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Bangladesh's Shrimp Industry and Sustainable Development: Resource-Use Conflict and the Environment

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Abstract

Shrimp culture plays a central part in the fisheries sub-sector in Bangladesh. Cultivation of shrimps experienced a spectacular boost over a period of a decade. This led to a significant change in the structure and composition of Bangladesh's export trade.

Through a network of backward and forward linkages, shrimp culture has created substantial employment on shrimp farms as well as an increase in ancillary activities such as trade/commerce, processing and marketing. However, the employment and export gains have been achieved at considerable costs. The present paper identifies these costs using a blend of primary and secondary data.

The process of shrimp cultivation epitomises conflicting resource-use patterns. Extensive shrimp-farming systems require more land than intensive ones. Given the extreme scarcity of arable land in Bangladesh, this threatens Bangladesh's ability to expand and sustain rice supply as well as salt production. Increased salinity and soil acidification as a result of shrimp culture are believed to have led to decreased rice yields. Furthermore, declining shrimp yields due to continuous use of the same land and use of chemicals are impediments to sustainable land-use in the shrimp belt with potentially serious implications on the sustainability of rural communities and their livelihoods. The adverse effects of shrimp culture on capture fisheries must also be taken into account.

Introduction

Shrimp culture is financially central to the fisheries sub-sector in Bangladesh. The fisheries sub-sector is of critical importance to the country's economy. Fish ranks next to rice as a staple food and constitutes about 80% of the animal protein intake. Fisheries accounts for 6% of GDP and 12% of export earnings and employs two million people on a full-time basis. An additional 10 million people are employed on a part-time basis (Ali 1991; see also Hamid and Alauddin 1997).

Shrimp cultivation experienced a spectacular boost from next to nothing in the early 1970s to become a major export earning industry by the mid-1980s. This represented a major change in the structure and composition of Bangladesh's export trade. Bangladesh is the seventh largest exporter of shrimp to the combined Japan and US markets even though Bangladesh accounts for only about 2% of this market with the four major exporters (Thailand, Indonesia, India and Ecuador) having a market share of 57% (ASCC 1995). The increase in exports is largely due to the effects of various

government policies and high demand for shrimp in other countries. The shrimp industry is influenced by a range of government policies and institutional arrangements, including subsidized credit, and leasing of government land for shrimp farming. Expanding shrimp cultivation consistent with ecologically sustainable development is a priority area identified by the government (MOF and FAO 1992; Rahman *et al.* 1995; Khalequzzaman 1996).

This paper provides a background on the shrimp sector. It also analyses the socio-economic and environmental implications of shrimp farming. Farm-level evidence is presented employing data from three areas in the greater Khulna region. The objective is to identify gainers and losers from prawn cultivation in terms of employment gain/loss resulting from shrimp cultivation, effects on the environment, income distribution, and possible conflicts between agriculture and aquaculture as well as conflicts of interests between landowners and shrimp farm owners.

Industry Background

This section provides an overview of the industry's background. It provides a general background and considers the role the shrimp industry plays in Bangladesh's foreign trade.

General Background

According to estimates of the Master Plan Organisation (MPO 1986), the total area under shrimp culture in Bangladesh is expected to increase from 96 048 hectares in 1990 to 135 000 hectares by the year 2005. According to Ahmed (1996), shrimp production increased from 4.4 thousand tonnes in 1983-84 to 28.3 thousand tonnes in 1993-94 with the expansion of culture area and improved management practices. At the same time, the area under cultivation increased from about 51 thousand hectares to 125 thousand hectares.

Although shrimp cultivation has great potential in some areas of Bangladesh, the current level of yield is very low. According to Mazid (1995), shrimp aquaculture is practiced mostly (75% of area) using extensive (traditional) and only occasionally (24% of area) using improved extensive (improved traditional) and semi-intensive technologies. Under the extensive method, the annual yield ranges from between 60 and 200 kilograms per hectare. Yields per hectare for the improved extensive and the semi-intensive techniques are 0.6-1.0 and 2-6 tonnes per hectare, respectively. On very rare occasions, intensive cultivation is practiced. Under this technology, yields can go as high as 5 to 10 tons per hectare (Mazid 1995; Ahmed 1996). Ahmed (1996) argues that although "the rate of production of semi-intensive system is higher than the extensive systems, the epizootic 'white spot' disease has been a major threat." This is reminiscent of widespread decline of shrimp production in Taiwan (see also Primavera 1991 for some evidence on the Philippines). Apparently, this casts doubt on the long term viability of intensive shrimp culture.

Rapid expansion of area under shrimp culture notwithstanding, what seems unclear is whether the government has considered the medium and

long-term effects of expanding shrimp cultivation on the environment. It is entirely possible that the likely environmental degradation and natural resource depletion following shrimp cultivation could outweigh the short and medium term gains of export-led growth (Rahman *et al.* 1995). Current national income is perhaps overestimated given that it does not account for the depletion and degradation of natural resources (Repetto *et al.* 1989).

