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Cured Fish in Bangladesh
Report on a visit to Bangladesh,
November 1990, on behalf of ODA
Post-Harvest Fisheries Project,
Bay of Bengal Programme, Madras, India.

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SUMMARY

This report is based on a three week visit to Bangladesh in November 1990 by David Walker (Fish Processing and Infestation Technologist) and Martin Greeley (Marketing Economist) to examine the incidence of insect infestation in cured fish and report on both the technical and economic features of current insect control methods including the potential for improved post-harvest practices. The assignment was made on behalf of ODA for the Bay of Bengal Programme (BOBP) and included a debriefing visit to BOBP, Madras. In Bangladesh, the team included two local counterparts - S H Shamim, a socio-economist from a local research organisation, UBINIG, and Md Kador Ahmed an Inspector from the Chittagong Quality Control Office of the Department of Fisheries. The team made visits to cured fish production sites at Cox's Bazar and on islands in the Bay of Bengal including Sonadia, Dubla and Afatia Char. They observed production of cured fresh water fish in villages in Sunamganj district. They visited retail and wholesale markets in several towns including visits on three days to the major wholesale market for cured marine fish at Asadganj, Chittagong. These visits provided the opportunity to observe directly the problems of blowfly and beetle infestation and to discuss control practices with workers, managers, traders and entrepreneurs within the cured fish industry. In addition to the Ministry of Fisheries the team also visited a number of public sector agencies involved, *inter alia*, in research on or regulation of the Bangladesh fisheries. In practice there has been very little research or regulation of the cured fish industry. Indeed, there is not a comprehensive descriptive account of the location, organization and scale of cured fish production in Bangladesh. This is the justification for this report to include a fairly basic description of cured fish production in Bangladesh prior to discussion of insect infestation problems and controls. Many gaps remain in this description because of the lack of data on most aspects of the industry including the output levels for each product type; exported jewfish excepted.

Beyond this general appreciation of the cured fish industry, the main focus of our visits and of this report is on control of insects and of possible project opportunities in this area. Our findings are that insect loss control practices being employed seem relatively effective and are economically beneficial given the sensitivity of price to quality. However, in some cases e.g. the non-approved use of DDT - current practice is

potentially hazardous to the health of consumers with high measured residue levels in samples of cured fish purchased in the wholesale and retail market. There is very widespread use of dichlorvos, an insecticide similarly not approved for use on fish but there is some doubt whether a health hazard exists. Research on the potential hazards constitute the main recommendations of this mission and specific proposals have been incorporated in this report. Otherwise, no specific interventions are proposed. The socio-economic discussion highlights the difficulties of targeting project interventions to the benefit of the poor. Given the structure of economic interests in the cured fish industry, long-term programmes of human resource development and local institutional strengthening are necessary prerequisites for effective poverty alleviation programmes.

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1. INTRODUCTION

This study was undertaken on behalf of the ODA Post-Harvest Fisheries Project of the Bay of Bengal Programme for Fisheries Development (BOBP), as a component of the Fisheries Extension Development Sub-Project in Bangladesh. It was a direct response to a request, made by the Joint Secretary for Fisheries, Bangladesh, at the 1990 Advisory Committee Meeting of BOBP, for the Project to evaluate the problems of insect infestation of cured fish.

Such a request was directly in line with the Project's remit to improve fish utilisation and reduce post-harvest wastage in the region. The terms of reference for the study are given in Appendix 1.

There have been no previous comprehensive field studies of the cured fish sector in Bangladesh, hence the initial requirement was to collect primary data. Accordingly, visits were made to what were believed to be the principal production and processing areas. Additionally, secondary sources of information were sought wherever possible.

The team visited the coastal locations of Dubla Island in the Sundarbans region of Khulna district, Afatia char and Rangabali in Patuakhali district, Sonadia Island, Cox's Bazar and Chittagong in Chittagong district, and the inland districts of Sunamganj and Sylhet in the north east. Full details of universities, government departments, and institutes visited, together with staff met, are given in Appendix 2. Many fishermen, processors, traders and consumers were interviewed in depth.

The report is presented in nine sections. There is an initial description of the cured fish industry outlining the major classifications of the contributory fisheries followed by details of gear, catch and seasonality. The post-harvest practices, with a focus on the insect infestation, are described in full. This is followed by details of the economics and marketing. A full appraisal of the control of insects infesting fish precedes the technical assessment and socio-economic discussion. The report concludes with the recommendations for further actions arising from the study.

2. CURED FISH PRODUCTION IN BANGLADESH

2.1 Broad Structure of the Industry

The cured fish industry in Bangladesh appears to be substantial but its technical and economic features are poorly surveyed and documented. Even rudimentary production figures for cured fish are not available. Best guesses suggest that cured fish constitutes some 5 to 15 per cent of total fish production (of over 800,000 tonnes in 1987-88 according to the Fisheries Resource Survey), although estimates of 30 per cent, even 40 per cent for specific regions, have also been offered by some authorities. Some evidence, fragmentary and unreliable, concerning location, scale, catch composition, gear, processing and marketing can be pieced together from various fisheries sector reports, notably from FAO/BOBP commissioned work. Much of this literature is listed in Appendix 3; these sources, together with field visits to production areas in November 1990 - see Appendix 2 for details - were the basis for the following description and analysis.

In Bangladesh cured fish production involves both freshwater and marine. Freshwater fish are sun-dried during the dry winter months in the *haor* (floodplain) areas of north central and north eastern Bangladesh - notably in Netrakona and Sunamganj districts. They are also produced from Kaptai Lake and the greater districts that were previously known as Dhaka, Faridpur and Comilla. In other regions commercial curing of freshwater fish is not on a significant scale.

Fish from marine and estuarine catches are produced predominantly in winter by sun-drying. The main producing areas correspond to the seasonal set-bag net fishing areas (Appendix 6). The major concentrations of production are on the islands near the coast, particularly Dubla, near the Sundarbans, and Moheskali and Sonadia near Cox's Bazar. The predominant dried products are ribbon fish (*Trichiurus* spp.), pomfret (*Pampus* spp.), and Bombay duck (*Harpodon nehereus*). Miscellaneous small fish contribute greatly to the total volume. Sun-dried marine fish are the dominant product in the Bangladesh cured fish industry.

A sub-sector of the marine cured fish industry is the processing of jewfish (*Otholithoides microdon*) for export mainly to Hong Kong. This salting and sun-drying industry is centred on Cox's Bazar where there is also a curing industry producing mainly for the local market in which

small sharks are the dominant species.

There is an important sub-sector concerned with the production of salted hilsa (*Hilsa ilisha*), chiefly from the marine catch. A further, small, sub-sector produces smoked shrimps throughout the year in some estuarine areas in Khulna division. Finally, there is also a small fish-meal industry producing for the larger-scale poultry enterprises.

The production and marketing structure closely parallels the structure for fresh fish, with the addition of a processing stage. In the main producing areas processing is undertaken by specialised groups - independent of the fisheries - mainly employed on a wage labour contract, by the merchants (*sowdagars*) who buy fish on the shore-line, dry it and sell it in the Chittagong wholesale market. Typically, much of their working capital will have been provided by commission agents (*aratdars*) based in the Chittagong wholesale market for cured fish at Asadganj. Capital investment in processing is modest; the main expenditure is the use of working capital to buy fresh fish. Insecticides are purchased both to control blowfly infestation of drying fish, most commonly in cloudy weather, and as a matter of standard practice for fish which are larger and slower to dry. They are also purchased for the control of beetle infestation of dried fish.

In the greater Chittagong region dried fish is a regular, often daily, item of food consumption. From this substantial minority of the population there is a strong demand across all expenditure groups. However, most people in Bangladesh are occasional consumers. For the poor a little dried fish goes a long way - it provides a means to add some taste to a boiled rice meal as well as providing a source of protein. For less poor households it is an occasional, sometimes seasonal, purchase. The frequency of purchase can vary enormously, being dependent on personal consumption preferences. In general, it is only a minority, especially Chittagonians, for whom dried fish is a dietary staple. There is a strong consumer preference for freshwater fish which is readily available in most regions and in most seasons.

2.2 Cured Fish Production

There are four principal production groups: sun-dried marine fish; sun-dried river, *haor* and lake fish; salted hilsa; and smoked shrimp. There is no hard evidence available on the relative size of these four groups but

field visits, market visits, interviews with informants and information in reports would suggest that the sun-dried marine fish are easily dominant. Some inferences can be drawn about sun-dried marine fish production based on information about catch, composition, and gear. Such information is published annually, by the Department of Fisheries, in the Fish Catch Statistics of Bangladesh.

We assume that, as field visits suggested, the set-bag net (*behundi jal*) is the principal source of marine fish for curing. The 1987-88 estimate of set-bag net production is 63,000 tonnes out of a marine catch of 228,000 tonnes and a total catch of 827,000 tonnes in Bangladesh. However, this catch is divided between seasonal (45,000 tonnes) and all-season (18,000 tonnes) set-bag net operations. The principal source of dried fish is from the seasonal nets; the all-season nets include a high, although unknown, proportion of catch which is marketed fresh.

Further information is available from a number of surveys of the set-bag net catch. Islam (1967) undertook the first survey. His study concerned the set-bag net fishery of Sonadia, Moheskali, and Kutubdia islands near Cox's Bazar. Field survey methods are not described but he estimates a total production of 5,300 tonnes from 100 fishing units each with two boats and four nets fishing for 100 days over the season with a daily catch per net of 132 kg. Islam further assumes that all of this catch is dried at a ratio of 4:1. In 1966-67 the total marine catch was estimated at 81,000 tonnes.

Another survey of the set-bag net was undertaken in 1983 (FAO 1985a and 1986c). This used a three per cent sample based on a 1967-68 census of coastal fishing villages, although, in the course of the survey, several other, perhaps new fishing villages were identified in the sample area. The survey identified three major off-shore fishing grounds (Dubla, Sonadia and Sonar Char) for sample survey as well as 51 coastal fishing villages. Based on an analysis of these results, and using information from the earlier census it was estimated that there were nearly 16,000 set-bag nets operating in 1983. The survey involved the measurement of 224 nets which were classified as large, medium or small. The large nets accounted for only 25 per cent by number of nets but, according to survey results, accounted for nearly 64 per cent of the catch. Also, the large nets were predominant in the three coastal fishing grounds which had a fifth of all nets and were seasonal in production - on average 90 fishing days during September to March. Small and medium

nets were found mainly in the coastal villages that fished all year round but produced sun-dried fish in winter. Total output was estimated at 72,000 to 83,000 tonnes. For that year, this is considerably more fish than reported in the official catch statistics and clearly suggests that the official figures may be an underestimate. Official figures for each net size in 1984 indicates a total set-bag net production of only 60,000 tonnes of which only 58 per cent comes from the large seasonal off-shore set-bag nets (Shahidullah, 1985).

One reason for such an underestimate could be the fact that the Forestry Department is responsible for the catch statistics for much of the set-bag net fishery, notably in the Sundarbans and Dubla. Statistics are based on revenue receipts from taxes of "forestry" products; there is material incentive, and considerable scope, for under-reporting both the volume of fish and the revenue received. FAO (1976) indicates that the Forestry Department estimate for Dubla may be only a quarter of the actual catch.

A further noteworthy observation from this survey is the estimate of over a three-fold increase in the number of set-bag nets since the 1967-68 village census. The distribution of these by size is not recorded. However, a comparison of these survey results for Sonadia with those of Islam (1967) indicates a growth in cured fish production of over 30 per cent, or nearly two per cent compound growth annually. This is based on a similar yield (140 kg as opposed to 132 kg per net per day), fewer fishing days (90 compared to 100) but 550 nets compared to 350. Comparing estimates of the number of set-bag nets for Dubla in FAO (1976 & 1982) and Anon (1977?) with the estimate given by the 1983 survey of 2248 set-bag nets on Dubla suggests that growth in the industry may have been much faster at Dubla than at Sonadia. However, the earlier reports were not based on sample surveys.

Trials in 1987 near Sonadia, (FAO, 1987c), showed a catch rate of over 180 kg per net per day based on 114 observed hauls. It is possible therefore that the earlier results are still underestimates of total seasonal production from these off-shore fishing grounds, although it must be recognised that yields vary considerably over the season and these later results were based on only four days sampling.

These figures of set-bag net production could only directly confirm estimates of dried marine fish

production if there was a perfect correspondence which of course there is not. Firstly, other gears are also used to catch species which are dried. FAO (1987c) indicates that sardine-like fish (Clupeidae), which are often dried, were important in fixed gill-net catches in estuarine localities in Patuakhali and Chittagong. The results also showed that over seven per cent of the set-bag net catch at Sonadia consisted of shrimp, much of which would enter the frozen export trade. However, putting together the catch composition data from 1987 with the 1983 surveys on the number of set-bag nets does allow some broad indication of the likely size of the industry in the mid 1980s. These suggest that over 90 per cent of the marine set-bag net catch is sun-dried i.e. a total volume of 65,000 to 75,000 tonnes fresh weight. It is difficult to express this as a percentage of total production because the FAO survey gives a set-bag net catch which is larger than official figures. If underestimation is consistent across all net types and if the winter season catch of fish by small and medium nets is also 90 per cent dried then this would suggest that over 20 per cent of all marine fish caught are sun-dried; this corresponds to nearly five per cent of all fish caught - marine and freshwater. This is a very uncertain estimate; for example, the catch composition survey results (FAO, 1987c) for large set-bag nets in Teknaf (south of Cox's Bazar) show that 75 per cent of the catch there is shrimp and other invertebrates which are not sun-dried. Before a total estimate of cured fish can be produced the three other categories listed above and the jewfish production need to be included. Only for the last of these are there any production figures.

