Report on a Mission to Thailand and Bangladesh, 11 March - 12 April 1991 to conduct a socio-economic survey of aquaculture and feed utilisation

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Acknowledgements

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Glossary

Aman	Rice planted in the Kharif season during the monsoon (June) and harvested in November to December
Boar	Ox-boar lake
Beel	Natural depression in a flood plain which floods annually
Decimal	Bangladesh measurement of land area, 1 Decimal = 1/100th acre
Discounting	The process of finding the present value (worth) of a future amount.
Feed Conversion Ratio (FCR)	$FCR = \frac{\text{weight gain}}{\text{weight of feed given}}$
Grow out	The phase in which fish are grown to table weight (following nursery)
Hapa	Net cage used for nursery growing of fish fry
Landless	In Bangladesh this is defined as any household owning less that 25 decimals
Marginal value product	The value of additional output generated by an additional unit of variable input
Net Benefit	The amount remaining after all outflows are subtracted from all inflows.
Net present value	The amount remaining after all outflows are subtracted from all inflows.
Net present value	A discounted project value - the present value of the benefits less the present value of the costs of

	the project.
Nursery	The phase in which fish fry are grown on to fingerling size (5-15cm) prior to release into a pond.
Rai	Thai measurement of land area 1 Rai = 1,600 m^2
Sunderbans	Area of mangrove forest in Sw Bangladesh
Switching value	The amount by which an element of the project would have to be changed in an unfavourable direction before the project would no longer meet the minimum level of acceptability.
Upazilla	Smallest administrative unit in Bangladesh

Acronyms

AIT	Asian Institute of Technology
B	Baht (Thai unit of currency) B44 = £1
BAFRU	Bangladesh Aquaculture and Fisheries Resource Unit, Stirling University
BARC	Bangladesh Agricultural Research Council
BRAC	Bangladesh Rural Advancement Committee
BBS	Bangladesh Bureau of Statistics
CAP	Common Agricultural Policy
DOF	Department of Fisheries (Bangladesh and Thailand)
DOT	Department of Trade (Thailand)
EC	European Community
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
IAFMM	International Association of Fish Meal Manufacturers
IAS	Institute of Aquaculture, Stirling University
NGO	Non Government organisation
NRI	Natural Resources Institute
RDRS	Rangpur Dinajpur Rural Services
SPARRSO	Bangladesh Space Research and Remote Sensing Organisation
Tk	Taka (Bangladesh unit of currency) TK64 = £1

1. Introduction

This is the result of a mission to Thailand and Bangladesh between 11th March and 12th April 1991. The terms of reference for this mission are outlined at Annex I. These included the study of small-scale on-farm feed production in the target countries and was specifically focussed on farmer needs. An itinerary for the mission is at Annex II.

2. Background

This report results from a perceived need on the part of NRI to consider the future strength and direction of its research in the area of aquaculture (pre and post harvest) and animal feed utilization in South East and Southern Asia.

This report is split into two sections covering the two countries visited during the mission. An attempt is made to characterise aquaculture in both countries. The results are summarised below.

SUMMARY

The scope for development of small-scale aquaculture as an income generating activity is considerable. Aquaculture has a number of advantages for those with the necessary access to water resources. These include high returns to labour, low initial capital outlay and excellent synthesis within the existing farming and socio-economic system.

The mission was particularly struck by the possibilities presented by semi-intensive approaches to increasing yields. These include supplementary feeding and pond fertilisation. Greatly increased production is possible without the complex technology, management know-how or large amounts of working capital usually associated with intensive fish farming in developed countries.

The development of appropriate fish production strategies in collaboration with farmers has proved particularly successful, producing widely extendable recommendations which are highly robust.

The value of pre-project social and economic appraisal was also highlighted. Where this had been absent, projects were inadequately designed to meet the needs of the market. The mission made particular note of those projects which endeavoured to adopt a demand-led approach. These were markedly more successful than those which were technology led and neglected the needs of the end user.

Key social and economic constraints to further development are: provision of credit, access to resources by disadvantaged groups, particularly women, and marketing of fish.

Technical constraints were considered subordinate to access to know-how. The use of a process approach to developing new technologies was seen to achieve higher rates of adoption. By this we mean a step-by-step progression in partnership with the beneficiaries in which the perceived needs of the collaborators are addressed iteratively, combining available knowledge and technical know-how to produce pragmatic and usable solutions.

There is now, and will be in the future, an increasing need for simple feed for fish. The development and utilisation of feed resources within existing farming systems should follow the approach outlined above and elsewhere in this document. The possible financial, economic and social benefits from increased utilisation of aquatic resources in this way are great.

A number of opportunities exist for NRI and these are outlined. In addition, it is recommended that NRI consider its current work programme in the area of small-scale aquaculture farming systems in the light of these findings. The expansion of demand for know-how presents opportunities for consolidation of our comparative advantages, particularly in the areas of socio-economics, social development, farming systems research, feed technology, and process technology.

3. Recommendations

3.1 Bangladesh

The mission identified a need for improved fish marketing, including better transportation of the product and consideration of keeping qualities.

A request was received from BRAC for NRI assistance with various aspect of small-scale fresh water shrimp production, including feed production and utilisation of shrimp by-products. **It is recommended that NRI should follow this up** and a costed proposal for a mission to investigate the requirements for this work is presented at Annex IX, B and D.

3.2 Thailand

The mission recommends that efforts to link the research of NRI and the Asian Institute of Technology in the area of aquaculture be pursued and that a Regional approach be adopted. To this end an outline memorandum is at Annex IX, E.

The possibilities for use of cassava leaves and tubers as ingredients for fish diets were considered promising. A concept note is presented at Annex IX, A.

3.3 Regional

Any future programmes in aquaculture development should give special consideration to the position of women as possible beneficiaries of inputs. Further investigation of the role of women in aquaculture in Bangladesh is recommended.

The mission is convinced that the adaptive approach used by AIT to develop its recommendations for small aquaculturalists is appropriate for other, similar socio-economic groups in the South East Asia agro-ecological zone. **NRI should consider funding further socio-economic investigation of aquaculture in other countries in the region.** Initially Laos and Vietnam are most promising. A costed proposal is presented at Annex IX, C.

4. Key findings

4.1 Implications of agro-ecological zones

The mission visited two agro-ecological zones, both rice based farming systems. In theory, areas of common climatic and cropping patterns should have common problems and common solutions, though social and cultural norms may differ considerably. Zones may be on the macro or micro scale, allowing for fine differentiation of farming systems where necessary.

4.2 Socio-economic constraints

Small-scale farm families in Thailand and Bangladesh are risk minimisers. They do not seek to maximise returns from individual resources but rather adopt a low input/output strategy, commonly based on subsistence rice production.

The three key socio-economic constraints shared by Bangladesh and NE Thailand are access to credit at a reasonable rate of interest, know-how to carry out profitable aquaculture and access by disadvantaged groups such as women and landless peoples, to the possible benefits from aquaculture. In Bangladesh, access to aquaculture for landless and poor farmers is further inhibited by common ownership of ponds, and lack of tenure.

The provision of credit is an important part of any farming operation, particularly when there is a long time between investment (stocking) and profit taking (harvest). Informal credit is important in both countries, although the interest rates may be very high. Credit is often extended by suppliers in return for customer loyalty. The line of credit may extend from fingerling trader to fish wholesaler, and is an important way of spreading the risk of production and marketing.

4.3 Physical and technical constraints

It is difficult to separate physical constraints from socio-economic ones. There can be an acute lack of labour in NE Thailand due both to high demand during peak rice planting/harvesting and to outmigration of men to urban areas. Small farms are limited in their ability to physically develop

their resources. This can result from both scarcity of labour and/or capital.

The technical constraints are often due to lack of access to an effective extension service. Where farmers have access to reliable and appropriate advice, development can be rapid and innovations come from the farmers themselves. It is important that technical recommendations are low risk and take adequate note of social and economic factors.

4.4 NRI involvement in aquaculture

The team consider that NRI should concentrate its present resources on small-scale farming systems which include aquaculture.

The possibilities for financial benefit as a result of adopting minimum technology, low risk strategies which suit current farming practices, are considerable. The research strategy adopted should be primarily farmer driven. To this end, the mission is recommending the furthering of contact between NRI programmes and in-country operatives who have an established record of effective farmer participation in research. A number of such schemes are identified.

The mission was struck by the effective and appropriate training provided by AIT having met a number of former ODA funded trainees in both countries visited. This confirmed our belief that third country training in aquaculture method is of greater benefit than developed country training and results in a more realistic approach to aquaculture technology and extension.

It is considered that additional socio-economic inputs into aquaculture development programmes, including studies of social norms and marketing constraints, should become a standard part of project identification. This should include a thorough understanding of the socio-economics of the beneficiary population before, rather than subsequent to, disbursement.

4.5 Cross cutting issues

4.5.1 Gender in aquaculture

1. Access to and control over resources

Land

Sen et al (1991) observes that access to and control over resources are two separate issues in determining whether women can participate in aquaculture.

In North East Thailand, women have access to land through matrilineal inheritance of ponds. However, women's ability to control these resources is in doubt, with men making investment and use decisions and controlling subsequent derived income.

In Bangladesh, women are in a very weak position, having neither access to nor control of resources as a result of long standing cultural and religious norms (see Maal and Ali, 1990 for a more in depth review of these norms).

Labour

Sen points out that, in general, it is easier for men to cope with the extra work involved in fish farming since their labour requirements are seasonal, whilst women have fixed, repetitive household duties which vary little. Additionally, female headed households (common in Thailand and becoming increasingly common in Bangladesh) find it difficult to obtain access to male labour for pond construction, harvesting etc.

Credit

Appropriate credit schemes which extend to women and which do not increase indebtedness are an essential element of aquaculture. The ability of women to benefit from such schemes should be considered during their design.

Extension services

The majority of fish farming extension agents are male, who will tend to have most contact with men as heads of households. This is particularly the case in Bangladesh. Interviews in both Bangladesh and Thailand suggested that men, women and children all have some involvement in fish farming where practiced. The danger is that gender bias in extension will lead to aquaculture being regarded as a solely male activity.

Women have lower literacy rates in both Bangladesh and Thailand and, therefore, reduced access to extension material. The level of inter household communication is uncertain (though probably lower in Bangladesh than Thailand) reducing the possibility of extension messages being transferred from male extension agents to male household heads to female household members.

Fingerlings

In both countries studied, fingerling trading was exclusively a male domain. Women who want to buy fingerlings must do so through an intermediary. Hatcheries should consider this problem when marketing fingerlings.

2. Access to and control over benefits

Quantitative

Fish can be consumed within the household or distributed outside for cash or for patronage. Decisions concerning the consumption of fish and the revenues from sales are often controlled by men. This is particularly the case in Bangladesh when cultural taboos limit the ability of women with access and control over resources, to enter markets.

Qualitative

Aquaculture can improve household food security, though the relative nutritional status as a result of aquaculture is dependent upon access to and control over benefits. Changes in intra-household dynamics can result

from variation in relative status brought about by additional cash income. This has implication for expenditure patterns and allocation of resources.

Strategies for increasing the benefits to women from aquaculture

Sen suggests the following strategies:

1. Labour and time: In order to free women's time for income generating activities such as aquaculture, time-saving technologies should be introduced (eg, improved water availability).

2. Credit and Equipment: Credit schemes should be assessed critically against access and control criteria as well as viability before implementation.

3. Extension services: Firstly, women fish farmers should be used as examples to enhance the perception of aquaculture as a female activity. Secondly, staff of existing extension services should be "gender sensitized" ie, trained in gender awareness. Other extension agents with access to women such as health and nutrition workers, should be considered as possible agents for aquaculture extension. Finally, extension material (books, leaflets, videos, posters etc) should show women as actively participating in aquaculture. An example of the successful promotion of women as extensionists is given in Box 1.

Box 1

The use of women extension workers in Bangladesh

The Danida Project in Mymensingh, Bangladesh (see Annex VIII) addresses the problem of extension by and to women with a team of specially recruited and trained female extension workers led by a Senior female extensionist. The team is tasked with identifying and collaborating with women and women's groups. This has proved a successful strategy for gaining access and enabling women to participate in project activities.

4.5.2 The environment impact of aquaculture development

Flood control

Small-scale aquaculture can form part of an extensive water management system intended mainly for crop irrigation. Changes in management practice to allow greater aquaculture production do not necessarily prove detrimental to other parts of the system. The existence of ponds within an irrigation system would increase its buffering capacity which could assist in flood control.

Small-scale aquaculture is often carried out in marginal areas which are prone to flooding. The risk of total crop loss is high and cropping systems may be severely constrained by the need to harvest fish early in order to avoid the risk of loss by flood.

Projects which reduce fish habitat

Uncontrolled aquaculture development may have a negative impact on natural waters by removal of habitats essential for the survival of natural fish stocks, or by the degradation of habitats by pollution. Small-scale, low intensity aquaculture is not likely to have a more significant effect than existing water management and fishery practices.

Large-scale, intensive aquaculture can have highly detrimental effects on the environment unless adequate planning and provision are made for protection. Shrimp culture in mangrove forests has proved particularly destructive. Pollution of irrigation canals and salination of soils may result from poor planning of water supply and effluent discharge.

The Flood regulation measures proposed for Bangladesh may affect those relying on ponds stocked by annual flooding. If the major rivers are prevented from reaching the floodplain, the stock left in small water bodies will not be sufficient to re-populate them. These fisheries rely on an annual input of sizeable fish for immediate consumption and of small fish which can be harvested as they grow. While the measures may benefit those harvesting the main river, it seems likely to deprive others of an important source of food and income.

A deeper understanding of the wider social benefits of flood plain fisheries is required.

Pesticides which can kill fish and fry

Conducting aquaculture as part of a crop based farming system brings with it the hazards of pesticide contamination. Standards of use of agro-chemicals in ldc's usually leave much to be desired. Acute effects of exposure to pesticides are well known, but the long term effects are not.

NRI is currently involved in research in the area of the impact of pesticides on aquaculture.

Population pressure

As the population of ldc's increases, the pressure on their fishery resources will increase. Unless production increases at least as fast as the population grows, availability of fish will decline. Consumption of fish remains high in Thailand, and production of farmed fish is increasing rapidly. However, in Bangladesh there appears to be a long term decline in fish consumption, particularly in rural areas, with prices rising. If population and fish production continue to grow at their present rates, this decline will accelerate.

Many capture fisheries are at, or beyond their maximum sustainable yield and are not likely to make a significant additional contribution to supplies. Indeed, it is possible that over-exploitation may lead to lower yields. Correct management of aquaculture resources could lead to much improved yields for relatively small inputs. A great deal could be achieved by better stock management and by a modest fertilisation regime. The use of feeds could provide a much greater return from aquaculture, if under-utilised feed materials can be found. Some promising materials have been identified by this mission and are considered below.

5. Conclusions

There is considerable scope for the development of small-scale aquaculture as an income generating activity for farmers or as a means of improving food security. Given access to sufficient resources, this is a suitable activity for disadvantaged groups, including landless people and co-operatives.

There are considerable constraints for poor people wishing to become fish farmers, the foremost of which is capital. Without sufficient capital a resource cannot be exploited effectively. The returns from unmanaged fish ponds are low and do not provide enough profit for direct investment in improvements. Provision of credit as well as resources is important for small farmers.

Technical constraints to aquaculture development are of less importance than access to know-how and the adaptation of current knowledge. Where farmers are given sound advice on a regular basis, aquaculture development is rapid. It is important that farmers are given low-risk innovations, which have a high probability of success. A step-wise progression is more likely to be adopted by farmers than one requiring radical change. Once farmers are confident with a technology, they will adapt it to their own needs or ask for specific improvements.

The use of simple feeds, based largely on on-farm resources is a low-risk technology for farmers, relying more on labour inputs than capital. Financial benefits from feeding can raise farmer incomes substantially as well as fish yields. Demand for fish is high in both countries.

Despite apparent social constraints on the involvement of women in aquaculture, experience has shown that they can become involved and benefit from the farming of fish. Projects which specifically target women, or which actively seek to involve women can be successful. The use of women field workers and direct contact with target women's groups is important if women are to retain some control over their enterprises. It is difficult to ensure that women retain all (or even some) of the benefit from aquaculture, and attention needs to be paid to ways of improving this situation.

6. Findings from Thailand Mission

6.1 Introduction

Constraints to increased utilisation of aquatic resources in Thailand include labour availability due to outmigration, access to and availability of adequate water supplies and shortages of inputs such as feed. Fishing is an important supplementary socio-economic activity, particularly in the poorer regions of the country which have not benefited equally from development elsewhere. The use of water resources as a source of supplementary protein and for cash income will become increasingly important, both in Thailand and in neighbouring countries such as Laos and Vietnam as farm families seek to maximise the returns from their available land. These issues are discussed below.

6.2 Aquaculture resources

6.2.1 Introduction

At the time of this visit, the most recent fishery statistics were not available and therefore, the 1986 figures will be used. Aquaculture development in Thailand is a relatively recent phenomenon, especially for commercial farms. The number and area of freshwater fish farms has increased steadily in recent years (see Tables 1 and 2). There has also been an expansion of marine aquaculture, particularly in shrimp farming. Large scale, commercial aquaculture tends to be concentrated in particular areas, with a high concentration of farms in the region of Bangkok.

Table 1: Number and type of Freshwater Fish Farms in Thailand 1980 - 1986

Type of Culture	1980	1981	1982	1983	1984	1985	1986
Total	29,484	31,676	34,154	35,751	38,235	44,321	47,269
Pond	23,470	25,136	27,397	28,942	31,234	36,508	39,015
Paddy-field	4,585	5,028	5,425	5,634	5,725	6,443	6,990
Ditch	610	632	707	575	419	528	554
Cage	819	880	625	600	857	842	710

Source: DOT Statistical Year-book (1988)

Table 2: Area of Fish Farms (rai) in Thailand by type (1 rai = 0.16 ha)

Type of Culture	1981	1982	1983	1984	1985	1986
(Total)	163,695	173,717	233,733	200,766	230,924	241,169
(Pond)	33,042	37,330	52,247	61,294	80,983	90,691
(Paddy-field)	129,127	134,676	179,747	138,123	148,678	149,011
(Ditch)	1,502	1,697	1,693	1,315	1,232	1,443
(Cage)	24	14	46	34	31	24

Note: Total area of Fish Farms in Udon Thani 4,298 rai

Source: DOF Statistical Year-book 1988

6.2.2 Distribution

Since statistics for the whole country are not available (Table 3), it is difficult to assess the distribution of freshwater fish farms with accuracy. There will also be a considerable number of smaller enterprises for subsistence or small-scale commercial aquaculture which are, at present, not quantifiable.