Shrimp cultivation is almost exclusively concentrated in four districts, namely, Satkhira, Khulna, Bagerhat and Cox's Bazar. Figure 1 highlights the shrimp belt, with the percentage area under cultivation in each district. Over 70% of the total number of farms are located in the greater Khulna district (Satkhira, Khulna and Bagerhat), which accounts for 74% of the land area under shrimp cultivation and 77% of total output. The remainder of the farm area under cultivation and their output are almost entirely accounted for by Cox's Bazar. In the major shrimp producing areas, shrimp yields range from between 150 kilograms per hectare in Cox's Bazar and just over 200 kilograms per hectare in Satkhira.

Two types of shrimp farming systems predominate in the coastal belt in Bangladesh: (i) paddy cultivation alternating with shrimp culture in the Khulna region; and (ii) salt production alternating with shrimp cultivation in the Cox's Bazar region. According to Alauddin and Tisdell (1997) rice-shrimp farming in the Khulna region follow basically the same lines below:

Paddy is grown in the wet season.

In the dry season, after rice is harvested and the stubble removed, farms are flooded with brackishwater containing shrimp post-larvae from nearby waterbodies. They are then stocked primarily with shrimp fry caught from the wild and occasionally with hatchery bred ones.

Mature shrimps are harvested and the ponds are drained before the end of the dry season. The land is then prepared for the wet season rice crop. The cycle then repeats itself.

Shrimp in Bangladesh's Export Trade

This section records the changing structure and composition of Bangladesh's exports during the last two decades. Figure 2 (based on EPB 1991, 1992, 1996) presents the relative shares of shrimp, raw jute and readymade garments in the export market. Trends in relative shares of different categories of exports are also presented in Figure 2.

A careful inspection of the information given in Fig. 2 reveals that there is a progressive decline in the share of primary exports (raw jute and shrimp). This decline comes despite a significant increase in shrimp exports (which now contribute nearly half of the primary export items), suggesting a considerable decline in raw jute exports from over 80% in the early 1970s to only a third of the total primary exports in recent years. By implication, manufacturing exports have shown considerable growth (from about 60% to more than 80% of the total) over the same period. As for shrimp, its share of total exports grew from next to nothing in the early 1970s to more than 7% in the early 1990s. Its share rose to as high as 11% in the mid-1980s.