Jewfish caught on longlines are separately detailed in the official statistics. There was a recorded increase of 100 per cent from 1985-86 to 1987-88 to over 6,000 tonnes. Most of this catch is salted and sun-dried for export, principally to Hong Kong. Smaller quantities of other dried fish, both marine and freshwater, are exported to South East Asia, the Middle East, Europe and North America, largely though not entirely to Bangladeshi and other South Asian nationals. Separate export data are not available.

No figures of any description are available on the production of salted hilsa and smoked shrimps. Part of the salted hilsa production is from fish remaining unsold in the fresh fish market but the majority comes from planned production of seasonally surplus fish. The hilsa catch has a strong seasonal peak in September when production is five times greater than the January trough.

Similarly, there are no data on the production of sun-dried fish from freshwater sources. The field and market visits indicated reasonably clearly that sun-dried freshwater fish were second only to the sun-dried marine fish in their contribution to total cured fish production. It seems likely that much of the catch is in fact included in the sample catch survey of the Department of Fisheries but there is no breakdown of that data into fresh and dried products. We are unable therefore to offer any estimate of the total size of the freshwater dried fish catch. One of the problems is that sun-drying tends to take place when marketing of fresh fish is not economically feasible; it also occurs when there are seasonal gluts in production such as when *bheels* (ponds which may dry in winter) are fished during the winter. These are very difficult conditions under which to organise catch assessment.

Unlike marine production, there is some anecdotal evidence of decline in production. This is a result of improved communication allowing more fresh fish marketing and also as a result of the reduction in fishing grounds due to modernising agriculture through flood control, drainage, and irrigation investment. However, this is a trend of unknown strength affecting an industry of unknown size; hence for the three production groups (salted hilsa, smoked shrimp, and dried freshwater fish) there is no basis for estimation of production. Given the apparent relative sizes of the different sub-sectors and given the earlier minimum estimate of marine dried fish constituting five per cent of the total Bangladesh catch it seems likely that total cured fish production may, at most, be 15 per cent of total catch.

3. GEAR, CATCH AND SEASONS

3.1 Sun-Dried Fish

3.1.1 Gear

The greater proportion of marine fish that is sun-dried is caught in set-bag nets; this gear is known locally as *behundi jal*. The set-bag net is a fixed tapering net, resembling a trawl net, set in the tidal stream by attachment to two holdfasts. The rectangular mouth is held open by two vertical bamboo poles.

The hold-fasts are two wooden stakes embedded in the sea bed in such a way that the net is parallel to the direction of the current. At each slack water period the net is emptied and the direction of the net is reversed ready for fishing during the next tide. Because of difficulties in embedding the wooden holding stakes in the sea bed this method of fishing is restricted to a maximum water depth of 20 to 25 metres. Depth of water and distance from shore determine the size and number of nets as well as size and number of associated boats. A full and detailed description of the construction and operation of the set-bag net is given in FAO (1986c).

The set-bag net fishery is assumed to be very old but it remains a major contributor to the marine catch. Set-bag nets are believed to contribute approximately one third of the total marine catch of Bangladesh. During recent years the set-bag net fishery has undergone changes, mainly through the introduction of motorised boats and synthetic nets, which have extended its operational area further off-shore and also led to the use of larger fishing units in terms of size and number of nets and size and number of boats engaged in the fishing operation.

In a census undertaken in 1982/83 the number of set-bag nets in the coastal districts of Barisal, Chittagong, Jessore, Khulna, Noakhali and Patuakhali was estimated at over 15,000. The same survey indicated that Dubla in Khulna district was the largest centre with 4,811 fishermen and 2,248 set-bag nets, followed by Sonadia Island in Chittagong district with 2,607 fishermen and 549 set-bag nets, and Sonarchar in Patuakhali district with 578 fishermen and 289 set-bag nets. Hence about a fifth of all marine units are concentrated in these areas (FAO, 1985a). A typical feature of large marine set-bag net operations are the temporary fishing camps which are established just for the duration of the season.

An illustration of a set-bag net and a map showing the distribution of this gear are at Appendix 5 and 6 respectively.

3.1.2 Catch

The set-bag net catches a wide range of pelagic and demersal species. The catch normally comprises finfish or crustaceans which drift with the current or do not swim fast enough to oppose the current or maintain a fixed position in relation to the sea. The most common species caught are ribbon fish (*Trichiurus* spp.), anchovies, Bombay duck (*Harpodon nehereus*), croakers, pomfrets (*Pampus* spp.) and shrimps. A detailed study of the specific composition of set-bag net catches in the Chittagong region was made by Alam *et al.* (1989). Sixty four species of fish belonging to 30 families were recorded.

Catches are normally landed to the shore twice a day. With the exception of some types of shrimp, the bulk are sun-dried.

3.1.3 Seasons

The operation of the set-bag net requires calm waters. Therefore large marine units operate from September/October to February/March while medium and small units which set their nets in estuarine areas can operate throughout the year.

3.2 Salted Fish

Salted fish comprise predominantly hilsa caught in gill-nets set in both estuarine and marine waters. The peak season for the fishery and for production of salted fish is July and August, with considerable activity in June and September.

Other fish are only salted when there is no access to market, or when sun-drying facilities are inoperable possibly because of cloud or rainfall.

3.3 Smoked Shrimp

Different types of shrimp appear to be caught by a variety of gears in river estuaries in western Bangladesh. The processing is reported to take place throughout the year.

4. POST-HARVEST CURING PRACTICES

In most instances fish and crustaceans destined for the domestic market in Bangladesh are sold for consumption in fresh form, often iced. There are exceptions but the economics of marketing normally favour sale for fresh consumption when this option is available. Nevertheless approximately 15 per cent of the total freshwater and marine landings are cured.

Five types of fish curing were observed in Bangladesh. Smoking of small shrimps appears to be a small-scale activity restricted to the Khulna area. Salting of hilsa is a major and widespread activity at times of glut landings. Sun-drying, primarily without use of salt, is a major activity both in the remote coastal regions and in inland areas such as Sunamganj and Sylhet. Jewfish destined for export to the Hong Kong market are heavily salted and part-dried by a 'Chinese cure'. Some types of small fish and shrimps are fermented.

4.1 Sun-drying of Fish and Shrimps

Large quantities of freshwater fish are sun-dried in the *bheel* and *haor* areas of the Sylhet-Mymensingh flood plain. Coulter and Disney (1987) estimated that between 25 and 40 per cent of the annual catch in this area was dried.

The bulk of the sun-dried fish, however, is produced in the distant seaboard islands in the Bay of Bengal. This comprises marine and estuarine fish predominantly caught in set-bag nets.

Details of species and processing techniques are described by Ahmad (1953). The same author also mentions the practice in Khulna of boiling shrimps in brine prior to sun-drying. However, this practice was not observed or reported during the study. Sun-drying of shrimps is prevalent in the winter months when peak landings occur. The main production sites are the coastal regions and parts of Sylhet, Mymensingh, Rajshahi and Pabna (Hossain, 1985).

Observations and discussions with fishermen, processors and traders indicate that whilst very many types of fish may be sun-dried the predominant marine and brackish water species are:

Ribbon fish (Trichiurus spp.)
Bombay duck (Harpodon nehereus)
"Chewa" (Gobioides rubicundus)
"Boiragi" (?)
"Physae" (Ragonda russeliana) (Recunda russellana?)
(Engraulis sp.)
Silver Pomfret (Pampus argenteus)
Catfish
Sharks
Shrimps: Penaeidae
Metapenaeidae
Ascetes-like varieties

Ribbon fish, Bombay duck and pomfrets are normally dried on vertical open bamboo frames which may be five metres high and 30 to 40 metres long. Ribbon fish can be hung on the frame by simply bending the fish double and hanging over one of the bamboo poles, or more commonly they are dried on mats on the ground for one day after which they become pliable and can be attached to the frame by tying the tails of two fish together and then hanging them over a pole so that each fish hangs straight. Similarly two Bombay duck are attached by interlocking the lower jaws prior to hanging on the frame. Pomfrets and similar sized fish are first split, gutted, and then attached to poles by string threaded through the gills.

Very large fish such as sharks and rays are gutted, then cut into strips which still connect at the head and the tail; the strips are held apart with small pieces of wood to facilitate drying after the fish are hung from poles. Catfish are simply gutted.

Other fish are commonly dried whole on raised wooden racks. The top of the rack is often made of split bamboo threaded together so that it can be detached from the supporting poles and rolled up for storage as necessary.

Small fish and shrimps are sun-dried whole on split-bamboo mats on the ground. However, at times of glut landings some of the ribbon fish may be dried on racks at the expense of some of the smaller fish which will be moved from racks to mats. Ultimately at such times the smaller and less profitable species will be dried directly on the open ground.

Drying may be completed in two or three days for very small fish, but a period of five to six days is more common for larger fish. Very large fish may take more than eight days to dry fully.

The general standard of processing is very high; fish are turned at regular intervals to facilitate drying and may be covered with plastic sheets at times of rain or heavy dew. Most of the processors appear very skilled. There is little potential for economic improvement.

The one area of great concern is the current use of insecticide to prevent and combat insect infestation during sun-drying. This extremely important aspect is discussed in full in Section 7.

4.2 Salting of Hilsa

Hilsa (*Hilsa ilisha*) is the most sought after fish in Bangladesh. There is a major trade in fish freshly caught or preserved in ice. When landings are heavy the fresh fish market channels cannot cope with the quantities and dry-salting becomes commonplace.

The peak season for the catches, and therefore the curing, occurs from June to September with July and August the main months. Production takes place in many coastal and estuarine regions. Ahmad (1953) listed production centres in the districts of Chittagong, Tippera, Faridpur, Khulna and Bakarganj. Although many commercial units may dominate the business at times of glut landings, production may occur at the domestic level. Fishermen are not normally involved in processing the catch.

It is said that the main markets are Dhaka, Jessore, and possibly India. It was reported that Sylhet was also an important market. Consumer sales are mainly in the off-season for hilsa landings when prices of fresh fish are high.

The decision to salt hilsa depends on several factors of which condition of the fish, prevailing market price, and access to market are dominant.

Hilsa is commonly cured by packing the fish in granular salt in concrete vats, concrete-lined pits or similar containers. The fluids drawn out of the fish are allowed to drain away. After some time, maybe a few months, the fish may be repacked into small metal tins or drums. The colouring of the cured product indicates that some fermentation may take place during the process. It was reported that the preparation of the fish prior to curing depended on its condition. Very fresh fish may be cut into cross sections about 20 mm thick with the vertebrae removed. A cured product prepared in this manner will

command the highest price. Fish that are less fresh may be gutted and cut diagonally along the sides to facilitate ingress of salt. Other products presumably made from semi-spoiled fish are just gutted or salted whole. Processors in different areas may have locally specific preferences with regard to the method of fish preparation. Rubbi et al. (1981) details initial salt uptake and moisture loss during salting of hilsa.

Ahmad (1953) reported the pickling or wet-salting of hilsa in earthenware vessels in Khulna. Pickling was also reported to the team during the present study, but the procedure appears to be less widespread than dry salting.

Sun-drying of hilsa does not appear to take place possibly because of the large size of the fish and the high oil content.

4.3 Dehydrated Jewfish

A specialised trade in the production of heavily salted, semi-dried jewfish (*Otholithoides microdon*) commenced in the late 1970's. The product, known locally as 'dehydrated jewfish' is produced for the Hong Kong trade under the supervision of Chinese technicians. Production is centred in Cox's Bazar but there are processors in Chittagong and Dubla Island. Presumably, these are the areas where fish are most readily available; salt is also readily available in the Cox's Bazar area. A full account of the trade and its origins are given in FAO (1984b).

To ensure a top quality product it is necessary to use good quality fish in very fresh condition. Jewfish caught in trawls, or other gear in which the fish may remain dead for some time before being lifted and may also be damaged, are not considered satisfactory material for processing. The trade is based on jewfish caught by long-lines which yield fresher and undamaged individuals.

Annual catches by long-line are estimated to be in excess of 6,000 tonnes. However, there is little doubt that some netted fish are also processed.

The peak processing season is from September to February. The fish are firstly gutted and salted on-board the catching vessel. On arrival at the processing yard the gills are removed and the fish are repacked in salt and left for up to two days depending on size. After removal from the salt the scales are removed and the fish are washed prior to being sun-dried.

The fish are spread on raised racks; the gut cavity being held open by a small wooden stick to facilitate drying. Drying commonly takes three or four days. Fish of this size, although heavily salted, would be expected to experience some infestation by blowflies during drying. This does not happen; it is reported that this is achieved by adding an insecticide to the final rinse water during processing. The final product has a typical moisture content of 33 per cent and a salt content of 34 per cent.

Of the 12 or 13 processors in Bangladesh 10 are in Cox's Bazar. One yard at that centre reported six Chinese technicians who live at Cox's Bazar for up to six months each year to oversee the processing in two yards on behalf of their principals. Production from Cox's Bazar was said to be in the region of 2,000 tonnes. The trade is centred on the Chinese market in Hong Kong but it was reported that there may be some informal trade with Burma.

Formal exports are inspected by quality control staff of the Department of Fisheries. However, the analyses for moisture, salt, and acid insoluble ash contents are performed by the Hides and Skins Department of the Ministry of Commerce in Chittagong. The quality control inspection is primarily a physical inspection concerned with packaging and presentation.

Some threadfin bream (*Nemipterus japonicus*) is reported to be processed and exported in a similar manner.

4.4 Smoking of Shrimp

Ahmad (1953) states there is no smoking of finfish but that smoking is confined to shrimps. Recent trial production of smoked finfish by the Bangladesh Council for Scientific and Industrial Research confirms that there is little demand in Dhaka.

Hossain (1985) reports the smoking of small shrimps in Khulna district. A smoke house for the production of smoked shrimp was visited at Rangabali, Patuakhali district. It was constructed of wooden poles with matting-covered walls and a thatched roof. A mixture of small shrimps, (mainly *Metapenaeids* and *Macrobrachium* spp. up to 60 mm in length) was being hot smoked on a mat-covered wooden frame raised one metre above an open wood fire. Production in the 6 x 4 metre building was stated to be approximately 70 kg per four hours. Maximum daily production was given as 185 kg per day; processing

was said to take place throughout the year. Shahidullah (1978) states that the shrimp are further dried in the sun following smoking.