Table 3: Distribution of Freshwater Fish Farms in Thailand by main province 1980 - 1986

Province	1980	1981	1982	1983	1984	1985	1986
Khon Kaen	3,326	2,794	3,471	4,463	4,162	5,842	5,311
Nakhon Ratchasima	1,986	2,230	2,264	2,576	2,919	3,015	3,268
Samut Prakan	2,328	2,295	2,321	2,286	2,281	2,950	2,966
Udon Thani	1,916	1,967	2,205	1,915	1,802	2,208	2,362
Chiang Rai	1,001	1,182	1,340	1,475	1,563	1,747	1,745
Ubon Ratchathani	927	1,101	1,166	1,132	1,366	1,444	1,771
Nong Khai	955	1,061	1,081	1,106	1,318	1,374	1,490
Chachoengsao	1,451	1,349	1,400	1,330	1,234	1,280	1,385
Nakhon Pathon	523	730	753	945	1,234	1,302	1,333
Bangkok Metro	481	476	488	506	534	612	716

Source: DOF Statistical Year-book 1988

6.2.3 Farm type

It can be seen from Tables 1 and 2 that farm size varies considerably, with paddy field farms being largest on average. However, this will not reflect the production from the different types of farm as paddy fields yield fish as a secondary crop and are low yielding. Cage farms, by contrast, would be extremely high yielding due to their small size. The descriptor "pond" is also misleading as it would be inappropriate to compare an intensive Clarias farm near Bangkok with a small farmer's pond in the NE.

6.2.4 Farmed fish

Although a very wide range of aquatic organisms is farmed for food in Thailand, aquaculture production is dominated by a few species. These are a mixture of traditional Thai species (e.g. gourami), with introduced species such as tilapia. Markets for fish tend to be regional and therefore the mix of fish being farmed shows a marked geographical variation. The quantity and value of major farmed, freshwater fish is shown in Table 4.

Table 4: Quantity and value of major freshwater fish produced in Thailand, 1986.

Common name	Scientific name	'000 tonnes	Baht (million)
Nile tilapia	*Oreochromis niloticus*	18.4	22.0
Gourami	*Trichogaster pectoralis*	16.1	24.3
Catfish	*Clarias spp*	15.8	35.8
Catfish	*Pangasius*	12.6	12.4
Silver barb	*Puntius gonionotus*	8.8	15.6
Snakehead	*Ophiocephalus spp*	6.0	20.3
Freshwater prawn	*Macrobrachium rosenbergii*	4.5	43.0
Total		82.2	173.4

Source, DOF

6.2.5 Intensive fish farming

Intensive fish farming is carried out for two purposes, for food fish and for fingerling production. Intensive food fish farming is well developed, and is similar to that found in other, more developed countries in SE Asia. Culture is at high density with a complete ration being fed. Aeration is often used (e.g. paddle wheels). These farms concentrate on the production of higher value fish such as Clarias and snakehead for the urban market although live, fresh and frozen fish may be transported considerable distances to meet market requirements.

6.2.6 Small-scale fish farming

It is difficult to define where control of wild fish populations stops and fish farming begins as so much of the Thai farming system has evolved to maximise the yield of fish of wild fish. However, there is a substantial (but unquantified) amount of small scale fish farming, mainly in ponds. The ponds usually have multiple uses and are more likely to have originated for reasons unconnected with aquaculture (e.g. irrigation). It is almost

certain that production from this sector in underestimated due to the problem of quantifying a large number of small ponds and in estimating their production.

6.2.7 Marine shrimp farming

Although not the specific subject of this mission, the opportunity was taken to examine intensive shrimp production in the Songkhla area. This has expanded very rapidly in recent years and large areas of paddy have been turned over to shrimp farming. The farm visited was part of the Aquastar organisation, and was run as a contract growing operation, farmers receiving advice and being supplied with feed by the company. On the basis of the figures supplied by the company, this appears to be a highly profitable operation and is run efficiently. They are in no need of outside help and are quite capable of undertaking their own development.

This development has not been without its problems, and the uncontrolled expansion of shrimp farming in the Songkhla area has had some negative impacts. Conversion of rice irrigation systems into shrimp pond supply or effluent channels has denied their use to rice farmers. The same channels are often used for effluent by one farm and for supply by another. Farmers attempting to obtain high profits by high stocking levels (60-70 PL/m^2) have made their own ponds unusable through self-pollution and uncontrollable disease outbreaks, made worse by the routine use of antibiotics. Ponds degraded in this way cannot currently be rehabilitated.

6.3 Feed resources

6.3.1 Fish meal

Thailand is a major producer of fish meal, producing about 230,000 tonnes in 1989 (IAFMM, 1990), compared with global consumption of 6.5 million tonnes and a global export market of 3 million tonnes. Increased internal demand has led to a fall in fish meal exports from 72,000 tonnes in 1985 to 30,000 tonnes in 1988. Production appears to be levelling off (Table 5 and 6), probably as a reflection of increasing pressure on fishery resources. Fish meal is produced from two main sources. The main supply of raw material is trash fish, including waste from the large fish processing

industry. This yields a low quality fish meal due to the high bone content. Higher quality meal is produced from Sardinellas, a small, pelagic fish. Due to their generally low oil content, de-oiling is not necessary. This also means that fish meal plant can operate by direct drying, so the drying temperature is high. The production of speciality meals for the prawn feed industry is lacking and is one area for possible expansion. Fish meal prices vary from B14-16/kg for lower grade meals to B20/kg for premium grade.

Table 5: Catches of trash fish and Sardinellas used for fish meal production, quantity produced and number of fish meal plant, 1972 - 1986.

Note: trash fish includes processing wastes

	Total Catch Tonnes		Quantity used in fish meal production - Tonnes				
Year	Trash Fish	Sardinellas	Trash Fish	Sardinellas	Total	Total fish meal production Tonnes	No. of fish meal Plant
1972	719,091	11,376	365,880	2,275	73,176	73,176	37
1973	804,478	34,285	458,870	6,857	465,727	91,774	54
1974	690,270	58,222	450,297	11,644	461,941	94,717	64
1975	634,971	63,522	507,976	12,704	520,680	94,980	66
1976	620,646	105,692	496,516	21,124	517,640	119,880	69
1977	836,643	214,077	690,914	42,815	733,729	138,304	73
1978	847,421	145,278	829,131	58,111	887,242	197,165	79
1979	784,267	161,890	784,267	24,605	808,872	180,956	91
1980	786,858	105,413	751,982	21,083	773,065	184,054	95
1981	796,747	139,800	753,317	28,727	782,044	186,201	99
1982	812,789	116,898	738,429	26,168	764,597	182,047	94
1983	803,337	124,901	770,791	46,373	817,164	194,563	98
1984	757,637	117,323	808,382	73,136	881,518	209,885	95
1985	776,421	97,742	832,111	67,573	899,684	214,210	92
1986	976,236	121,242	815,766	54,263	870,029	207,150	93

Source: DOF Statistical Year-book 1988

Table 6: Fish Meal: Number of fish mealplant, quantity of marine products used in fish meal production and quantity produced by province, 1986.

Note: Trash Fish includes processing wastes.

Province	No. of fish meal plant	Quantity of marine products used in fish meal production - Tonnes			Total fish meal prod. Tonnes
		Total	Trash Fish	Sardinellas	
Trat	4	40,596.20	40,586.50	9.70	9,665.76
Chanthaburi	4	29,843.00	29,843.00	-	7,105.48
Rayong	4	48,225.00	39,268.00	8,957.00	11,482.14
Chon Buri	1	3,343.00	3,278.00	65.00	795.95
Samut Prakan	8	69,365.00	69,365.00	-	16,515.48
Samut Sakhon	10	90,692.00	90,692.00	-	21,593.33
Samut Songkhram	2	3,904.00	3,831.00	73.00	929.52
Prachuab Khiri Khan	5	33,138.00	31,853.00	1,285.00	7,890.00
Chumphon	8	70,527.37	58,977.96	11,549.41	16,792.23
Surat Thani	4	36,114.43	36,114.43	-	8,598.67
Nakhon Si Thammarat	12	77,714.00	67,842.00	9,872.00	18,503.33
Songkhla	9	146,966.04	146,966.04	-	34,991.91
Pattani	4	25,914.00	23,950.00	1,964.00	6,170.00
Satun	4	30,380.00	30,380.00	-	7,233.33
Trang	4	57,467.00	56,977.00	490.00	13,682.62
Ranong	6	69,135.28	50,980.99	18,154.29	16,460.78
Phangnga	1	2,597.14	996.83	1,600.31	618.37
Phuket	3	34,107.00	33,864.00	243.00	8,120.71
Total	93	870,028.46	815,765.75	54,262.71	207,149.61

Source: DOF Statistical Year-book 1988

Some trash fish or Sardinella is also used directly for fish feed or in moist diets. Prices and supply are very variable, and trash fish is often much more expensive on an equal dry weight basis than fish meal. Prices for trash fish in Songkhla vary from 4 to 6 B/kg. Such fish will vary from 20-25% dry matter, giving an equivalent cost of B16-30/kg. Industrial fish, as used for lower grades of fish meal sells for B2.5/kg.

Direct use of trash fish is limited, and is mostly by sea bass farmers. Trash fish is used for reasons of palatability. Prices of trash fish can fluctuate due to variations in supply, and in times of prolonged bad weather may be unavailable for several days at a time.

6.3.2 Grain by-products

Rice bran is a mainstay of the Thai feed industry and is widely available throughout the country. Quality varies considerably, with that from large mills being of better quality than that from village or on-farm rice mills. The coarse rice bran tends to contain large amounts of husk and other fibrous material. Competition comes mainly from the poultry industry. From the rice production of 21.3 million tonnes (1989), rice bran supply will be about 2.1 million tonnes.

6.3.3 Oilseed residues

The range of oilseed residues produced in Thailand is limited and availability may be highly regionalised. Only two oilseeds suitable for inclusion in fish feeds are produced in any quantity. 1989 production of soybeans was 617,000 tonnes, and that of groundnuts 177,000 tonnes (weight in shell). Soybean meal is also imported from a number of countries. The NE is particularly constrained by an acute lack of protein sources as there is very little oilseed production and processing in the area. The situation may improve slightly as the growing of sunflower is becoming more popular. However, the oil extraction industry to support this appears to be lacking in the NE, and cake from small scale extractors is said to be used as crop fertiliser rather than animal feed.

6.3.4 Root-crops

Cassava production is a major industry in Thailand, with the NE being the most important production area. A total of 23.5 million tonnes of root was produced in Thailand in 1989. Much of the cassava is produced as an export crop, but it can also be an important ingredient in animal feeds. Despite being a major producer of cassava only 3.5% is used in domestic consumption (Konjing, 1989). Changes in EC policy on Common Agricultural Policy (CAP), due to be implemented from 1992 will mean that cassava will be less attractive to the European feed industry. The removal of subsidies from European grain is likely to cause the price to fall in line with the world price. In order to remain competitive, cassava prices would also need to fall.

Nutritionally, cassava offers little more than an energy source, but in fish feeds it does serve the very important purpose of being a binder. Cassava has tended not to be competitive against maize for inclusion in non-ruminant feeds, but it offers real opportunities for improved on-farm utilisation outside of maize growing areas. In addition to the roots, the leaves can also be harvested to provide a protein supplement (see proposal A at Annex IX). Literature figures indicate that up to 5 tonnes of leaf dry matter per ha can be obtained at harvest. Serial harvesting of leaves may increase the yield, but the effects on root yield would need to be established.

6.3.5 Minor raw materials

There are many potentially useful raw materials available for use in fish feeds in Thailand. The localised or limited availability of many means that they are not realistic options for industrial feed production. However, some show considerable scope for on farm use e.g. vegetable gardening wastes, seed tomato waste. Seed tomato growing is an expanding industry in Udon Thani area. At the time of this visit, tomatoes were being harvested, and the seeds extracted. The villagers had no plans for disposal of the residue, and most was simply left to rot. There were not enough pigs to eat all the tomato waste produced. The waste could be dried and used as animal feed. Data on tomato pomace (Gohl, 1981; Tacon, 1987) show that the dried pulp would be medium protein (21%) and high in fat

(10%), making it suitable for a variety of animals. Against this, the waste may be bitter, reducing palatability and can contain tannins. Further investigation is needed.

6.3.6 Industrial feed production

Two main sorts of freshwater fish feed are produced at present, one for herbivorous fish and the other for catfish. The herbivorous fish diet is low protein (<20%) and is reported to have a high feed conversion ratio. The catfish diet has a higher specification (>30% protein) and a low FCR. It is widely used by intensive catfish farms. Combined production of freshwater fish feeds is about 60,000 tonnes per annum. An additional 10,000 tonnes of freshwater prawn feed is also produced.

Production is in the hands of a small number of companies and is dominated by the multinational CP group which has feed mills throughout SE Asia. The bulk of fish feed is produced on extruders to provide a floating feed, suitable for pond and cage culture.

The expanding penaeid shrimp farming industry has led to a large shrimp feed industry to support it. Some of this production is by integrated farming companies and it is difficult to obtain reliable estimates of production. Based on shrimp production, it can be assumed that shrimp feed production is in the region of 80,000 tonnes per annum, although much high figures were quoted by one feed company.

6.3.7 Livestock production

Considering the relatively advanced state of the Thai economy, especially near Bangkok, livestock production is still unsophisticated and much is rural based. Figures for the national livestock population (Table 7) show a surprisingly small number of poultry, suggesting that village production may not be included. As with many developing countries, it may be expected that the broiler industry will grow rapidly, providing competition for feedstuffs with other livestock sectors.

Table 7: Livestock population of Thailand, 1989.

Category	Number
Cattle	5,285,000
Buffaloes	5,443,000
Pigs	4,679,000
Sheep	145,000
Goats	100,000
Chickens	95,000,000
Ducks	16,000,000

Source, FAO

6.4 Aquaculture in NE Thailand

6.4.1 Introduction

The NE of Thailand is the least developed part of the country and is lacking in resources and investment. This part of the country is less prosperous than others due, in part, to the long dry season which means that only one rice crop can be obtained per year and to the poor soil quality. The area does have a relatively rich fishery resource and freshwater fish features extensively in both the rural and urban diets (see Table 8 and 9). The high demand for fish is currently met by aquaculture, capture fisheries and the importation of fish from other regions. A considerable trade in marine fish supplies 200 tonnes of fresh fish and 180 tonnes of salted fish (mostly Pacific mackerel) to the NE every day.

Table 8: Consumption of animal products in rural communities in NE Thailand (kg/person/year)

Item	Water resources			
Food	Rich	Medium	Poor	Average
Duck egg	3.2	4.1	1.2	2.9
Hen egg	1.6	0.8	1.2	1.1
Pork	6.6	5.4	2.4	4.3
Beef	5.5	5.8	5.3	5.6
Duck meat	0.6	0.8	0.5	0.7
Chicken	10.0	9.3	7.0	8.4
Freshwater fish	36.4	25.1	13.3	21.5
Marine products	4.9	4.8	5.8	5.2
Fermented fish	5.1	6.0	6.1	6.0
Frog	2.3	5.1	6.6	5.4
Freshwater mussel	3.7	4.2	1.9	3.2
Total	79.9	71.4	51.3	64.3

Source : DOF/CIDA survey of fish consumption (1989)

Notes : Average is a weighted average based on rich:medium:poor water resources of 1:5:4

Total freshwater fish consumption in NE Thailand 394,981 tonnes p.a.
Total value of freshwater fish consumed in NE Thailand 11,794 million Baht (c.f. pork 6,879 million Baht)

Table 9: Consumption of animal products in rural NE Thailand by household economic status (kg/person/year)

Item	---------Economic status---------		
Food	High	Medium	Low
Duck egg	4.1	2.5	2.1
Hen egg	1.6	1.3	0.9
Pork	6.9	4.4	2.7
Beef	7.8	5.9	4.3
Duck meat	0.9	0.6	0.6
Chicken	10.7	9.0	7.0
Freshwater fish	27.6	24.7	23.5
Marine product	5.5	5.1	4.7
Fermented fish	5.1	6.1	5.9
Frog	4.2	4.9	4.7
Freshwater mussel	2.5	2.7	3.8
Total	76.9	67.2	60.2

Source : DOF/CIDA survey of fish consumption (1989)

6.4.2 Demand for aquaculture products

From Tables 8 and 9 above it can be seen that there is a considerable demand for aquaculture products in the NE. Total freshwater fish consumption in the NE was 394,981 tonnes worth B11,794 million (DOF/CIDA), compared with pork valued at B6,879 million. The inclusion of marine products would add substantially to the value of aquatic produce consumed. The market shows no sign of being fully supplied at present, although demand/supply trends were not available. In addition to marine products being imported into the region, there is also a large trade in fresh and frozen fish from Bangkok. Live Clarias and snakehead and frozen tilapia are trucked up from Bangkok area daily. Large transporters carry the fish to distribution points where they are off-loaded onto smaller trucks for distribution to local markets. The diffuse nature of this market made it difficult to quantify, but interviews with fish traders and information

supplied by AIT Outreach Project staff suggest that at least 10-12 large trucks travel up from Bangkok daily. At a conservative estimate of 10 tonnes of fish per truck (the live fish require little water), at least 100 tonnes of freshwater fish is being imported to the NE every day.

All persons interviewed, whether involved in production or marketing of freshwater fish said that selling their fish was not a problem. There are problems associated with marketing, but these relate more to logistical problems of transporting fish in rural areas. Locally produced fish can be sold at a premium, compared to fresh or frozen fish, as there is a high demand for live fish. Transporting fish to local markets alive should prove possible, although this is more difficult with the carp dominated crops currently being harvested.

6.4.3 Aquaculture production

It can be seen from Table 3 that Udon Thani Province has developed a fish farming industry. However, data from a thorough survey conducted by the Outreach Project shows that there is considerable potential for expansion. Data quoted in Outreach documents (Working Paper No 6), shows that the DOF has estimated there to be 3,297 fish farming families in Udon Thani in 1988, a substantial increase on the 1986 figure. However, the broader definition used by the Outreach Project, which includes those fish farming as part of water management, suggests that as many as 13,000 families may be involved. Pond production in many farms is low as there is little management, and production is the same as that in natural water bodies (60-120 kg/rai/year). Relatively simple extension messages developed by the Outreach team have improved production by Project farmers to an average of 250 kg/rai/year. There is potential to improve production further and so the scope for the NE in general is enormous. Some farmers are now obtaining yields in excess of 350kg/rai/year.

Fish farming in Udon Thani has evolved as part of the rice-based farming system, and is intricately linked to other aspects of crop production. Initial improvements were simply to modify irrigation ponds or catch pits built into rice fields so that their fish retention capacity was improved. Through the Outreach Project, this has been progressively modified to include stock management, proper fertilization regimes, better pond design,

and feeding. However, it should be stressed that many ponds still retain a vital function for the rest of the farm for irrigation, buffalo wallows etc.