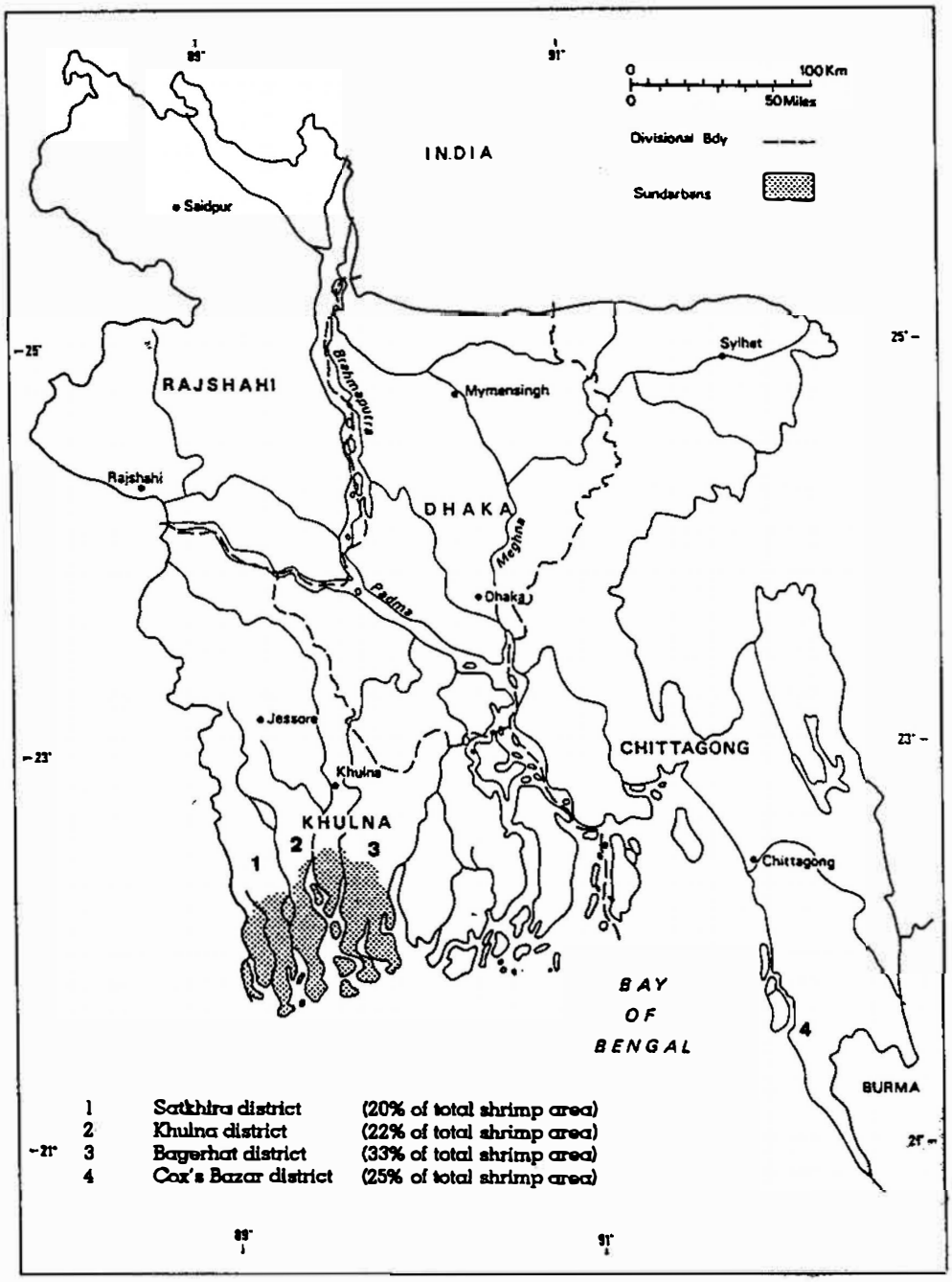

Fig. 1. Map of Bangladesh showing the four major shrimp growing districts with their contribution to the total shrimp area.

Thus, Bangladesh appears to have moved away from its traditional dependence on the export of jute-based items. A closer examination of the changes in the relative shares of the various broad components of the primary exports indicates that while the share of raw jute export has continuously declined, that of shrimp has increased quite considerably. By the second half of the 1980s shrimp exports (by value) surpassed raw jute in relative importance. On the other hand, after considerable fluctuations and a somewhat increasing

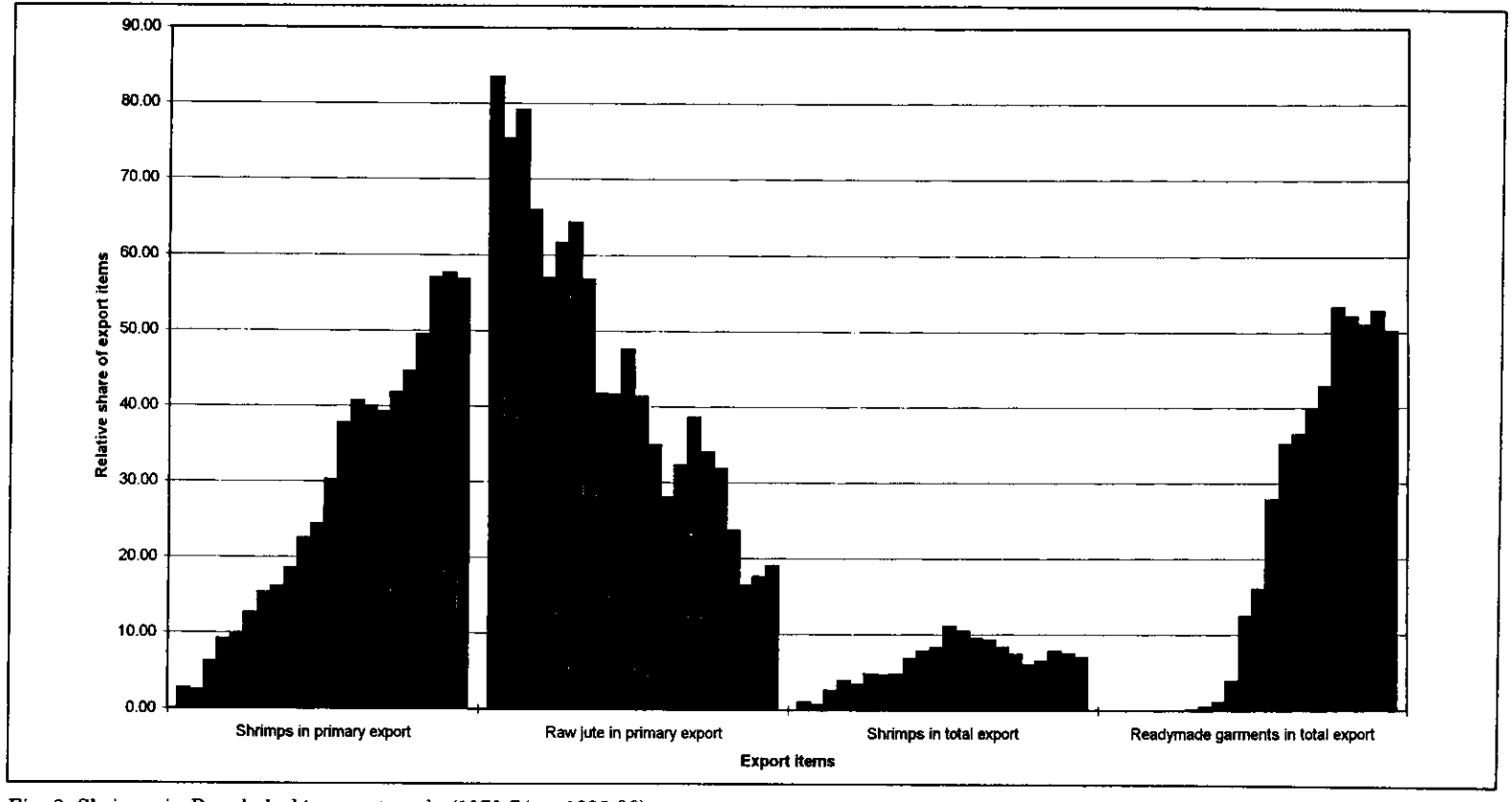

Fig. 2. Shrimps in Bangladesh's export trade (1973-74 to 1995-96).

tendency up until the early 1980s, the remaining items in this category have declined and stabilized to about a quarter of total exports in the last few years. Thus, shrimp has replaced jute as the dominant export item in the primary goods category.