The private owner of the smoke-house had no other involvement with fisheries. Hossain (1985) reported more than 100 such units in Khulna district.

The reason for smoking was said to be the value added by the processing which imparted flavour, reduced moisture content - hence extended shelf life, and some protection against insect infestation. Hence smoked shrimps command a higher market price than shrimps which have been sun-dried.

4.5 Fermented Fish

A local practice reported in some parts of Bangladesh is to ferment small salted fish or shrimps in earthenware pots, the interior surfaces of which have been rubbed with oil. Local names for the products were given as *sidal* and *nappi*.

5. ECONOMICS OF CURED FISH PRODUCTION

This section deals first with the structure of economic interest, and then considers post-harvest losses. It is based on field visits and the limited secondary sources of socio-economic studies and surveys that touch on the cured fish industry. The information available is very patchy and will remain so until systematic data from socio-economic surveys become available. The broad structure of socio-economic interest outlined here is further discussed in Section 9 after the evidence on insect infestation and the technical assessment has been presented.

5.1 The structure of economic interests

A main operational concern of our Bangladesh field work was the review of needs and opportunities for intervention in cured fish production. Of particular concern was whether changes in post-harvest practices could improve efficiency by reducing food losses; if so, what might be the income distribution consequences and to what extent might any such intervention contribute to poverty alleviation. Ideally, we should understand the size and distribution of costs and benefits involved in current practices as a point of departure for analysis of possible interventions (recognising as well, of course, that the outcome of any apparently warranted intervention will be determined by the quality of the implementation strategy).

In practice, the information now available does not permit such a detailed assessment of economic interests; nevertheless certain key features are clear enough. Some preliminary assessment is possible, at least of the structure of interests, even though rates of returns on investment cannot be calculated from the available data.

Somewhat crudely, two major economic types of cured fish production can be identified. These are: i) the large temporary fishing camps established on the off-shore islands during the winter months; and ii) fishing villages where household-level production of dried fish takes place, largely during the winter months. This second type covers almost all the freshwater dried fish production, notably in the *haor* areas, as well as many coastal and estuarine fishing villages. In addition to these two main groups, there are special products for which the structure of economic interest will be different. These are the salted hilsa, smoked shrimp and fermented fish products. Aside from interviews with one

smoked shrimp and one fermented fish (*sidal*) producer, we have no data on these (apparently lucrative) products; they are produced on a very small scale relative to the main dried fish industry discussed below.

The fishing camps are the major suppliers of marine dried fish. They are relatively large-scale operations with hundreds of metres of drying racks and large areas covered in mats for initial drying of larger fish and full drying of small fish. Labour in these temporary camps is employed on a piece rate or on a fixed contract. For example one young labourer interviewed on Sonadia reported receiving Tk 3,000 plus food and a lungi (cloth) for 5 months work. Other rates quoted at Cox's Bazar and in Dubla were lower than this at Tk 2,000 plus food and clothing. More senior and experienced men (*dulabhangamajee*) in charge of managing drying floors would also receive kind payments of fresh fish from *bahardars* that they would dry on their account and sell via *aratdars* in Chittagong. Hours of work vary according to size of catch but since fishing, by and large, took place every month only in the first half of the lunar cycle the average hours worked are unlikely to have been extremely long. Thus, the labour force was not working under great strain but, on the other hand, they were separated from family and had little to do on the islands other than work. Also, the labour has no economic interest beyond their wage and it is the drying yard operators who hold the major economic interest in the fish drying enterprise.

Local terminology seems to vary for the operators were referred to as *bahardars* at Dubla and *sowdagars* at Sonadia. (It may be that the former term is used to refer to boat owners who operate drying yards as opposed to merchants who have specialized as drying yard operators). At Sonadia, near Cox's Bazaar, it was our impression that it was more usual for the drying operation to be a separate economic activity to that of the fishing operation; at Dubla Island, a more remote location off the Sundarbans, this separation was not so clear.

With this caveat, the fishing operation is essentially the same as that for fresh fish. An owner may have one or more motorized boats each with a captain (*majhi*) who employs a labour force on a fixed contract or on a piece rate. Often, these boats are rented - seasonally or monthly during the season (September to March). There are substantial fixed costs involved, in addition to the boat, because the fishing gear itself, - the set-bag net,

(*Behundi jal*) is expensive - ranging between Tk 21,000 and Tk 40,000 per large net in 1987. Country boats (non-motorised) are often part of a fishing unit and they will be used for helping to set and to harvest from the nets.

No detailed estimates could be made of the profitability of the fish drying enterprise, with or without fishing boats. As described in the next section, money advanced by commission agents (*aratdars*) is the principal source of finance and, presumably, the agents are main beneficiaries. The average commission at the wholesale market was Tk 1.00/kg of dried fish when no loan was involved and Tk 2.00/kg when there was a loan. A large commission agent will handle as much as 10,000 kg in a day so the gross revenues he receives can be very substantial.

FAO (1986c) has provided an estimate of returns for a 'typical' fishing unit that dried fish on Sonadia; it estimates net profits to the *bahardar* of about Tk 100,000 with only Tk 10,000 for the season shared by the four shore labourers. This differential seems to be of the right order of magnitude but the authors emphasise that the figures are only indicative since the returns vary considerably from season to season. This was confirmed by an individual drying yard owner, who reported an overall loss last season of Tk 40,000 on a throughput of 21,000 kg. He estimated that he needed a throughput of 35,000 kg to make a reasonable profit. Profit levels clearly depend very heavily on being able to maximise throughput.

We did not have the opportunity to visit permanent fishing villages on the coast and spent just an hour in each of two fresh water fishing villages in Sunamganj. These villages, predominantly, are producers of fresh fish with dried fish production being a seasonal activity as in the camps. Drying is mainly carried out by the fishermen themselves on fish that they are unable to sell or on small species that command a very low price when sold fresh. The fish are dried on mats and racks as in the island camps although, because of space constraints, the mats are often on platforms (*macha*) built over the river. (In Jasomantupur village there was evidence of competition between paddy and fish drying on the limited land available). Insecticides are used only in bad weather where the drying rate is slowed enough to increase the risk of blowfly infestation causing losses; it was reported that insect damage could reduce the price by over 50 per cent. In Jasomantupur, the whole village, a hindu village, was engaged in drying. Men, women and

children were all spreading and turning the drying fish; mainly it was small fish, *chapila* was a common species; they would fetch Tk 1,000 - Tk 2,000 per maund (37.3 kg) according to quality and species when sold to visiting traders. These households were extremely poor, with very, very small and poor quality housing; it was not possible to get meaningful data on income levels and indebtedness which are too sensitive to address properly in short visits. However, there have been several studies of fishing villages and the poverty of most fishing households has been well documented. By contrast, several - not all - of the traders we met were extremely well to do and handled up to 500 maunds of dried fish every week; largely this was through purchase of dried fish but they also have some limited capacity to buy fresh fish and dry it themselves. In one case (Jamir Ali of Ibrahimpur) buying and drying fish accounted for 20 to 25 per cent of his total dried fish sales. This particular trader was extremely well to do and had a turnover of Tk 20 to 25 lakh, using credit from commission agents at Asadganj, Chittagong. Others operated on a much smaller scale due to lack of working capital; some of these smaller traders, selling both wholesale and retail in the local markets, were clearly only earning a modest income. As with marine cured fish production the access to working capital depended on the commission agents - for Sunamganj these agents were located mainly in Sylhet (Khaliganj) and also in Netrakona and Asadganj (Chittagong).

5.2 Post-Harvest Losses

Ahmed (1983) has examined the costs of curing and storing dried fish and compared prices of the dried product to fresh fish prices. His conclusion, that there are substantial "disguised losses" (p 195) in cured fish production, is based on a comparison of conversion cost ratios (CCR) to the ratio of dried to fresh fish prices. Ahmed does not give a definition for the CCR; it appears to be based on the ratio of fresh fish purchase plus curing and storage costs to the fresh fish purchase price times the weight ratio of dry to wet fish. Values quoted for the CCR range from 3.12 to 4.4 (p 194). He compares these with ratios of dried fish to fresh fish retail prices - ranging between 1.74 to 2.84 to establish that losses are associated with the production of dried fish. The total level of losses is estimated by Ahmed (p 195) to have been Tk 115 crore in 1981. The exact steps for the estimate are not given but are presumably based on the estimated difference between the sales price of dried fish and the sales price that could have been achieved if

the fish had been sold fresh. There are alternative methods possible using his two ratios, described above, but no detail is given.

These losses are a reflection of the lower value consumers attach to dried fish relative to fresh fish. Ahmed argues that the principal reason they occur is because of inadequate transport from the remote dried fish production sites. Whilst it seems reasonable to accept the broad thrust of this argument a number of qualifications are required. First, as Coulter and Disney (1987, p 25) state, not all dried fish are downgraded product - i.e. inferior goods. For some dried fish products demand rises with income. Also, not all consumption is highly price elastic. In other words, it is only because of a surfeit in the market, relative to demand, that enables some consumers to exercise their preference at a lower price than they might otherwise have been prepared to pay. This is a speculative but almost certainly valid assessment of the likely shape of the demand curve for dried fish. It is less clear that it is a valid argument for a downward adjustment of the value of losses being incurred currently and the 25 per cent adjustment to Ahmed's figures that Coulter and Disney offer is wholly arbitrary. However, their argument does draw attention to market segmentation; poor consumers buy dried fish as a cheap source of nutrients and flavour; richer consumers buy well-prepared dried fish products as a delicacy with intrinsic consumption value and not because they cannot afford fresh fish. For the former group demand is highly sensitive to price, for the latter demand is price inelastic.

Secondly, whilst Ahmed may be correct to argue that commercial value is lost through curing, from a consumer welfare perspective what matters is whether nutritional losses are occurring also. No Bangladesh studies are available to evaluate such losses - which would require study of local culinary practice as well as losses due to biochemical changes in processing and storage. However, on Ahmed's data it would seem likely that dried fish are in fact a cheaper source of nutrition for poor consumers than fresh fish; commercial losses to the dried fish industry are at least partially compensated therefore by lower food consumption costs for the poor.

Thirdly, it is debatable whether Ahmed's method is intrinsically correct. Quite aside from lack of clarity about which prices exactly have been used to derive his estimate and, critically, whether they are a genuine weighted average of dried fish prices, his neglect of

transport costs is an important omission. It is certainly the case that dried fish are cheaper to transport and store than fresh fish; transport, storage costs and trading margins represent a variable but substantial proportion of fresh fish prices and may average around 50 per cent of the final retail price. The transport and storage margin for dried fish is likely to be a significantly lower proportion of total costs and this would provide a partial explanation of the difference between sales prices of dried fish and their equivalent as fresh fish. The data required to take this argument further are not available but we believe it constitutes a major explanation for the significant differences Ahmed observed between his conversion cost ratio and the ratio of dried to fresh fish prices.

A fourth factor concerns fish species. For some fish that are usually dried, notably ribbon fish, the demand for them in fresh fish form may be quite limited. Again, substantiation requires data that are not available but recognition of such product differentiation provides cause for treating Ahmed's results with caution.

For these reasons we feel, that the value of losses may be considerably below Ahmed's estimate. It was our general observation that curing practices - especially use of insecticides - are carefully designed to minimise post-harvest losses and that, by and large, they are successful. As discussed in Section 7, the main problem of current insecticide use practices is that they involve a potential health hazard to consumers. Further research is required to identify the extent and magnitude of this hazard.

6. MARKETING CHAIN

Cured fish marketing in Bangladesh has a very high degree of concentration at a handful of primary wholesale markets. For marine sun-dried and salted fish, smoked shrimp, and cured fish from Kaptai Lake the wholesale market at Asadganj in Chittagong town handles the vast majority of production with small amounts marketed directly to other wholesale markets including Khulna, Barisal and Dhaka. The important exception is the jewfish export trade which agents from Hong Kong control directly at the drying yards in Cox's Bazar. For dried freshwater fish a similar though slightly weaker concentration occurs with Kalighat wholesale market in Sylhet town; in addition there are a few other significant markets including Shachna Bazar in Sunamganj district, Sunamganj town and Mohanganj in Netrakona.

First sale for dried fish which takes place through auctions organised by commission agents (*aratdars*) occurs at these wholesale markets. These agents receive a commission from the seller who will typically be the owner of the drying facility; the buyer, in Asadganj and we infer in Kaliganj, will typically be a local wholesaler who in turn sells on to traders from tertiary markets around the country. These traders then transport their purchases to the tertiary markets for sale to local small wholesalers and to retailers. Retail sale is usually a specialised activity, although the scale of retail activity varies greatly. Large retailers buy in bulk and have permanent stalls and some storage facilities whereas there are poor women who buy small quantities on a daily basis for doorstep sales in nearby villages (Feldman *et al.* 1982). In comparison with major items of food expenditure such as rice and fresh fish, the retail market is thin - Chittagong excepted - reflecting the low average budget share of dried fish in food expenditure.

Although there are important exceptions to do with processing and storage, the main features of the cured fish marketing chain have important parallels with fresh fish marketing. This is fortunate for this study because although there has been no documentation of the dried fish marketing chain, fresh fish marketing has been extensively documented.

