladesh
Bangladesh Secretariat, Dhaka.**

Preface

This policy working paper is part of the joint effort of the Bangladesh Ministry of Fisheries and Livestock (MoFL), the WorldFish Center (WorldFish) and the Bangladesh Shrimp and Fish Foundation (BSFF) to work with other stakeholders to create dynamic, agribusiness-focused aquaculture through which fish and aquaculture can be more effectively linked and mainstreamed into the poverty reduction and economic growth strategies of Bangladesh.

An Expert Consultation on Dynamic Agribusiness-focused Aquaculture Development was held on 19 April 2005, organized by the WorldFish Center, Agri-business Technology Development Project 2 and BSFF with strong support from the MoFL. The consultation examined a set of technical, infrastructural and extension delivery questions to the development of aquaculture as a pro-poor agribusiness. It concluded that aquaculture as an agribusiness presents opportunities for stimulating rural, urban and export markets, and using markets as a tool, it can make substantial contribution to realizing the national poverty-reduction objectives. However, the challenge would be to include the needs of the poor as a core focus of this market-based activity. Innovation and extension in improvement and maintenance of genetic quality, seed supply and nursery operations, and these factors integration with growout phases as well as with the value chain, all have the potential to improve income and nutrition and to provide important opportunities for women.

The expert consultation recognized the role of integrated aquaculture-agriculture as a viable economic enterprise for poor people. At family and community levels, there are real gender-equity benefits in an integrated strategy. Many of the family and community-based activities associated with aquaculture are “gender-friendly” in that they encourage and support involvement of women in the production of shrimp and fish, and the running of family businesses. At the regional and watershed levels, there is scope for a system view of rural water management and irrigation to obtain maximum benefits from scarce resources, particularly during dry seasons. However, integration of fish to rural poverty reduction and economic growth will require a reorientation in policy and institutional thinking. Resource management sectors, business and finance sectors, and rural development sectors will all need to work together. There is a bigger role for public-private partnerships (PPP) in the extension and knowledge transfer on aquaculture.

As a next step, MoFL, WorldFish and BSFF conducted a policy stakeholder consultation in August 2005 to: (1) identify policy and institutional constraints and recommend measures and policy instruments in the development of poverty reduction and economic growth-oriented aquaculture; (2) develop potential means for integrating aquaculture with income growth and employment creation in rural areas in cross-sectoral settings;

(3) identify critical interministerial, nongovernment organization (NGO) and private sector stakeholders for building partnerships and implementing an integrated approach to development of a poverty reduction and economic growth-oriented aquaculture industry; and (4) discuss a possible framework through which interministerial collaboration and PPP can be developed for supporting a dynamic, agribusiness-focused aquaculture.

This policy working paper was prepared to serve as a background document for the policy stakeholder consultation. The paper examines the potential impacts of agribusiness-focused aquaculture on:

1. diversification of the rural sector and creation of additional backward and forward linkages in the local economy;
2. market supply of fish, and the participation of poor people in product development and product marketing for local to urban, upscale and export markets;
3. infusion of income to rural areas;
4. nutritional security and consumption effects and linkages;
5. resource access and resource use competition;
6. competitiveness of smallholders and resource-poor households in production, processing, trade and commodity supply-chain;
7. inequity and imbalances from aquaculture development; and
8. environmental integrity and gender participation.

We hope that by considering the major shifts taking place in the fish sector, and by combining forward-looking policies with investments in useful new technologies, policymakers will be able to help ensure that aquaculture will be beneficial for Bangladesh's poor people. It is also hoped that politicians, international organizations, national agencies, NGOs and civil society groups will be able to align aquaculture development more directly to the poverty reduction strategies of the country.

We acknowledge and are grateful for the support and cooperation from MoFL, Department of Fisheries Bangladesh, WorldFish and BSFF in the preparation of this paper.

Introduction

Globally, some 1.2 billion people live in poverty; nearly 75% of them in rural areas. South Asia alone accounts for about 44% of the world's poor. In the new millennium, poverty reduction has emerged as the main challenge for economic growth in developing countries. One hundred and eighty heads of state including that of the People's Republic of Bangladesh pledged to combat extreme poverty and hunger by 2015 and encoded their resolve in the United Nations Millennium Development Goals. Many of them have designed detailed Poverty Reduction Strategies to achieve these objectives but the real challenge is the implementation of these strategies in order to pull out the world's poor from the cesspool of poverty.

Bangladesh is a densely populated country with 138 million people living in a land mass of only 147.5 thousand km². About 76% of the population lives in rural areas, of whom about one-half lives below the national poverty line. Of the poor, two out of three are caught in hard-core or extreme poverty, as measured by their consumption of food and other basic needs.¹ Data on labor force employment indicate farming, raising livestock and fishing to be the primary occupations for 61% of working men and 56% of working women in these rural areas.

Poverty has some adverse implications for the economic growth of the country. Poverty is the principal cause of malnutrition and inadequate saving. Both contribute to low productivity and meager income of the workforce. Malnutrition causes ill health and morbidity among poor people, reducing their ability to do productive work. A low savings rate prevents the poor from investing adequately in human and physical capital which leads to their lower productivity. Wages or incomes of the poor are accordingly depressed. The poor are thus caught in a vicious circle of poverty. Widespread poverty may also give rise to criminal activities which in the absence of adequate legal and police protection hinders economic growth. Hence, there is a price to be paid for poverty in terms of reduced economic growth. It is imperative that poverty be reduced on an urgent basis in order to unlock the growth potential of the economy.

According to the Bangladesh Bureau of Statistics, the fishery sector accounted for about 5% of the gross domestic product (GDP) and 28%

¹ Source: <http://www.worldbank.org>

of the value added in agricultural production in 2003-2004. It is one of the fastest growing subsectors of the economy. Fisheries products earned US\$390 million in export revenues in 2003-2004, second only to ready-made garment exports. An estimated 1.3 million of the rural population are directly employed in the fishery sector. Many more earn their livelihood from fisheries-related linkage activities. Nutritionally, fish provides about 70% of the total animal protein intake of the rural households.

Fish has always been an important part of the diet of the people of this region. But until recently fish has been harvested from nature only—there has not been much attempt to farm fish. Even as late as the early 1970s, only about 1% of the total fish output of the country was farmed. However, since then fish cultivation or aquaculture has spread quite rapidly. By 2003-2004, aquaculture became the major source of fish accounting for 43% of the total fish output of the country (see Figure 1). This has been encouraged by three main factors: (1) the possibility of further expansion of fish output by exploiting open water bodies declined markedly as natural and environmental constraints became acute with more intensive exploitation of the common property; (2) increased nutritional requirement of a rapidly growing population with higher purchasing power expanded the demand for fish very substantially, resulting in large increases in real prices of fish, thus raising the profitability of fish cultivation relative to other food crops. The opening up of an international market, especially for shrimp, gave a further boost to demand and profitability; and (3) technologies that were not overtly expensive or difficult were made available to farmers so that they could make a cost-benefit analysis of various available technologies to assure themselves of the profitability of aquaculture relative to other production opportunities. All these factors combined to make aquaculture an economically attractive production alternative that was adopted on a large scale in the rural areas.

The aquaculture sector has now become one of the most dynamic sectors of the economy with its growth rate far in excess of almost all other sectors (except ready-made garments). Aquaculture has made an important contribution to the income generation and employment of ordinary rural people. However, much of the potential for its growth remains to be harnessed due to various social, economic and policy constraints. If these constraints could be relaxed through appropriate policies and actions, the sector could make a much bigger contribution to national economic development.

This paper highlights the poverty reduction potential of aquaculture; it outlines an appropriate policy and institutional environment under which aquaculture can flourish and be more effectively integrated with the poverty reduction and economic growth strategy of the country. To this end, a thorough examination is undertaken of the aquaculture subsector along with the important backward and forward linkages and the associated stakeholder activities. Based on these, the paper suggests a policy framework and a viable framework of interagency (public and private sector) collaboration that would support the promotion of a pro-poor dynamic agribusiness-focused aquaculture in the country.