Socio-Economic and Environmental Implications: The Broad Picture

Large-scale shrimp farming is a relatively new phenomenon in Bangladesh. There have been earlier studies that dealt with resource availability and production potentialities of brackish-water aquaculture operation. Cook and Schmidt (1979) described the production process, and size and ownership of shrimp ponds in the coastal areas of Bangladesh. Islam (1983) presented the growing conflicts between rice farming and shrimp culture in the Khulna region. Some later studies (Chowdhury 1988; Das 1992) identified problems of decreasing yield of paddy and salt in Khulna and Cox's Bazar due to shrimp cultivation. These studies showed the distribution of gains from shrimp culture to be uneven.

For the purpose of this paper, sustainability is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs..." (WCED 1987). The process of agricultural development has led to environmental changes which has undermined the sustainable livelihood of people in many less developed countries (LDCs), including Bangladesh (Ahmed and Doelemean 1995; Alauddin *et al.* 1995; Alauddin and Tisdell 1997).

The analytic literature on shrimp culture in Bangladesh to date concentrates on the socio-economic aspects by emphasizing the social and economic background of the different groups affected by the process of shrimp farming: shrimp-farm owners (or gher) owners, land owners and landless labourers. These studies provide useful insights into the sociology of the relevant rural society and useful pointers to the resulting income distribution pattern. A recent study (Nijera Kori 1996) documents displacement of small and marginal farmers, increasing landlessness and gross human rights violations as problems resulting from the process of shrimp farming.

However, there has been little discussion of the effects of environmental changes using rigorous analytical techniques [e.g. Ali (1991), Chowdhury (1988)]. Rahman *et al.* (1995) correctly identified important environmental problems associated with shrimp cultivation but, like many earlier studies, did not analyze their effects on the sustainability of shrimp farming. While suffering from the limitations mentioned above, the available literature does identify (1) uneven gains between gher owners and land owners; (2) the environmental effects of shrimp culture resulting in declining rice yields; (3) loss of green vegetation; (4) increased salinity; and (5) decline and loss of indigenous species of fish.

The environmental consequences of the process of shrimp farming generate external effects or externalities. These effects result from unintended interdependencies among economic decisionmaking units (Common 1988). Externalities

may either be favorable or unfavorable depending on the perspective of the affected party.

This can be explored further by considering some external effects of shrimp farming. While shrimp farmers profit from the activity, the collateral damage inflicted on the environment (resulting in loss of/decline in green vegetation and indigenous species of fish and other aquatic life as well as increased salinity) could be substantial. The full costs of production due to shrimp culture include increased environmental rectification costs which the society is called upon to bear. These represent side effects of the process of shrimp culture, for which producers are not charged and hence are able to ignore. Thus, the deterioration of environmental quality due to shrimp culture is an external effect and hence the process entails external costs. The implication of this is the divergence between private costs (the ones borne by the producers) and social costs (actual costs = private costs + external costs). As a consequence of producers ignoring the external costs, their output level is not consistent with the one necessitated by efficiency in resource allocation. This is illustrated in Fig. 3. The shaded area ABC represents the deadweight loss to the society as a result of production (OQ_1) above the socially optimum level (OQ^*) or as a result of the utilization of resources over and above the socially desirable level. It would have been interesting to estimate the extent of this loss due to shrimp culture in Bangladesh. But data limitations preclude this possibility. Nevertheless, it indicates the existence of social loss consequent upon shrimp culture in Bangladesh.

Farm-Level Evidence

Rahman *et al.* (1995) argue that despite the destruction of mangroves in Chakaria (Nijera Kori 1996), environmental degradation is relatively less pronounced in the Cox's Bazar region than in the Khulna region. Partly because of this and partly because of the longer history and greater relative importance of shrimp culture in the Khulna region, the present study relies on primary data from this region. Employing direct questionnaires, farm-level data were collected The field work was conducted from Dec 1992 to Mar 1993 in the coastal region of greater Khulna district. Primary data were collected from more than 500 households in three different categories: shrimp farm (gher) owners (107), landowners (262) and landless labourers (216). These are analyzed in detail by Alauddin and Tisdell (1997) and Alauddin and Hamid (1996). The following sections present in brief some of the main findings.