Studies by Ahmed (1983) and Rapport (1986) provide accounts of detailed survey work and these are supplemented by an array of secondary studies including Sabur and Rahman (1979), Dunn (1982), Danida (1984 &

1987), Coulter and Disney (1987). It is likely that the principal trade flows of cured fish will be similar to those for fresh fish except in the more remote markets where dried fish, because of its greater shelf life, will have greater penetration. This would be the case for the reportedly substantial market for salted hilsa in North Bengal (north-west Bangladesh). However, the single most important parallel between the marketing systems concerns the financial role of the *aratdars*. Dried fish *aratdars* provide longer term, seasonal or annual, finance to the owners of the drying yards much as fresh fish *aratdars* do for boat owners who market fresh fish. The owner of the drying yard may actually own a boat(s) engaged either on the fishing grounds or as a carrier boat operating as a freighter between the drying sites and the market. However, this is by no means always the case and, often, there is a clear separation of the economic interests in fish catching from fish processing with sale of fresh fish taking place on the shore-line.

In addition to the auction commission *aratdars* profit from their financing arrangements. Several *aratdars* reported that their commission on sales by merchants indebted to them was Tk 2.00/kg as opposed to Tk 1.00 on a free sale. *Aratdar* loans to purchasers appear to be shorter term and linked to specific purchases. Apart from the capital requirements there appear to be non-financial barriers to trade entry which allow quasi-monopoly powers to the group of *aratdars* acting as a cartel. In the Chittagong primary market there are just 23 *aratdars* who apparently agree on minimum prices on a daily basis prior to the auction. They are operating on a flat rate commission and their interest clearly lies in maximising market throughput. Their intervention over price, limited though it is by the vagaries of supply and demand, is designed to promote an orderly market, to fulfil their obligations to sellers to obtain the best price (thus encouraging them to use their brokerage services again) and, of course, to look after their financial interest which is often closely bound up with the fortunes of the sellers.

The key differences between the fresh and cured fish marketing chains relate to the processing and storage functions. In processing, the controlling interest of the fish drying yards, as noted above, may often be wholly separate from the fishing net and boat interests. This is especially true for the seasonal migratory fish drying teams operating on the coastal islands. The smaller scale drying activities in the (permanent) coastal villages and in the villages in the *haor* areas do not have this

separation and the (very unequal) financial and ownership interests correspond to that traditionally found in Bangladeshi fishing communities. One implication of the separation of the fishing enterprises from the fish drying interests is that the drying yards are fairly large-scale, taking the catch from several boats. This may make intervention, for example to improve handling practices, more easy but it also means that the distribution of benefits from any such intervention is likely to be highly unequal.

The storage of dried fish is generally undertaken by wholesalers who buy from *aratdars* and use their stock to supply the market during the summer and monsoon months when dried fish production is minimal. This is an important component of the marketing chain which has received little attention to date. Aside from quality control problems there are also serious financial risks because of price uncertainties. Preliminary investigations suggest that there may be some scope to intervene to improve quality control procedures - particularly to reduce the indiscriminate use of insecticides - but further investigation is required before any recommendations can be made. Again however, because of the concentration of ownership the benefits of intervention are likely to be highly unequal.

7. INSECT INFESTATION AND CONTROL

7.1 Insect Infestation

Fish which have been cured, or are in the process of being cured, by traditional methods in warm climates are often infested with insects. While fish are still relatively wet, i.e. with a moisture content of 50 per cent or more, they are liable to infestation by blowflies. During processing the moisture content is progressively reduced until the fish become too dry for blowfly activity but they then become susceptible to beetle infestation during storage, distribution and marketing.

Dried shrimps are also susceptible to beetle infestation but additionally are also liable to infestation by mites. Samples of mites collected from dried shrimps (and dried fish) were identified at NRI as *Lardoglyphus konoii*, a species previously known to be prevalent in Bangladesh.

Observations and interviews in Bangladesh indicate that blowflies and fish beetles can cause significant problems in the cured fish industry.

7.1.1 Blowfly Infestation

There are many types of blowflies and although the adults are attracted to drying fish in order to feed, not all species lay eggs and thereby initiate an infestation. Eggs are commonly deposited in the mouth, gills or surface wounds of the fish. It is the developing larvae which cause quantitative and qualitative losses by moving through and feeding on the soft tissues of the fish. When fish drying can be completed in one or two days blowfly larvae have little opportunity to cause measurable damage because they cannot develop or survive in dry fish. However, infestation will have serious consequences when fish drying takes the three to five days required for significant and possibly total larval development. Blowfly infestation will be exacerbated when rainy or cloudy weather prolongs the drying period. This will be of greatest consequence with large, or thick sectioned, fish which normally require longer drying periods.

Observations in Bangladesh indicate that blowflies pose a significant problem; most large ribbonfish examined at several processing locations in November 1990 were infested. Processors on Dubla island indicated that problems were greatest at the beginning and end of the drying season. This pattern would be consistent with the

incidence of high humidity and scattered rainfall during these periods. However, the situation was reportedly different at Sonadia where processors stated that there were few problems when processing commenced but that the incidence of infestation became greater as the season progressed. One explanation for this scenario could derive from differences in general hygiene. Dubla Island is basically very muddy; some domestic debris and human excrement was visible around the processing yards. Hence there will always be a significant background population of blowflies which clearly will rise during favourable climatic conditions. The part of Sonadia which was visited was, in contrast, very clean and sandy. As the season progresses it may be that the level of sanitation falls thereby resulting in increased blowfly infestation. An account of the fish processing activities on Sonadia is given in FAO (1984).

These observations support the findings of Doe *et al.* (1977) who reported that blowfly infestation in Bangladesh was a major problem for larger fish species and that weight losses could be 25 per cent giving rise to financial losses of 50 per cent.

Ahmed *et al.* (1989) indicated that one of the blowflies infesting fish in Bangladesh is a *Lucilia* species. Staff of the Institute of Food and Radiation Biology, Atomic Energy Research Establishment, in Bangladesh stated that a particular species had recently been identified as *Lucilia cuprina*. This is a cosmopolitan blowfly which has also been reported as a pest of drying fish in Indonesia (Esser *et al.*, 1985) and Malawi (Walker and Donegan, 1984). It is highly probable that other blowflies of the family Calliphoridae also infest fish in Bangladesh.

CONTROL

i, Bangladesh

During visits to fish drying sites in the coastal regions it was apparent from both direct observation and discussions with traders and processors that use of insecticide was commonplace both as a prophylactic and as a means of blowfly control.

The insecticide most commonly observed and reported as being used on fish was dichlorvos, marketed by Ciba-Geigy (Bangladesh) Ltd as the proprietary product "Nogos 100 ec". The instructions on the container indicate that it may be used to control insects on rice and vegetable crops. This insecticide is widely available, even in some remote locations, as a nominal 100 per cent emulsifiable concentrate. However, a sample purchased from a retail

outlet in Bangladesh was found to contain an active ingredient of only 82 per cent when analysed at NRI, UK.

Application of dichlorvos to the fish appears to be achieved by a variety of means. At Dubla the team observed the use of simple hand-held spray-pumps to treat fish drying on mats. Mr Khursid Alam, managing director of Community Development Centre (CODEC), described how he had seen application by "flicking with a brush (and by fingers !)" in Patuakhali District in late 1989. Processors themselves demonstrated how the head and gill region of ribbonfish were treated by dipping it into a dilute preparation of dichlorvos.

Such common and well established usage by the trade is clearly indicative that blowfly infestation is perceived as the cause of economically significant losses. Very little information is available on the origins of the practice. What was reported indicated that it first began in or around 1983. Interestingly this is the same year that Ciba-Geigy commenced production of "Nogos" from its Chittagong factory and subsequently developed a sales marketing team active in remote areas.

ii, International

At this point it would be useful to review the above activities in the light of good post-harvest practice and international recommendations and general usage of insecticides.

There is no such thing as a "safe" insecticide. All insecticides are potentially dangerous to other animals including people. "Safe usage" depends on the rate, mode and timing of the application. Because of the inherent risks associated with the post-harvest treatment of foodstuffs it is responsible practice to explore non-chemical control procedures before resorting to the use of chemical insecticides.

Given that the dried fish trade is a major source of employment and income, and that dried fish is a significant source of animal protein in Bangladesh, it is not viable to propose that fish are not processed at times when they are at risk from blowfly attack. However, this may become a feasible consideration if at any time in the future it is demonstrated that there is over-fishing of the resources.

Internationally, the most common practice to prevent blowfly infestation of sun-drying fish is to use salt during curing. Islam *et al.* (1987) demonstrated in

Bangladesh that rohu (*Labeo rohita*) was completely protected from blowfly infestation after being dipped in a 10 per cent salt solution for 30 minutes. In general salt has been shown to give good results, although some limitations have recently been highlighted (Esser, 1990). Salt appears to be readily available in coastal Bangladesh and its use with hilsa is extensive and well established. However, all indications are that very little salt is used in the dried fish sector; the main exception being the specialised production of dehydrated jewfish for the export market. Some processors said they do occasionally use salt to preserve fish that would otherwise spoil prior to processing and there was a general awareness that salted dried fish weigh more than the conventional product. The latter consideration may be of interest because most fish are sold by weight.

However, there is strong consumer resistance, and therefore trade resistance, to salted dried fish on the domestic market. Traders interviewed in Chittagong stated very clearly that they frequently had problems in selling salted products, and that salted fish did not store well at times of high humidity; being hygroscopic the moisture content rises thereby creating favourable conditions for spoilage by moulds and beetles.

Other non-insecticidal methods of preventing and reducing blowfly infestation were reviewed by Walker and Wood (1985). World-wide experiences of solar dryers or screens indicate that because of the operational skills required they have very limited practical application in remote artisanal seasonal fishing camps such as found in Bangladesh. Nevertheless, the technical viability of solar dryers was demonstrated in that country by Doe et al. (1977). There may be some potential to improve the site hygiene and sanitation in some processing yards so as to reduce the level of the blowfly background population but initial indications are that such an activity would yield only marginal benefits given the general good standards that prevail at present.

The use of hot smoke, which would be a viable option in some countries, does not have an application in Bangladesh because smoked fish would not readily sell on the domestic market.

The conclusion appears to be that the blowfly infestation problems in Bangladesh do warrant the use of insecticides. The Codex Alimentarius Committee of the WHO/FAO has agreed maximum residue limits for two insecticides for use on fish. These are pirimiphos-

methyl, and pyrethrum synergised with piperonyl butoxide. No other insecticides have international recognition for use on fish.

The use of a non-approved insecticide, such as dichlorvos, in Bangladesh is not an isolated instance. A review of the use of insecticides on drying fish indicated that 19 non-approved compounds had been used or were still in use world-wide (Walker, 1987). Dichlorvos has been reportedly used for blowfly control in Indonesia, Malawi and Nigeria. Its use in Indonesia is especially widespread, and practice in this country appears to have similarities with those in Bangladesh (Gordon and Esser, 1989).

The fact that dichlorvos has no maximum residue levels set by the Codex Alimentarius for use on fish does not necessarily imply that present usage is dangerous. Whilst it is suspected that the use of such a highly toxic insecticide presents a health hazard to both the fish processors and the consumers of the treated product, this still remains to be demonstrated.

7.1.2 Beetle Infestation

There are many beetles that are associated with dried fish but only those belonging to the family Dermestidae cause widespread and significant losses. It is commonly assumed that *Dermestes maculatus* is the major pest in Bangladesh. Indeed it is the only one named in the available literature. However, very little systematic collecting appears to have been undertaken because a limited survey during the study revealed the presence of *Dermestes ater*, occasionally in larger numbers than *D. maculatus*. The associated beetles, *Necrobia rufipes* and *N. ruficollis*, have doubtful pest status and can be disregarded for most practical purposes.

Beetle infestation can commence on the drying rack but this was not observed or reported during the study. Indeed beetles were rarely stated to be a problem at the production sites.

Inspection of dried fish in retail and wholesale stores commonly revealed a residual population both in the commodities and in the structural fabric of the premises. Beetles were also observed on dried fish and packaging material of a carrier boat from Dubla unloading at Asadganj in Chittagong.

Commission agents, wholesalers and retailers all accept the presence of a few *Dermestes* beetles in cured fish as a normal occurrence. However, they are clearly aware of the potential financial losses that can occur. Quantitative and qualitative losses resulting from beetle infestation are a direct function of the length of time the fish are in store and the number of beetles present. It was reported that customers would pay 10 to 15 per cent less for beetle damaged fish. This loss would be additional to the trader's quantitative loss incurred because of the common practice of retailing by weight.

CONTROL

It appeared that most of the commission agents in Chittagong used insecticides at some time in their stores to control *Dermestes* beetles. Interviews indicated that some storekeepers dusted the fish with DDT or something similar, whilst others only applied the dust to the packaging material. One trader appeared to spray the fish with dichlorvos. Similar treatments were reportedly used by retailers.

Two samples of DDT powders were analysed at NRI, Chatham, UK. One, obtained from a fish trader in Chittagong, had an active ingredient of 3.6 per cent; the other, purchased from a retail outlet, had an active ingredient of 57 per cent. It would appear that DDT is readily available from a factory in Chittagong.

Two samples of dried fish were also analysed at NRI. One, purchased from a retail market stall in central Dhaka, contained 22 parts per million (ppm) of DDT. Another, purchased from a wholesaler in Chittagong, contained an astonishing level of 428 ppm.

A sample of dried jewfish obtained from a processing yard in Cox's Bazar was not found to contain any insecticide.

Discussions revealed that the use of DDT on dried fish in Bangladesh had been reported in 1986 by staff of the Institute of Marine Science, University of Chittagong, during a study of the Kaptai lake fishery (Anon, 1986). The use of DDT to control fish beetles has also been reported from countries in West Africa (Walker, 1987). It is important to note that this insecticide is not only non-approved for use on fish but its application to foodstuffs at any level is proscribed in many countries.

The actions of traders appear to be motivated primarily by economic expediency with no regard for the safety of

the consumer. This may result from a lack of knowledge concerning the possible adverse effects of using non-approved insecticides on food commodities.

INSECTICIDE REGISTRATION IN BANGLADESH

Pesticide registration is regulated by the Pesticide Technical Advisory Committee of which the main working body is the Pesticide Technical Advisory Sub-Committee. The Director of Plant Protection, Department of Agriculture, heads the Sub-Committee.