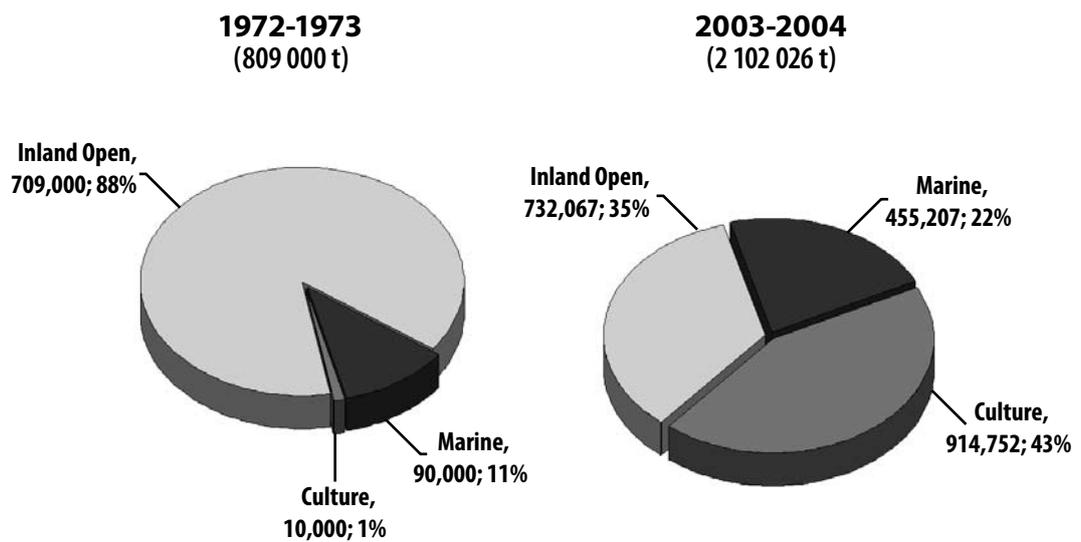


Figure 1. Fish production by sources.

Traditional fishing has been an activity geared mainly to self-consumption. The increase in demand for fish has gradually opened a space for fishing as a business activity. Much of aquaculture are now agribusiness ventures where production is undertaken mainly for the market. This is a welcome development. No production activity that is undertaken principally for self-consumption can attain the scale needed for efficient resource allocation and technological advancement. The growth of agribusiness-focused aquaculture made it possible to introduce new and better technology of fish cultivation, and promoted the growth of a whole chain of activities, from hatcheries to retailing and export, that not only added value to fish production, but also increased the demand and profitability of fish cultivation at the farm level. Actual fish production by farmers is now only one link in the entire value chain of the fish industry with perhaps much less than one-half of the total value addition of the industry. The whole chain of activities, beginning from the backward linkage activities of production and marketing of fish seed and fish feed, and continuing through the forward linkage activities of icing, transportation, storage, processing and retailing or export, that are supported by agribusiness-focused aquaculture has not only made significant contribution to employment and income generation in these linkage activities but also revitalized aquaculture by opening up a larger market for its products. The additional employment and income generated in the fisheries industry create demand for other products and thus support the growth of other economic activities. The relative stagnation of crop agriculture and the very robust growth of aquaculture suggest that aquaculture has the potential to act as one of the major thrust sectors for the economy pushing out the frontiers of production possibilities of the country. This needs to be explicitly recognized by the government and acted upon on the policy front to allow aquaculture to play its due role in national economic development.

An aspect of aquaculture that has attracted some attention is the potential of the activity in poverty alleviation (see PRSP 2004)². Many believe that fishing can raise the income of the poor people in a greater measure than many of the other agricultural activities. The Interim Poverty Reduction Strategy Paper (I-PRSP 2003) also indicated that income-generating opportunities for the rural poor in the fishery sector are the most promising. Most of the poor people of the country are located in rural areas where there are few income-earning opportunities. Aquaculture, by its very nature, can be undertaken mostly in rural areas. Hence, it opens up new avenues for employment in rural areas by increasing both self-employment opportunity and the opportunity to work as laborers in aquaculture farms that use hired labor. Already a strikingly high proportion of rural households, 73%, are engaged in some form of fresh water aquaculture (Mazid 1999). Any rural household that owns a pond or ditch can engage in aquaculture to meet its nutritional needs and to augment income by disposing of the surplus production in the market. This allows rural households to both improve their health standard and supplement their incomes.

As reported later, fishing is still a subsidiary occupation of an average fish-farming household. The highest fraction of income of the average fish-farming household is derived from crop cultivation which provides 31% of total income, while fishing contributes 27%. With the spread of agribusiness-focused aquaculture, adoption of superior technology and better forward and backward linkage services, farmers may be induced to specialize in aquaculture such that it may emerge as their sole production activity. With greater specialization and division of labor, the productivity of aquaculture would further increase, providing more income (and more employment) for the farmers and workers engaged in aquaculture. Given the low productivity of aquaculture and the consequent large gap between current yield and technological potential, the prospect of large increases in yields, and hence income, is bright.

At current market prices, aquaculture provides a more lucrative use of land than alternative activities. According to the findings of a sample survey in four districts, the gross annual return from a hectare of land on which two crops, Pajam and BRRIDhan 29, are raised is Tk81 098; but, a hectare

² The Poverty Reduction Strategy Paper (PRSP 2004) was prepared by the General Economic Division of the Planning Commission.

of pond land devoted to only carp polyculture generates a gross return of Tk115 788 (Talukder 2004). Since neither crop cultivation nor aquaculture use much imported inputs, the gross return may be regarded as the value addition in the respective activity. Thus, aquaculture supports a 43% higher value addition than crop cultivation. A hectare of land devoted to aquaculture (e.g., carp) would generate 43% higher income for all factors engaged directly or indirectly in fish production than would a hectare of land under crop cultivation. Thus, aquaculture can make a greater contribution to increasing income than crop cultivation. Some other aquatic crops, such as shrimp, could yield a higher income.

It should be pointed out that crop cultivation and aquaculture are not necessarily substitutes competing for land. Part of the land devoted to aquaculture, such as ponds, ditches, canals, deep floodplains, rivers and other water bodies, are not available for crop cultivation and hence aquaculture in these areas does not compete with crop cultivation. In all areas where only dry season crops can be grown due to deep flooding, fish may be cultivated during the wet season such that fishing does not compete with crop cultivation. Some areas that are subjected to shallow flooding may be used to cultivate both crop and fish simultaneously such that in this case too they are not substitutes. Thus, very little of aquaculture at the present time actually competes for land with crop cultivation. Aquaculture can be adopted profitably to supplement income from crop cultivation.

Poverty is the incapacity to earn sufficient income to lead a decent life. Poverty has numerous manifestations, such as malnutrition, ill health, lack of education and skill, lack of sanitation, disempowerment and so forth. However, the most fundamental cause of poverty is the lack of income-earning opportunities. This happens due to a lack of gainful (self or hired) employment opportunities. Hence, at a fundamental level, the only way poverty can be reduced or eliminated is by creating sufficient gainful employment opportunities for the poor. The more remunerative or gainful the employment is, so is the greater the reduction of poverty of the employed people. The reduction of the extent and intensity of poverty would thus depend on the volume and the productivity (quality) of the additional employment. Aquaculture could make a significant contribution to poverty reduction only if it can provide significant additional gainful employment. Available evidence suggests that aquaculture does have this potential.

Creation of additional employment requires investment in both physical and human capital. Some production activities (e.g., steel or textile production) require much greater investment in human and physical capital than certain other activities (e.g., ready-made garments). This makes the task of increasing employment through such activities difficult and expensive. A country that lacks sufficient trained human resources and investment resources would find it difficult to increase employment substantially by investing greatly in capital-intensive industries. However, aquaculture requires only modest investment. Neither the physical nor human capital requirement is prohibitive. The principal factor of production required for aquaculture is water bodies or land that could be mobilized by appropriate policies and incentives at modest cost. Table 1 below shows that there is scope for bringing at least an additional 1 million hectares of land under aquaculture in the short term and perhaps 4 million in the long term.