Data Analysis for Gher Owners

In general, gher owners do not own the land under shrimp culture. They only lease it from landowners for a specified period of time, paying rent that varies across regions (Fig. 4). The duration of agreements between landowners and gher owners ranged from 1 year to 7 years with an average of 4.35 years and a modal value of 5 years. Depending on the contractual arrangements (whether the landowner had the right to an annual lease fee, a combination of

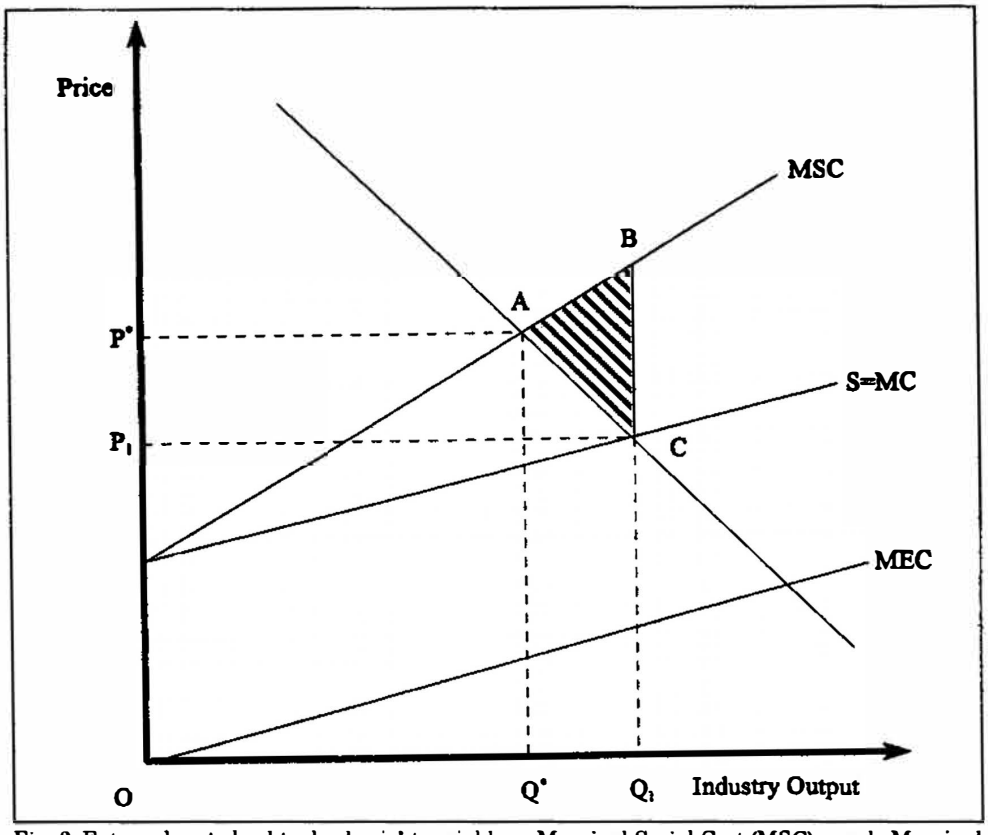

Fig. 3. External costs lead to deadweight social loss. Marginal Social Cost (MSC) equals Marginal Cost + Marginal External Cost. (MC + MEC). Socially optimal output is OQ*. Profit maximizing output is OQ1.OQ1>OQ*. Deadweight loss is represented by the area ABC.

annual lease fee and a share of the crop, or the crop only), the fee varied from zero taka to 15000 taka per hectare, the average being 6300 taka per hectare (US$ 1=45 taka approximately). In the sample, it was found that many of the gher owners practiced shrimp aquaculture on their own land.

Many of the gher owners are based in urban centers and, for many of them, shrimp culture represents no more than a side business. They have resources at their disposal and wield considerable socio-political power in the local community. Even though a majority of the gher owners in the sample did not reveal their political identity, those who did have affiliations with the major political parties, particularly the party in power at the national level. However, most of the gher owners in the sample revealed having readier access to and influence over the higher echelons of the local (regional) administration and law enforcement agencies.

The gher owners were asked various questions about the impact of shrimp farms. These include, among other things, whether the local community has had improved economic conditions after gher and the adverse effects of shrimp farming on the environment, e.g., on green vegetation and indigenous fish.

Almost all of the gher owners suggested that shrimp farming has had a favorable impact on the economic condition of the community in general. This was further analyzed using discriminant analysis for gher owners on groups