Project farms are small averaging from 37-84 rai, depending on agro-ecological zone. Ponds are also small, typically 0.8-1.0 rai. Other crops on farms vary, but the dominant crops for the region are rice and cassava. There are a great many other crops which are grown for cash income and for food. Most farms have a small vegetable plot. Agricultural production in the NE is generally constrained by poor soils and a prolonged dry season. Some areas also suffer from saline soils, partly due to natural causes and partly due to uncontrolled salt mining. Water shortages have also been exacerbated by commercial forestry development with eucalypts, which have been blamed for lowering the water table. The water shortage was acute at the time of this mission, and the NE had been declared a drought area. This was the result of several years of below average rainfall. This problem is severe in the southern parts of the NE.

Low rainfall imposes some restrictions on fish farming in the NE, but these still allow for a growing period of at least 10 months, more than enough time to rear small fry to marketable size. The local market accepts (and may prefer) fish of relatively small size (200-400g) and so a prolonged grow-out period is not essential.

6.4.4 Demand for fish feeds

Like other Outreach Project recommendations, the use of feeds for fish has evolved from fairly crude and ineffective inputs of materials to an attempt to balance and optimise feed utilisation. The concept of feeding fish was novel to farmers at the start of the Project and the benefits were not apparent to them immediately. The 80 Project farmers currently receiving recommendations, have widely varying feed input patterns, ranging from no supplementary feeds to all off-farm feeds. Those farmers interviewed by this mission showed an appreciation of the benefit of feeding their fish and were even attempting to improve their returns by better feeding techniques. Project farmers have requested assistance in the manufacture of simple, supplementary, compound feeds (See case study in Annex VI). These are perceived by the farmers as being the next step in a progressive

increase in pond production. Some farmers have experimented with simple dough type mixes, but are constrained by a lack of know-how on formulation and manufacture.

6.4.5 Feed resources

So far, the Outreach Project has identified over 100 different pond inputs being used by fish farmers in Udon Thani. Some of these are purchased (e.g. rice bran, duck feed concentrate) and others are available on farm, either as residues from crop processing/harvesting, weeds or crops specifically grown for feed. The great variety of potential feed materials poses some problems. Quantifying feed inputs is difficult, although these data can be obtained (see Outreach Progress Report No 3). Inputs have varied from a few tens of kg per rai to several hundred kg, but comparison is difficult due to the diversity of feeds, and the problem of comparing green fodders with dry feeds.

It would be extremely difficult to quantify the feed resources available to all fish farmers in the NE without a considerable manpower effort. However, from data already available in Outreach Project documents, it can be assumed that farmers have access to a substantial feed resource. The next stage of the process is to find ways of optimising the utilisation of these feeds. Current feed use appears to be relatively inefficient and it is likely that feeds are being used in an inappropriate manner.

Cost models show that farmers who adopt the Project recommendations have a better return than those who do not. Development of these models has demonstrated that the use of a simple feed could be highly profitable, and provide a high return for farmers. If all the 13,000 fish farming families were to follow Outreach Project recommendations, their total incremental net benefit would be approximately B17 million (at March 1991 prices and assuming average pond size of 1 rai). The use of a simple compound feed could increase this to B22 million (£0.5 million) based on an estimated incremental net benefit after finance of B1721/rai (See financial case study 3, Annex IV). Pre-visit trials carried out at AIT by the NRI Feed Technologist have demonstrated the feasibility of on-farm manufacture of such feeds, based largely on on-farm resources. It will be necessary to develop this work through close liaison with farmers through field staff in

order to enable a set of extension messages to be drawn up which would allow farmers to prepare their own feeds. Due to labour and technical constraints of on-farm feed production, farmers' inputs will be vital to this stage of development.

6.5 Socio-economic aspects of aquaculture

6.5.1 Introduction

As Duncan (1990) has observed farmers in NE Thailand are almost certainly risk minimisers who do not attempt to maximise returns to any single resource, typically using a low input/low output production strategy based primarily upon subsistence rice production. For small farms (2-17 rai[1/]), off-farm, non-agricultural incomes are increasingly important, reaching above 50% of total farm income in some areas.

6.5.2 Methodology

The analysis summarises recent simulation models (Duncan, 1990) and surveys completed as part of the ODA North East Thailand Outreach Project (AIT, 1990). The purpose is to explore the financial implications of small-scale aquaculture against various other alternatives available to farm families in the area drawing out implications for on-farm labour use and returns to labour.

The following crop options are compared: vegetables, lowland rice, kenaf, cassava (less than 30 rai), fish culture (both project recommended and actual production by project farmers) and cattle. This approach is used to summarise returns to various farming options and is not meant to be exhaustive. Risk minimising farmers may choose crops for a number of reasons of which pure financial return is only one. Returns to labour, tradition, peer pressure, diversification and rotation are others.

6.5.3 Results of case comparisons

Table 10 summarises the cost and returns from various farm production options. Details of project recommendations for aquaculture are given at

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1/ One rai = 1,600m^2

Annex III. This shows that the highest income is available from vegetable production, though labour input is high resulting in a lower return to labour. Fish production as practiced by the project collaborators has good returns to labour but this figure is an under-estimate due to overfeeding. It was found that project farmers invested over heavily in costly and inappropriately formulated purchased feeds, increasing inputs costs out of proportion to returns. On this evidence, aquaculture is an attractive option for labour-scarce farm families.

Table 10: Costs and returns to agricultural activities in NE Thailant

Crop	Cost Costs[1]	Net benefit	Labour	Net benefit/ labour day
	B/rai	B/rai	day/rai	B/day
Vegetables	5600	8400	100	84
Rice	560	40	12	3
Sugar Cane	2075	1916	52	37
Cassava (<30rai)	745	875	16	8
Cattle	881	119	20	6
Fish (I)	604	1896	15	126
Fish (II)	2898	3352	20	168

Notes: (I) Including labour at B40/day

Fish (I) without project Case 1) see Annexes III

(Fish (II) with project Case 2) and IV

It is noticeable that though returns to rain-fed rice are low, and that costs are negligible, typical of risk minimising low input/output production systems.

The fixed and working capital requirements of aquaculture for small-scale farmers is an important issue if significant take-up amongst target populations is expected. Issues of access to credit and availability of seed capital become increasingly important as incrementally more intensive aquaculture systems are considered.

6.5.4 Financial Cost

A financial cost/benefit analysis for a number of different production options is presented at Annex IV. The basis of the feed conversion, ratios, standing crop and production calculation are shown in Annex V. Four cases are considered:

Case 1: Without AIT Outreach Project, assuming the farmer purchases fry and harvests fish but no further inputs other than basic pond maintenance.

Case 2: With Outreach Project recommendations (see Annex III). Here it is assumed that nursery hapas are used to protect fry from predation and feed is used during fry rearing. During fish grow out, a pond fertilization regime using urea and buffalo manure is recommended.

Case 3: Recommendations prescribed in Case 2 followed with use of additional supplementary feeds in the last 90 days of the grow-out period.

Case 4: Case 3 except supplementary feeding continuous throughout the 202 days of grow-out.

In Annex IV (Tables 1-4) the net present value of Case 1 is compared with all other cases. At all discount rates (8%, 12%, and 16%), the preference between cases is as follows:

4 > 3 > 2 > 1

Table 11 summarises these results and the results of sensitivity analyses on feed parameters. The latter show that if both th ecost of grow-out feeds and the FCR were to increase by 20%, the preference ranking would change to:

2 > 3 > 4 > 1

However, if feed costs and the FCR were to decrease the preference ranking would not be any different to that for the standard scenario.

Switching values were calculated. These are the values for various inputs or parameters at which farmers would be indifferent between the improved farming techniques and traditional practises (because the net present values would be the same). Table 12 shows these values for case 3. (This case, and not the financially more attractive case 4, is likely to be preferred by farmers because the labour requirements are more compatible with existing demand for on-farm labour). See Figure 1.

Figure 1: On-farm labour patterns for selected crops in N E Thailand

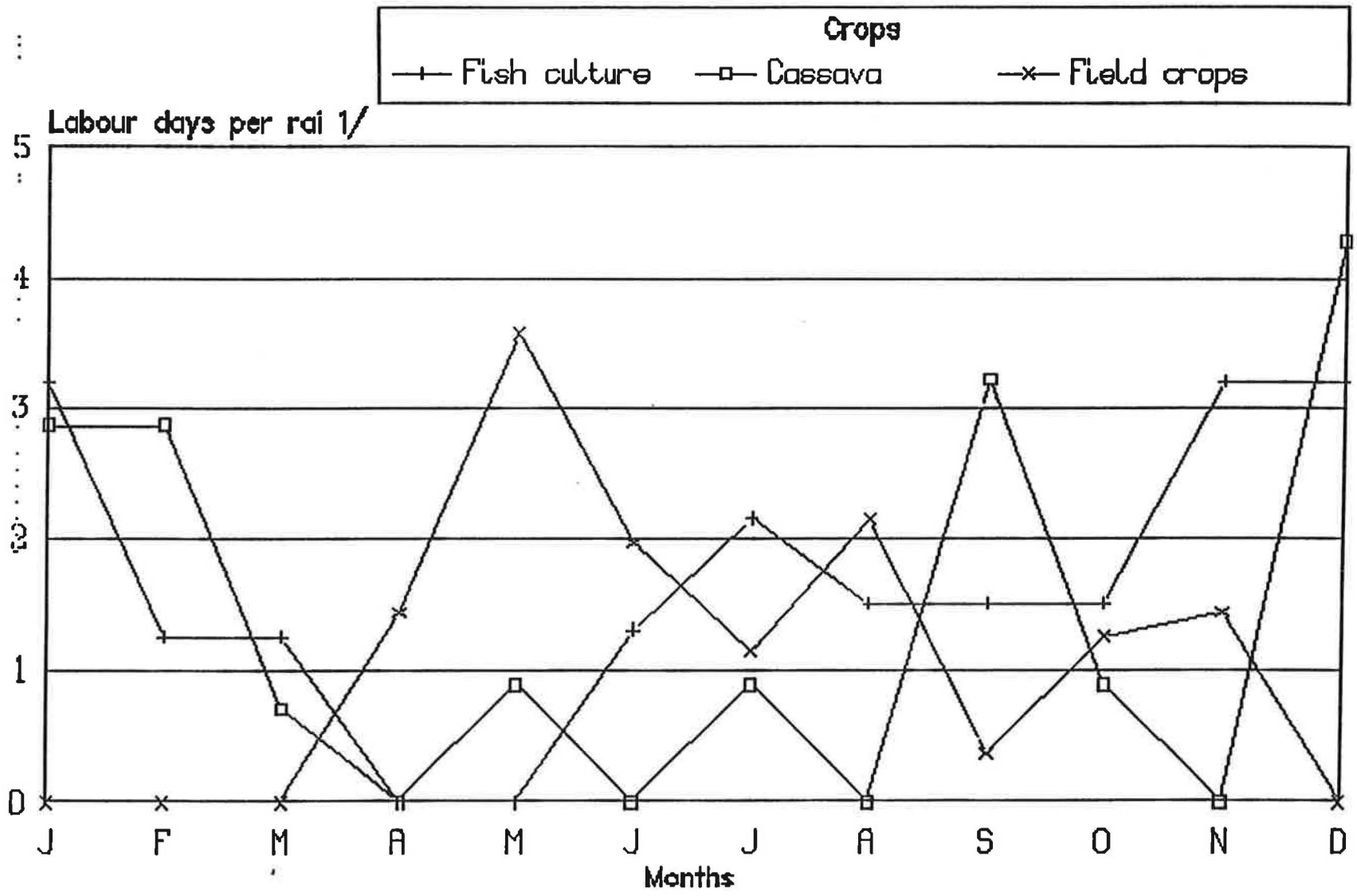

TABLE 11: Sensitivity analysis showing the effect of changes in feed costs and feed conversion ratios on net present values (AIT recommendations/supplementary fish feeding)

Discount rate	Case y	Base model Feed costs March 1991 Feed conversion Ratio 5[2/]	Feed costs + 20% FCR 6	Feed costs - 20% FCR 4
8%	1	12,722	12,722	12,722
	2	23,089	23,089	23,089
	3	27,108	16,272	37,945
	4	32,127	14,903	49,352
12%	1	10,713	10,713	10,713
	2	19,433	19,433	19,433
	3	22,817	13,692	31,942
	4	27,043	12,539)	41,548
16%	1	9,164	9,164	9,164
	2	16,615	16,615	16,615
	3	19,510	11,704	27,316
	4	23,125	10,718)	35,532

Conclusions:

Base assumptions	4 > 3 > 2 > 1
FCR 6 Feed cost + 20%	2 > 3 > 4 > 1
FCR 4 Feed cost - 20%	4 > 3 > 2 > 1

Notes:

1. See text
2. See Annex V for derivation of feed conversion ratios

Table 12: Switching values for 90 day supplementary feeding (case 3)

Variable	Break even value	Current value	% increase/ decrease
Price of mixed feed (B/kg)	8.3	3.5	+ 136%
Price of fish (B/kg)	16.1	25.0	- 36
Opportunity cost of labour (B/day)	189.0	40.0	+ 473%
Price of Urea	15.6	5.0	+ 312%
FCR	20.8	5.0	+416%

Source: based on information in Annex IV

These results show that case 3 is most sensitive to the price of fish and feed, but fairly insensitive to other inputs costs/parameters.

6.5.5 Conclusions

The financial analysis suggests that supplenentary feeding is financially beneficial and that, of the three options, case 4 offers the greatest returns. However, information on farm family labour use suggests that case 3 is likely to be preferred by farmers, because the associated labour demands are more compatible with the labour demand calendar.

6.6.1 Access to and use of water resources

A study of 6 villages in Northeast Thailand in 1988 (Lovelace et al, 1988) indicated that the utilization of small water resources was dependent upon the three key factors;

1) locational factors, ie, positioning of the pond, topography, access to markets for fish and irrigated products, availability of other natural resources such as irrigation/drinking water;

2) farmer factors, ie, identification of and response to the real needs of farmers, local organisation and leadership, anticipated vs. actual benefits, economic conditions, and conflicts of interest;

3) factors relating to planning and communication, ie, relationship between local authorities, individual farmers and the implementing agency.

Combined together, these factors are the basis for understanding the position of farm families with access to manageable water resource who are likely to be the clients of aquaculture extension efforts.

Discussions held with a number of farmers (see Annex VI for sample summaries of interviews) plus secondary sources combine to produce the following outline of insights into the structure and make-up of society in the project area:

6.6.2 Village structure, labour exchange and production

Typical villages of the region comprise on average 710 people in 105 families (Khonkaen 1986). These villages tend to be clustered and separated from household agricultural holdings. Homesteads are used for living and storage. Lack of space usually means that vegetable production is conducted in the fields in close proximity to water sources.

Traditionally, villages do not have public markets, so most people go to towns or district centres for supplies.

Land rights are traditionally inherited through the female line in Thai-Isan culture, so men usually acquire land through marriage. The result is a general fragmentation of land holdings and a high degree of mobility amongst the rural population. Virtually all land in the region is owner occupied. Average land holding in the region in 1986 was about 32 rai (5.2 ha).

A traditional system of exchanging labour is practised in Northeast Thailand. Called `long khack' this involves farmers assisting neighbours and relatives during peak production periods in return for reciprocal assistance in time of need. Labour exchange is becoming less common as a result of upland cropping which involves much tighter labour scheduling, and also because of the increasingly common practice of hiring labour.

In addition to major crops (rice, kenaf, cassava) farms usually have clumps of trees grown for subsistence and sale (ie, kapok, coconut, banana, papaya, and mango). Most farms have vegetable gardens located near water supplies (average size in the Khon Kaen study was 48 sq m). Common vegetables are beans, chillies, garlic, onions and Chinese cabbage.

Livestock is typically in the region of around 3 buffaloes, 1 cow, a pig and several chickens per household. Buffaloes are important role as draft animals. They also confer status upon the owner.

Sericulture is important in the region and mulberry bushes are common around villages and on farm land. The study by Khon Kaen showed that most farms in flood plain areas had access to fish ponds, swamps, streams of

rivers for fishing and that such non-crop agricultural activities provided a significant percentage of the gross income of households. Non-agricultural activities involving both men and women include production of cotton, mats, baskets, salt, knifes, rice containers and ox carts (see Khon Kaen, 1986). At this time off-farm income was shown as growing more than twelve times faster per annum than on-farm incomes.

6.6.3 Labour availability and use

Rural Thailand is experiencing a general labour shortage as a result of out-migration and increasing wage earning opportunities in urban industries. Fish culture requires regular small labour inputs, especially during the nursery stage. Labour inputs during the grow-out stage are minimal and can be timed to fit in with the general pattern of daily labour needs. Harvesting of fish can be delayed for some time, in which case the pond becomes a food storage unit or a method of saving. Returns to labour for a number of crops are shown at Table 10 above.

Use of labour for fish culture is at its lowest during the month of May and peaks in November at harvesting (Figure 1). This coincides with a peak in paddy harvesting during the period November to January. A strong desire for formulated feed for use during this key part of the season has been expressed by project farmers. 3/

6.6.4 Targeting of beneficiaries

A number of interview were conducted with farmers involved with the Outreach Project (see Annex VI). On the whole early participants perceived themselves to be amongst the better off members of their communities with access to their own pond and ownership of their own land and homestead. Fish production was seen to confer a number of advantages apart from additional financial returns. These included increased status as a result of project involvement; an ability to provide fish for feasts, cultural events and guests; and greater food security.

Out migration, especially amongst the male population, means that increasingly women are left in sole charge of the farmstead. What

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3/ See AIT (1990b)

difference this makes to these women's ability to have access to and control over resources is uncertain and should be the subject of further investigation (see Section on Gender in Aquaculture 4.5.1 above).

The development of more intensive aquaculture systems is already having some multiplier effects. Groups of fish catchers were identified (see Annex VI, case study 4). There was evidence of the use of hired labour for pond construction. Demand for feeds, including commercially available duck feed concentrate was seen to outstrip supply in the region during 1990.

6.6.5 Fish marketing and marketability

Discussions with farm families, women and market traders produced an outline picture of the main qualitative characteristics of three key fish available in the Region.

These are presented below in Box 2:

Box 2: Results of focus group discussion

Characteristic	Name		
	Tilapia	Grass carp	Common carp
Grows quickly	*		
Tastes good	*		
Tastes bad		*	*
Easy to feed (visible)	*		
Easy to steal	*		
Keeps the pond clean		*	*
Blooody		*	

Note: "" denotes a characteristic of importance to producers and consumers*

Source: discussions with farmers

Tilapia, which are quick growing are considered "tasty" by most consumers (despite being quite boney). They usually feed at the surface, therefore the farmer can check on his/her crop. It is generally perceived that this characteristic also makes them easy to steal. Consumers did not like the flavour of either of the carp and were especially troubled by the poor cooking characteristics of the grass carp which was considered "bloody". Both carps are bottom feeders, and their ability to cleanse the pond was highly prized.