If it is assumed that each hectare of the additional land if brought under aquaculture would on an average yield the same output as that of the sample farms engaged in carp polyculture and would employ about the same amount of labor, then it would increase the gross return of aquaculture farmers by about \$2 billion (or about 3.5% of current GDP) and generate additional employment of 247 million person-days, or about 1 million full-time worker equivalent. Since the gross return is estimated at farm-gate prices, the income earned by all downstream activities, such as storage, transport, processing and retailing are not captured in the above figure. The employment figure also does not take into account the employment created in either downstream or upstream activities supporting production at the farm level. If these linkage effects are taken into account, the incremental contribution of aquaculture to GDP and total employment would also be much higher.³ Very few sectors could make such a large contribution to GDP and employment growth at comparable cost. Another attractive aspect is that most of the additional employment would be created in the rural areas that are the main pockets of poverty. All these considerations make aquaculture particularly suitable as *a modest cost instrument of policy of accelerated growth and poverty reduction* in Bangladesh. It deserves greater attention from the policymakers.

³ For example, if the farm-gate prices are on average about one-half of the retail prices, then the additional fish output would contribute an additional 7% to the current GDP. If for every person-day of employment created in the aquaculture farm, another one-half person-day of work is created in the upstream and downstream industries, another one-half million full-time worker equivalent of employment would be created. These are very impressive gains.

Table 1. Water types and areas available for aquaculture.

Water type	Area (ha)	Cultured (ha)	New potential (ha)
Pond and ditch	305 025	198 179	106 846
<i>Baor</i> (oxbow lake)	5 488	5 488	-
Floodplains, paddies	2 832 792	?	700 000
River, canal	1 031 563	?	100 000
Road, railway side canals	?	?	?
Shrimp <i>ghers</i> (estate)		203 071	100 000

It is necessary to both expand the area under aquaculture and increase the productivity or yield in order to harness the full potential of aquaculture for poverty reduction. Notwithstanding the fact that the productivity of land (or labor) is higher under aquaculture than under crop cultivation, the average productivity of aquaculture in Bangladesh is much lower than that in comparator countries. Indeed, the productivity is as low as one-eighth of the productivity of some high-performing countries. There is thus tremendous scope for increasing the output of fish with appropriate policies that raise the yield rate.

In Bangladesh, aquaculture is broadly divided into two categories: inland fresh water culture and coastal brackish water culture. In the fresh water culture, fish seed producers and traders, including the nursery people, vendors, fish farmers, fish-farm workers and fish traders stand to benefit. In the coastal brackish water, shrimp culture dominates by providing employment to shrimp hatchery owners, hatchery workers, shrimp fry collectors, fry traders, *gher* owners, land lessors, *gher* workers, depot owners, depot workers, shrimp processors and exporters. Apart from these groups, who are directly involved in fish industry, manufacturers and traders of fish feed, food distributors, ice makers and distributors, transporters and related work groups, benefit from business-oriented aquaculture. The cost of creating employment through this approach is by far the least expensive. In fact, it can be accomplished with the available resources and without dependence on external resources.

The shrimp industry consists of four distinct subsectors; the shrimp farms (*ghers*), shrimp hatcheries, feed mills and shrimp processing plants. Table 2 shows a regional distribution of the subsector establishments. Shrimp farms are the mainstay of the industry and the activities of the other subsectors depend largely on the growth of shrimp farms in the country.

Table 2. Shrimp farms and other allied establishments composing the shrimp industry.

Sectors of shrimp industry	Cox's Bazar region	Khulna region	Other areas	Total
Shrimp hatchery	50	5	-	53
Shrimp farms	2 369	44 141	198	46 708
Shrimp processing plants	69	27	19	127
Feed mill	1	1	18	20

Source: Islam et al. (2004).

The major stakeholders of the industry are shrimp farmers, shrimp farm laborers and workers, owners of related industries (feed mill, processing plant, depot and hatchery), shrimp seed collectors, land lessors and shrimp traders. An integrated picture of the shrimp industry, linking the different stakeholder activities, is depicted in Figure 2. Women are actively involved in the subactivities. Shrimp depots are the largest source of employment for women. It is estimated that more than 50% of workers in the shrimp depots and processing plants are women. Shrimp fry collection is also an

important source of employment for rural women. The scene of women collecting shrimp fry in knee to shoulder-deep water in the coastal belt area is a familiar scene. Besides, a large number of rural women are engaged in the collection of shrimp seed and artisanal production of fish trapping and packing materials.

Information derived from a sample survey of 100 farmers from Khulna, Satkhira and Cox's Bazar areas indicate that year-round shrimp farming yields much higher return and employment than year-round rice farming: gross return is 170% higher while employment is 130% greater and labor income is nearly 100% higher. The average productivity is also higher by about 20%. Thus, shrimp farming can make important contributions to employment and income of the ordinary rural laborers who are predominantly poor.

Carp-based fish polyculture has about 25% lower employment intensity per hectare than double-cropped rice farming. However, productivity is 78% higher. Thus the quality of employment is superior in carp polyculture. Furthermore, carp polyculture is not necessarily a substitute for rice/crop cultivation such that it does not displace other employment opportunities.

The survey results show that the average annual income of a five-member fish-farmer household is Tk126 698. Crop constituted the highest proportion (31%) of household income, followed by fishery which contributed 27%. In some locations, for example, in Iswarganj of Mymensingh, income from fish culture constituted as high as 60% of household income. Thus fish culture, if well planned and integrated into the rural development plan, has the potential to sustain rural income growth.

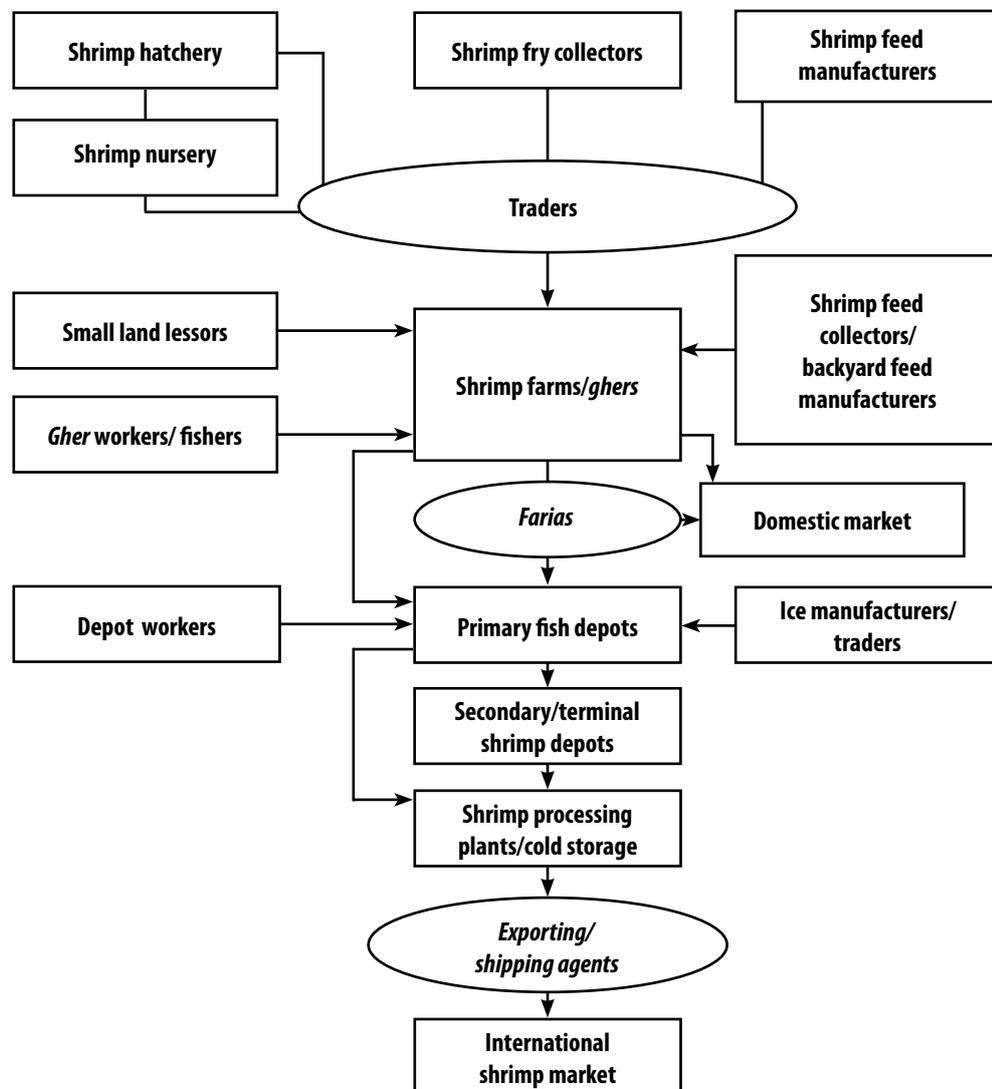


Figure 2. Integrated structure of stakeholders associated with the shrimp industry.