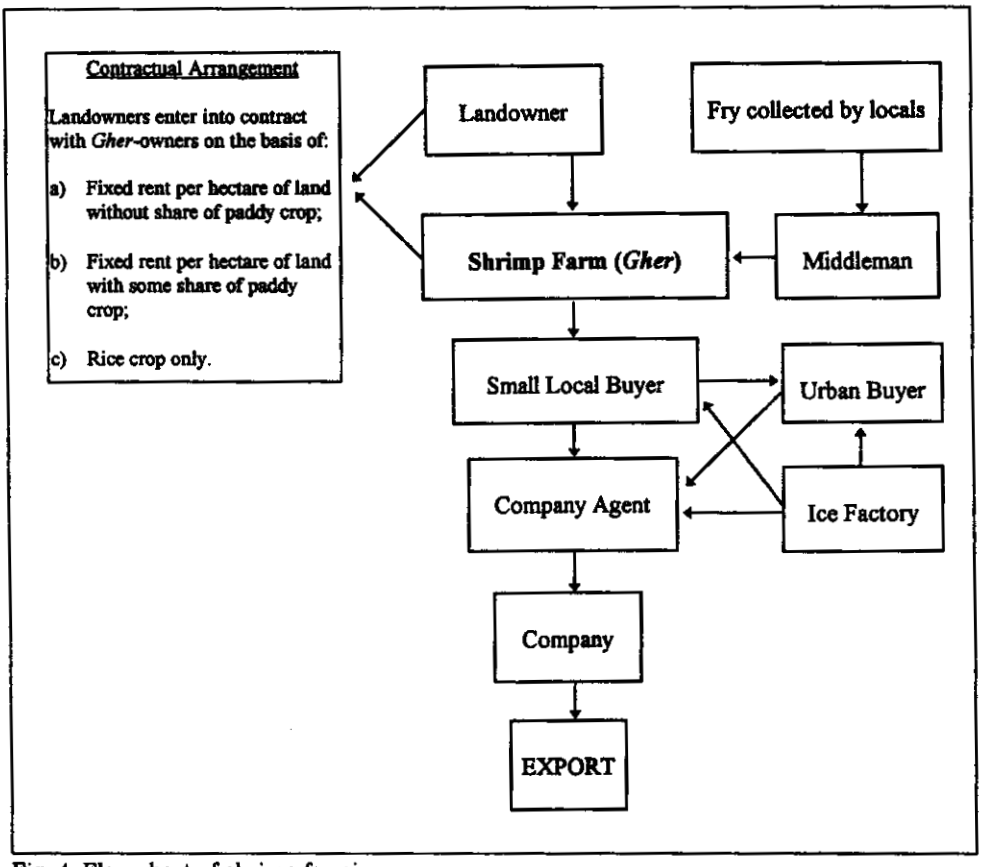

Fig. 4. Flow chart of shrimp farming.

defined by a dichotomous variable. The discriminant function was estimated to identify the variables that differentiate the groups of respondents (for further details see Alauddin and Tisdell 1997). A stepwise run of discriminant analysis identified employment as the variable discriminating between those who reported an improvement and those who reported a deterioration in economic condition following shrimp cultivation. The standardized canonical discriminant function coefficient was 1.0 with a Wilk's lambda value of 0.7327. The coefficient was highly significant at 0.001% level of significance (Alauddin and Tisdell 1997). Thus, increased employment was synonymous with improved economic conditions.

Results indicate that while these recorded employment and export gains seem highly impressive, they have been achieved at considerable costs. These costs relate to environmental and ecological problems in the form of loss of green vegetation, loss of genetic diversity (loss or extinction of indigenous species of fishes) and declining rice yields in shrimp farms. Employing the t-test for paired samples confirmed that there was a significant decline in rice yields in the post-gher phase compared to the period preceding shrimp cultivation. Also, rice yields on farms not used for shrimp production were significantly higher than those on farms used for this purpose. As reported in Alauddin and Tisdell (1997) for the paired variables rice yields on and off ghers, the t-values were 13.42, 10.59 and 15.26, respectively, for 1990, 1991 and 1992. For paired

variables rice yields pre- and post gher periods, the corresponding t-values were 5.67, 5.63 and 5.55, respectively. All the t-values were significant at 0.001% level.

Data Analysis for the Land Owners

In contrast to the distribution of ownership of the ghers, land distribution is dominated by a very large number of small owners. Nearly 60% of the farms are below 2 hectares in size. Many of these landowners (about 47%) have their entire land resource within the ghers. About 34% of the landowners have up to 50% of their land within the ghers while the remaining 19% of the landowners have between 50% and 99% of their entire land leased out for shrimp cultivation.

In conformity with the discriminant analysis for gher owners we conducted discriminant analyses for landowners divided into groups according to economic condition, increased employment, percentage share of ownership in the gher land rent per hectare annually payable to the landowner by the gher owner as the discriminating variables that separated the group of respondents reporting improvement in their economic well-being and the one that reported to the contrary. The same procedure was repeated to identify variables that separated landowners on the basis of their attitude toward continuation of shrimp farming on their land. The two variables that differentiated the two groups (those in favour and those against shrimp continuation of shrimp farming) were rent and percentage share in the shrimp farm (further details are provided in Alauddin and Tisdell 1997).

It could be inferred from the above that employment is the key factor separating the two groups categorized by perceived improvement or deterioration in economic well being. Annual land rent and percentage share in gher are the other two discriminating variables that differentiate between the groups classified by economic condition and attitude toward continuation of ghers. The results of the discriminant analysis suggest that the standardized coefficients of canonical discriminant function were significant at 0.001% level. Thus, share in the gher, amount of rent received and employment generation seem to be critical determinants of landowners' perception of the impact on their economic condition as well as their attitude towards the continuation or otherwise of use of land for shrimp cultivation.

Results of the t-test for paired samples on the differences in paddy yields on and off shrimp farms as well as pre- and post-gher phases for landowners clearly support the view that paddy yields on shrimp farms are significantly lower than those off the shrimp farms. The same conclusion applies to the paddy yields in the pre- and post-gher periods. This pattern is consistent with the results discussed earlier on the samples from gher owners. These results are statistically significant at 0.001% level of significance (Alauddin and Tisdell 1997).