Discussions with the Director indicated that no insecticides have been approved nationally for use on fish in Bangladesh. Apparently the current treatments for blowfly and beetle control could, in theory, be banned under the Pesticide Ordinance Act of 1971 and the consequent Pesticide Rules of 1985. How such a ban could be enforced was not apparent.

It was made clear that the Pesticide Technical Advisory Committee would not endorse an insecticide treatment that was not supported by the Codex Alimentarius. In part this is because Bangladesh has no facility at present for pesticide residue analysis. Any application would initially comprise an evaluation to establish product specifications. If these were acceptable the evaluation would then be followed by field trials to ascertain efficacy and residues. Residue analysis is clearly a constraint but it was stated that the Department of Agriculture had made an application to establish a residue analysis laboratory.

The Plant Protection Wing had previously identified dichlorvos as one of seven pesticides which it seeks to replace or to reduce usage. Pirimiphos-methyl, one of the two compounds with an established Codex Alimentarius maximum residue level for fish, is already registered in Bangladesh for the control of various non-fish pests.

DDT is not registered for use on any food commodities in Bangladesh.

The Department of Fisheries has no involvement in pesticide regulation. We were unable to determine the possible role, if any, of the Ministry of Food. However, from discussions with a Department of Health member of the PTA sub-committee it appears that at the time of the visit there was no professional body responsible for the consumer health and safety aspects of insecticide usage.

NON-INSECTICIDE CONTROL

Solar Dryers

The Mennonite Central Committee (MCC) has a long established Job Creation Programme in Bangladesh. This NGO has conducted field trials on the Meghna River since 1983 in an attempt to produce a high quality dried fish product. NRI provided some technical guidance and advice in 1986.

MCC recognise the need to control blowflies and undertook successful trials with pirimiphos-methyl. However, use of this insecticide ceased when MCC found it was not registered in Bangladesh for the protection of fish.

However, pilot-scale production of a jewfish product is scheduled to commence in Patuakhali in 1991 using a combination of brining and solar dryers. This activity will be undertaken jointly with the NGO CARITAS with an aim to produce a value added product for the Dhaka market. Production costs are expected to be double those of the traditional sector. An MCC marketing survey conducted in 1989 collected information on artisanal production, prices and preferences for dried fish products. There were indications that there is a market for a quality packaged product. This market is already being targeted by Saikat Chemical Industries, Dhaka, with its "Rupsa" proprietary brand of dried fish.

Ionising Radiation

It was demonstrated in West Africa in the 1960s that ionising radiation could be used for the control of *Dermestes* beetles infesting dried fish. Since then little practical application has been found for this method of control.

However, the Institute of Food and Radiation Biology of the Bangladesh Atomic Energy Commission has recently undertaken a series of studies on the control of both blowflies and beetles infesting fish. A possible control application could be the release of sterile adults amongst the natural populations on remote fish processing islands at the mouth of the delta.

The Institute is also involved with BEXIMCO which is presently setting up a food irradiation plant at Chittagong with the assistance of UNDP funding. Marketing trials with irradiated fish have already been undertaken in Bangladesh (Matin & Bhuiya, 1990).

8. TECHNICAL ASSESSMENT

This is the first in-depth study of the cured fish industry in Bangladesh. A much more substantial and technical investigation would be required to produce comprehensive and definitive information. However, the present findings are indicative of the situation.

8.1 Fish Curing

8.1.1 Sun-drying

The predominant cured products are sun-dried marine and freshwater fish. The overall standards of handling, processing and production are quite good. There is extensive use of raised racking and frames for the higher valued fish. Processors appear to be aware of the disadvantages of drying on the ground, a procedure used mainly for low value fish and at times of glut landings. Fish are regularly turned on the racks to facilitate drying; some processors cover the drying fish with plastic sheeting at times of rain or heavy dew.

These are high standards considering the volume of production and that the transient winter camps are often set up in remote and isolated locations.

Some minor improvements in handling and site sanitation at some locations would be helpful but would not command any priority.

The major areas of concern are the infestations of blowflies and beetles, and the use of non-approved insecticides to prevent and/or combat them.

Options for using non-insecticidal techniques in Bangladesh are severely constrained because of the limited domestic market for salted sun-dried fish. It is fortunate that the Mennonite Central Committee are pursuing the approach of using solar driers and brine to produce a high value product for the Dhaka market. This venture may well yield helpful information on the economic viability and market volume of this and related processes. It is also of interest that the use of ionising radiation is under investigation, although there must be doubts about the scope for its potential application.

There have been no loss assessment studies in Bangladesh to determine the extent of losses or the impact caused by blowfly infestation of sun-drying fish. However, the

widespread and extensive use of dichlorvos indicates that the processors are well aware of the extent of the potential losses and perceive a need to take effective action.

Dichlorvos is not approved for use on fish. Hence the toxicological problems associated with its application and the residues remaining in the fish when purchased by the consumer are not known. Given the widespread use of the proprietary product Nogos, this must be a cause for concern. The more so because it is supplied as a nominal 100 per cent concentrate. There are reports of processors applying the insecticide in a manner sure to contaminate their skin; a hazardous situation even assuming the formulation is diluted sufficiently to achieve the required concentration of, say, 0.1 per cent.

The logical step would be to replace dichlorvos with the approved insecticide, pirimiphos-methyl, which is readily available in Bangladesh and much safer to handle. It is assumed that the cost benefits of using pirimiphos-methyl would be suitably favourable. However, such a replacement exercise would be a major exercise given the remote, isolated, and transient nature of the winter camps where much of the dichlorvos is applied. The difficulties appear even greater in the absence of any government staff equipped to undertake such a task. In this situation it may be expedient to investigate the use of dichlorvos with a view to quantifying the actual risks and identifying means whereby these can be reduced or removed without loss of efficacy in controlling the blowflies.

The outcome of such a pragmatic approach may strengthen the case for substituting pirimiphos-methyl or it may indicate means by which dichlorvos can be used without risking the health of either applicator or consumer. In the event of the latter there would still be the problem that the Government of Bangladesh may decline to endorse an application procedure that has no international acceptance. Pirimiphos-methyl does have long-standing international approval.

The situation with regard to control of beetles on dried fish is also a great cause for concern. There is no "off the shelf" safe alternative as there is with blowflies, but there is little doubt, based on results from preliminary investigations, that pirimiphos-methyl can be used safely and efficaciously, although the definitive field trials need to be undertaken. The economics of its use on dried fish in Bangladesh need to be demonstrated.

The current widespread use of DDT on dried fish is a known health risk to consumers. It is important that the use of this non-approved insecticide be proscribed with the minimum of delay. Most of the application of DDT probably takes place in Chittagong and other urban centres involved in the dried fish trade. However, the difficulties in enforcing such a ban should not be underestimated. Additionally, the potential losses caused by the beetles will stimulate traders to seek a replacement insecticide. If an approved and economically attractive application procedure for piriphos-methyl is not available as an alternative there can be little doubt that processors will find another alternative to DDT which may be just as dangerous.

An in-depth investigation to determine a full comprehension of the use of DDT would be a useful step in planning its replacement.

8.1.2 Dehydrated jewfish

The industry appears to be well managed by the Chinese technicians based in Cox's Bazar. However, it would be helpful to know the identity of the suspected insecticide used in the process. If the Bay of Bengal Programme is to be instrumental in encouraging the development of this industry elsewhere, as appears likely, then it becomes important to identify and ensure the safety of the substance.

8.1.3 Salting

The salting of hilsa is a major industry which does not appear to have been studied or adequately documented. A few brief observations indicate that there may be potential for improving the curing process. Further clarification will be useful in view of the current proposals to promote this activity at village level. The use of salt during sun-drying is very limited with little apparent potential for increase.

9. SOCIO-ECONOMIC DISCUSSION

The limited field visits on which this report is based were not sufficient to allow any very detailed analysis of the social and economic conditions within the cured fish industry. We can however, draw some general conclusions and there are four that are especially relevant here.

9.1 First, in both production and in trade there is a high degree of specialization in the cured fish industry which operates through an entirely separate, though parallel structure to that of the fresh fish industry. This has evidently resulted, over the seasons, in very high levels of skill and knowledge in the curing of fish which appears generally to be efficiently organized. No doubt, the intensity of competition is an important factor contributing to efficiency. Whilst specific production locations are often controlled by individual entrepreneurs, marketing of cured marine fish is almost always channelled through Chittagong where competitive bidding tends to promote fair pricing. In discussions with entrepreneurs engaged in production and with commission agents organising wholesale buying and selling, it was not possible to collect usable data on income levels. The impression was that the commission agents are able to make substantial profits but these varied according to the size of their capital advances to entrepreneurs as well being affected by trading volumes. For entrepreneurs, the risks are greater since they incur substantial fixed costs; their profit levels depend mainly on volume of production and, in a poor season with thin catches, they can lose money.

9.2 Second, the competitive and risky nature of the industry encourages the adoption of efficient production methods. From interviews it would appear that, in less than a decade, there has been a substantial technological shift from salt as the main preservative to the use of insecticides to control blow-flies during processing and beetles during transport and storage. This change, involving the use of a number of different insecticides as described in Section 7, has been made by virtually the whole industry in striving to maximise the quantity and quality of cured fish output. Market visits indicated strong sensitivity of price to quality with, for example, good quality ribbon fish fetching 57 per cent more than poor quality ones in the Chittagong wholesale market in Asadganj. There is little doubt that the economic benefits from use of insecticides are substantial. However, as the discussion in Section 7 indicates, there

are unknown but potentially very high health risks to consumers (and to those applying hazardous insecticides) from current usage. This is a priority topic for research and is the focus of our recommendations in Section 10.

Beyond the evaluation of current practices from a health perspective the technological base for the industry - with two possible exceptions - seems to provide little opportunity for innovation. The first exception concerns the fishing gear itself, the set-bag net (illustrated in Appendix 5) and the opportunities that may exist for reducing wastage by increasing mesh sizes and improving use practices. This is an avenue that has been, and continues to be, researched by FAO (see for example FAO 1986c and 1987c); it was not an area we examined at all during our visits but FAO (1987b) research has demonstrated the potentially high social costs of the catching of immature shrimps and finfish due to small mesh size on set-bag nets. The problem is particularly acute with the smaller set-bag nets. Intervention is difficult; partly because of the inherent difficulties in organising extension activities within the fishing community; partly because a larger mesh size, whilst good for other fishermen and the growth of the fisheries, will most likely reduce immediate income of the individual adopter.

9.3 The second exception where there may be some opportunity for technological innovation relates to the structure of demand for cured fish and is our third main topic for socio-economic discussion. On average, the demand for cured fish is thin with a food expenditure share varying between only 0.3 and 0.6 per cent (Bangladesh Bureau of Statistics 1986). As expected, the share falls as income rises although the cross-sectional expenditure elasticity is 0.6 (estimated from data in Bangladesh Bureau of Statistics 1986 with a standard error of 0.06 and an R^2 of 0.86). Rahman and Roy (1990) calculate the expenditure elasticity for all fish to be close to unity whereas that for cured fish is significantly lower suggesting that, relatively, cured fish is a less desirable commodity for consumption.

However, these are aggregate figures and disaggregation, were it to be possible, would probably reveal a range of expenditure elasticities for different cured fish products. For example, top quality salted hilsa or smoked shrimps and some of the large cured finfish are speciality products which command price premia in certain retail markets. It is possible that innovation, for

example in retail packaging and presentation, could cost effectively raise such premia and increase industry profits. One NGO (MCC) in Bangladesh that we visited is exploring this avenue for income generation for poverty alleviation target groups, having pursued a similar strategy successfully with dried fruit. It is known, for example from the salted jewfish export industry, that there can be very high returns to enhancement of product quality for speciality markets; similar possibilities most certainly exist with richer urban consumers in Bangladesh amongst whom there is a subset - mainly but not just in Chittagong - which traditionally consumes a much higher quantity of cured fish than the aggregate statistics suggest.

9.4 The fourth and final, though perhaps most fundamental, socio-economic aspect of the cured fish industry that we wish to focus on concerns intervention strategy. It is as well to recognise first that, apart from the exceptions noted above, there are no strong technological reasons for intervention; post-harvest losses appear to be very modest and the cost structure of the industry appears competitive. Despite this there could still be grounds for project intervention if it were possible to alleviate poverty through an improved distribution of income within the industry. Indeed, any technologically-based ODA project intervention would have this underlying goal. In practice, such intervention will be extremely difficult both in the large off-shore island fishing camps and the household-based cured fish production systems in the estuarine and fresh water areas (the division used in Section 6). In the fishing camps the basic problem is that the poor operate as labourers not as own-producers. Improvement of their wages is likely to be one consequence of output-enhancing technological change but, given the competition for jobs, such benefits are likely to be rather small. It can be observed in other sectors of the Bangladesh rural economy (e.g. rice production) that labour shares in the benefits from technological innovation are small. Competition for jobs, the possibilities of labour-displacing technical change and the improvements in labour productivity associated with land-augmenting technical change all conspire to reduce the size of benefits to labour. During the last fifteen years of fairly substantial rice crop yield improvement the gains to labour have been positive but extremely modest. Essentially similar results could plausibly be anticipated from yield-enhancing technological innovation in the cured fish industry. It is worth recognising also that, in the absence of yield enhancing innovation and with constant output prices, the

alternative route to improved income in the industry is cost reducing technical change. This would almost certainly mean labour reduction just as it has done in the rice processing sector in Bangladesh.