Results from a sample survey of 300 stakeholders (of which 100 were shrimp farmers) are available to show that income from shrimp culture constituted the major proportion of household income for most of the stakeholders (Table 3). Average incomes of shrimp farmers, depot and hatchery owners were several times higher than those of other categories of households. However, household incomes of shrimp seed collectors were substantially lower compared to the incomes of land lessors and workers of processing plants. For shrimp farmers and farm laborers, shrimp farming contributed more than 80% to their total income, while for other groups of people it contributed 30-50%.

Table 3. Annual income by sources of income of stakeholders of the shrimp industry.

Sample respondents (stakeholders)	Household income (Tk/year)		
	Shrimp-related activities	Farm and nonfarm activities	Total household income
Shrimp farmers	670 180 (78.34)	185 270 (21.66)	855 450 (100)
Land lessors	32 890 (23.82)	105 185 (76.18)	138 075 (100)
Hatchery owners	870 135 (84.96)	153 985 (15.04)	1 024 120 (100)
Depot owners	126 600 (47.42)	140 400 (52.58)	267 000 (100)
Shrimp seed collectors	13 550 (37.85)	22 250 (62.15)	35 800 (100)
Shrimp farm laborers	40 170 (75.00)	13 340 (25.00)	53 510 (100)
Processing plant workers	50 780 (51.33)	48 150 (48.67)	98 930 (100)
Hatchery workers	61 000 (70.64)	25 350 (29.36)	86 350 (100)
Feed mill workers	55 584 (78.41)	15 300 (21.59)	70 884 (100)
Depot workers	19 200 (36.20)	33 840 (63.80)	53 040 (100)
Shrimp traders (<i>faria</i>)	48 500 (65.63)	25 400 (34.37)	73 900 (100)

Note: Figures in parentheses indicate percentage of total income.
Source: Islam et al. (2004).

E*conomic Benefits from Pond Fish Culture.* Over the past years, many derelict ponds have been brought under fish culture; many low-lying areas, previously used for capture fishing, have been turned into cultured ponds. Even the upland ricefields are being converted into fish ponds. All these changes suggest that fish culture is a relatively profitable activity. There is some hard evidence to support this view. As indicated earlier, the findings from a sample survey of 366 fish farmers in 4 districts, namely, Mymensingh, Comilla, Bogra and Jessore, showed that per hectare gross return from pond fish culture was Tk115 788. The average benefit-cost ratio (BCR), which represents return per taka of investment, was 1.89.

The major cost items in pond fish culture were human labor, fish seed, feed and cost of land use. It was revealed from the above survey that total labor requirement for culture of 1 ha pond was 247 person-days for 1 year cycle of culture of which family labor contributed about 43%. The results of the survey also showed that the labor cost constituted about 30% of the total cost. Cost of fish seed constituted the second major cost items representing 27% of total cost of pond fish culture. It is evident that very substantial employment can be created in aquaculture.

Economic Benefits from Rice-cum-fish Culture. Rice is the major rural agricultural product in Bangladesh. The cultivation of fish in irrigated and rainfed ricefields has been widely practiced by rural farmers in Bangladesh for several decades. It may be noted that Bangladesh is one of the very few countries which actively promotes rice-fish farming through various research and development programs. One of the earliest efforts in rice-fish farming was made by the Noakhali Rural Development Program in 1989. Through low-cost rural experiments, the program increased the production of cultured fish from 223 to 700 kg/ha in 50 fields planted with local rice varieties.

Results from a comparative research between double-cropped rice culture and year-round fish culture showed that the net return for fish culture was more than four times the net return from double-cropped rice culture. The employment intensity was slightly higher in the rice culture, but the net profit and BCRs were overwhelmingly higher in fish than in rice culture (Anik 2003; Rahim 2004; Talukder 2004).

A recent study by Akteruzzaman (2005) in three locations of Mymensingh district indicated that net returns per hectare from exclusive pond fish culture, alternate rice and fish culture and simultaneous rice-cum-fish culture were Tk56 444, Tk61 426 and Tk55 877, respectively. Net returns from alternate rice and fish culture were marginally higher compared to the other two cultures. What is noteworthy is that the net returns from all these practices were overwhelmingly higher than those from double-cropped rice culture. Furthermore, all the three culture practices were fairly labor-intensive and therefore offered substantial employment opportunities for the rural people.

The benefit derived from rice-fish farming goes beyond income and employment benefits. It enhanced the knowledge of farmers. They learned that insect attack was generally less in ricefields where they also stocked fish. They realized that fish feces and their movement contributed to organic matter supply and increased microbial activities in the soil, and these in turn contributed to increased rice production. There have been marked changes in the farmers' attitude, knowledge and practice in favor of undertaking the modern way of fish cultivation. Today, rice and carp polyculture as well as carp with *galda* culture in ricefields are gaining popularity among farmers in different regions (Mandal et al. 2004). Clearly, fish from ricefields contribute towards food security and poverty alleviation of many rural farmers.

Economic Benefits from Shrimp. Shrimp farming and related activities contribute significantly to the national economy of Bangladesh. The main areas of contribution are employment, income generation and export earning through on and off-farm activities. Most of the shrimp produced in brackish water is exported. In the last several years, shrimp has emerged as the second largest export earner of Bangladesh. Total export of shrimp was about US\$360 million in 2003-2004. There is vast scope of increasing shrimp export as the international demand is buoyant, and there are not many countries that engage in shrimp culture.

Special Importance of Galda Shrimp. The fresh water *galda* shrimp accounted for 15% of total shrimp export and 10% of total agro-based primary commodity export of Bangladesh in 2003-2004. *Galda* shrimp constituted 26% of total shrimp catch in 2003-2004. The special features of *galda* farming are that the species can be cultured in relatively smaller water bodies, often alternately or simultaneously with rice. *Galda* culture is more eco-friendly and does not affect mangrove forest or environment. The species is also not susceptible to white spot syndrome virus disease or frequent tidal bores. *Galda* shrimp gives relatively higher yield of around 400 kg/ha. The embankments of *galda* culture ponds allow for production of fruits and vegetables that provide extra income and household nutrition. *Galda* farming and the supplementary enterprises provide substantial employment opportunities for women members of the family. All these features indicate that *galda* farming has a direct bearing on the poverty issue in Bangladesh.

Culture of *galda* shrimp is constrained by inadequate supply of fry and post-larvae (PL). Most of the PLs come from wild catch. *Galda* culture is mainly dependent on rain water and consequently maintenance of water depth in ponds is a critical issue. Also, availability of good quality commercial feed is inadequate and expensive. The future of *galda* culture is threatened because of declining wild brood stock, due to overfishing and lack of conservation.

The government has recognized the need for identifying new sources of economic growth and social development to improve the life of the rural poor. In the last three decades, aquaculture has played a growing role in providing employment and improving the livelihood of the rural poor. It has the potential to make a much greater contribution but this will depend on future government policies that improve the productivity, and the expansion, of aquaculture as well as a workable strategy to encourage greater gainful participation of the poor.

There are some barriers to entry and efficient operation of aquaculture enterprises. These largely revolve around financial resource constraints such as:

- Shortage of investment capital;
- Lack of knowledge of the nature and profitability of alternative enterprises;
- High interest rates;
- Inappropriate loan repayment schedules; and
- Poor management of existing financial resources.