What is interesting about these results is that many apparently important characteristics were not mentioned. Saleability, keeping qualities, size at full growth, availability of fry etc, were all considered less important

than speed of growth, taste, cooking characteristics, visibility and manageability.

Availability of fry and marketing do not seem to be a major constraint at the moment. Much fish is produced for home consumption or for sale within the village. If a producer does go to market, rural communications are good, ice is readily available, and markets are accessible.

7. FINDINGS FROM THE BANGLADESH MISSION

7.1 Introduction

The major constraint to increased food production in Bangladesh is land. The cultivatable area has remained roughly the same since independence whilst the population has increased by about 50%. In Bangladesh, fish make up 80% of the protein in the average diet. In recent years the gap between supply and demand has widened as a result of pressure on traditional freshwater fish production, population increases and urbanisation. It has been estimated that more than 10m households engage in seasonal subsistence fishing which represents an important socio-economic activity. Additionally, there are said to be nearly a million professional fishermen, whose livelihoods depend on continued demand for their services.

Increasingly, aid donors are turning to aquaculture as a possible solution to the protein supply problem. Success has so far been variable. The issues emanating from this development are discussed below.

7.2 Aquaculture resources

7.2.1 Introduction

Bangladesh is a country rich in aquatic resources. Tables 13 shows the amount of freshwater fisheries currently in production and Table 14 the value that this adds to production. However, these figures underestimate the potential as there are many water bodies which are not being utilised fully and many more small water bodies which were missed by the pond census. SPARRSO (1984) estimated that as much as 43% of ponds may be derelict and therefore not producing their full potential. Ammen, (1987)

quotes production of only 148 kg/ha/year for derelict ponds. Unmanaged ponds can produce over twice the yield, and cultured, low intensity managed ponds can produce 1161 kg/ha/year. This last figure can certainly be improved upon further. Fishery resources are underestimated as many small, village ponds were missed by the census. In the immediate area of Mymensingh, DANIDA found twice as many ponds as the official estimates and are still finding new ponds.

Table 13: Bangladesh freshwater fisheries resources

		Area (ha)
(a)	Capture	
	Rivers, estuaries	1,030,563
	Beels & haors	114,161
	Kaptai Lake	68,800
	Flooded lands	2,832,792
	Capture total	4,047,316
(b)	Culture	
	Ponds	148,346
	Baors	5,488
	Shrimp farm/ coastal aquaculture	51,812
	Culture total	205,646
	Inland total	4,252,962

Source: DOF Survey 1986, quoted in Ul-Ameen, 1987

Table 14: Gross value of agricultural products in Taka million based on 1984/85 prices

	--------Current prices---------			---------Constant 84/85 prices----		
	86/7	87/8	88/9	86/7	87/8	88/9
Crops	164,975	167,646	176,467	139,596	137,119	134,509
Forestry	20,544	25,374	24,187	11,168	12,038	12,309
Livestock	16,222	17,875	21,266	12,801	12,922	13,348
Fisheries	18,020	207,28	23,472	12,685	12,822	12,871
Total Ag products	219,761	231,623	245,392	176,250	174,901	173,037
Total Agric Products as % of GDP	40.76	38.79	37.20	39.84	38.43	37.08

Source: BBS (1990)

7.2.2 Distribution of fisheries resources

The distribution of fisheries resources in Bangladesh is fairly even, although the type of resource available varies with region. Ponds are evenly distributed (Hasan, 1990), and , since so many of these are small, probably represent the major resource for rural poor. The distribution of other fishery resources is much less even. The presence of a substantial baor (ox-bow) fishery is dependent on the presence of a major river. Rural communities often have access to capture fisheries either in rivers or in enclosed waters, and these form an important resource.

7.2.3 Fishery production

Given the problems of estimating the total area of the inland fishery in Bangladesh, production figures should be seen as indicative only. Total inland fishery production in 1987-88 was 599,523 tonnes (Table 15), about 72.5% of total fishery production. 175,925 tonnes was from inland aquaculture. This gives an average production of 855 kg/ha, which is well below the potential of 1161 kg/ha. This would yield 291,000 tonnes of fish if it were applied to all cultured water bodies. The capture fisheries (inland and marine) account for 79% of total fish production.

Table 15: Total fisheries catch 1987-88, tonnes

Inland Fisheries		
		Tonnes
(a) Capture	1. Rivers & estuaries	183,817
	2. Sunderbans	8,066
	3. Beels	45,610
	4. Kaptai Lake	4,068
	5. Flood lands	182,037
	Capture total	423,598
		(51.2%)
(b) Culture	1. Ponds	149,423
	2. Baors	1,254
	3. Shrimp farms	25,248
	Culture total	175,925
		(21.3%)
	Inland total	599,523
		(72.5%)
	Marine fisheries	227,582
		(27.5%)
	Country total	827,105

Source: BBS (1990)

7.2.4 Fish farm types

There were no statistics available on the characterisation of fish farms in Bangladesh. The definition of a fish farm in Bangladesh would also need clarification since many water bodies undergo some form of management in order to obtain or increase a fish yield, but are not farmed as such. As little as 27% of ponds may be under managed cultivation (Hasan, 1990). From interviews conducted with aid workers in Bangladesh, it is apparent that formal fish farming is virtually non-existent, and only conducted

by a few, commercial operations. The vast majority are conducted as small co-operatives, or as grace and favour fisheries by land owners. The latter are maintained more for social reasons in maintaining patron/client relationships than for financial reasons. As far as the rural landless are concerned, two main types of water body are available for cultivation. Large ponds which have previously been derelict have been taken over by NGOs such as the Grameen Bank and are being leased back to fisheries co-operatives. These ponds have the potential for substantial yields, and may extend to over 10 ha. The greatest number of ponds are the very small village ponds which are only a few hundred square meters in area. Problems do occur with multiple ownership and with conflicting uses for water, but these ponds are the main resource for landless fish farmers.

7.2.5 Farmed fish

The dividing line between cultured and capture fisheries in not well defined in Bangladesh as there is no clear line dividing managed from unmanaged waters. Rather there is a gradation from totally unmanaged waters, through those where natural stock or water management is carried out, to properly constructed ponds which are deliberately stocked. Thus, virtually the entire ichthyofauna of Bangladesh may be regarded as being farmed to some extent. However, for practical purposes, the cultured fish are relatively few. The Indian major carps are the most valued, and are in great demand for stocking. However, the greater culture problems of the Indian carps (e.g. longer grow out period) has meant that the Chinese carps have found some favour. They are not the favoured fish for consumption, but rapid growth and higher yields available through polyculture make them an attractive proposition (See also Section 7.5.10). Another introduced fish, the Thai silver barb is also finding favour. A typical polyculture would be based on silver carp, common carp and at least two of the Indian carps, mrigal and rohu. Catla, although being very popular as food fish, are less good for pond stocking as the fingerlings are expensive, and the fish are traditionally grown for a two year period.

7.3 Feed Resources

7.3.1 Introduction

There is an acute shortage of feed materials in Bangladesh and this situation is almost certain to deteriorate. There is intense competition for all feed materials. Rice by-products are an important source of fuel in rural communities (Tables 15 & 16). Additional competition comes from the livestock population, which is deficient in feed materials. These problems are compounded in poor, rural communities where the option of purchasing feeds may not be available. As with many developing countries, there is a trend towards urbanisation. Coupled with the increased demand for meat and fish products from higher income groups, this has led to materials being drawn from the countryside in to the towns.

Table 16: Energy supplied by traditional fuels - million tonnes

Year	Cow dung	Jute stick	Rice straw	Rice hull	Bagg-asse	Wood leaves	Twig	Other	Total
1980-81	5.2	0.9	3.6	4.3	2.2	0.7	2.2	2.2	21.3
1984-85	5.6	0.8	3.2	4.9	2.3	0.8	2.4	2.4	22.4
1988-89	6.4	1.3	3.5	4.6	2.3	0.9	2.4	2.4	23.8

Source: BBS (1990)

Table 17: The importance of agricultural by-products as domestic fuel

	Total	Straw/ leaves/ cowdung	Husk	Wood	Kerosene	Gas	Elec	Other
Bangladesh	100	71.75	0.20	23.50	1.87	1.40	0.33	0.95
Urban	100	19.54	0.93	50.43	13.79	11.71	1.62	1.98
Rural	100	78.61	0.11	19.97	0.30	0.04	0.17	0.80

Source: BBS (1990)

7.3.2 Grain by-products

The two major grain by-products of use to fish farmers are rice and wheat brans. Rice preparation is unusual in Bangladesh in that the rice is par-boiled and then re-dried before dehusking. Total production of rice bran is about 1.6 million tonnes, of which an unknown proportion is husk. Competition from the growing poultry industry is intense in some areas. It was reported that at times no rice bran is available in the markets around Mymensingh as it shipped down to Dacca for feeding intensive poultry. If the poultry industry undergoes a period of expansion similar to that in India, it may be expected that materials will be drawn in to Dacca from other areas, particularly as the transport network improves. About 3 million tonnes of wheat is available in Bangladesh, which should yield 780,000 tonnes of bran. Again, this will be competed for by the livestock industry.

It should be noted that straw and husk derived from grain processing are very important to rural communities. It is estimated that 35-40% of rice straw is used as fuel. Additionally, 25-30% is not usable as it is harvested wet. Given that there is a substantial shortfall in fodder for cattle in Bangladesh (Dickey and Haque, 1986) and that draught animals are particularly badly affected, there is an urgent need to address this problem. A substantial amount of fuel is used in par-boiling rice, and much of this is derived from rice by-products. Current boiler designs are inefficient and attention to improved boiler design (e.g. NRI suspension burner) could free fodder for cattle feed. Linked with the production of e.g. Napier grass, this could bring about a considerable improvement in the nutritional status of ruminants.

7.3.3 Oilseed residues

There is an even greater shortage of oilseed residues which would be expected to provide the bulk of protein in fish feeds. To make matters worse, most of the oilseeds contain anti-nutrients or toxins which constrain the use in fish diets. Total oilseed and oilseed residue production is low (Tables 18 & 19). Compared against the total livestock population (Table 20), it is obvious that supply is totally inadequate if intensive feeding is to be undertaken.

Table 18: Production of oil/seed cakes (various years 1985-87)

Item	Tonnes
Mustard oil cake	75,500
Cotton seed cake	10,000
Linseed oil cake	4605
Til seed cake	11,600
Total	101,705

Source: Bangladesh Agricultural Research Council (1990)

Table 19: Production of oilseeds 1987-88 ('000 tonnes)

Rape & Mustard	Til	Linseed	G'nut	C'nut	Castor	Misc	Total
222	49	43	48	86	0.36	0.19	448.5

Source: BBS (1991)

Table 20: Livestock population, 1983-84 livestock census

Item	'000
Cattle	21176
Buffaloes	457
Goats	8725
Sheep	490
Poultry	78371

Source: BBS (1990)

7.3.4 Fish meal

Production of fish meal in Bangladesh is so small that it is probably best regarded as insignificant (see Table 21). The total production is only 650-750 tonnes of which just 250 tonnes is of higher quality. There is some potential for increasing fish meal production by landing rather than dumping by-catch from the marine shrimp fishery. However, this could almost certainly be better utilised for direct human consumption, and its use in animal feed would be difficult to justify. Some small shrimp (Acetes) are used as fish meal. It is not known whether these are included in the totals for fish meal production. There is scope for the production of shrimp head meal as most of the processing waste from shrimps is currently discarded, amounting to some 5,000 tonnes annually. This should supply at least 1000 tonnes of shrimp head meal, which is equivalent to low grade fish meal. The material would be in demand from the expanding shrimp feed industry. From information obtained by this mission, most of the shrimp head waste is dumped (some at sea), causing pollution and wasting a valuable resource. BRAC has attempted to set up small scale shrimp head meal production as a means of income for landless communities, but was constrained by a lack of know how. A proposal for a joint project with BRAC is contained in Annex IX, B.

Table 21: Fish meal production, 1990

Grade	Tonnes
A1	250
A2	150-200
B	200
Total	650-750

Source: Direct trade inquiries

7.3.5 Slaughter house waste

Several researchers suggested to the mission that slaughter house waste could be a significant feed resource. While it is true that slaughter house waste can provide high quality animal protein, a brief examination of the availability shows that it is not likely to make any significant contribution to overall supply. It is estimated that only 374 tonnes of blood is discarded annually. Most slaughtering is not carried out at formal slaughter houses, and the logistical problems of trying to recover such a widely dispersed resource would be enormous.

7.3.6 Minor materials

There are many materials which are available for animal feed in Bangladesh, but most are not available in quantity. It would be difficult to establish a coherent strategy for their effective utilisation as availability is often highly localised and seasonal.

7.3.7 Potential feed materials

There are many potential feed materials suitable for inclusion in fish feeds. However, for reasons of low availability many will have little overall impact on the country's feed supply. The team was treated to a number of depressing interviews with research scientists who were carrying out work wholly inappropriate to the needs of Bangladesh. Even if the work were to be useful, the impact of work on any raw material available in amounts less than 100,000 tonnes must be highly questionable. Additionally, much of the work has already been done elsewhere.

There are some attempts to approach the problem realistically. Aquatic weeds have considerable potential, although their availability is obviously localised. Composting water hyacinth has proved particularly successful and its use is being promoted by a number of NGO's. Analysis of data provided by the Grameen Bank shows that aquaculture systems using compost are highly profitable and require low manpower inputs (See Section 7.5.6 and Annex VIII).

The potential for production of feed for aquaculture is very limited as most cultivatable land is currently fully utilised. Grasses for herbivorous fish feed production could provide additional feed and their h

high productivity (60 tonnes/ha/year) makes them an attractive proposition. Pond banks are not utilised fully for growing crops. If the average pond of 1180 m^2 is taken to be square, the slope area on the inner bank would be about 380 m^2 (assuming a bank height of 2m and a slope of 45^0). This could yield up to 2280 kg of Napier grass, which, at a FCR of 27 would yield an 84 kg of herbivorous fish. Additional yield from other fish would be expected due to the pond enrichment due to grass feeding. The direct increase in yield would be 15-20% for the project areas visited. If this could be applied to all 1,288,222 ponds in Bangladesh, the additional yield could total 147,166 tonnes, an increase of 80% in freshwater farmed fish production. It is, however more realistic to expect that due to problems of bringing the whole, available area into production for the entire growing season, that the yield would be somewhat less than this.

Growing green fodder for fish feed could have additional benefits. With irrigation, grass production can be maintained year round. However, it would not be needed all year, so surplus production could be diverted to cattle, possibly through hay production, for use in times of fodder shortage. It should be noted that there are substantial social constraints to developing such a feed resources due to multiple ownership of ponds and the need to retain access for cattle, washing and bathing. Other uses for pond banks may appear to be more profitable (e.g. vegetable growing) but growing grass for feeding of a communal pond may overcome some of the problems with ownership which have hindered effective pond development.

7.3.8 Livestock production

It is impossible to take one section of rural agriculture and treat it in isolation as so many of the aspects are inextricably linked. The link between livestock and aquaculture is mainly competition for feed. As stated in section 7.3.1 above, there is simply not enough feed to go around. There are cases where feed utilisation could be improved, such as wet season rice straw. Feed are not only in short supply, but the supply is unbalanced. RDRS informed the mission that in the Dinajpur area, cattle are faced with an annual shortage of about 50% of required feed, but with 70-80% shortage of digestible crude protein. Cattle, especially draught animals lose weight through the dry season. There is a clear need for some urgent action to address the problems facing rural cattle owners.

The main input from livestock to aquaculture is manure for pond fertilizer. Attempts to integrate fish and livestock production have been made, but as in other countries, this approach does not seem to be applicable to small-scale farming. The two examples of small scale poultry production examined by the mission seemed almost certain to be loss makers, and were not suitable ventures for risk minimisers as they required a high capital investment and had a long payback period.

It should also be noted that human sewage is an undervalued pond input in rural Bangladesh. While it is generally held that the use of night soil for pond fertiliser is unacceptable to Bangladeshis, it is common practice for the pond to be used as a communal toilet. This accounts for the green colour of many ponds, and their high productivity despite the apparent lack of inputs.

7.4 Aquaculture development

7.4.1 Demand for aquaculture products

There is a large demand for freshwater fish in Bangladesh, and if productivity is not increased, demand will outstrip supply in the near future. This is discussed further at 7.5.3 below. Despite some short term variations, the general trend has been for an increase in the real price of fish. It is doubtful whether an increase in supply would benefit the rural poor or landless as they cannot afford to eat much of the fish they produce at present. Table 22 shows that per capita availability of fish has remained more or less static as assessed from production data. However, there is a marked difference between this data and that from the household consumption survey (Table 23). While the data are incomplete, they suggest that total country supply of fish is increasing. They also shows that there was a sharp decline in fish consumption by rural communities from 1962-82. It is not known whether this trend has continued. Consumption of fish is believed to have been high in the past, but changes in the way in which data were collected mean that comparison is difficult. From interviews conducted during this mission, it is generally felt that urban demand, especially from Dacca will continue to expand, and that the market

will respond accordingly. The Grameen Bank has already started trial shipments of fish from its Joysagor fish farm to Dacca.

Table 22: Per capita availability of basic foods kg per annum based on production data

Year	Foodgrain	Meat	Pulses	Eggs	Fish
1978-79	164.5	2.19	2.3	11	7.54
1983-84	164.3	3.97	2.0	14	7.60
1988-89	159.3	3.13	4.1	12	7.72

Source: BBS (1990)

Table 23: Per capita consumption of fish based on household expenditure survey

	1962-63	1975-76	1981-82	1983-84	1985-86
Rural	10.1	8.5	8.4	n.a	n.a
Bangladesh	n.a	9.9	10.2	11.0	13.1

Source: BBS (1990)

7.4.2 Scope for development.

The main scope for increasing aquaculture production in Bangladesh is by bringing more water bodies into production and improving the management of those already under cultivation. Depending upon how much the pond fishery resource has been underestimated, this could result in a four to eight-fold increase in freshwater farmed fish production. This can be achieved without any startling new technical innovations, using tried and tested methods already in use by development projects.

Several, inappropriate suggestions have been made for increasing aquaculture production in Bangladesh, the least promising being that of the introduction of intensive production, based on developed country

technology. Since such systems rely on a steady supply of electricity, spare parts, and feed and require a high capital input, it is difficult to see how such schemes could be implemented.