The second situation, that of the fishing villages, might appear at first sight to offer more hope of addressing poverty alleviation goals through technological innovation since the poverty target groups are the producers themselves; here, cost reduction even if it meant labour reduction would apparently benefit the poor since it would largely be a saving of family labour that could be redeployed in other productive activity. But, in these households there is a great dependence on non-institutional credit, the suppliers of which are likely to be the main beneficiaries from cost-reducing or yield-enhancing investment. The major reason for this is that the credit suppliers are very frequently also engaged in the renting of equipment (boats, nets etc.) or in the marketing of cured fish output. The transactions are not simple single market ones but interlinked transactions in which the prices (e.g. of output and credit) are jointly determined in ways which allow the lender of credit/buyer of output to exploit the cured fish producers and capture the benefits from technological innovation. Basu (1984, Chapter 12) gives a general theoretical exposition of how such interlinkage works; fundamental to the process, and why exploitation occurs, is the fragmentation of markets that occurs when transactions in different markets are linked. The consequences for project interventions are serious since it becomes very difficult to direct increased incomes to intended beneficiaries. As with other fishing communities in Bangladesh the approach required is one that has a more fundamental concern with change in social and economic structures and not simply a narrow technological perspective. One NGO (CODEC) we visited is working in Patuakhali with coastal fishing communities with this more radical and longer-term perspective. The main thrust of their approach is human resource development and the evolution of alternative local institutional structures - usually cooperatives - to act as vehicles for identification and implementation of income enhancing activities. They have a long-term perspective, not the two to five years common to aid-funded projects, and put a main emphasis on beneficiary participation in planning and implementation.

Thus, to summarise, our overall conclusions on intervention opportunities via projects are in effect to deny the existence of significant opportunities at least in the short run. This is partly because there is little evident scope - or indeed current need - for technological innovation in fish curing, except that concerned with the use of insecticides. It is also partly because, even with such needs identified, there is little possibility of being able to promote technical innovation in ways that will benefit the poor. The fishing villages, because they are permanent, unlike the seasonal camps on the off-shore islands, offer some opportunity to develop longer-term programmes through local NGOs; in the seasonal camps there seem to be no effective methods at present of targeting the income and welfare needs of the labourers employed there.

10. RECOMMENDATIONS

[In order of priority]

- i, The use of DDT to control beetle infestation of cured fish should cease.

In recognition of the economic, social and technical implications of this recommendation, and additionally to facilitate the required intervention, it is recommended that an in-depth and detailed sampling survey be undertaken to determine the degree and extent of DDT usage. The survey should fully ascertain the economic and social motivations involved in the present practice in an effort to ensure that DDT is not simply replaced by another easily available but hazardous insecticide.

- ii, The potential health hazards associated with the use of dichlorvos for control of blowflies on drying fish should be investigated and evaluated.

Depending on the outcome, it may be necessary to amend or change present practice.

- iii, The suspected use of non-approved 'insecticides' on jewfish should be clarified and any necessary action taken to safeguard the health of production workers and consumers.

- iv, The Department of Fisheries should develop a post-harvest unit or 'focal point' concerned with the broader aspects of processing, storing and handling finfish in Bangladesh.

The Quality Control staff of the Department of Fisheries presently provides this type of support for export commodities.

- v, The production of salted hilsa in Bangladesh should be investigated with a view to both determining the losses and evaluating the potential of the process for promotion as a small-scale village activity.

- vi, The ODA Post-Harvest Fisheries Project of BOBP should maintain close links with the Mennonite Central Committee to learn from, and assist if necessary, the pilot attempts to produce and market packaged quality dried fish products.

11 ACKNOWLEDGEMENTS

We wish to acknowledge with warm gratitude the support for our mission provided by the Director of Fisheries, Mr Ataur Rahman, and his staff whose involvement in planning and executing our programme of visits to cured fish production sites enabled us to learn and observe a great deal in a short period.

We are very grateful to Mr A Kashim, BOBP, Dhaka for organising our trip and to the British High Commission, Dhaka, especially Ms Susan Loughhead, for arranging help with transport. We give very special thanks also to Md Kador Ahmed, Inspector, Quality Control Office, Department of Fisheries, Chittagong and to Shahid Hossain Shamim, Senior Researcher, UBINIG, for accompanying us during the mission and sharing their knowledge and experience.

APPENDIX 1

TERMS OF REFERENCE

MARKETING ECONOMIST (Martin Greeley)

In collaboration with the Fish Processing and Infestation Technologist to:-

(a) Review available information on cured fish products, concerning markets, marketing, losses and their economic significance

(b) Supplement this, as appropriate, by collecting primary information, particularly on:

the economic significance of losses due to insect infestation

where within the marketing chain the losses are incurred

the groups ultimately affected, from fishing communities via processors and traders to consumers

(c) Appraise current practices to minimise insect-induced losses, in particular the current use of insecticides and any relevant on-going programme - from both an economic and institutional standpoints

(d) Appraise possible alternative means of improving product quality and reducing losses, in particular the safe use of insecticides and/or improved processing. The appraisal should consider, *inter alia*:

- financial and economic viability
- potential for adoption
- sustainability
- distribution of benefits including in terms of gender

(e) Asses the need for complimentary public/private sector, governmental activities e.g. in input supply, credit and extension, and draw up outline programmes, as appropriate, in consultation with relevant agencies

(f) Draw up a project logical framework as the basis for the team's report and proposals

FISH PROCESSING AND INFESTATION TECHNOLOGIST
(D J Walker)

- (a) Assess the problem of infestation of cured fish products at production, storage and distribution sites
- (b) Make observations on use of insecticides and, if necessary, assess methods of replacing their use with safer alternatives
- (c) Assess shortcomings in existing processing practices and suggest appropriate improvements
- (d) If appropriate, provide practical and suitable training to producers and/or traders in use of insecticides and improved handling and processing practice

Tuesday 13th November

Arrive Dhaka

Director of Fisheries, Mr A K Ataur Rahman

Institute of Food Science and Technology, Bangladesh
Council of Scientific and Industrial Research (BCSIR),
Dr M Muslem Uddin, Director and Chief Scientific Officer
Mr M A Wahed, Senior Scientific Officer
Mr S Shamimjahan, Senior Scientific Officer
Ms Majeda Begum, Senior Scientific Officer

Danida - Counsellor, Mr Paul Ernst Christensen

Wednesday 14th November

Depart Dhaka for Cox's Bazar
Arrive Cox's Bazar

DOF Marine Survey Project

FRI Marine Fisheries and Technology Station
CSO Dr M A Hossain

Bangladesh Fisheries Development Corporation (BFDC)
Processing Assistant Mr Bijoy Mozumder
Fishmeal yard/mill/store

Mr Md Nurun Nabi Sarker BFDC Project Manager

Mr Delwar Hossian Chowdhury, Manager - Nor Mohammed and
Co. Fish Exporters - commercial jewfish production yard

Thursday 15th November

Speedboat to Sonadia Island - Fish drying on beach

Secretary to Fishermen's Association
Mr Yunus Bhodher

Visit Cox's Bazar - fish drying yards
Evening depart for Chittagong
Arrive Chittagong

Friday 16th November

Asadganj Wholesale Market - commission agents and wholesalers

BOBP - Mr C Angell
Mr H Nielsen

Saturday 17th November

Asadganj Market

DOF Marine Survey Office - Mr Giasuddin Khan

DOF Quality Control Office - Deputy Dir., Mr Akther Ali

DFO Chittagong, Mr G K S M Sayed Amin

BFDC Chittagong HQ fishmeal plant and drying yard
Senior Stores Officer, Mr Zakaria Mamoon

Asadganj Market

Fish Home Ltd (Seafood Exports)
General Manager, Mr Faiz Ahmed Siddique

Sunday 18th November

BCSIR Chittagong-
Dr Md Nural Alam, Director
Mr Abdul Huq, Food Technologist

Marine Science Institute-
Director, Mr Nani Gopal Das, Assoc. Professor
Mr Nuruddin Mahmood, Assoc. Professor
Mr Abdul Hakim, Assoc. Professor

University of Chittagong-
Chairman, Dept of Zoology, Mr Badrul Amin Bhuiyan
Associate Professor, Dept of Zoology, Mr Hafeez Uddin
Dept of Economics, Dr Mahbub Ullah

CODEC Mr Khursid Alam - Managing Director

CARITAS- Mr John Flaviah Quiah

Depart Chittagong for Dhaka
Arrive Dhaka

Monday 19th November

Depart Dhaka for Jessore
Drive Jessore to Khulna
Drive Khulna to Mongal
Depart Mongal for Heron Point
Arrive Heron's Point

Tuesday 20th November

Dubla Island - fish drying yards

Wednesday 21st November

Depart Heron's Point
Arrive Khulna

Thursday 22nd November

DOF Khulna, Mr R I Chowdhury
BFDC Khulna - Mr Mesbahul Islam
Retail/wholesale markets

Depart Khulna
Arrive Jessore
Depart Jessore
Arrive Dhaka

Friday 23rd November

Retail markets Kowran Bazar and New Market, Dhaka

Saturday 24th November

Ministry of Agriculture, Plant Protection Wing-
Director, Mr Md Mazharul Haque
Entomologist, Mr A K M Azad

Institute of Epidemiology, Disease Control and Research
(IEDCR) - Mr Touhid Uddin Ahmed, Head of Department of
Medical Entomology

University of Dhaka-
Professor of zoology, Dr Anawara Begum

BOBP, Mr C Angell

Sunday 25th November

David Walker - Mymensingh

Fisheries Research Institute -
Director, Professor Md Aminul Islam
Mr Muhammed Zaher - SSO

Bangladesh Agricultural University (BAU)
Head, Dept of Fisheries Technology, Mr Md Kamal
Assoc Professor, Dr Nazural Islam

Martin Greeley - Sunamganj

Depart Dhaka
Arrive Sylhet
Mr Shabbir Ahmad, DFO, Sylhet

Depart Sylhet
Arrive Sunamganj
Mr Md Ershad Miah, DFO, Sunamganj
Mr Dewal Kamal Raja - fisheries leaseholder
Ibrahimpur village - fish drying
Sunamganj Retail Market

Monday 26th November

David Walker - Dhaka

Institute of Food and Radiation Biology (IFRB)
CSO Mr M A Matin

Mennonite Central Committee (MCC)
Mr Kurt Kuipers - Appropriate Technologist/Engineer
Mr Shahjaban Miah - Co-operative Liaison Officer

Action Aid
ex-Director, Stuart Rutherford

Oxfam, (Dwrp Unnayon Songstha)
Mr Kafil Ahmed - Project Officer

Martin Greeley - Sunamganj

Mr Mushtaq Uddin Ahmed, District Commissioner, Sunamganj

Speedboat to Shachna Bazar
Mr Serajul Islam, Upazila Nirbahi Officer (UNO)
Mr Yusuf
Al-Azad, Upazila Chairman
Mr Tapan Kumar Pal, Upazila Fisheries Officer

Speedboat to Jasomantopur village (Dhalai riverfish curing at household level

Shachna Bazar retail and wholesale dried fish market

Sylhet - Khalighat wholesale dried fish market

Return to Dhaka

Tuesday 27th November

David Walker - Chittagong

Ciba-Geigy Chittagong - Mr Chowdhury F Imam,
Quality Control Manager

Chittagong University-
Vice Chancellor - Professor Alamgir Md. Sirajuddin
Chairman, Dept., Zoology - Mr B A Bhuiyan
Mr Md Ismail Mia, Assistant Professor

BOBP Mr H Nielsen
Dr K Sivasubramaniam

Martin Greeley - Dhaka

Ministry of Fisheries and Livestock - Deputy Chief
(Planning) Mr Malik Md Shah Noor

Bangladesh Bureau of Statistics, Household Expenditure
Survey Unit

Kowran Bazar - wholesale market for cured fish

Dr S F Rubbi - ex-director, Institute of Food Science and
Technology, BCSIR, Dhaka

Wednesday 28th November

Dhaka

Thursday 29th November

Depart Dhaka
Arrive Calcutta
Depart Calcutta
Arrive Madras

Friday 30th November

Mr T Bostock - Debriefing Meeting
Mr G Pagot
Mr L O Engvall

Saturday 1st December

Mr R N Roy
Mr T Bostock
Mr L O Engvall - Debriefing Meeting

Sunday 2nd December

Depart Madras

APPENDIX 3

PRINCIPAL DOCUMENTS CONSULTED

- Ahmad N., 1953, "Preservation and curing of fish in East Pakistan", Pak. J. Sci. 5 (3) 117-122
- Ahmed A.T.A., Ullah M.R., Fazl-I-Rubbi S. and Muslemuddin M., 1981, "Investigations on solar tent drying of rupchanda (pomfret), *Stromateus sinensis* (Bloch) and shrimp, *Macrobrachium dayanus* (Henderson)", Proc. 3rd National Zoological Conference, Zoo. Soc. Bangladesh, p136-144, Dhaka
- Ahmed M., Bhuiya A.D., Alam M.S. and Huda S.M.S., 1989, "Radiation disinfestation studies on sun dried fish", Technical Report No. 303, International Atomic Energy Agency, Vienna
- Ahmed M., Karim A., Alam Z., Bhuiya A.D., Hossain M.M. and Saha A.K., 1988, "Effect of salt concentration on the larval mortality of *Dermestes maculatus* Degeer (Coleoptera: Dermestidae) in dried *Hilsa ilisha* Ham", Bangladesh J. Agri. 13 (2) 123-126
- Ahmed N., 1983, "Marketing of selected fishes in Bangladesh, a study in efficiency." Department of Marketing, University of Dhaka. Unpublished Ph.d. thesis
- Alam M.S., Das N.G., Islam M.A. and Roy B., 1989, "The fish composition in the behundi net catch of Chittagong coast, Bangladesh", Chittagong Univ. Stud. Part II: Science 13 (1) 71-76
- Anon. (undated, 1977?), "Integrated development assistance to Dublor Char fishery", (BOBP library, Madras)
- Anon. 1986, "Hydrobiology of the Kaptai Reservoir", Report prepared by Aquatic Research Group, Institute of Marine Sciences, University of Chittagong, Bangladesh for FAO/UNDP contract DP/BGD/79/015-4/FI