Participation of the Poor in Aquaculture and Leasing Policy. Being largely a rural activity, one would expect aquaculture to play a big role in combating extreme poverty. Studies conducted since the early 1990s indicated that the farmers who incorporated aquaculture into their farming system were an economically better-off segment of the farm population with larger landholdings, higher literacy rate and greater annual income. This perhaps indicates that they were in a better position in terms of influence, capital and expertise to exploit the opportunities opened up by aquaculture. The hard-core poor benefited mainly by way of wage employment in aquaculture farms. An institutional approach that addresses the complex problem of asset distribution will be needed if the resource-poor are to participate in the expansion of aquaculture as entrepreneurs.⁴

Expansion of Aquaculture to Public Water Bodies. Poor households often do not have access to water resources such as ponds or ditches. A substantial increase in the participation of the poor, for that matter the expansion of aquaculture itself, must entail an expansion of aquaculture into government-owned or controlled water bodies such as the floodplains as most of the privately owned water areas are already in use and over which the government does not have any control. The availability of government-controlled water bodies gives an opportunity to the government to involve the poor directly or indirectly in aquaculture through suitable leasing policies. However, it must also be ensured that the leased water bodies are given to people or organizations that can engage in aquaculture efficiently to avoid wastage of scarce resources and/or the creation of intermediaries. This obviously is a very complex and difficult task; the government will have to investigate the matter in depth to come out with a workable solution that is

⁴ This was one of the findings highlighted by Gupta et al. (1999) in their five-year study on incorporating aquaculture into the farming systems of the floodprone ecosystems of Bangladesh. Similar observations were made by Ahmed et al. (1993) for pond fish farming and Gupta et al. (1998) for integrated rice-fish farming.

also economically efficient. *A priori* one could think of two broad options keeping in view the poverty reduction priority of government policies. The more popular option would perhaps be to lease out the water bodies for aquaculture to organizations or cooperatives of the local poor people. The other option is to lease out the water bodies to entrepreneurs competitively. The first option will be much more difficult to implement than the second. The identification of the poor people may pose some problems. There may not be any organizations or cooperatives of the poor people. Hence, the first task would be to identify and organize the poor people into production groups. Rent seeking may raise its ugly head in the allocation decisions. Poor people, almost by definition, do not own many assets, in particular financial assets. They are unlikely to have the financial capital needed to engage in aquaculture. Some credit mechanism must be worked out to provide funds to those groups such that they can put the leased land to use. Microcredit operations could be helpful. Commercial banks could be encouraged to extend credit using the leased land as collateral. This will require longer term leases (i.e., five years) and the leases must be transferable. Legal aspects of such leasing and mortgage arrangements would have to be carefully worked out. Credit could be advanced for purchase of inputs against output (something similar to letter of credit could be conceived). Some efforts will have to be expended to figure out a credible guarantee against the moral hazard problems.

The other option of leasing out the water bodies to entrepreneurs could also serve the objective of increasing the participation of the poor in aquaculture or related activities. If the entrepreneurs are more efficient than the poor in running aquaculture as an agribusiness, they could employ more workers at a higher wage rate and generate higher aggregate income than the poor people's organizations. They would be in a better position to introduce the most efficient technology, bring in management expertise, mobilize the inputs and market the products at competitive prices in order to maximize the profit of the aquaculture business. In this event, the poor people stand to gain more by working as wage workers rather than trying to run the agribusiness themselves. If they are not adept at managing aquaculture as agribusiness, they could go bankrupt and consequently waste the opportunity of improving their economic well-being. The economy also loses as scarce resources are suboptimally used or wasted.

If there are several leases, another option that could work is a combination of the above two options. Both the poor and entrepreneurs could be allocated leases in some proportion. This has the advantage of reducing strife between the poor and the well-to-do people of the region and also offers the opportunity of having an efficient farm as a model for others to learn from and emulate.

Extension Services for the Poor. Poor people are unlikely to have the management capacity, technical expertise or marketing know-how to operate an aquaculture farm profitably as an agribusiness. Hence, substantive extension services will have to be made available to bring them up to speed on the various facets of management of an aquaculture farm as an agribusiness, the technical details of fish production, and the best method of marketing a perishable product with multiple intermediaries and fluctuating prices. Designing an extension program to deliver these essential educational and training services is a complex problem.⁵ The government will have to devote adequate resources to identify the training needs and a suitable mechanism to implement the training program. Such a program is also essential to raise the productivity of the fish farms.

Low-quality Fish Seed Production. A major problem behind low productivity of fish-farms is the unavailability of high-quality inputs at reasonable cost. The poor quality of brood stock, fry and fingerlings that the fish farmers are obliged to use for fish production directly contributes to the poor quality of the output and low yields. It will not serve any useful purpose if the poor people are given the water bodies to engage in aquaculture, but do not have access to good quality fry and fingerlings. Good quality fish feed also would have to be made available. Without adequate backward linkage services that provide these inputs the fish farms may not emerge as viable agribusiness units. Since it is unadvisable for the government to engage in all these backward linkage business activities, many of which are likely to be fairly small operations, it may encourage the growth of private business enterprises to provide the inputs as an agribusiness activity. Some public-private partnership whereby the government provides research and advisory services in fishery input management including fish seed while the private enterprises conduct the actual business could prove to be useful.

⁵ Such services may also be needed by the richer farmers and entrepreneurs engaged in aquaculture.

Increased production of fish depends largely on the availability of good quality fish seed. About two decades ago, farmers had to depend almost entirely on seed from natural breeding grounds which supplied more than 85% of total requirement of seed (Karim and Ahsan 1989). However, fish seed collection from natural sources declined from more than 20 000 kg in the mid-1980s to less than 6 000 kg in the mid-1990s. The government established 113 fish seed multiplication farms, covering almost all districts of the country, to fill in the gap in fish seed supply (DOF 2002). In the 1980s, private hatcheries began emerging. The number increased dramatically from 40 farms in 1985 to 439 farms in 1994 and 779 farms in 2001 (DOF 2002). According to the latest Department of Fisheries (DOF) estimate, there are 697 private hatcheries operating in the country, with spawn production of about 292 000 kg (DOF 2004). This indicates that the private sector does have the capability to cater to the market demand if given the opportunity to do so.

Improper Brood Stock Management. An important aspect of hatchery operation is the management of brood stock. The source of the brood stock, size and weight of stock, maintenance of male-female ratio, type of brood pond including quality and depth of water, feeding of brood stock are the important considerations in maintaining good quality stock. Procurement, selection and maintenance of good quality stock have emerged to be matters of serious concern in brood stock management. Improper maintenance of stock has led to inbreeding of fish species which has resulted in excess supply of inferior quality seed that in turn leads to less than expected yield and production of fish species. However, the exact nature and magnitude of the problem are less known, and this calls for broad-based investigation.

Inadequate Expertise in Spawning Method. A related consideration in seed production is proper spawning through which fish larvae are obtained. Two methods are generally followed in fertilizing the ova: natural mating of male and female in the brood tank and stripping of the brood fish. In both cases, injections are to be pushed at the right time and in the right manner. The source, size and age of the brood stock are critical determinants for obtaining good quality seed. All these technical considerations suggest that proper fish breeding requires adequately trained personnel/technicians.

Empirical evidence suggests that the hatchery operators and technicians do not have the requisite type and quality of training on technical aspects of hatchery operation. Results of a field survey from two locations (Mymensingh and Jessore) revealed that 44% of hatchery operators did not have any formal training and 56% had training of an average duration of 22 days (Khan 2003). Operation of a hatchery by nontrained personnel has adverse consequences on the production of quality fish seed. The high yield gap of fish between on-station yield trial and on-farm yield may be attributed to indiscriminate involvement of nontrained and unskilled human resource in the hatchery business.

Poor Water Management and Delivery System. One of the critical determinants of proper spawning and survival of spawn is the water management and delivery system in a hatchery. Proper construction and location of an overhead tank is very important. Pumping of water into the overhead tank from a reliable source is another important consideration. Inflow and outflow of water to and from circular tank, breeding tank, hatching jar and spawn house with the requisite speed of water flow are also the critical determinants of spawning and survival of spawn. It is often observed that the technical specifications are not properly followed in the construction and maintenance of hatcheries. As a result, mortality of spawn, fry and fingerlings becomes high. Lack of technical skill of the hatchery operators and financial constraints are often responsible for substandard operation of fish hatcheries.