Data Analysis for the Landless

For the purpose of this study, landless are defined as the ones owning 0.25 hectares of cultivable land or less. About 60% of the landless in the sample

seemed to have experienced an improvement in their economic condition since the introduction of shrimp farming in their area while the remaining 40% had experienced the contrary. The process of shrimp cultivation has had a significant impact on the incomes of the landless in the survey area (see Alauddin and Tisdell 1997).

Some Further Observations

Shrimp cultivation, through a network of backward and forward linkages, has created substantial employment in shrimp farms as well as in ancillary activities like trade/commerce, processing and marketing. In 1983, it was estimated that 4.1 million person days of employment were created on-farm for 51 000 hectares of shrimp farms in the coastal areas of Bangladesh. Off-farm employment was 5.1 million person days. As of 1988-89, shrimp farming had been extended to 108 000 hectares with a total on and off-shrimp employment of about 22.2 million person days (Ali 1991). While these recorded employment and export gains seem highly impressive, they have been achieved at considerable costs. Our findings indicate: (i) uneven gains between gher owners and land owners especially the small land owing households, (ii) adverse environmental spillovers in the form of loss of green vegetation (vegetables, coconut trees, bamboo plantation), loss of genetic diversity (loss or extinction of indigenous species of fishes), and declining rice yields and (iii) increased employment opportunities off the shrimp farms - overall increase in employment. These findings are consistent with those of Mazid (1995), Rahman *et al.* (1995) and Nuruzzaman (1992, 1994a, 1994b, 1995).

In case of any ecological or environmental disasters resulting from shrimp farming, those who have the least to lose are the shrimp farm owners who often are not the owners of the land under shrimp culture. In sum, shrimp farm owners represent a very powerful class of people who can easily accumulate funds in other occupations in urban locations. In the event of their being forced to quit shrimp farming leaving a legacy of environmental crisis behind, they can adjust easily in an economic sense.

In contrast, those with the most to lose from any possible irreversible damages to the environment are primarily the landowning and the landless households. For these two classes of people the land and water-based activity i.e. agriculture and related activity, subsistence fishing represent major occupations. According to a recent study (Nijera Kori 1996), at the beginning of the process, the landless were the most adversely affected party. However, they engaged in fry catching and other fringe jobs. Subsequently, the small landholders were the worst affected.

World Bank (1991) estimates indicate that over 10 million people are engaged in subsistence fishing in Bangladesh. To quote one important study "A vital aspect of the subsistence fishing is its role in cushioning poverty. The significance of the small miscellaneous fish species as distinct from the principal commercial species - is that the 'miscellaneous species' constitute the main part of the catch in the subsistence fishery and as such are a key resource for the rural poor. They can be seen as poor people's fish and their economic and

nutritional value for rural poor people must not be underrated, though they are of less commercial significance" (ODA 1990).

Even though shrimp cultivation and ancillary activities have provided employment and income gains for these groups of households, they may have been achieved at the cost of the future. Thus, it is at odds with the concept of sustainable development as defined in WCED (1987).

Shrimp farming has had a significant impact on the economy of Bangladesh in terms of its contribution to export earnings and employment generation on and off-farm through a series of backward and forward linkages. However, this process has entailed high environmental costs, including the destruction of mangrove forests and reduction of crop production (especially paddy) and green vegetation. The process of shrimp cultivation therefore epitomises conflicting resource-use patterns. It has also set in motion socio-economic changes. All these may have serious implications for sustainability of shrimp farming itself, of rural livelihoods and of communities in the coastal belt of Bangladesh.

Concluding Observations

Both rice and shrimp farming are of enormous significance to the economy of Bangladesh. Rice is the staple food while shrimp is an important export item and has created significant volume of employment, including employment for women (Hamid and Alauddin 1997). This notwithstanding, there are costs that need to be taken into consideration in any assessment of the sustainability of the rice-shrimp farming systems. The costs include (1) environmental degradation resulting from conversion of mangroves into shrimp farms, increased salinity, dumping of pond effluent and use of chemicals affecting neighboring ecosystems, and loss of bio-diversity, (2) declining production/yield of rice and other crops and (3) greater income polarization. All of these impact on the sustainability of livelihoods and on the sustainability of rural communities.

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References

Ahmed, A.T.A. 1996. "Policy guidelines for management of coastal shrimp culture development", A paper presented at the World Aquaculture '96 Conference, Bangkok, January 29- February 2, 1996.

Ahmed, I. and J.A. Doeleman (eds.). 1995. Beyond Rio: The environmental crisis and sustainable livelihoods in the Third World. Macmillan Publishing, London.

Alauddin, M. and M.A. Hamid. 1996. Economic, social and environmental implications of shrimp farming in Bangladesh: An overview of issues and agenda for research. In: (eds. M. Alauddin and S. Hasan) Bangladesh: Economy, People and the Environment, pp. 301-22.