- Anon. 1990, "Pesticides, promoting safe and efficient use of pesticides in the region", Agro - Chemicals News in Brief, XIII, 28-30
- Anon. 1990, "Fisheries and the flood action plan (Supporting study No 17), Report and recommendations of the ODA project identification mission to Bangladesh", March - April 1990, 2 volumes, London
- Asadur Rahman M., 1986, "Socio-economics of aquaculture development, country paper - Bangladesh", Workshop on socio-economics in aquaculture development, (BOBP library, Madras)
- ADB, 1986, "Handling, marketing and processing practices in Bangladesh", Second Aquaculture Project preparation report, Appendix 7, Manila (BOBP library, Madras)
- Bangladesh Bureau of Statistics, 1978, "A report on the household expenditure survey of Bangladesh 1973-74", Household consumption statistics by income classification, Volume I, Dhaka
- _____ 1980, "A report on the household expenditure survey of Bangladesh 1973-74", Household consumption statistics by expenditure classification, Volume II, Dhaka
- _____ 1986, "Report of the Bangladesh household expenditure survey 1981-82", Dhaka
- _____ 1990, "Statistical pocket book of Bangladesh." Dhaka
- Bangladesh Small and Cottage Industries Corporation, 1982, "Survey report on small industries of Bangladesh", Dhaka
- _____ 1983, "Cottage industries of Bangladesh", Dhaka.
- Basu, K., 1984 "The less developed economy: A critique of contemporary theory", Blackwell, Oxford
- Bhuiya B.A. and Huda K.N., 1981, "Two mite species predated on the mite pests of dry fishes, prawns and shrimps from Chittagong", Chittagong University Studies, Part II, 5, 85-90

- _____ 1983, "A preliminary study on some mite pests of dry fishes, prawns and shrimps from Chittagong", Chittagong University Studies, Part II, 7, (1)
- Bhuiyan A.D., 1990, "Packaging and storage studies of irradiated dried fish for commercial application", Draft report, Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Dhaka
- Bostock T., 1990, "Report on a visit to Bangladesh to define phase II sub-project activities", BOBP-ODA Post-Harvest Fisheries Project
- Choudhury S.H., 1975, "Findings of socio-economic survey of Bhola Central Fishermen's Co-operative Society in the district of Barisal", Christian Commission for Development in Bangladesh
- Community Development Centre, 1989, "Support to coastal and river based fishing communities, socio-economics of the fishing communities, Patuakhali", Draft, Chittagong
- _____ 1990, "Coastal and riverine fisherfolk community in Bangladesh and CODEC - a participatory approach to development", Workshop on fisheries extension in Bangladesh, BOBP/FAO and Mymensingh Aquaculture Extension Project, Chittagong
- Coulter, J.P. and Disney, J.G., 1987, "The handling, processing and marketing of fish in Bangladesh", ODNRI Bulletin No. 1. Chatham, UK
- DANIDA, 1984, "Bangladesh: wholesale fish market in Chittagong", Appraisal Report, Copenhagen
- _____ 1987, "BFDC Fish Marketing Project, Bangladesh", Evaluation Report, Copenhagen
- _____ 1988, "Situational analysis study of Patuakhali and Barguna districts", Upazila reports for Galachipa and Kalapara, prepared by Development Design Consultants Ltd., Dhaka
- _____ 1988, "Report on fisheries in Patuakhali, Barguna and Bhola districts", Executive summary, prepared by Bangladesh Centre For Advanced Studies, Dhaka

- _____ 1988, "Patuakhali and Barguna Development Programme Bangladesh, Identification Report", Technical Papers 2 and 3, Copenhagen
- _____ 1988, "Bangladesh, Community Development Centre", Evaluation Report
- _____ 1989, "Study of credit systems for aquaculture in Bangladesh and proposal for credit scheme to be implemented by the Aquaculture Extension Project in Mymensingh, Bangladesh", Copenhagen
- _____ 1990, "PABADEP support to the coastal and river based families of Patuakhali, Barguna and Bhola districts", Draft report of Project Formulation Mission, Copenhagen
- Department of Fisheries, 1989, "Experimental project for new and improved management of open water fisheries in Bangladesh", Report of Ministry of Fisheries and Livestock (prepared by Bangladesh Centre for Advanced Studies, Dhaka)
- _____ (undated), "Fisheries fourth five year plan 1990-95", draft, Dhaka
- _____ (undated), "Fisheries catch statistics, July 1987-June 1988", Dhaka
- Doe P.E., Ahmed M., Muslemuddin M. and Sachithanathan K. 1977, "A polythene tent drier for improved sun drying of fish", Food Technology in Australia, 437-441
- Dunn I.G., 1982, "The hilsa fisheries of Bangladesh-1982: An investigation of its present status with an evaluation of current data", Fisheries Advisory Service, Planning, Processing and Appraisal Project, FAO
- Esser J.R., 1990, "Factors influencing oviposition, larval growth and mortality in *Chrysomya megacephala* (Diptera: Calliphoridae), a pest of salted dried fish in south-east Asia. Bull. Ent. Res. 80 369-376

- Esser J.R., Hanson S.W. & Taylor K.D.A., 1985, "Loss reduction techniques for salted/dried marine catfish (*Arius* sp.). In Reilly, A. (ed.) 1985. Spoilage of tropical fish and product development. Proc. of Symposium held in conjunction with Sixth session of Indo-Pacific Fishery Commission Working Party on fish technology and marketing. p315-327, Melbourne, Australia. FAO Fish Rep. 317
- Feldman S., Akhter F. and Banu F., 1982, "Survival on the edge: Marine fishing families in Bangladesh", BOBP, Madras
- FAO, 1976, "Report from a visit to Dubla Island, December 1976", F.H. Meyer, (BOBP library, Madras)
- ____ 1977, "General description of marine small-scale fisheries, Bangladesh", Working paper 3, FAO project - Development of small-scale fisheries in southwest Asia, RAS/74/031, Columbo
- ____ 1982, "Fishermen on Dubla Char and adjacent islands during the fishing season 1981-82", C. Grant, BOBP/79/015, (BOBP library, Madras)
- ____ 1984a, "Country craft of Bangladesh", (BOBP/REP/18) Madras
- ____ 1984b, "Making a fortune from jewfish export", Bay of Bengal News, 13, 20-23
- ____ 1985a, "Pilot survey of set bagnet fishery of Bangladesh", BOBP/WP/34, Madras
- ____ 1985b, "Profile of marine fisherfolk in Juldra Shampur: Participation in fishermen's activities", report by P. Natpracha
- ____ 1985c, "Marine small-scale fisheries of Bangladesh: a general description", BOBP/INF/8, Madras
- ____ 1986a, "Bangladesh fisheries sector", Infofish Marketing Digest, (1) 11-13
- ____ 1986b, "Fisherwomen's activities in Bangladesh: a participatory approach to development", BOBP/REP/24

- ___ 1986c, "The coastal set bagnet fishery of Bangladesh - fishing trials and investigations", BOBP/REP/34, Madras
- ___ 1987a, "Terms of reference of socio-economic and participatory planning study. Preparatory study of set bag net fishery", RES/CEN/SBN/BGD (BOBP library, Madras)
- ___ 1987b, "Pilot survey on socio-economic status of set bagnet (SBN) fisherfolk of Bangladesh", (BOBP library, Madras)
- ___ 1987c, "A preliminary survey of the setbag net fishery and its interaction with other marine fishery in Bangladesh", BOBP/RES/SBN
- ___ 1989, "Results of an explanatory study of the socio economic conditions of fishing households in Barguna and Patuakhali districts, Bangladesh", BOBP/GCP/RAS/118/MUL, Madras
- ___ 1990, "Coastal fisherfolk community development in Bangladesh", BOBP, Madras
- ___ 1990, "Report of the fourteenth meeting of the Advisory Committee", BOBP/REP/44, Medan, Indonesia
- FRI, 1988, "Introducing the Fisheries Research Institute", Fisheries Research Institute, Mymensingh, Bangladesh
- Friendship R., 1990, "Review; The fumigation of fish", Tropical Science 30 185-193
- Gordon A.E., 1990, "Fish marketing problems in Bhola District, Bangladesh", Natural Resources Institute, Chatham, UK. Draft
- Gordon A.E. and Esser J.R., 1989, "Financial evaluation and adoption of the insecticide Pirimiphos-methyl ('Minawet') as a protectant of cured fish against blowfly infestation. Report of field investigations conducted in Indonesia, May-June 1989", Report No. 7, ODA regional technical co-operation project:- Post-harvest losses of fish in Indonesia

- Haque K.A., 1982, "Prospects for improved solar fish drying in Bangladesh", Appropriate technology for alternative energy sources in fisheries, ICLARM Conf. Proc. 8 113-115
- Hossain M.A., 1985, "Shrimp processing in Bangladesh", ICLARM Newsletter, 8 (3) 13
- Islam M.R., Mazid M.A., Gheyasuddin S., Bhuiyan A.K.M.A. and Humayun N.M., 1987, "Comparison of dried fish cured in sun and in solar tent, I. A technological study", Bangladesh J. Fish. 10 (1) 19-22
- Islam M.S., 1967, "A description of the behundi net (set net) operation in the Cox's Bazar area", Reprinted from Transactions of the Fish Protein Concentrate Seminar (BOBP, library, Madras)
- Islam M.S., Bhuiyan S.M.I. and Sivasubramaniam K., 1987 "A preliminary survey of the setbagnet fishery and its interaction with other marine fisheries in Bangladesh", Chittagong
- Jabbar M.A. and Karim M., 1979, "Economics of alternative technologies for harvesting and processing marine fish", Bangladesh Journal of Agricultural Economics 2 (1)
- Kabir Ahmed, M., 1984, "Studies on the behundi net fishery in the brackishwater area of Patuakhali with emphasis on bioeconomics and mortalities of shrimps", Chandpur (BOBP library, Madras)
- Kidd H., Hartley D. and Ekstrom G. (eds), 1989, "World directory of pest control organisations", Royal Society of Chemistry, Cambridge, UK
- Madhu S.R., 1984, "A profile of Sonadia Island", Bay of Bengal News, 13 12-15
- Marr J.C. (Associates), 1985, "Twenty year fishery development plan For Bangladesh", (Report prepared for FAO/UNDP)

- Matin M.A. and Bhuiya A.D., 1990, "Test marketing and consumers' acceptability of irradiated foods in Bangladesh", Food Irradiation Newsletter 14 (1) 57-61
- Mennonite Central Committee, 1989, "Job creation program, report 8", p91, Dhaka,
- _____ 1990, "Job creation program, report 9", p99-100, Dhaka
- Ministry of Fisheries and Livestock, 1989, "Coastal fisherfolk community development in Bangladesh", Dept. Fisheries, Dhaka
- Palfreman A., 1988, "Hatiya Island fish marketing project", ODA, London
- Rahman, M.A., 1986, "Socio-economics of aquaculture development: Country paper - Bangladesh", Workshop on socio-economics on aquaculture development, (BOBP library, Madras)
- Rahman S.H. and Roy D.K., 1990, "Consumption demand for fish in Bangladesh: An empirical analysis with cross-sectional data", Research Report No. 121, Bangladesh Institute of Development Studies, Dhaka
- Rapport Bangladesh Ltd, 1986, "Report on survey of marketing of fish and shellfish in Bangladesh", Prepared for FAO
- Rezaur R., Bhuiya A.D., Islam M. and Ahmed M., 1983, "Use of common salt as a controlling agent of dried fish pest in the store houses", Proc. 8th Bangladesh Sci. Conf., p153, Dhaka
- Rubbi S.F., Muslemuddin M., Debnath A.K. and Ahmed A.T.A. 1981, "Some aspects of preservation of *Hilsa ilisha* (H.) by salt curing method", Proc. 3rd national zoo. conf., Zoo. Soc. Bangladesh, p231-237
- Sabur, A.S. and Rahman, L., 1979, "Marine fish marketing in Bangladesh", Bangladesh Journal of Agricultural Economics 2 (1)

- Shahidullah, M., 1978, "Processing, preservation, curing and transportation of fish in Bangladesh", Symposium on fish utilisation, technology and marketing in Indo-Pacific Fishery Commission Region, Manila, Philippines, March 1978
- _____, 1985, "The small scale marine fisheries development in Bangladesh and its present status", National seminar on fisheries management and development in Bangladesh, Chittagong, (BOBP library, Madras)
- UBINIG (1989?), "Pesticide use in Bangladesh and CIBA-GEIGY", Dhaka
- Walker D.J. 1987, "A review of the use of contact insecticides to control post-harvest insect infestation of fish and fish products. FAO Fish Circ. No. 804
- _____ 1988, "Control of insect infestation in fishery products in LDCs", in Morrisey M.T. (ed.), Post-Harvest Fishery Losses, Proceedings of an international workshop, April 12-16, International Centre for Marine Resource Development (ICMRD), Rhode Island, USA
- Walker, D.J. and Donegan, L. 1985, "Spray application of insecticides to protect sundrying fish from blowfly infestation during the wet season in Malawi. Int. Pest Control 26 (5) 132-137
- Walker, D.J. and Wood C.D. 1985, "Non-insecticidal methods of reducing losses caused by infestation of blowflies (Diptera) during fish curing procedures. Fish Processing in Africa. Proceedings of FAO expert consultation on fish technology in Africa, p374-379, Lusaka, Zambia, January 1985. FAO Fish. Rep. suppl. 474p

APPENDIX 4

PRODUCTION OF "DEHYDRATED JEW FISH"

The Fish

It is economically important to process good quality fresh jewfish because the market pays a substantial quality premium. Hence fish caught by long-line are preferred to gill-netted fish which may have hung dead in the water for many hours. However, there is little doubt that some netted fish is also processed.