Lack of Lease Right or Ownership. Roadside ditches and canals, including flood control, drainage and irrigation canals, constitute a significant proportion of water bodies in the country and are owned/controlled by several ministries and government departments. These water bodies hold perennial and/or seasonal water and therefore are suitable for fish culture for varying durations. Many of these water bodies are not properly cultured and as a result the society is deprived of the gains that could accrue from increased fish production. The main problem associated with utilization of these water bodies is the tricky matter of user rights and lack of

popularization of technologies suitable for these. Efforts need to be taken to make a comprehensive inventory of these water bodies and to work out a formula for interagency cooperation to ensure unambiguous conferment of use rights to genuine aquaculture farmers. Individuals or groups will have to be motivated to participate in the use of the water bodies with appropriate technological interventions. As discussed earlier, these could be leased out for a long term to organizations of the local poor and/or to entrepreneurs. Over the past years, aquaculture activities have been expanded in the form of pen and cage cultures in the floodplain and open water bodies including *beels*, canals and rivers. The main problem associated with pen and cage culture is the ownership or user right. Community ownership or lease right should be established for efficient management of pen and cage cultures.

Negative Impact on the Environment. Globally, the aquaculture subsector has been under the scrutiny of environmentalists. In Bangladesh some of the leading aquaculture-related environmental problems are: (1) increased salinity leading to serious loss of soil fertility; (2) damage of traditional economic activities such as crop and animal husbandry; (3) damage to household vegetation and social forestry; (4) loss of common property rights of the poor fishers; (5) adverse effect on income distribution; (6) damage to the mangrove forest and loss of biodiversity; and (7) increasing social tension resulting from absentee entrepreneurship, having no commitment to conservation of resources for sustainable shrimp culture. These issues will have to be effectively addressed to assuage the environmental concerns.

Policy measures and institutional support play an important role in determining efficiency and overall performance of the aquaculture sector. Policy incentives include both macro and sectoral policies. Institutional environment includes laws, rules, regulations and organizations that determine the right to use the fisheries resources, particularly land and water. Support services include credit, research and development, training, extension services and various infrastructures.

Policy Incentives. The Bangladesh economy has experienced significant macro and sectoral policy reforms since the mid-1980s. Macroeconomic reforms were characterized by successive import liberalization, devaluation of exchange rate and deregulation of foreign exchange rate. Under trade policy reform, import duties were successively reduced or rationalized to conform to the liberalized trade policy regime. Under sectoral policy incentives, the government declared the fishery sector as one of the thrust sectors. Interest subsidy has been introduced to attract investment in agriculture which includes the fisheries subsector. Banks were asked to fix lending rates within the bands of 8-10% for export of agricultural products.

During the 1990s, the government offered several export incentives. These were: (1) export finance at concessional interest rate on working capital; (2) development funds; (3) foreign exchange for business travel abroad; (4) export performance benefit equal to the difference between the official exchange rate and the market exchange rate for every US dollar earned through fish export; (5) reduced or no duties and excise taxes on the import of equipment and machinery for export-oriented industries; and (6) other financial and nonfinancial incentives. All these macroeconomic and sectoral policy incentives have direct and indirect implications for the fishery sector (Hossain 2002).

Institutional Arrangements. Many government agencies have been involved in planning, research, promotion, development, management and regulation of the fishery sector. As many as 15 public organizations/departments are involved in the management and development of the fisheries sector. However, private sector participation in fisheries development has rapidly increased in recent years, especially with the introduction of aquaculture, shrimp farming, seafood export and mechanized fishing boats. Fish harvesting, marketing, processing and trade have remained mainly in the private sector.

Four sets of laws and regulations are available to protect and encourage the development of the fishery sector (Habib 1999). They are: (1) The Protection and Conservation of Fish Act, 1950 (as amended in 1982); (2) The Tank Improvement Act (as amended in 1986); (3) The Fish and Fish Products Inspection and Quality Control Ordinance, 1983; and (4) The Marine Fisheries Ordinance, 1983 and The Marine Fisheries Rules, 1983.

The National Fisheries Policies 1998 outlines the following broad objectives:

- To enhance fisheries production;
- To alleviate poverty through creating self-employment and improvement of socioeconomic conditions of the fishers;
- To fulfill the demand for animal protein;
- To achieve economic growth through earning foreign currency by exporting fish and fisheries products; and
- To maintain ecological balance, conserve biodiversity, ensure public health and provide recreational facilities.

Within the overall framework of objectives, some specific objectives with respect to aquaculture were outlined as follows:

- Fish culture will be encouraged in all ponds, *dighis* and other water bodies.
- Union-based demonstration fish farms will be established at both government and private levels in order to expand aquaculture technologies. Fish farmers will be trained at *thana* and Union levels through the self-program of the Directorate of Fisheries or with the nongovernment organizations (NGOs).
- Ponds remaining uncultured due to multiple ownership or other such problems will be brought into fish culture through the Pond Development Act.
- Brood banks will be established in the government seed multiplication farms.
- Farmers will be encouraged in fish culture and trained accordingly.
- Local fisher communities will be encouraged to culture fish in the *baor* areas.
- Jobless youths will be trained in fish culture and financial assistance will be provided for their post-training fish culture activities.

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- Measures will be taken to conserve biodiversity in the coastal region and necessary steps will be taken to culture shrimp/fish along with rice, either alternately or simultaneously.
 - Proper training will be given to fry collectors in order to reduce mortality of fry and larvae of other fish species.
 - Shrimp harvesting during breeding season will be banned. Some selected breeding grounds of the sea and estuaries will be declared as shrimp sanctuaries.
 - Facilities of the quality control laboratories will be modernized to ensure quality of exportable fish and fish products.

Keeping in view the broader national objectives, the pertinent issues and their policy implications have been analyzed with respect to the aquaculture subsector of the overall fishery sector. The policy issues have been analyzed under three components of the aquaculture subsector: (1) production and marketing of fish seed; (2) fresh water aquaculture practices; and (3) brackish water aquaculture and related practices. Upon analyzing the issues, several policy recommendations were strongly suggested.

Production and Marketing of Fish Seed. In the area of production and marketing of fish seed, there has been significant expansion of hatcheries in the country, and hatchery operations are significantly contributing to employment and income generation in the rural areas. However, many of the hatcheries are not being run under ideal conditions. Serious problems exist with respect to management of brood stock and operations with respect to technical aspects of spawning. Use of undersized and low-quality brood stock affects yield of fish species. Besides, indiscriminate use of broods of same parental descendant causes inbreeding, resulting in low yields of fish.

There should be a carefully controlled and accredited breeding program to ensure that high-quality brood stocks are maintained, collected and supplied to the hatcheries. Section 6.12 of the National Policy Statement clearly proposes the establishment of brood banks at government farms so that improved brood stocks can be supplied to the private hatchery owners who will engage in commercial seed production. Measures taken to implement this policy goal are not fully known or understood. To ensure quality, it is essential that strong control measures be adopted in the form of certification of the seeds by a competent authority.

In the case of shrimp seed production, the hatcheries, particularly those producing *bagda* fry, depend on brood stock collected from deep sea, mainly as by-catch. The brood shrimp collected during December–March are of good vigor and are generally free from disease. Because of climatic reasons, brood shrimp collected after March are generally of poor health and seeds produced from these broods are lesser in quantity and poorer in quality. Furthermore, indiscriminate expansion of hatcheries has led to the problems of poor quality and oversupply.

In the production and distribution of fingerlings, emerging issues are prevailing technologies for transporting grown-up fingerlings to far-flung

areas. As a result, the fingerlings are subjected to heavy stress which causes damage and high mortality. This situation calls for decentralized production of fingerlings, preferably at Union level, under the supervision and monitoring of the local government body (Union Parishad) and DOF personnel.

In this system, fingerlings should be produced by selected farmers with a proven record of performance. They should be encouraged to buy fingerlings from certified fingerling producers in the locality.

Several policy recommendations are proposed to address the issues above:

- Technical capabilities of persons engaged in fish seed production activities should be improved by imparting appropriate training on the technical aspects of hatchery management.
- Some form of regulation should be imposed to control indiscriminate and unplanned expansion of hatchery establishments.
- Regulated expansion of *galda* shrimp hatchery should be encouraged, particularly in locations closer to *galda* farm areas.
- Seed certification scheme should be introduced to ensure quality seed supply to growout farms.
- Adequate facilities should be developed and some form of compulsion should be introduced for testing all *bagda* PLs for white spot syndrome virus through polymerase chain reaction testing before releasing the PLs for stocking.
- Effective measures should be taken to enable the private hatcheries to procure mature, good quality brood stocks, preferably from government farms.
- Measures should be taken to establish fish nurseries at more decentralized locations, such as at Union level, to minimize the travel distance for transporting fingerlings from nurseries to growout ponds. The scheme should be implemented under the close supervision of the Union Parishad and DOF personnel.
- Open water stocking with uncertified fingerlings should be totally stopped to prevent further genetic degradation of the natural fish species.
- Measures to prevent stock depletion should be taken to restrict collection of brood shrimp after March every year. Brood shrimp may be imported from other countries to keep production going. It is believed that brood shrimp from water areas of some African countries such as Mozambique are of superior quality.