7.4.3 Training and institutional development

There was a disturbing lack of realism about the aquaculture research being carried out at the Institutes visited by this mission. Very little thought seems to be given to the end product, and while some of the research may be scientifically, it is unlikely to be of any developmental benefit to Bangladesh. Characteristic of the approach was the obsession with detailed nutritional experiments with complete feeds. It must be questioned what is the point of doing such work must be questioned, when it cannot be applied. Additionally, much of the information on amino acids levels, proximate composition and anti-nutrients is available in the literature, and this is simply repeating work done elsewhere. A substantial body of literature has been generated in India which would be applicable directly in Bangladesh.

The reasons for such an approach are not obvious. It may be that the training received in developed country institutes in not appropriate to the needs of Bangladesh. Certainly, most researchers interviewed showed a formal, academic attitude to their work. It was notable that the one fishery officer who had received developing country training was significantly more aware of the needs of poor farmers, and of the social and financial constraints they faced. There is also a lack of motivation among government sector workers to carry out field based extension work as it is regarded as low status work, and allowances for field work as not sufficient. The single extension worker at FRI, Mymensingh has a petrol allowance of 10 litres a month. Clearly, he is not intended to do much field work.

The obsession with copying developed country institutes is reflected in the high capital investment in laboratories, and in the consequent laboratory based approach to work. More contact with farmers, and a pond based research programme would almost certainly be of greater developmental use. Suggestions that research institutes should adopt a farmer-orientated research policy met with bemusement.

7.4.4 Non-Government Organisations

By contrast, the NGOs contacted showed a much greater degree of awareness of the need for farmer involvement, although they varied in the degree to which this has been adopted. It was also noted that most recommendations for farmers were low-risk, and did not involve a substantial outlay. There were a few exceptions to this, such as the RDRS small scale poultry project, but mostly, additional inputs were limited in terms of expenditure and labour. There are a number of NGOs which could be suitable partners in any NRI aquaculture related projects.

7.4.5 Fry and fingerling supply

Despite substantial expenditure, the public sector has failed to make a significant impact on fry and fingerling supply. Public sector involvement has been characterised by poor productivity, substantial losses, and a lack of appreciation for the way in which the fry and fingerling markets operate. By contrast, the private sector has flourished, and has expanded rapidly to meet demand. In between are the NGO hatcheries, such as those run by the Grameen Bank. These are a good example of what can be achieved. Some large, loss making hatcheries were taken over from the DOF. By installing business managers rather than aquaculture technicians, the Grameen Bank has managed to turn these round into productive and profitable units.

The private sector and now the Grameen Bank have turned away from expensive, mega-hatcheries and have concentrated on dispersion into a larger number of small and very simple mini-hatcheries. In the most basic form, even the buildings are dispensed with. Even such basic hatcheries are capable of high levels of production. One of the Grameen Bank mini-hatcheries visited produced 32 kg of fry last year (equivalent to about 14 million fry). In addition to being much cheaper to build, mini-hatcheries are more accessible than centralised hatcheries.

In addition to the local hatcheries, large numbers of fry and fingerlings are dispersed from hatcheries in Jessore area. Some of the fingerlings are derived from hatcheries and some from the natural production in rivers. This trade is enormous and dwarfs any contribution made by local

hatcheries. In Dinajpur district, over 100 million fry and fingerlings are supplied from outside the area. However, the rapidly expanding private sector is certain to take a large share of the market in the future. In addition to supplying fish, the fingerling traders perform a number of important social functions, especially the supply of credit. Schemes to improve fry and fingerling supply without provision for credit are much less likely to prove attractive to farmers. The traders also provide a useful and effective channel for the spreading of extension messages. The patron/client relationship is very important in fingerling trading and attempts to alter this may not be well received. The provision of credit is vital in fry and fingerling trading. The usual practice is to provide credit of 50%, and this extends along a line of supply. Thus a fingerling trader would obtain 50% credit on purchases from a hatchery and would then supply fingerlings on the same basis. Aquaculture development in Bangladesh is not likely to be constrained by fry or fingerling production.

Fingerling farming is an attractive proposition for poor farmers, as while it involves some outlay for fry, feed and fertiliser, the turnaround time is short, and the profits are high. A farmer can recoup the entire outlay on fingerling rearing in less than a month. An experiment initiated through the ODA Parbatipur Project seems particularly suited to poor farmers as it involved use of existing facilities. Fry were stocked into paddy fields for growing on. The first trials indicate that the fry grow well, reaching 1-3 g in under a month. By partial harvesting of fingerlings from a catch pit, farmers can respond to local markets as and when fish are required. There is also a thriving business devoted to fingerling rearing in ponds, but this seemed to be conducted mainly by better off traders. Spreading fingerling rearing through a large number of farmers has the advantage of increasing access to fingerling supplies in rural areas.

7.4.6 Demand for fish feeds

There is almost certain to be an increasing demand for fish feeds. This need is unlikely to be met from in-country resources. Even discounting competition from other sectors, there are simply not enough feed materials available. Taking the DANIDA project recommendations as an example, rice bran and mustard oil cake are fed at the rate of 18-30 kg/decimal, in the

ratio 3:1 during the earlier part of the rearing cycle. If this were applied to all fish ponds in Bangladesh (148,346 ha, at 247 decimal/ha), then 490-825,000 tonnes of rice bran, and 165-275,000 tonnes of mustard oil cake would be needed. The lower figure for mustard oil cake is greater than the entire production of oilseed cakes in Bangladesh. The figure for rice bran is slightly more realistic, but still requires 25-50% of all rice bran production. Clearly feed is not the answer to increased fish production in Bangladesh, and any use of feed must be targeted carefully. The use of feeds for fry and fingerling nursing appears to be worthwhile, although this will still place excessive demands on feed supply. Several farmers and extension workers complained that even the modest use of mustard oil cake in fry rearing had pushed up the price.

One sector of aquaculture which may benefit from the use of feeds is the marine shrimp farming industry. Although not the specific subject of this mission, a feed mill was visited in order to ascertain the current state of the art in Bangladesh. There are only three fish feed mills in Bangladesh. The one visited is run by Sabinco, a joint Saudi/Bangladeshi operation. The diets rely heavily on high quality materials such as fish meal and wheat. Even a modest increase in production is not likely to be met from in-country supply of key raw materials, and large quantities will need to be imported. In the case of shrimps, this may be justified as the resulting gains from exports should more than offset the cost of raw materials.

7.4.7 Impact of increased aquaculture activity

Those interviewed by this mission were generally optimistic about the future of aquaculture in Bangladesh. The prospects for small-scale, low input aquaculture seem good, and this should prove of direct benefit to ODA target groups (landless, poor farmers) in financial terms. However, increased consumption of fish by rural communities is less certain, as it is currently of more benefit to sell the fish than to consume it. In some cases, selling the fish may be the only option due their indebtedness. The high demand for fish will probable result in rising prices. While there are negative aspects to this in that it will make fish unavailable to poor people, it will have the benefit of increasing their incomes, and may

therefore improve their ability to purchase basic foodstuffs such as flour and legumes.

Intensive aquaculture has a much less certain future and the impact on rural communities is not likely to be positive. Capitalisation required for intensification is beyond the means of even co-operative groups, and is only possible for well off sectors of the population. Demand for feeds from intensive aquaculture may have the effect of removing key materials from the market and forcing up prices. This may have a negative impact on more traditional aquaculture.

Generally, the environmental impact of freshwater aquaculture from low-input, primary production based systems is not likely to be significant. The greatest impact is from shrimp farming. Serious concerns were expressed by some of the bodies contacted about the negative effects of the expansion of shrimp farming in Bangladesh. Disadvantaged groups have been particularly badly affected, with landless people being displaced, and loss of access to traditional fishing areas. Environmental degradation has also occurred through widespread destruction of ecologically sensitive, coastal zones such as the Sunderbans. The introduction of intensive shrimp culture would bring with it problems of effluent disposal. The large amount of waste generated by the shrimp processing industry is likely to increase, with resulting impact on the environment. It is a waste of a valuable resource to simply dump this material, and it is recommended that steps be taken to encourage its recovery.

7.5 Socio-economic aspects of aquaculture

7.5.1 Background - fisheries and aquaculture in Bangladesh

Fish for human consumption are available from a variety of source in Bangladesh, including the Bay of Bengal, the three major rivers, oxbow lakes, seasonally flooded lowlands, excavated pits and canals. Increased population, rural-urban migration and higher incomes allied to ecological changes, such as river siltation and poor water management, have led to depletion of these natural fish stocks. Solutions include intensifying traditional fish cultivation and bringing more ponds into cultivation. Figures supplied by the Bangladesh Bureau of Statistics suggest that there

are about 1.3 million ponds in Bangladesh with an area of about 147,000 ha. Average pond size is 0.11 ha. Recent surveys suggests that over 50% of these ponds remain uncultured or derelict.

The implications of this under-utilisation of resources are explored below.

7.5.2 Fish Supply

If shrimp culture is not included, annual growth in fish production in Bangladesh between 1983/84 and 1987/88 was 1.8% (Department of Fisheries figure). Production for the export market between 1981/82 and 1988/89 increased in volume by more than 13% per year. However, between 1984/85 and 1988/89 this growth has been averaging 4% per year. The results of applying these moderate growth figure to supply for domestic consumption are presented below in table 24.

Table 24 Projections for the supply of fish

Year	Fish supply	Fish Export
	(000 tonnes)	
1987/88	795	32.0
1990/91	839	36.0
1994/95	901	42.1
1999/20	985	51.2
2004/05	1,077	62.3
2009/10	1,177	75.8

Source: DOF

Supply of fish is projected to grow from 795,000 tonnes in 1987/88 to 1.2 million tonnes by the year 2009/10 under conservative growth estimates. Exports of fish are projected to grow from 32,000 tonnes in 1987/88 to 75,800 mt under moderate growth estimates.

7.5.3 Fish Demand

Growth in domestic demand for fish and fish products is determined by growth in the following factors: population, per capita income, income elasticity of demand for fish and fish prices. The population of Bangladesh was estimated at 108,851,000 in 1988 (World Bank, 1989) and was growing at a rate of 2.8% per annum. The World Bank project that this rate of increase will decline whilst per capita income will increase (see Table 25. Income elasticity of demand for fish is taken from Hossain (1988).

Table 25: World Bank Projections for Population and per capita Income Growth

Period	Annual Population Growth (%)	Annual per Capita income Growth (%)	Income Elasticity of Demand Fish (%)
87/88-94/95	2.8	1.2	1.03
94/95-99/00	2.7	1.4	1.03
99/00-04/05	2.6	1.5	1.03
04/05-09/10	2.5	1.6	1.03

Source: Hossain (1988) and World Bank (1989)

Based on these assumptions and using the formula:

$$\text{Growth in fish demand} = \text{population growth} + \left[\text{income elasticity of demand for fish} \times \text{growth in per capital income}\right]$$

thus;

87/88 to 94/95: 2.8 + (1.3 x 1.2) = 4.0%

94/95 to 99/00: 2.7 + (1.3 x 1.4) = 4.1%

99/00 to 04/05: 2.6 + (1.3 x 1.5) = 4.2%

04/05 to 09/10: 2.5 + (1.3 x 1.6) = 4.2%

Using these figures it is possible to estimate per capita domestic fish demand and compare it against estimated per capita domestic fish supply:

Table 26: Potential domestic per capita supply and demand for fish

Year	Pop' (million)	Fish supply kg/capita/yr	Fish Demand kg/capita/yr	Supply as a % of demand
87/88	109	7.29	7.30	100
90/91	118	7.11	7.58	94
94/95	132	6.83	7.95	86
99/00	151	6.52	8.52	77
04/05	172	6.26	9.16	68
09/10	194	6.06	9.95	61

Under these conditions the gap between supply and demand will be in the order of 750,000 tonnes by year 2009/10.

The impact of this increasing gap between supply and demand will be assuaged by the workings of the market. Prices for fish can be expected to rise and substitution of fish for alternative products (ie, chicken) will take place. It might be expected that the result will be increasing imbalance between urban and rural fish consumption in favour of the former. However, higher fish prices will favour fish producers, who are rurally based.

Further analysis of projected fish supply against the expected dietary requirements of the population might be expected to show an even wider gap between supply and demand. This is, however, beyond the scope of the current report.

7.5.4 Demand for fish feeds

Rising demand for fish and livestock products will result in greater demand for feed ingredients. At present there are only three fish feed plants in Bangladesh, none of which are fully operational. Intensive aquaculture, especially shrimp culture will demand further production of feeds. Evidence from Thailand suggests that feed accounts for around 60% of production costs of which the great majority is taken up by protein meals.

At present most of the available fish meal in Bangladesh is imported. Importation for shrimp culture is justified economically on the grounds that the industry is a major hard currency earner. However, there is limited scope for the indigenous production of protein meals using shrimp wastes, trash fish and abattoir residues. Other sources of protein for use in animal feeds are discussed above at section 7.3.

7.5.5 Fish supply and the question of protein availability

The potential for diversification from rice production into fisheries has been underestimated. A number of projects have shown that the returns from aquaculture (for both food fish and fingerling production) are greater than those from rice culture. Additionally, projections for supply of fish, export and domestic demand, and per capita fish availability suggest that the gap between fish supply and demand will widen in the foreseeable future (see the Bangladesh Five Year Plan). This will result in rising fish prices, and given that Bangladesh is practically self sufficient in rice (ie, rice is in full supply), an increasing differential between the relative prices of the two.

At present it is estimated that aquaculture in ponds accounts for 18% of fish production (1.3 million ponds over 147,000 ha). Department of Fisheries estimates show potential growth rates of between 3.2% and 3.7% up to the year 2010 if ponds are rehabilitated and simple aquaculture technology is introduced. There is also great potential for integrated rice/fish farming.

Marine fish production has reached its maximum sustainable level of production with diminishing return to investment expected. Scope for further development is limited.

7.5.6 Returns to labour - aquaculture vs other activities

A farm budget for involvement in cooperative aquaculture on a 10 ha farm with 30 landless farmers is presented at Annex VII. This is based on a Gremeen Bank funded and managed programme which uses formerly government owned ponds for aquaculture. Landless groups living on the embankments of these ponds are trained in basic aquaculture methods including pond fertilization using Water hyacinth compost, and provided with capital for the first year.

Under prevailing prices and market conditions, net returns after credit costs are deducted, show that each family can gross Tk 2,058 per season. The minimal labour requirement of this approach (5.6 person days per participating family over the whole season) mean that returns to family labour are in the order of Tk 368 per day.

A comparison of returns to labour of time invested in Aman rice production cooperative aquaculture is presented in Box 3 below.

Box 3:

1. Aquaculture:

Labour required (person days per ha) = 0.56[4/]
Gross returns per ha per family = Tk 205.8
Return to family labour per ha = Tk 36.8 per person day

2. Aman rice:

Labour required (person days per ha) = 205.6[5/]
Gross returns per ha per family = Tk 4,809
Family returns per ha = Tk 23.4 per person day

Aquaculture is shown to compare very favourably with the main available alternative, on-farm activity. A word of caution is needed in comparing these activities. Firstly, it should be remembered that the ability of landless groups to participate in such activities is very limited. Furthermore, overall returns to aquaculture are limited by availability of water resources. Not all rice land can be converted for fish production and vice versa. Rice production plays an essential role in the socio-cultural make-up of rural Bangladesh, and the many non-financial benefits that accrue from involvement in it are disregarded in this analysis.

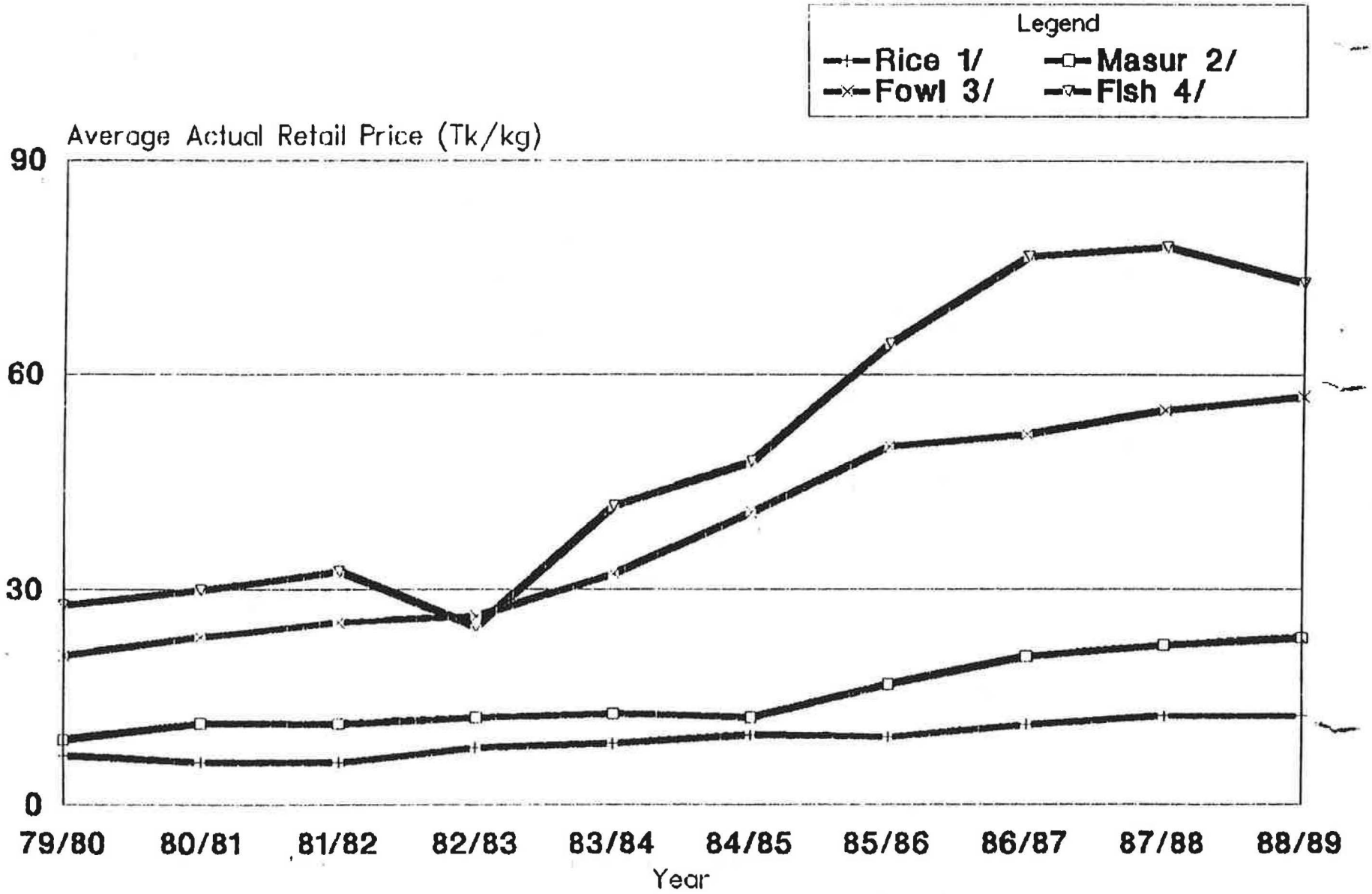
Risk averse farm families are unlikely to specialise in one activity and gain considerable advantage in involvement in a spread of activities which fit into their pattern of existence most conveniently.