Alauddin, M. and S. Hasan (eds). 1996. Bangladesh: Economy, People, and the Environment. Economics Conference Monograph Series 1, Brisbane, Queensland: Department of Economics, The University of Queensland.

Alauddin, M., M.K. Mujeri and C.M. Tisdell. 1995. Technology-environment-employment linkages and the rural poor of Bangladesh: Insights from farm-level data. In: (eds. I. Ahmed and J.A. Doeleman) Beyond Rio: The environmental crisis and sustainable livelihoods in the Third World. Macmillan Publishing, London. pp. 221-56.

Alauddin, M. and Tisdell 1997. The environment and economic development in South Asia: An overview from Bangladesh. Macmillan Publishing, London.

Ali, M.Y. 1991. Towards sustainable development: Fisheries resources of Bangladesh. Bangladesh Ministry of Environment and Forest and National Conservation Strategy Secretariat, Dhaka.

ASCC 1995. Asian Shrimp News, Third Quarter, Issue No. 23. Asian Shrimp Culture Council, Bangkok.

Chowdhury, M.A.M. 1988. Socio-Economic Consequences of Shrimp Cultivation in Bangladesh: A Case Study of Satkhira, Chakaria and Maheshkhali. Bangladesh Journal of Public Administration 2(2):49-76.

Common, M. 1988. Environmental and resource economics: An introduction. Longman, London.

Cook, N.L. and V.W. Schmidt. 1979. Shrimp culture for small-scale fishermen in Bangladesh: Report of a mission to study the feasibility of involving small-scale fishermen in shrimp culture in Bangladesh. Aquaculture Development and Coordination Programme, FAO.

Das, R.K. 1992. A study on social and economic aspects of shrimp prawn cultivation in Bangladesh. Master of Agricultural Science Thesis in Agricultural Economics. Bangladesh Agricultural University, Mymesingh.

EPBB 1991. Export from Bangladesh 1972-73 to 1991. Export Promotion Bureau, Dhaka, Bangladesh.

EPBB 1992. Bangladesh export statistics 1991-92. Export Promotion Bureau, Dhaka, Bangladesh.

EPBB 1996. Export from Bangladesh 1972-73 to 1995-96. Export Promotion Bureau, Dhaka, Bangladesh.

Hamid, M.A. and M. Alauddin. 1997. Coming out of their homesteads? Employment for rural women in shrimp aquaculture in coastal Bangladesh. International Journal of Social Economics 25(2-4):314-317.

Islam, A. 1983. A report on aquatic culture in Bangladesh. Fisheries Information Bulletin 1(2).

Khalequzzaman, A.R.M. 1996. Upakuliyo Elakai Chingri Chash ebong Sarkari Neetimala (in Bengali), Cox's Bazar.

Mazid, M.A. 1995. Bangladesh, country paper. In: FAO/NACA Regional Study and Workshop on the Environmental Assessment and Management of Aquaculture Development (TCP/RAS/2253), NACA Environment and Aquaculture Development Series, No. 1: Network of Aquaculture Centres in Asia-Pacific, Bangkok, p.61-82

MOF and F.A.O. 1992. National Fishery Development Programme. TSS-1 Fishery Sector Programming Mission to Bangladesh, Rome: Ministry of Fisheries and Livestock, Bangladesh and Food and Agriculture Organisation of the United Nations.

MPO 1986. Final report (Vols. I-III). Master Plan Organisation, Dhaka.

Nijera Kori. 1996. Profit by destruction, International Workshop on Ecology, Politics and Violence of Shrimp Cultivation, Dhaka; Nijera Kori.

Nuruzzaman, A.K.M. 1992. The socio-economic importance of mangroves to coastal environments in Bangladesh, A Paper presented at the Workshop on Coastal Zone Management in Bangladesh, 30 November - 4 December, Dhaka, Bangladesh.

Nuruzzaman, A.K.M. 1994a. Loss of biological diversity and conservation measures. Bangladesh Agricultural Research Council, Dhaka.

Nuruzzaman, A.K.M. 1994b. Environmental issues on aquaculture development in Bangladesh. Bangladesh Agricultural Research Council, Dhaka.

Nuruzzaman, A.K.M. 1995. Some critical issues for sustainable floodplain fisheries development in Bangladesh. Bangladesh Agricultural Research Council, Dhaka.

ODA. 1990. Report and recommendations of the ODA Fisheries Project Identification Mission to Bangladesh under Fisheries and Flood Action Plan, March 3 - May 1, ODA, London.

Primavera, J.H. 1991. Intensive prawn farming in the Philippines. Ambio 20(1):28-33.

Rahman, A., A. Islam, I. Roy, L. Azad and K.M. Islam. 1995. Shrimp culture and environment in the coastal region. Bangladesh Institute of Development Studies, Dhaka.

Repetto, R., W. Magrath, M. Wells, C. Beer and F. Rossini. 1989. Wasting resources: natural resource in national income accounts. World Resources Institute, Washington, D.C.

World Commission on Environment and Development. 1987. Our common future. Oxford University Press, Oxford.

World Bank 1991. Bangladesh: Fisheries Sector Review, Report # 8830-BD. World Bank, Washington, D.C.

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