Freshwater Aquaculture Practices. Pond aquaculture (including shrimp culture) accounts for the largest proportion (42%) of total fish production in the country. There has been significant expansion of pond aquaculture practices in the country. Financial profitability analyses have revealed that both gross and net returns from pond fish culture are several times higher than returns from other crop and noncrop enterprises. Employment intensity of pond aquaculture is also fairly high compared to that of other enterprises such as rice cultivation. Fish culture, alternatively or simultaneously with rice culture, is highly labor-intensive and can contribute to increased employment and income generation and poverty reduction.

Although pond fish culture expanded rapidly over the past years, it has been observed that about 24% of the ponds, which are cultivable, and 13%, which are derelict, remain uncultured. There are some technical and socioeconomic constraints to using these ponds. Joint ownership is the main impediment to the use of many cultivable ponds.

The National Policy Statement (MoFL 1998), through the Pond Development Act, clearly proposes to have these ponds cultured. A prominent ongoing project entitled “Poverty Reduction through Integrated Fish Culture” has a clear mandate to accomplish this objective. It is, however, not known whether any impact assessment has been done or is underway to assess the degree of accomplishment of the project. The performance of the project should be thoroughly evaluated; the lapses (if any) should be identified; and if necessary, follow-up activities should be undertaken.

Utilization of roadside canals and ditches including the flood control, drainage and irrigation canals is also an important issue which calls for policy attention. In cases involving these water bodies, the issue of property rights is also a major concern. Community participation with proper use rights should be ensured to have these water bodies cultured. A related issue is the pen and cage culture in some floodplains and open water bodies where use rights of the water resources should be ensured through legal and institutional supports.

Indiscriminate fish catch during breeding season has already caused depletion of fish stock in perennial and seasonal waterbodies. The National Policy Statement proposes a ban on fish harvest during the breeding

season. No visible action in this regard seems to have been taken. Against this backdrop, increased production of cultured fish has not only the potential for employment and income generation, but also the potential to increase consumption and improve the nutritional status of the people. A worthwhile exercise would be to quantify and measure the extent of social gains, including examination of distribution of gains among the classes of producers and consumers.

Several policy recommendations are strongly proposed to address the issues raised above:

- More motivational work should be done, along with technical and financial support, to induce people to bring the culturable and derelict ponds into fish culture.
- The problem of multiple ownership of ponds should be addressed by some suitable leasing arrangements that provide adequate incentives to the owners to make the ponds available for fish culture under a single management.
- Roadside canals and ditches owned by various government agencies should be brought under fish culture by organizing community participation and offering use rights of the water bodies to the people. A high-powered interagency committee should be set up to ensure cooperation among them that is essential for designing a workable program for use of the public water bodies.
- Besides conventional closed water bodies, open floodplains and low-lying lands that naturally retain or can be made to retain at least 50 cm of monsoon or tide water for at least 3 months at a stretch should be recognized as suitable for aquaculture.
- Cultivable *khas* water bodies should be leased out to target groups for 5 years for pen/cage culture, and for 10 years for pond culture to encourage investment and develop viable agribusiness. Leases should be transferable to allow flexibility.
- More demonstrations should be conducted in remote areas to popularize the newly developed fish species and technologies relating to growout cultures with appropriate species combinations.
- A necessary ban should be imposed on fish harvest during breeding seasons, and some selected breeding grounds should be declared as fish sanctuaries.
- As a matter of species priority, carp and monosex tilapia culture should be further expanded in fresh water areas, and mullet culture should be popularized in brackish water areas.

- In addition to *bagda* and *galda* shrimp, *koi* and *magur* culture should receive high priority for their high market prices and export potentials.
- Almost 80% of the marketed fish move from producers to consumers through a long chain of wholesalers and retailers. However, the gap between the producers' price and the consumers' price is often high and producers often do not get a good price. Because of the bad communication system, buyers from distant places cannot take part in the local auctions. Adequate transportation network should be developed to improve this situation. Fish farms and landing centers located in the *beels*, *baors* and along the sea coast should be linked with the improved transportation network.
- Studies should be conducted on a regular basis to assess consumer preference at home and abroad for fish species and demand and supply potentials of different fish species to assist planning of necessary investment in the aquaculture and fishery sector.

Brackishwater Aquaculture Practices. Shrimp monoculture or shrimp culture alternately with rice and salt are highly profitable activities. They provide a high level of employment per unit of water area. Shrimp trading and processing activities also offer high levels of employment, particularly to unskilled female labor force.

Although the absolute income of stakeholders is high, there is evidence of gross inequality in its distribution. The large *gher* owners allegedly appropriate the higher share of benefits from the chain of activities. The issue needs to be addressed through selective policy measures that raise the bargaining strength of the disadvantaged.

The land use conflict is one of the critical issues that need to be mitigated through a combination of legal measures and mutual participation in the sustainable shrimp culture practices, such as alternate shrimp-rice culture in which both crops can be shared by land lessors and *gher* owners.

Protection of mangrove forest from expansion of shrimp culture activities is a long-standing issue. Effective zoning of coastal regions should occur, and measures should be taken to prevent encroachment in zones.

Maintenance of quality of exportable shrimp has remained a burning issue. The shrimp industry has poor perceived health safety standards and quality assurance. This is reflected in the generally lower price that Bangladeshi

shrimp fetches in the world market. The European Union banned imports from Bangladesh in 1997 after discovering major deficiencies in sanitary standards and quality assurance. The ban caused serious dislocation in shrimp trade. Virus and bacteria can infect the shrimp, making it unsuitable for human consumption. Shrimp can also be contaminated by banned substances such as mercury and certain antibiotics. The stakeholders need to be apprised of the strict sanitary and phytosanitary and hazard analysis critical control points (HACCP) standards required to be complied with to assure foreign buyers of the health quality of the exports. The fish export sector has to increasingly rely on reliable means to quickly trace the source of infection or contamination in order to segregate the healthy products in the event of disease or contamination. Traceability has thus emerged as a key problem in maintaining health standards and thereby protecting the export market. Adequate technical and financial support must be provided to put in place such a mechanism. Strict vigilance, monitoring and punitive measures need to be adopted to ensure the hygienic standards of the exportable shrimp and fish products.

Based upon the issues above, several relevant policy recommendations are strongly proposed:

- Land utilization policy should be urgently formulated. The coastal land should be classified into various economic zones on the basis of detailed survey of topography, tidal inundation, water salinity and land quality.
- Farm water supply and drainage network should be improved through implementation of local level Master Plan for rainfed, pumped and tided ponds.
- As has been suggested in the Report on Fourth Fisheries Project (Karim and Stellwagen 1998), the following criteria can be followed for earmarking the coastal lands for different purposes:
 - The coastal area where river water salinity remains at or above 8 ppt, at a stretch for at most 4 months of the year, should be declared as brackish water shrimp aquaculture area.
 - Land within the brackish water aquaculture area, where river salinity remains at or above 8 ppt, for at least 8–9 months of the year, should be primarily used for brackish water aquaculture, with marine shrimp as the principal culture species.
 - Land where soil and river water salinity remains below 3 ppt, for at least 4 months at a stretch, should be used for paddy and shrimp in rotation.