7.5.7 Fish Prices and Marketing

The prices of fish are related to season, variety, and size. There is a strong preference amongst Bangladeshi's for larger fish. Demand for fish is growing faster that supply (see above 7.5.4) in response to population

4/ from Annex XII, Estimated costs and Returns to cooperative aquaculture.
5/ From Ministry of Agriculture figures.

FIGURE 2: Annual growth in average retail prices, selected food commodities



Source: Adapted from the Bangladesh Bureau of Statistics (1990)
Notes: 1/ Medium Quality, 2/ Husked whole, 3/ Large liveweight, 4/ Ruhi, big

and income growth. Fish prices are increasing faster than other foods. This is shown in figure 2.

Price fluctuation between species seems to vary, though no accurate data is available. Seasonal price variation is great as is the variation in prices in different parts of the country.

Spatial and inter-temporal price fluctuations could be much reduced with improved transportation and storage. Consideration should be given to the financial viability of ice production and more efficient marketing of these highly perishable products.

7.5.8 Credit

The lack of accessible credit is possibly the key constraint to aquaculture development. Credit can be divided into institutional and non-institutional sources. Institutional sources are often overly bureaucratic and complex, with smaller operators and farmers failing to qualify due to lack of collateral. Non-institutional sources, upon which the great majority of the rural population depend, consist of friends, relatives and fish traders. Fish traders charge high levels of interest (as much as 20% per month) tie borrowers into long-term arrangements which often involve selling fish at lower-than-market prices. Disbursements and recovery rates for the main development banks are poor, partly because of the following risks involved in aquaculture:

(i) Flooding or drought;
(ii) Availability of inputs (feeds, hapas);
(iii) Quality of fingerlings;
(iv) Diseases;
(v) Limited technical know-how;
(vi) Theft from ponds.

The importance of a "bottom-up" communication approach to credit is stressed if target groups amongst the rural poor are to be reached.

McGregor and Alam (1990) identify four areas where these groups can be involved at each stage of a project:

(i) Identifying resource requirements;
(ii) ensuring that the timing of inputs is commensurate with other important household and income generating activities;
(iii) equating the degree of risk involved with the resources available to the household;
(iv) the necessary institutional arrangements for implementation of the activity.

The use of NGO's and non-institutional credit source (such as input suppliers) should be encouraged. The client-patron relationships enjoyed by suppliers are ideal avenues for both sending extension messages and for supplying credit. Increased aquaculture development will lead to greater competition in credit supply at both institutional and non-institutional levels.

McGregor and Alam also point out the important contradiction that exists between provision of credit for projects intended to provide food fish and those which are intended to produce fish as a cash crop. Obviously the latter will have a lower default rate!

7.5.9 Gender

The position and role of women in agricultural activities in Bangladesh is particularly poor. Despite the great poverty in rural Bangladesh, cultural and religious taboos prevent the participation of women in work outside the household in all but the most impoverished family, since this would result in a lowering of status. Hindus particularly will make every effort to maintain their status and position in the caste hierarchy.

In a recent survey of women participating in fish culture in the Greater Dinajpur District of Northwest Bangladesh it was noted that 15% of rural households in Bangladesh are headed by women (Maal and Ali, 1990). Furthermore, among landless households as many as 25% are headed by women. Such women would not be in a position to conform to traditional standard of

caste and purdah behaviour and would, therefore, be legitimate targets for aquaculture development.

In an intensive study of 16 households the authors found that men often underestimated the engagement of women in aquaculture.

A major constraint to further development of the role of women in farming and aquaculture is the almost total lack of female representation in the extension services of both Government and non-government institutions. The problems of recruiting and training female extension workers are noted. This should be an area for concerted effort on the part of the institutions involved in extending aquaculture methods.

7.5.10 Marketing and Marketability

Fish is a highly perishable product. It is expected that an expanded aquaculture production in Bangladesh will experience problems getting the product to market in a salable state.

Bangladeshi consumers prefer to buy fresh fish and any other mode will be heavily price discounted.

A brief qualitative survey of perceived important fish characteristics was conducted using a focus group of landless fish farmers from the immediate Neemgachi area. The results are presented below in Box 4.

Box 4: Results of focus group discussions

Characteristic	Name					
	Bighead carp	Silver carp	Common carp	Rohu	Catla	Mrigel
Grows fast	*[i/]	*				
Low profit			*			
Low price	*	*				
High price			*			
Slow growth				*	*	*
Good taste [ii/]			3	1	4	2
Poor taste	*	*				
Thick flesh	*	*				
Bad smell	*	*				
Difficult to catch [iii/]		*				
Difficult to cook	*	*				
Good in muddy ponds			*			
Strong [iv/]			*			
Fingerlings unavailable					*	

Notes:

i/ "" denotes a characteristic of importance to consumers and producers*

ii/ Number denotes stated order of preference with "1" the best

iii/ A tendency to remain on the bottom was mentioned

iv/ Refers to the fishes ability to survive out of water and therefore enhance marketability

Source: discussions with farmers

Bangladeshis interviewed expressed a strong preference for characteristics associated with traditional river fish varieties (Rohu, Catla and Mrigel) ie, size and taste. There was an apparently strong resistance to newly introduced fish varieties, which were considered unpalatable and therefore cheap although Thai Silver Barb has proved very popular.

Though the method used in this analysis is necessarily simplistic, the results to suggest that new, fast growing varieties of fish which enhance pond yields and are adaptable to new feeding regimes, may meet with market resistance if introduced in Bangladesh. Increased availability and quality of local varieties offers greater promise.

REFERENCES

AIT, (1990,a) Working Paper No 3, Project on-farm trial methodology during intervention year one.

AIT, (1990,b) Working Paper No 5, A Economic comparison of aquaculture with cropping options for small-scale farmers in Northeast Thailand.

Ammen M-U, (1987), Fisheries Resources and Opportunities in Freshwater Fish Culture in Bangladesh. NRD-II/DANIDA, Noakhali, Bangladesh

BARC, (1990), Training Manual on Feed Resources Assessment, BARC, Dhaka, Bangladesh

BBS, (1990), Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, GOB, Dhaka, Bangladesh

Bangladesh Planning Commission (1989), Food Strategies in Bangladesh: Medium to long term perspectives, University Press Limited

Coulter J P and Disney J G (1987), The handling, processing and marketing of fish in Bangladesh, ODNRI Bulletin No 1.

Cunningham S, Dunn M R and Whitmarsh D (1985), Fisheries Economics: An Introduction, London

Deppart D, Khalegue M A and Jenson R (1990), The Aquaculture Extension Project (AEP): A possible approach to increasing aquaculture production in Bangladesh, Danida project paper.

DOF, Thailand, (1998), Analysis of freshwater fish consumption and marine product marketing in NE Thailand, Khon Kaen University Report No. 9

Dickey J R and Huque Q M E, (1986), Status of the Bangladesh Livestock Industry in Relation to Fodder Supply and to Consumption of Animal Products, BARC, Dhaka, Bangladesh

Duncan B, (1990) Economic aspects of diversification on cassava dependent farms in Northeast Thailand 1985-1990. Northeast Crop Development Project (NECDP). EEC Project No. ALA 84/02

Göhl B, (1981) Tropical Feeds. FAO Rome. 529p.

Hasan M R (1990), Aquaculture in Bangladesh, in Joseph M M (Ed), 1990, Aquaculture in Asia, pp 105-139, Asian Fisheries Society, Indian Branch.

Hoare P W C and Crouch B R, (1988) Required Changes to the Project Management Cycle to Facilitate Participatory Rural Development, Agricultural Administration and Extension, 30, 1988, pp 3-14.

Hossain M (1988), Nature and Impact of the Green Revolution in Bangladesh, International Food Policy Research Institute, Washington DC, Research Report No 67

Huq M and Huq A , Fishermen in natural depressions of Bangladesh: Socioeconomic conditions and standards of living in Panayou T, (1985), Small-Scale Fisheries in Asia: Socioeconomic Analysis and Policy, IDRC, Ottawa

Jansen E G, (1987) Rural Bangladesh: Competition for Scarce Resources, University Press Limited, Dhaka

John C Marr Associates (1986), Twenty Year Fishery Development Plan for Bangladesh, FAO/UNDP and People's Republic of Bangladesh, Dhaka.

Khonkaen (1986), Northeast Thailand, Farming System Research Project, Khon Kaen University.

Kirk C M et al (1990), Dinajpur Fish Culture Development Project: First Project Review ODA project report

Lewis D and Ali M S (1990), The Food Fish Network: production, harvesting and trading in North Western Bangladesh, Unpublished preliminary

workshop draft, Centre for Development Studies, University of Bath, UK

Lewis D and Gregory R (1989), Trading the Silver Seed: A study of fish seed trading in North Western Bangladesh ODA project report

Lewis D and Gregory R (1991), Social research and aquaculture in Bangladesh: A case study from the North West, Paper to the Bangladesh Sociological Association Seminar on Environment and Natural Resources Management in Bangladesh, 25-26 January 1991.

Lovelace G W, (1988) Rapid Rural Appraisal in Northeast Thailand, Case Studies. KKU-FORD Rural Systems Research Project, Khon Kaen University.

Maal B and Ali S (1990), Women Participation in Fish Culture in Greater Dinajpur District - Constraints and Possibilities, report to the Overseas Development Administration.

McGregor J A & Alam S S (1990), Credit and the Development of Fish Culture in North West Bangladesh, report produced in association with the Dinajpur Fish Culture Development Project for the ODA/DOF.

Tacon, A G J (1991), The nutrition and feeding of farmed fish and shrimp - A training manual. 2. Nutrient sources and composition. FAO Field Document. Project GCP/RLA/075/ITA, Field Document No. 5/G, Brasilia, Brazil, 129p.

de Vylder S (1982), Agriculture in Chains, Bangladesh: A case study in contradictions and constraints, Zed Books, London

White J M (1989), Fisheries Synthesis Evaluation Study, Evaluation Report EV416, ODA

Annex I: Terms of Reference

SOCIO-ECONOMIC SURVEY OF FISH FEED UTILISATION, BANGLADESH AND THAILAND

The mission seeks to investigate various aquaculture and farming systems prevailing in selected South-East Asian agro-ecological zones, specifically Thailand and Bangladesh, with a view to assessing the needs for fish feeds amongst the peoples of those areas.

The mission should address the following:

1. Quantify the rates of growth of aquaculture in the target countries and identify the current and future likely demand scenarios. This should include information on who grows and who consumes these products.

2. Identify current and potential feed sources, their utilisation, and the key constraints to further utilisation within existing farming systems. Consideration should be given to competition from other livestock and human sectors for these feed sources.

3. Assess feed sources, technology and materials against marketing, financial and socio-economic criteria such as opportunity cost. Identify which have most potential for subsequent development work.

4. Characterise current practices and farming systems for aquaculture in the target agro-ecological zones.

5. Assess the likely financial cost and benefits to the farmer of on-farm fish feed production and indicate whether the economic benefits of on-farm or commercial fish feed production are likely to be positive.

6. Appraise the likely role of and impact upon women of farming systems that have increased emphasis on aquaculture production.

7. Assess the likely costs to NRI of development work.

8. Identify possible collaborators.

Annex II: Itinerary

Thailand

11th March	Bennett arrives Bangkok pm
12th March	Asian Institute of Technology
	- Prof P Edwards
	- Dr D Little
13th March	EC Delegation
	- A Chalmin
	SEADD
	- D Trotman, Natural Resources Adviser
	- E Hawthorn, Economic Adviser
14th March	Flight: Bangkok - Udon Thani
	- T Warren, Research Fellow
	- N Innes-Taylor, Project leader
15th March	Field work
16th March	Field work
18th March	Field work
19th March	Khon Kaen University
	- Dr Kanok, Farming systems group
	The Agricultural Development Research Centre in North East Thailand
	- K Chompoonutprapa, Dpty Dir
20th March	Flight: Udon Thani - Songkla
	Songkla Fisheries College
	- C Chalaruk, Asst Dir of Planning
21st March	Aquaservice Ltd
22nd March	Field visits
	Flight: Songkla - Bangkok
24th March	Bangkok - Dhaka
25th March	British High Commission
	- S Loughhead
	UNDP/Dept of Fisheries
	- Dr M Kasim
26th March	Report writing

27th March	Gremeen Bank
	- D C Barua, Dpty Gen Manager
	- S A Daiyan, Dpty Gen Manager
	Drive: Dhaka - Neemgachi
28th March	Field visits, Neemgachi
	- A A Khan, Principle
	- A Kemal
29th March	Drive: Neemgachi - Saipur
	- R Gregory, TCO
30th March	CARE/BRAC
	- Mohosur, CARE Lotus Coordinator
	- R K Bhuyan, BRAC Fisheries Officer
	- Silvana, CARE Programme Coordinator
	Field Visits
31st March	Fish traders workshop, Champatali
1st April	Gremeen Bank projects, Shakpura, Ramshakail and Dinajpur
	- Joshim
	Mustard Oil factory
2nd April	Upizala Fisheries Officer
	- Benay
	RDRS
	- Rafik
	- M Ali, Livestock specialist
3rd April	Flight: Saipur - Dhaka
4th April	Association of Development Agencies in Bangladesh
	- F Noble, Aquaculturist
	- M G Nayeen Wahra, Programme Coordinator
	Bangladesh Rural Advancement Committee
	- M Bhuiya, Manager, Rural Enterprise Project
5th April	Report Writing
6th April	Drive: Dhaka - Mymensingh
	Bangladesh Agricultural University
	- Dr M Hasan, Asst Prof, Dept of Fisheries
	Graduate Training Institute
	- Prof M Rahman, Director

7th April	Fisheries Research Institute
	- Prof M A Majid, Director
	- Dr M V Gupta, ICLARM
	DANIDA Aquaculture Extension Project
	- R Jensen, Project Coordinator
	Drive: Mymensingh - Dhaka
	Sabinco, Shrimp feed manufacturer
	- Z Abedin, Admin Officer
	- M Rehman, Qual Control Officer
8th April	Rangpur and Dinajpur Rural Services
	- M Rozaria, Assistant Director
	University of Bath
	- Dr D Lewis
9th April	World Bank
	British High Commission
10th April	Flight: Dhaka - Bangkok
11th April	SEADD
	- J Hansel, Natural Resources Adviser
	AIT
	- Prof P Edwards
12th April	Flight: Bangkok - London

Annex III: AIT Project Recommendations

Developed in conjunction with farmers in the North Eastern Region of Thailand, these recommendations seek to provide a low cost method of increasing returns to aquaculture. They consist of 3,000 fish fry per rai being raised in a nylon net-cage over 6-8 weeks after which fish are released into a fertile pond for a further 6 months before harvest.

Nursing

During the nursing period fish are to be fed a mixture of duck layer concentrate (readily available in local markets) and fine rice bran. The later is a by-product of rice preparation and is either available on farm of in local commercial processing facilities. After four weeks this is supplemented with one kilogram per day of vegetable *Ipomea sp.* until release. A minimum application of 2 Kg per day of *Ipomea sp.* is recommended after release. It has been estimated that the collection time for this quantity of material is about 7 minutes per kg.

ie, 1 Kg x 31 days + 2 Kg x 213 days = 457 Kg

457 Kg x 7 minutes = 6.7 working days

Labour use during nursing is 1.3 days per month for a period of two months.

Pond fertilization

This commences after 5 weeks nursing and lasts until harvest. It consists of a minimum incorporation of 10 Kg per rai per day of buffalo manure;

ie, 10 Kg x 202 days = 2,020 Kg

Collection is assessed at 1 minute per kg ie, 4.21 working days. Not more than 1 Kg of urea per rai per day is also recommended;

ie, 1 Kg x 202 days = 202 Kg

Labour demand for harvest is based on base-line data gathered from project farmers. This consisted of 40 hours spread over the last three months of the project cycle plus 20 hours for pond maintenance.

A labour use diagram is presented at Table 1.

Basis of Project Philosophy 1/

The AIT Outreach Project seeks to develop appropriate aquaculture strategies for farmers in Northeast Thailand by completing trials with about 100 farmers over a three year period. The objective is to be adaptive, responding to farmers whilst testing aquaculture strategies and devising appropriate methods of extending methodologies.

Initially, the project conducted an extensive baseline study of fish farmers in the region to obtain an in-depth understanding of the farming systems.

Subsequently the project has devised a number of 'promising recommendations' which have been tested and refined in 'farmer trials'. This process involves 'farmer managed experiments' conducted in collaboration with project staff and intended to develop `mature recommendations' for further extension.

The project provides no financial assistance to collaborating farmers on the principal that any recommendation that is ready for extension should be highly likely to succeed in providing increased benefits for collaborators.

The result of this process is an 'extension package' which consists of; a 'mature recommendation', 'guide-lines for its extension', 'media to assist extension', and 'guide-lines for training of extension agents'.