The Process

The fish are gutted on the boat soon after capture. The gut cavity is then filled with salt and the fish are stacked between layers of salt. On arrival at the processing yard the gills are removed and the fish repacked in salt in vats for a period of one or three days; the duration being dependant on the size. On removal from the salt the scales are removed and the fish well washed to remove surface salt and debris.

The fish are then put to sun-dry on raised racks for three to five days until suitably dried. Small pieces of wood are commonly used to hold open the belly cavity to facilitate drying. (An illustrated account of this process is given in Bay of Bengal News 1984 13 20-23)

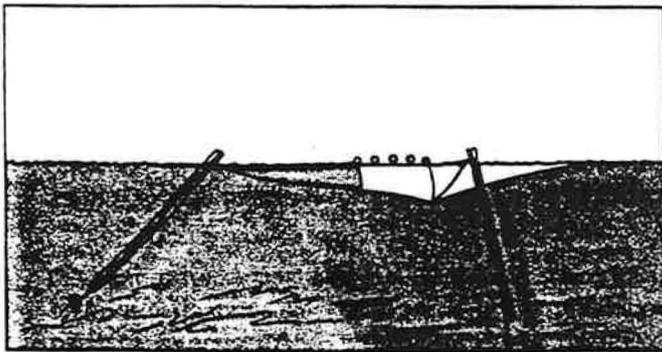
The Product

The fish typically have a moisture content of 33 per cent, a salt content of 34 per cent and an acid insoluble ash content of 0.4 per cent. The fish are well packed in cartons and kept in cool stores prior to being airfreighted to Hong Kong.

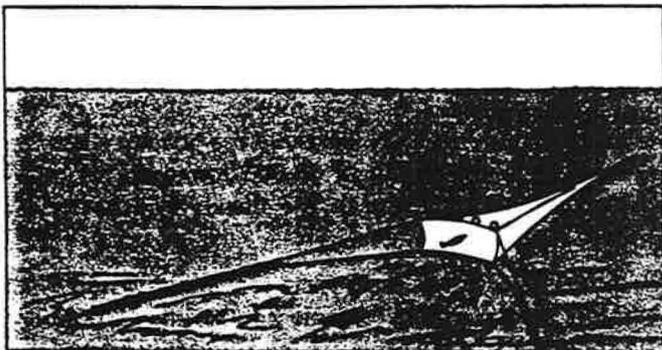
Note: It was reported by several producers that an unknown compound (either liquid or powder), supplied by the Chinese agents of the Hong Kong buyers, was added to the final rinse water prior to the fish being put on the drying racks.

Appendix 5

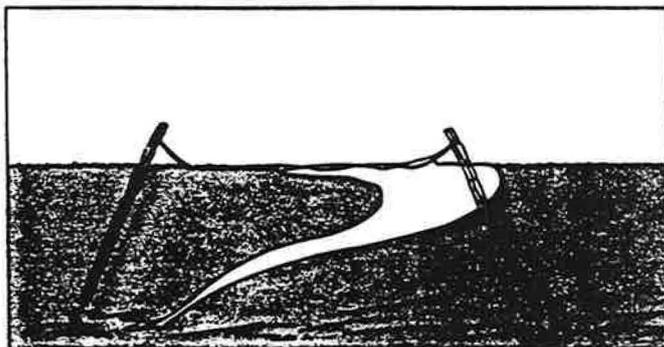
Set-Bag Net



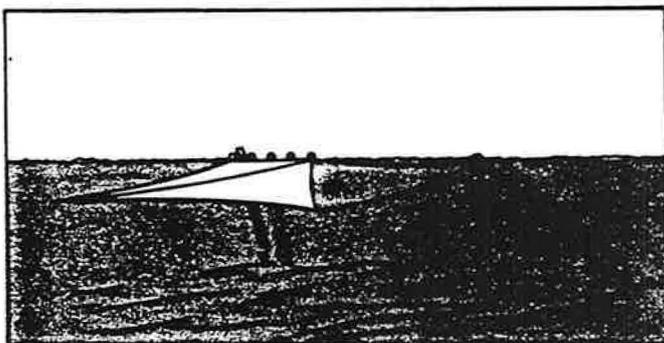
1. During the intertidal period the net is set in the current by attaching it to holdfasts. The net floats on the water surface.



2. When the current gets strong, the net sinks and stretches. Fish drift in with the current.



3. During a subsequent intertidal period the net comes up to the surface and is emptied of catch.



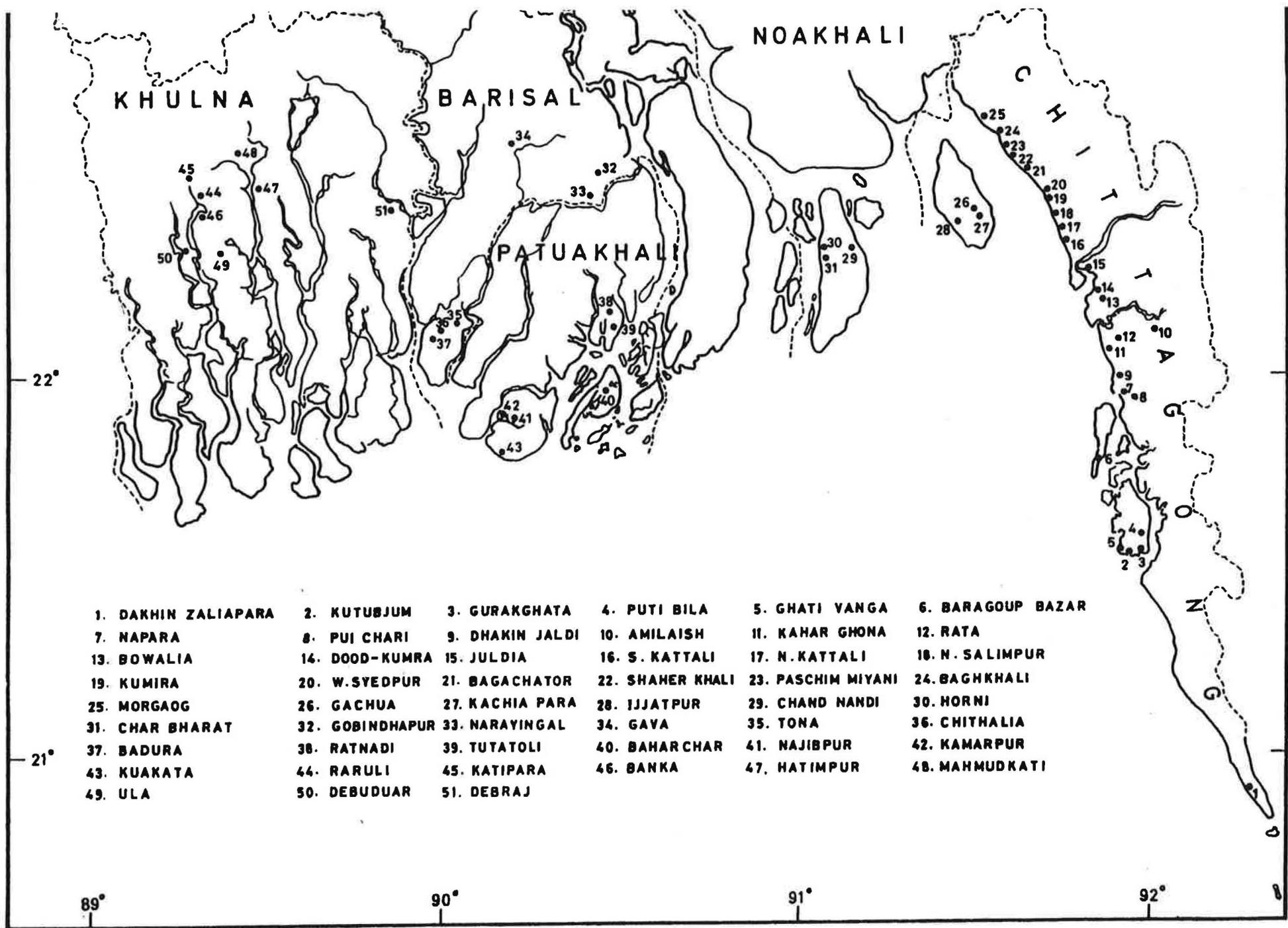
4. The current reverses itself, and the net is set in the opposite direction.



5. As the current gains strength, the net once again sinks and stretches, this time in the opposite direction.

The sequence of operations may be repeated as long as

- (a) satisfactory catches are attained
- (b) the gear remains undamaged, and
- (c) the weather remains fair.



APPENDIX 7

Proposals for Collaboration with Chittagong University

1, Outline Contract with Chittagong University to Provide Technical and Logistical Support for:-

"Application and uptake of insecticides to control beetle infestation of dried fish".

REQUIREMENTS

1, Research Assistant

Most probably a recently qualified M.Sc. student of Chittagong University with an entomological background.

Duties: To assist NRI staff with the setting up of the experiment and then to undertake routine monitoring of insect infestation, weight loss, and moisture content.

Duration: Six months

Remuneration: Tk 4,000 per month

2, Research Supervisor

Most probably an assistant professor in the Zoology Department e.g. Mr Md. Ismail Mia.

Duties: To be responsible for the experiment during the storage period and to supervise the Research Assistant.

Duration: Six months (part-time)

Honorarium: Tk 5,000 per month to represent additional duties.

3, Fish Processing Area

A convenient site where fresh fish, purchased locally, can be processed as necessary and dried on racks. The same site would also be used to treat the dried fish with the insecticide(s).

4, Dried Fish Store

A suitable room(s) of approximately 100 to 140 m²; ideally on or adjacent to the University campus for easy access and good security.
Approximate cost Tk 3,000 per month for six months.

5, Equipment

Weighing balances: a field balance to weight up to 5 kg with an accuracy of 5 to 10 g and a laboratory analytical balance.

Drying oven: to operate at +105°C.

Deep freeze: to rapidly achieve and then maintain -20°C.

Note: Miscellaneous small items of equipment can be supplied from NRI. But if the items listed above are not locally available then purchase or hire within Bangladesh will be necessary.

6, Timeframe: January to July 1992.

7, Total Cost: £1,200 (including local travel and subsistence)

8, Procedure

Any approach to Chittagong University should be addressed in the first instance to the Registrar (with a silent copy to Mr B A Bhuiyan, Chairman, Zoology Department). It should be made clear that collaboration must be with this department and in particular with staff who have had previous experience with *Dermestes* beetles.

Technical Notes

Background

Dried fish are commonly infested by beetles, viz. Dermestidae, during storage both at production sites and during normal marketing practice. Although traders in many countries apply insecticides to dried fish, their selection and application is based primarily on availability and cost rather than on efficacy and a knowledge that the treatment presents no health risk to the consumer.

Unlike blowfly infestation about which a great deal is known, there is much that remains to be determined concerning the control of beetle infestations.

Earlier work undertaken by NRI in dry climates goes some way towards the development of a safe, economic, socially acceptable and efficacious treatment. However, the pressing need is to undertake a final definitive study of beetle infestation in a humid climate that will

rigourously test the protection of candidate insecticides. Specifically, it is necessary to establish the rate at which dried fish take up insecticide sprays and the persistence of such treatments.

The current widespread use of DDT and other non-approved insecticides on dried fish in Bangladesh and the hot humid climate indicate that it is a very appropriate site for this investigation.

Specifics

i, To ensure a supply of dried fish with no previous exposure to insecticides it will be necessary to purchase fresh fish, e.g. ribbonfish, and supervise the drying.

ii, The dried fish will be sprayed (or dusted ?) with up to four candidate insecticides and put into store. The resulting insect infestation and the consequent dried weight loss will be compared to that of untreated fish and fish treated with salt alone. The trial will continue over a period of six months including several months of high humidity to ensure rigourous evaluation of the protectants.

iii, Residue analysis will determine any potential health risk to consumers of the treated fish.

iv, Location:- Chittagong

v, Timeframe:- January to July 1992, i.e. three dry season months followed by three months at the beginning of the wet season.

vi, Manpower:- 3mm NRI time in field
1mm NRI time in UK
1mm NRI residue analysis in UK
9mm local support of Chittagong Univ.

2, Application and Uptake of Insecticide to Control Blowfly Infestation of Sun-Drying Fish in Bangladesh

Objectives:- (1) To determine the extent of the potential health risk presented by current use of non-approved insecticide practice in the coastal regions of Bangladesh.

(2) To establish a protocol for the safe , efficacious, socially acceptable, and economic use of pirimiphos-methyl for the control of blowflies in Bangladesh.

Background

Blowflies commonly infest fish during the initial stages of sun-drying. That this is a problem of economic proportions in Bangladesh is clear from the present widespread use of non-approved insecticides. Although pirimiphos-methyl is cleared for use on fish by WHO/FAO Codex Alimentarius, the compound most commonly used in Bangladesh is dichlorvos.

Dichlorvos is known to be an acutely toxic compound which is normally very volatile under tropical conditions. However, little is known of its affinity for substrates such as fish which has a high protein content and possibly a high lipid content. Consequently it is not approved for use on fish. It remains to be established whether harmful residues are presented to the consumer.

If it is decided to replace the use of dichlorvos on fish it will be necessary to prepare an "extension package" for the use of pirimiphos-methyl under Bangladesh conditions. This in essence will comprise adaptive field research, and "fine tuning" of work undertaken in other countries during the last ten years.

The extent of potential health risk may have a bearing on the urgency and timescale of the replacement programme.

Specifics

i, Undertake controlled field applications of dichlorvos to freshly caught ribbonfish and monitor residues entering the market place.

ii, Undertake controlled field applications of pirimiphos-methyl to freshly caught ribbonfish to ensure efficacious and economic control is achieved without exceeding the maximum permitted residue limit of 8 ppm in the final product.

iii, Location:- Coastal Bangladesh (near Chittagong)

iv, Timeframe:- November 1991 to March 1992

v, Manpower inputs:- 2mm NRI time in field
1mm NRI time UK analysis/support
2mm local assistance of
Chittagong University