- Land where soil salinity is always over 3 ppt and river water salinity is over 25 ppt, for several months during dry season, brackish water shrimp culture should be alternated with salt production.
- The strip of land lying between the Bangladesh Water Development Board (BWDB) coastal embankment and the adjoining river must not be leased out and utilized for shrimp cultivation, but be compulsorily replanted with appropriate mangrove species through the collaborative efforts of the Department of Forest and Environment, BWDB, the local government and the shrimp farmers.
- Appropriate measures should be taken to encourage a fairer distribution of income among the stakeholders, particularly between the *gher* owners and the land lessors.
- Effective measures should be taken to check fraudulent practices, including contamination of shrimp by foreign materials. Local shrimp traders are alleged to be the agents of such contamination. Measures should be taken to shorten the supply chain and thereby minimize the role of local fish traders.
- Strict measures should be taken to maintain hygienic standard of shrimp by monitoring the quality standard from the point of harvest through the marketing channels to the point of processing plants.
- Incidence of shrimp disease has caused some damage to the shrimp industry. No appreciable preventive or curative intervention measures appear to have been taken to address the issue. Research efforts should be strengthened to quickly identify the disease and take quick remedial measures at field levels. The DOF and the saline water station of the Bangladesh Fisheries Research Institute (BFRI) can collaborate to undertake action research programs to increase yield and thereby contribute to higher national production and export of shrimp and fish.
- All aquaculture and fishery-related research facilities, including human resources, should be inventoried for better planning of research and development. The Fisheries Resources Survey System (FRSS) of the DOF should be revamped with more human resources at the grass-roots level for collection of more detailed and reliable data pertaining to the aquaculture and fishery sector of the country.
- Many of the aquaculture activities cannot be effectively performed, particularly by small and marginal fish farms, due to shortage of capital. Credit is an indispensable tool for getting aquaculture moving. Credit institutions, having voluntary and/or obligatory mandate to provide credit to the fishery sector, should carry out appropriate field studies to examine

the requirements for loans so that genuine borrowers get the required loan at the right time and at a reasonable rate of interest. Care should be taken to build sufficient flexibility in the lending terms. The dignity of the farmer-borrower must be upheld. At the same time, the borrowers should be kept under a kind of peer pressure to repay the loan timely.

- There should be close and obligatory linkages among the BFRI, Bangladesh Agricultural University, Khulna University and the DOF to improve institutional linkage. Students of the universities should be allowed to use the ponds and laboratory facilities of the BFRI for their practical learning. The BFRI, on the other hand, should use more farmers' ponds for field trials of their technologies.
- Also, there should be close linkages among the public sector research and extension organizations, private sector entrepreneurs and NGOs for sustainable development and dissemination of fishery and aquaculture technologies.

Conclusion

Aquaculture has emerged as a dynamic subsector of the economy with a growth rate far in excess of other activities. The gradual shift of focus from self-consumption to market has led to the proliferation of aquaculture as an agribusiness activity. The size restriction imposed by a self-consumption activity has thus been lifted, and an opportunity to benefit from scale economies and division of labor has presented itself. The recent rapid growth of the subsector owes much to the transformation of aquaculture as a private agribusiness activity.

Aquaculture is basically a rural activity. Most of the poor people of the country are located in the rural areas. The expansion of employment, both self and hired, in aquaculture has brought substantial economic benefits for the rural poor. Gainful employment in aquaculture where productivity of labor is higher than in crop cultivation has increased their income. A large number of backward and forward linkage activities have emerged to service aquaculture. Many of these, especially the backward linkage activities, are also concentrated mostly in rural areas. They have also played a role in raising the economic profile of the rural poor. A dynamic aquaculture that has significantly raised income has also had spinoff multiplier effects on the rest of the economy through increased consumer and producer demand.

Aquaculture is still a small subsector accounting for only 5% of GDP. Much of the potential of the subsector remains unfulfilled. The water area under aquaculture can be increased two to three-fold with some initiative from the government and a workable lease policy of government *khas* waters. The yield rate of aquaculture, which is one of the lowest in the world, could be increased several fold through appropriate actions and policies of both the government agencies and the private stakeholders. Development partners can play a supporting role. With an enabling policy environment, the share of fishery in GDP could easily rise to more than 10%. Employment could also increase two or three-fold. Few other sectors can make as large an impact on the national economy at comparable cost. Given the imperative of increasing employment and reducing poverty significantly, such an opportunity should not be ignored. The government should treat aquaculture at par with other thrust industries, some of which have a lesser impact on poverty, to fully harness the growth potential of the economy.

Creating such a policy environment will require close collaboration among the relevant government agencies, as well as between them and the private stakeholders. Government *khas* land is controlled by several ministries and departments. A workable leasing policy would need the acquiescence and cooperation of all of them. Other policies, such as the provision of credit and other inputs, including education and training facilities, will also require interface among several ministries and departments. The private stakeholders, who will be the principal driving force of the subsector, as well as the development partners must also participate actively to ensure that the outcome is conducive to the unlocking of the full potential of aquaculture.

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Annexes

Table A1. Catch statistics of fisheries, 2003-2004.

Type of water body	Fish production	
	t	%
A. Inland capture		
1. Rivers and estuaries	137 337	6.53
2. <i>Sundarban</i> [*]	15 242	0.73
3. <i>Beels</i>	74 328	3.53
4. Kaptai Lake	7 238	0.34
5. Floodlands	497 922	23.69
Total	732 067	34.83
B. Marine capture		
1. Industrial fisheries (trawl)	32 606	1.55
2. Artisanal fisheries	422 601	20.10
Total	455 207	21.66
C. Aquaculture		
1. Ponds and ditches	795 810	37.86
2. <i>Baors</i>	4 282	0.20
3. Coastal shrimp and fish farms	114 660	5.45
Total	914 752	43.52

Source: DOF (2005).

Table A2. Costs and returns of fish and rice monoculture per hectare (double-cropped with Pajam and BRRI 29).

Variables	Double-cropped rice culture			Carp-based fish polyculture
	BRRI Dhan 29	Pajam	Total	
Gross return (Tk)	50 902	30 196	81 098	115 788
Gross cost (Tk)	40 897	26 877	67 774	61 342
Variable cost (Tk)	27 810	17 748	45 558	-
Gross margin (Tk)	23 091	12 448	35 539	-
Net return (Tk)	10 005	3 319	13 324	54 446
BCR	1.24	1.12	1.19	1.89
Labor use (person-days)	149	159	308	247
Labor cost (Tk)	13 642	11 828	25 470	18 594
Labor cost as % of total cost	33%	44%	37%	30%

Sources: Anik (2003); Rahim (2004); and Talukder (2004).

Table A3. Costs and returns of rice-fish culture (per hectare).

Items	Culture		
	Exclusive pond fish	Alternative rice-fish	Rice-cum-fish
Gross return (Tk)	153 908	166 110	171 731
Gross cost (Tk)	97 464	104 685	115 853
Net return (Tk)	56 444	61 426	55 877
Labor cost (Tk)	32 002	35 185	41 551
Labor cost as % of total cost	32.83	33.62	1.48
Benefit-cost ratio	1.58	1.59	1.48

Source: Akteruzzaman (2005).

Table A4. Profitability of shrimp-based cropping systems in coastal areas.

Particulars	Costs and returns per hectare			
	Alternate shrimp-rice farming	Alternate shrimp-salt farming	Year-round shrimp farming	Year-round rice farming
Gross return (Tk/ha)	107 235	247 165	125 005	44 760
Variable cost (Tk/ha)	28 470	58 367	32 277	15 062
Fixed cost (Tk/ha)	16 465	33 750	15 502	13 250
Gross cost (Tk/ha)	44 935	92 117	47 779	28 314
Gross margin (Tk/ha)	78 765	188 798	92 728	29 698
Net return (Tk/ha)	62 300	155 048	77 226	16 446
Human labor (person-days)	199	213	255	110
Human labor cost (Tk)	9 950	14 910	15 300	7 700
Human labor cost as % of total cost	22.14	16.18	32.02	27.20

Source: Miah (2001).

List of Acronyms and Abbreviations

ATDP 2	Agri-business Technology Development Project
BCR	benefit-cost ratio
BFRI	Bangladesh Fisheries Research Institute
BSFF	Bangladesh Shrimp and Fish Foundation
BWDB	Bangladesh Water Development Board
DOF	Department of Fisheries
FRSS	Fisheries Resources Survey System
GDP	gross domestic product
HACCP	Hazard Analysis Critical Control Point
I-PRSP	Interim Poverty Reduction Strategy Paper
MoFL	Bangladesh Ministry of Fisheries and Livestock
NGO	nongovernment organization
PL	post-larvae
PPP	public-private partnerships
Tk	Bangladeshi Taka
WorldFish	WorldFish Center