1/ Compiled from AIT Working Paper No.3, 1990

Annex IV: Financial Analysis of Supplementary Fish Feeding in Thailand

ANNEX IV. FINANCIAL ANALYSIS OF SUPPLEMENTARY FISH FEEDING IN THAILAND

Table 1: Costs and assumptions under different feeding regimes

		Technical coefficients and per unit costs					Cost projections			
		Case 1 Without project	Case 2 Fertilization and hapas	Case 3 Case 2 plus feed x 90 days	Case 4 Case 2 plus feed x 202 days	Cost per Unit (Baht)	Case 1 Without project	Case 2 Fertilization and hapas	Case 3 Case 2 plus feed x 90 days	Case 4 Case 2 plus feed x 202 days
(1)	Fry	3,000	3,000	3,000	3,000	.10	300	300	300	300
(2)	Fertilizer:									
	Buffalo manure (kg)	-	2,020	2,020	2,020	.05	-	101	101	101
	Urea (kg)	-	202	202	202	5.00	-	1,010	1,010	1,010
(3)	Nursery equipment (hapas)	-	.5	.5	.5	370.00	-	185	185	185
	Feeds:									
(4)	Duck layer concentrate (kg)	-	29	29	29	15.00	-	435	435	435
(5)	Fine rice bran (kg)	-	13	13	13	5.00	-	65	65	65
(6)	Mixed grow-out feed (kg)	-	-	450	1,010	3.50	-	-	1,575	3,535
	Sub total (cash costs)						300	2,096	3,671	5,631
(7)	Labour									
	Fry nursing	-	2.6	2.6	2.6	40.00	-	104	104	104
	Ipomea collection	-	5.9	5.9	5.9	40.00	-	234	234	234
	Manure collection	-	4.0	4.0	4.0	40.00	-	160	160	160
	Fish harvest	5.1	5.1	5.1	5.1	40.00	204	204	204	204
	Pond maintenance	2.5	2.5	2.5	2.5	40.00	100	100	100	100
(8)	Fish feeding	-	-	1.9	4.2	40.00	-	-	76	168
	Total days	7.6	20.1	22.0	24.3					
	Sub total (labour costs)						304	802	878	970
	Total all costs						604	2,898	4,549	6,601

Notes:
(1) Delivered price
(2) See AIT recommended regime number 1, assumes feeding during nursery period and fertilization thereafter
(3) Assumes one hapa per rai replaced in alternate years
(4) Available in local markets
(5) Available on farm and in local markets (but in subsequent tables, this is assumed to be a purchased input)
(6) Assumes 5kg of feed per day for 90 days (case 1) and 202 days (case 2) at a maximum purchase cost of B3.5/kg
(7) Taken from AIT farmer surveys (see AIT, 1990a)
(8) Cases 3 and 4 assume 10 minutes feeding time per day during period of feeding

Source: AIT (1990a) and field observation

ANNEX IV. FINANCIAL ANALYSIS OF SUPPLEMENTARY FISH FEEDING IN THAILAND

Table 2: Cash flow projection showing incremental benefit with and without implementation of basic project recommendations (case 2) for a 1 Rai pond in Udonthani Province, North Eastern Thailand

	Case	Without project (case 1)	With project (case 2)									
	Years	1-10	0	1	2	3	4	5	6	7	8	9	10
	COSTS (baht)												
(1)	Fry	300		300	300	300	300	300	300	300	300	300	300
(2)	Fry nursing equipment (hapa)	-		185	-	185	-	185	-	185	-	185	-
(3)	Fertilisers and manure	-		1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111
(4)	Feeds	-		500	500	500	500	500	500	500	500	500	500
(5)	Labour	304		802	802	802	802	802	802	802	802	802	802
	Total costs	604		2,898	2,713	2,898	2,713	2,898	2,713	2,898	2,713	2,898	2,713
	INCOME												
(6)	Yield (kg/rai)	100		250	250	250	250	250	250	250	250	250	250
	Price (B/kg)	25		25	25	25	25	25	25	25	25	25	25
	Gross income	2,500		6,250	6,250	6,250	6,250	6,250	6,250	6,250	6,250	6,250	6,250
	Net benefit	1,896		3,352	3,537	3,352	3,537	3,352	3,537	3,352	3,537	3,352	3,537
(7)	Incremental net benefit	-		1,456	1,641	1,456	1,641	1,456	1,641	1,456	1,641	1,456	1,641
(8)	Amount borrowed ("with project")		1,715										
(9)	Repayment of loan	-		559	559	559	559		-	-	-	-	-
	Incremental net benefit (after finance)	-	1,715	897	1,082	897	1,082	1,456	1,641	1,456	1,641	1,456	1,641

	Without project	With project
(10) NPV at 8% discount rate (year 0)	12,722	23,089
NPV at 12% discount rate (year 0)	10,713	19,433
NPV at 16% discount rate (year 0)	9,164	16,615

Notes:
(1)-(5), see Table 1
(6) Based on figures supplied by AIT for expected average yield under project recommendations
(7) Compared with "without project" scenario
(8) Loan requirement based upon additional off-farm inputs requiring cash ie, urea, nursery equipment, feeds (assuming that feeds are 100% purchased off-farm)
(9) Current interest rate available at Udonthani Agricultural Bank is 11.5%
(10) Net present values have been calculated by discounting the net benefit stream at the rates indicated (ie. financing excluded)
Source: AIT (1990a) and discussions with project staff

ANNEX IV. FINANCIAL ANALYSIS OF SUPPLEMENTARY FISH FEEDING IN THAILAND

Table 3: Cash flow projection showing incremental benefit with and without implementation of basic project recommendations (case 3) for a 1 Rai pond in Udonthani Province, North Eastern Thailand

	Case	Without project (case 1)	With project (case 3)									
	Years	1-10	0	1	2	3	4	5	6	7	8	9	10
	COSTS (baht)												
(1)	Fry	300		300	300	300	300	300	300	300	300	300	300
(2)	Fry nursing equipment (hapa)	-		185	-	185	-	185	-	185	-	185	-
(3)	Fertilisers and manure	-		1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111
(4)	Feeds	-		2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075	2,075
(5)	Labour	304		878	878	878	878	878	878	878	878	878	878
	Total costs	604		4,549	4,364	4,549	4,364	4,549	4,364	4,549	4,364	4,549	4,364
	INCOME												
(6)	Yield (kg/rai)	100		340	340	340	340	340	340	340	340	340	340
	Price (B/kg)	25		25	25	25	25	25	25	25	25	25	25
	Gross income	2,500		8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500	8,500
	Net benefit	1,896		3,951	4,136	3,951	4,136	3,951	4,136	3,951	4,136	3,951	4,136
(7)	Incremental net benefit	-		2,055	2,240	2,055	2,240	2,055	2,240	2,055	2,240	2,055	2,240
(8)	Amount borrowed ("with project")		3,270										
(9)	Repayment of loan	-		1,065	1,065	1,065	1,065		-	-	-	-	-
	Incremental net benefit (after finance)	-	3,270	990	1,175	990	1,175	2,055	2,240	2,055	2,240	2,055	2,240

		Without project	With project
(10)	NPV at 8% discount rate (year 0)	12,722	27,108
	NPV at 12% discount rate (year 0)	10,713	22,817
	NPV at 16% discount rate (year 0)	9,164	19,510

Notes:
(1)-(5), see Table 1
(6) Based on figures supplied by AIT for expected average yield under project recommendations
(7) Compared with "without project" scenario
(8) Loan requirement based upon additional off-farm inputs requiring cash ie, urea, nursery equipment, feed (assuming that feeds are 100% purchased off-farm)
(9) Current interest rate available at Udonthani Agricultural Bank is 11.5%
(10) Net present values have been calculated by discounting the net benefit stream at the rates indicated (ie. financing excluded)
Source: AIT (1990a) and discussions with project staff

ANNEX IV. FINANCIAL ANALYSIS OF SUPPLEMENTARY FISH FEEDING IN THAILAND

Table 4: Cash flow projection showing incremental benefit with and without implementation of basic project recommendations (case 4) for a 1 Rai pond in Udonthani Province, North Eastern Thailand

	Case	Without project (case 1)	With project (case 4)									
	Years	1-10	0	1	2	3	4	5	6	7	8	9	10
	COSTS (baht)												
(1)	Fry	300		300	300	300	300	300	300	300	300	300	300
(2)	Fry nursing equipment (hapa)	-		185	-	185	-	185	-	185	-	185	-
(3)	Fertilisers and manure	-		1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111	1,111
(4)	Feeds	-		4,035	4,035	4,035	4,035	4,035	4,035	4,035	4,035	4,035	4,035
(5)	Labour	304		970	970	970	970	970	970	970	970	970	970
	Total costs	604		6,601	6,416	6,601	6,416	6,601	6,416	6,601	6,416	6,601	6,416
	INCOME												
(6)	Yield (kg/rai)	100		452	452	452	452	452	452	452	452	452	452
	Price (B/kg)	25		25	25	25	25	25	25	25	25	25	25
	Gross income	2,500		11,300	11,300	11,300	11,300	11,300	11,300	11,300	11,300	11,300	11,300
	Net benefit	1,896		4,699	4,884	4,699	4,884	4,699	4,884	4,699	4,884	4,699	4,884
(7)	Incremental net benefit	-		2,803	2,988	2,803	2,988	2,803	2,988	2,803	2,988	2,803	2,988
(8)	Amount borrowed ("with project")		5230										
(9)	Repayment of loan	-		1433	1,433	1,433	1,433	1,433		-	-	-	-
	Incremental net benefit (after finance)	-		1,370	1,555	1,370	1,555	1,370	2,988	2,803	2,988	2,803	2,988

		Without project	With project
(10)	NPV at 8% discount rate (year 0)	12,722	32,127
	NPV at 12% discount rate (year 0)	10,713	27,043
	NPV at 16% discount rate (year 0)	9,164	23,125

Notes:
(1)-(5), see Table 1
(6) Based on figures supplied by AIT for expected average yield under project recommendations
(7) Compared with "without project" scenario
(8) Loan requirement based upon additional off-farm inputs requiring cash ie, urea, nursery equipment, feed (assuming that feeds are 100% purchased off-farm)
(9) Current interest rate available at Udonthani Agricultural Bank is 11.5%
(10) Net present values have been calculated by discounting the net benefit stream at the rates indicated (ie. financing excluded)
Source: AIT (1990a) and discussions with project staff

Annex V: Feeding assumptions used in technical and financial analyses

The following shows the method and assumptions used to assess feed conversion models used in Annex 3:

1. Feed conversion ratio (FCR) is related to the maximum standing crop of fish in any given pond so that once the critical standing crop is exceeded, the FCR will increase.

2. It is assumed that production due to fertilizers is not dependant on the standing crop and that the critical standing crop is not exceeded.

Case 2: Basic outreach recommendation - no supplementary feed, fertilizer only.

Assumptions:

Fingerlings: 2400 @ 10g on day 0
Growth period: 202 days
Weight at harvest: 250kg
No. of fish harvested: 833
Constant mortality

Day	0	30	60	90	120	150	180	202
No of fish	2,400	2,139	1,879	1,617	1,356	1,094	964	833
Av weight (g)	10	17	27	45	75	124	205	300
Standing crop (kg)	24	36	51	73	102	136	198	250

Case 3: Feed for last 90 days @ 5kg/day

As case 2 from days 0-112, 450kg fed between days 112 and 202.
FCR: 5 i.e. incremental gain from feeding 90kg
Incremental growth: 90kg
Weight harvested: 340kg
Constant mortality

Case 4a: Feed 5kg per day for 202 days and same wight at harvest as Case 2.

Assumptions:

Fingerlings: 2400 @ 10g on day 0 | No. of fish harvested: 1500
Growth period: 202 days | Constant mortality
Weight at harvest: 450kg | Fish weight at harvest: 300g
FCR: 5 i.e. incremental gain from feeding 200kg.

Day	0	30	60	90	120	150	180	202
No of fish	2,400	2,266	2,132	1,998	1,864	1,730	1,596	1,500
Av weight (g)	10	17	27	45	75	124	205	300
Standing crop (kg)	24	39	58	90	140	215	327	450

Case 4: Feed 5kg per day for 202 days and constant survival to harvest

Assumptions:

Fingerlings: 2400 @ 10g on day 0 | No. of fish harvested: 833
Growth period: 202 days | Constant mortality
Weight at harvest: 450kg | Fish weight at harvest: 540g
FCR: 5 i.e. incremental gain from feeding 200kg.

Day	0	30	60	90	120	150	180	202
No of fish	2,400	2,139	1,879	1,617	1,356	1,094	966	833
Av weight (g)	10	18	33	59	106	192	347	540
Standing crop (kg)	24	39	62	95	144	210	335	450

Case 5: Maximum standing crop 675kg. FCR decreases with standing crop.

Assumptions:

Production due to Fertilizer: 250kg
Maximum standing crop: 675kg (less stock = 651kg)
Therefore, production from feed: 410kg
Total feed given: 260kg
FCR: 6.5

Case 6: Maximum standing crop 900kg. FCR decreases with standing crop.

Assumptions:

Production due to Fertilizer: 250kg
Maximum standing crop: 900kg (less stock = 876kg)
Therefore, production from feed: 626kg
Total feed given: 5008kg
FCR: 8

Note: A maximum standing crop of 450kg/rai is well within the limits achieved by farmers in NE Thailand. It is assumed that this is below the critical standing crop and therefore production and FCR are optimised. This suggests that cases 5 & 6 are pessimistic.

Day	0	30	60	90	120	150	180	202
No of fish	2,400	2,139	1,879	1,617	1,356	1,094	966	833
Av weight (g)	10	18	33	59	106	192	347	540
Standing crop (kg)	24	39	62	95	144	210	335	450

Annex VI: Interviews with farmers collaborating with the Northeast Thailand Outreach Project

Case Study 1

Mr Mee Suhachait, Flat rainfed area.

Owns 62 Rai (10.5ha) of which 38 is under cassava, about 10 to rice, 11 to sugar cane and 3 is fallow. The majority of his crops (sugar cane and cassava) are contract grown and require no harvesting as this is done by the contractor. Fishing is conducted between June and April. Cassava is grown all year round. Sugar cane is planted in October and harvested in April. His main labour input is in rice which is planted in May/June and harvested between July and August. This is the period of peak labour demand on the farm. His pond is 800 m^2 (1/2 Rai). He dug his pond 10 years ago using a tractor at a cost of B1,800. He originally build the pond to farm fish for family use. In addition, he sells some to neighbours. Up to now he has always harvested by net, but wants to harvest with a pump this year so that he gets all the fish and to restock. He stocked the pond in July/August 1989 and harvested 70kg of fish in April 1990 after following the project recommendations. The stocking was later than usual because he had trouble finding fry. In 1989 fry were B100 for 1000, and by 1990 the cost had doubled.

During 1990 he spent B400 for fish fry and B250 on urea. He also spent roughly B200 on duck feed for hapa feeding (cost = B15/kg) though he found it hard to come by due to the demand generated by the project. The hapa was made from old net available around the farm and was sown up by his daughter. He puts buffalo manure in the pond as recommended by the project.

Mr Mee visits the pond every day, usually in the morning when taking his cattle out to graze. He also feeds cassava leaves and morning glory. For cassava it is mainly mature plant leaves that are fed. During the hapa stage these are chopped up. Morning glory is gathered from the communal pond and brought to the pond by buffalo cart. When other feeds unavailable he puts in rice bran at B5/kg.

He markets about once a week and only sells his fish locally.

Case Study 2

Mrs Dhong, flat rainfed area

Mrs Dhong's farm is about 1 Km from her homestead and consists of a total of 10 rai. The major family crop is rice intercropped with duckweed for its soil improving properties. During planting season she hires labour and at harvest she gets assistance from her neighbours under a reciprocal labour arrangement. She constructed a pond six years ago to provide water for buffalo bathing/watering and for irrigation. This is her primary reason for having a pond.

The fish she grows are primarily for consumption by her own family. She does not sell fish but might consider doing so if the price was right. Traditionally her family has fished wild fish from the pond and collected wild fish from pre-prepared catchment areas in the rice fields. Fish are given as gifts to relatives and are netted when visitors come. Mrs Dhong said that having a successful fish pond conferred upon her considerable status in the eyes of other villagers.

The pond was stocked with tilapia, grass carp and common carp. The advantages of tilapia were considered to be their ease of feeding (ie, they come to the surface to get food), speed of growth and visibility. This was also considered a drawback since they could be easily stolen. The advantages of carps were considered to be that they made better use of available feed (they are bottom feeders), and keep the pond clean. However, grass carp is considered rather "bloody" and not favoured as a food fish.

Feeds used were Duck Feed Concentrate and Fine Rice Bran, Morning Glory, and Duck Weed during the nursing period. During the growing period she is fertilizing the pond with buffalo manure and morning glory. The latter she grows 50:50 as a cash crop and for fish feed. The growing season for morning glory is November-March.

Mrs Dhong is the only woman in the village who is actively farming fish. She claims that this is because of lack of knowledge or interest. In most households "pond management" is usually male work, but in her case her husband has another farm that occupies all his time. She claims that the labour demands on men of rice farming leave little time for fish culture, therefore it is common for women to undertake the day to day chores involved in keeping fish.

Case Study 3

Mr Bang, flat rainfed area

The owner of 31 rai and a pond of 1,200 sq m, Mr Bang has found the project recommendations highly successful. In 1990 his yield of fish was 264 kg per rai which he sold in the local village over a period as the pond water level lowered.

He has a preference for tilapia and silver barbs as these are fast growing and sell well. Common carp grow slowly and are difficult to market.

His fish are fed according to the project recommendations with the addition of morning glory (gathered on the farm and fed every day), vegetable waste (purchased for B2 per kg in the local market every few days) and broken rice. Broken rice and rice bran are cooked by him together with morning glory to make a type of porridge which appears to be an effective feed. This is prepared using the last embers of the fire that his wife has prepared for the evening meal. He is interested in experimenting with making feeds and has already tried some mixtures of farm wastes.

All family members are involved in fish rearing, including his wife and daughter.

Apart from fish culture, Mr Bang's main income comes from rice, chilli, long bean, corn, cucumber and tomato.

Case Study 4

Mrs Po ya s'tung, member of a fish catching team

Started a fish catching business last year in response to a perceived need for such a service. Usually the team consists of seven adults from the same village, a mixture of men and women. The arrangement is that they sub-contract a pond judging specialist to come and calculate the total likely catch. An offer is then made to the farmer for the whole catch. One a bargain has been struck, pumps are hired, the pond is pumped dry and the catch shared equally. Some of the fish are kept for family consumption and the rest are marketed.

So far business is booming and they expect to be able to invest in their own pumps this season instead of hiring.

Hiring fish catchers has advantages for the farmer who devolves the risk of marketing the catch.

Case Study 5

Mrs Tsong Mee Keaujanua

Mrs Tsong farms about 30 rai on her own as her husband works in Kuwait. Though still growing traditional crops, she has recently raised some capital to plant cashew trees and has gone into contract tomato production. She joined the project one season ago. Says that at least 10 of her neighbours have suitable ponds but none are practising fish farming. During the wet season, wild fish are abundant in the rice fields, and during the dry season villagers buy from a peripatetic salesman. When her husband comes back from overseas she usually nets the pond and has a feast.

The pond is restocked in the rainy season. She feeds the fish cooked rice waste and morning glory every day. The pond has a free flow of water, therefore fertilization is not possible. She picks a basket full of cassava leaves every few days and feeds them to the fish. On younger plants just a few leaves are taken, whilst on more mature plants the whole top is cut out. Cassava weed (`dong yung') is also used regularly.

Case Study 6

Mrs Tongsong Sing, water shed area

Farms 12 rai on her own though this is not the total family holding. A large part of this land has been recently given over from cassava to mulberry production for sericulture.

She has followed the project recommendations with some success. Feeds include dongung, cassava leaf, buffalo manure, and urea. She has had considerable problems with water control through the pond system and lost much of her fish crop last year as a result of floods. She does not have the capital to raise the banks to prevent this happening again. Last season she caught about 256 kg of fish from her ponds.

About 20-30 families in her village have ponds out of a village population of around 200 families. She would describe pond owners as falling in to the middle to upper band of income earners amongst those who own their land (see diagram)

Figure 1: Relative wealth ranking

```
I<----------All fish farmers------------>I
I<--most farmers-->I                    I<--landless-->I
I-------------------------------------------------------I
Rich                A           B                  Poor
```

On the continuum between wealthy and poor villagers in figure 1, Mrs Sing placed herself at point A, slightly less well off as the majority of fish farmers since her pond was less productive. Farmers without ponds but with their own land were placed at B, being of low social standing and unlikely to be rich.

Mrs Sing stocks her pond with grass carp, tilapia, and Puntius, though she will not use tilapia again as they all swam away during the flood. The taste of Puntius is preferred by her family, as is small grass carp, though big fish are highly prized.

Annex VII: Estimated Costs and Returns to Co-operative Agriculture in Bangladesh

Table 1: Farm budget for cooperative pond fertilization, 10 acre pond, 30 member families, Neemgachi, Bangladesh

Item		Taka
INPUTS		
(1)	Stocking (fry): 25,000 various species @ T200 per 1000	5,000
	Feed/fertilizer:	
(2)	Cow dung: 700 maunds @ T8 per maund	5,600
(3)	Compost: 6 mt @ T98 per mt	588
(4)	Chemical fertilizer: 500 kg	
	- 250 kg Urea @ T5 per kg	1,250
	- 250 kg Triple Super Phosphate @ T6 per kg	1,500
	Net hire: Seine net 1 day x 3 catches @ T500 per day	1,500
(5)	Fish exercising: Once a month during the growing period (ie, 6 time in total) @ T500 each time	3,000
(6)	Labour	
	Feeding, 90 person days	2,700
	Guarding, 4 people 210 days	-
	Stocking, 30 person days	900
(8)	Catching: 30 people x 2.6 hours x 3 catches (total 30 person days)	900
(9)	Marketing:	
	Transportation @ T2 per kg	7,770
	Labour, 2 person days per catch (total 6 person days)	180
(10)	Land: rental of 10 acres @ T200 per year per acre	2,000
(11)	Loan @ 12% of cast costs	2,490
	TOTAL COSTS	35,378
OUTPUTS		
(12)	Fish production: 105 maunds (3885 kg) @ an average of T25 per kg	97,125
	TOTAL NET BENEFIT	61,747
	TOTAL NET BENEFIT PER PARTICIPATING FAMILY	2,058
(13)	Labour requirement per family (days	5.6
	TOTAL FAMILY RETURN PER DAYS LABOUR INPUT INTO PROJECT	368

Source: discussions with project staff and farmers

Notes:

(1) Fry purchased from local Gremeen Bank hatchery, Feb 1991 prices

(2) One "maund" = 37 kg

(3) see Table 2, 'Cost of producing two metric tonnes of hyacinth compost for fish feed'

(4) Government of Bangladesh subsidised price

(5) see text for a fuller explanation of this activity assuming an 8 hour working day

(7), (8), and (9) done by villagers, therefore charged at the opportunit Guards usually charge T25 per night cost of labour. For guards this is T25 per nigh but not required in this case because participants occupy the pond banks

(10) Opportunity cost of land in project area

(11) Cash costs include stocking, feeding, net-hire, exercising and marketing

(12) project predicted

(13) see Table 3: "Family labour requirements"

Table 2: Cost of Producing two metric tonnes of Hyacinth compost for fish feed/pond fertilization

	Item	Taka
(1)	Water hyacinth x 4 mt	-
(2)	Collection of water hyacinth: 2 person 1 day	60
	Urea: 5kg @ T5 per kg	25
	Lime: 5kg @ T3 per kg	15
	Pit construction, 2 person days	60
	Polythene cover: 10′ x 10′ @ T20	20
	Cow dung: 2 maunds @ T8 per maund	16
Total cost		196

Source: Discussions with project participants

Notes:

(1) Available free on farm
(2) Opportunity cost of labour T30 per 8 hour day

Table 3: Labour requirement per participating family (person days)

Item	Person days
Fertiliser production (water hyacinth compost)	12
Feeding	90
Stocking	30
Catching	30
Marketing	6
TOTAL (ALL FAMILIES)	168
TOTAL (INDIVIDUAL FAMILIES)	5.6

Source: Discussions with project participants

Annex VIII: Bangladesh case studies

There follows a brief summary of three projects visited by the mission in Bangladesh. These provide a cross-section of the very large number of Government of Bangladesh, Bilateral, Multilateral and NGO assisted projects currently working in the area of aquaculture. It is generally true to way that where success has been achieved, it has usually been related to intensive, on-going and regular contact with recipients and adoption of low technology, low investment strategies.

The Parbatipur project extension-trader strategy

The mission visited the ODA funded Fish Seed Multiplication Farm at Parbatipur which is currently under construction. The project is intended to produce hatchlings for the local market. Coincidentally, it is situated right next to Parbatipur station, which is the main fish seed market serving the North West of Bangladesh.

This hub of an elaborate trading network evolved to transport fish seed from private hatching and nursery unit Southern Bangladesh to their markets in the North. In comparison to this enormous trade, the projected project output of 200kg of hatchlings per year is small. Additionally, commercially produced hatchlings are likely to experience some market resistance because fish producers prefer wild hatchlings.

To partially alleviate these problems, the project is promoting the use of mini-hatcheries as micro-businesses in collaboration with local NGO's. These hatcheries have relatively low capital outlay and high return on investment.

In addition, it is proposed to link in the extension work of the project with the existing fry trader network. Many fish farmers perceived fry traders as potential sources of knowledge on pond management and traders would be able to develop greater link with potential clients securing further sales (Lewis and Gregory, 1991). Initial studies identified three main areas where traders could pass information to fish farmers:

(i) Stocking levels;

(ii) Fishpond inputs;

(iii) Partial harvesting.

A survey of fish farmers who had made contact with project trained traders indicated that 64% had followed the advice offered. Some traders reported that their business had improved as a result of greater status derived from being associated with the project. Other have taken up fingerling production and, therefore, have moved to another level in the production "network".

Conclusions

This project highlights the importance of a thorough understanding of the existing practices and socio-economic norms before intervention. The appropriateness of a large commercial fish hatchery situated next to a major traditional centre of fry distribution is a case in point, though there are possibilities of linking the two to their mutual advantage as described above.

Mymensingh Aquaculture Extension Project

This Danida/Government of Bangladesh project, presently in the pilot stage, which seeks to increase aquaculture yields and sustainable income from about 40,000 owned or leased ponds in 6 Upizallas1/ in the Mymensingh District.

The project identified the following constraints to the spread and improvement of aquaculture:

(i) Inadequate supply of appropriate species of fingerlings;

(ii) Lack of aquaculture technology appropriate to the conditions of target beneficiaries;

(iii) Insufficient financial resources amongst potential participants;

1/ An Upazilla is an administrative region made up of a number of Unions

(iv) Poor understanding of pond production dynamics by pond operators.

Initially the project undertook a two-tier baseline survey to ascertain the "before" project situation. This included rapid assessment of all ponds in the project area and a sample survey of 20% of ponds for detailed technical and socio-economic information.

The project identified and trained local unemployed youths with farming knowledge as extensionists, contracting them for the initial period of the project and then allowing them to return to profitable fish farming in the communities in which they had been working.

An elaborate and highly managed system of credit was set up to provide physical and technical inputs during critical start-up periods. Particular attention was paid to the credit delivery system which was designed to ensure that loans and repayments were fitted to the requirements of technologies known to work in Bangladesh. Loans and project support were synonymous, tying borrowers to training, and the regular attention of project staff. No collateral is required, ensuring that beneficiaries with minimal assets could participate.

High yielding production models were deliberately chosen to maximise returns and minimise pay-back of loan capital. Sustainable aquaculture enterprises are considered to be the key output from the project. It is planned that once all the necessary support mechanisms are set up by completion the project will move onto another district.

Conclusions

The strong management and training element of this project adds considerably to its attractions as a sustainable approach to aquaculture development. It seeks unashamedly to create profit making, sustainable rural enterprises. It has been particularly successful in recruiting women, both as participants and as extensionists. If there were any doubts about the efficacy of the approach it might lie in the area of fish marketing and in supply of inputs. The project recommends fertilizing the

pond and supplementary feeding with mustard seed cake and rice bran. These commodities are already in short supply and will become scarcer in proportion to the success of the programme. Alternative sources of feeds will be necessary to sustain the momentum of project success.

Joysagor Fish Farm, Neemgachi

This hatchery, which had been constructed and funded by ODA, was taken over by the Gremeen Bank in 1986. The project produces fish for the market in its large ponds, and hatchlings for its associated re-conditioned pond scheme. Initially a loss making government institution, the hatchery now shows a profit and is able to plough this back into schemes to assist local landless groups with access to derelict, government owned ponds.

Ponds rehabilitated by the German Bank are worked initially by Gremeen Bank staff until fear of take-over by local elites is past. They are then handed over to groups of landless families who are trained and supported. Initially, the Gremeen Bank receives 50% of the return on fishing.

In 1989/90 the project produced 237 tonnes of various types of fish including Roi, Mrigal, Katla, Bighead Carp, Grass Carp, Caprio and Silver Carp.

Conclusions

The success of this project is based upon sound management and common sense. Before expanding into more risky investment, the Gremeen Bank assured the profit base of its operation. Project beneficiaries are closely supervised and supported with workable technologies (ie, simple pond management methods such as fertilization with manure and compost). It is able to target landless pond bank dwellers using cooperating groups living around formerly Government controlled water bodies.

The project staff expressed an interest in moving from pond fertilisation to more intensive models involving basic feeds, which would be the next stage in commercial fish production. However, they were reluctant to recommend supplementary feeding to collaborating farmers, preferring to use

the minimum possible burden of additional inputs on their resource - poor target group.

Conclusions for feed utilisation in Bangladesh

The main lesson drawn from these projects by the team is that, initially, aquaculture in Bangladesh will follow a minimalist approach, keeping input costs as low as possible regardless of possible returns. As the technology spreads, earlier and more successful farmers will begin to seek additional feed inputs to increase profit and turnover. At this stage, the severe shortage of feeding materials will come into play and there will be a demand for feed from alternative sources.

Annex IX: Project proposals and concept notes

A. Concept Note: Cassava Utilisation for Fish Feeding

Introduction

There follows an outline proposal for research in the Feed Availability and Nutrition Problem Area of the Livestock Production Programme. It is also related to the FSCU Root Crops Problem Area.

Statement of Problem:

The growth of small-scale extensive and semi-intensive aquaculture in South East and Southern Asia is leading to increasing demand for supplementary feed inputs to increase pond productivity. There are severe constraints on further aquaculture development in these areas resulting from competition for scarce protein resources for human and animal consumption.

International demand for cassava root in Thailand in predicted to decline dramatically in the near future. This product is an important cash crop throughout the country, especially in the poorest areas in the North East where its production is particularly suited to the farming system.

Cassava has a number of advantages because it requires minimal labour inputs, grows on marginal, poor quality land and provides cash income.

Two possible strategies are available to Thailand to inhibit the impact of falling international demand:

(i) Crop diversification;

(ii) In-country utilization.

This proposal seeks to address one aspect of the latter.

Scope of the Problem:

Cassava is very widely grown in Northern Thailand. It is also grown in some quantities in other parts of the same agro-ecological zone such as Laos, Cambodia and Vietnam. These countries also have significant under-utilized aquatic resources.

Purpose of the programme:

The overall objectives of the project will be:

(i) To increase the incomes of small-scale rural farmers with access to water resources;

(ii) To add value to a currently under-utilized on farm resource which is characterised by price inelastic demand;

(iii) To determine the socio-economic dynamics of cassava production and in conjunction with participating farm families to develop profitable and appropriate recommendation for widespread extension.

How the objectives will be achieved:

Initially, the project will build upon on-farm work conducted by the Asian Institute of Technology NE Thailand Outreach Project to develop recommended feeding regimes appropriate to farm family resources. The acceptable maximum resource use under supplementary feeding regimes which use cassava and cassava leaf, plus other on and off farm sources of feed inputs will be identified.

Concurrently, studies will be conducted on the socio-economics of cassava production in conjunction with the farming systems group at Khon Kaen

University. These studies will seek to identify the cultural norms associated with cassava production and cropping.

Scientific investigations will be instigated to identify the nutritional (or anti-nutritional) qualities of cassava root and leaves as fish feed material, the water stability properties of various made-up fish feeds and the effect on production of cassava root of leaf cropping.

Possible collaborators:

Dr D Little, Asian Institute of Technology, Bangkok

Dr T Charoenwatana, Farming Systems Research Group, Khon Kaen University

Kasem Chompoonutprapa, Director, The Agricultural Development Research Centre in Northeast Thailand

Proposed implementation:

Contacts with the relevant institutions have already been made and this could be furthered during a proposed visit to Thailand by Mr Watson.

The following programme is envisaged:

(i) Instigate socio-economic surveys;
- identify study sites
- analyse data and report

(ii) Design and start agronomic trials;

(iii) Conduct on-farm trials in collaboration with AIT;

(iv) Review findings of above and develop proposals for wider dissemination.

References:

Hoare P W C and Crouch B R, (1988) Required Changes to the Project Management Cycle to Facilitate Participatory Rural Development, Agricultural Administration and Extension, 30, 1988, pp 3-14.

Duncan B, (1990) Economic aspects of diversification on cassava dependent farms in Northeast Thailand 1985-1990. Northeast Crop Development Project (NECDP). EEC Project No. ALA 84/02

AIT, (1990,b) Working Paper No 5, A Economic comparison of aquaculture with cropping options for small-scale farmers in Northeast Thailand.

AIT, (1990,a) Working Paper No 3, Project on-farm trial methodology during intervention year one.

Lovelace G W, (1988) Rapid Rural Appraisal in Northeast Thailand, Case Studies. KKU-FORD Rural Systems Research Project, Khon Kaen University.

Khonkaen (1986), Northeast Thailand, Farming System Research Project, Khon Kaen University.

Maal B and Ali S (1990), Women's Participation in Fish Culture in Greater Dinajpur District - Constraints and Possibilities, report to the Overseas Development Administration.

B. Concept Note: Shrimp waste recovery project

Introduction

During the course of this mission, assistance was requested by Bangladesh Rural Advancement Committee (BRAC) with the recovery of shrimp processing waste. Previous attempts to make shrimp head meal by sun-drying had been unsuccessful, and the project had halted as a result. Subsequent to the visit, a meeting with staff from the Institute of Aquaculture, Stirling (IAS) showed that there was the possibility of collaborative research in this area. A possible link between BRAC, NRI and IAS should be examined.

Statement of Problem:

Three problems need to be assessed. From BRAC's point of view, the main objective is to create employment for groups of landless people. The other problems to be addressed are the large volume of waste currently generated by shrimp processing and the shortage of high quality materials for shrimp feed manufacture. It should be noted that technologies applied to shrimp waste recovery will be applicable to a number of countries.

Developmental work carried out at NRI has yielded a number of possible methods for the processing and recovery of shrimp waste. Total shrimp production in Bangladesh is about 20,000 tonnes which could yield up to 8,000 tonnes of waste. Information available to this mission suggests that most of this is dumped (some at sea). This represents the loss of some 2,000 tonnes of crude shrimp meal in a country where the total supply of fish meal is only 650-750 tonnes.

While shrimp heads can be sun-dried, this presents some problems. BRAC experienced problems in drying the material sufficiently quickly to prevent bio-deterioration. The smell of rotting shrimp meant that the project was extremely unpopular and had to be stopped. Also, the nutritional value of such material is low, and it may even be toxic. Prawn processing is dispersed widely along the coast of Bangladesh and logistical and financial constraints mean that it is not feasible to transport the raw waste over any distance. The solution of recovery through conventional fish meal plant is not, therefore viable.

Methods of accelerating drying are needed in order to prevent decay. While shrimp head meal is a satisfactory ingredient for fish, shrimp and poultry feeds, it contains a high percentage of ash and indigestible material. Separation of the meat from the carapace would yield a high protein concentrate which could be dried to provide a high quality meal for shrimp feed. Shrimp head meal has a high value as an export commodity and is much in demand for incorporation into shrimp feeds. It should also be noted that if the shrimp waste is in good condition, it is possible to make a human food grade product.

Recovery of chitin and derived products from the shrimp carapace offers the possibility of further income generation. However, such processes are not within the means of landless groups and would not form part of this project.

Possibilities for additional employment amongst landless people are limited by lack of access to facilities and lack of capital for investment in small-scale enterprises. These are problems currently being addressed by BRAC.

Scope of the problem:

While this work is specifically aimed at Bangladesh, the opportunities for application are much wider. A substantial proportion of the world's shrimp output comes from ldc's and it may be assumed that similar wastage occurs in other countries.

Purpose of the programme:

The overall objectives of the project will be:

(i) To increase the incomes of landless groups through the provision of small-scale industry;

(ii) To recover a currently wasted resource, which has a potentially high value;

How the objectives will be achieved:

An initial desk survey will be conducted to establish the likely financial viability of this project including the logistics of raw material collection. If this shows that the project has little chance of making a product at a saleable price, no further development will take place.

Before commencing work on the recovery of shrimp head waste, it will be necessary to conduct a survey of the market for possible products, and to balance the options of in-country use vs export and animal feed vs human food. Subsequent development strategy will be dependant on the results of this survey.

Initial development trials will be conducted at NRI, and will be followed by in-country trials working through BRAC. Depending on the choice of options (animal or human food) adopted, consultation with the feed/food industry and appropriate research institutes in Bangladesh will be necessary.

Studies on the benefit of whole, dried heads compared to recovered, high protein meals may be conducted with IAS, although they may not be carried out under the auspices of this project. The value of shrimp head meal in shrimp diets is well know and no further investigation is proposed in this project.

Possible collaborators:

Bangladesh Rural Advancement Committee, Dhaka

Dr J Brown, Dr C Fox, Institute of Aquaculture, Stirling

Proposed implementation:

Contacts are already established with IAS and BRAC. The request for this work originated from BRAC. Before any further work is proposed, a desk study should address the following:

Technologies for the recovery of shrimp head meal suitable for adoption by landless groups;

Potential export markets for shrimp head waste products for shrimp feed;

Recovery of food grade products from shrimp waste, and the potential for in-country use

C. Project Proposal: Socio-economic Survey of Aquaculture and Feed Utilisation in Laos and Vietnam

Introduction

A survey of aquaculture and farming systems in Laos and Vietnam is proposed. Terms of reference are outlined below.

Background and Purpose

A recent mission to Thailand and Bangladesh to assess the need for feed technology in small-scale aquaculture systems has detected a demand for similar activities in other countries in the same agro-ecological zone. Furthermore, the extension of the activities of the Asian Institute of Technology Thailand Outreach Project into Laos during its next phase, presents NRI with the opportunity of extending its established input in the area of feed utilisation to other countries in the Region.

The mission seeks to investigate various aquaculture and farming systems prevailing in selected agro-ecological zones, specifically Laos and Vietnam, with a view to assessing the needs for fish feeds amongst the peoples of those areas.

Objectives

(i) To establish the regional application of work to be conducted by NRI in collaboration with AIT in the area of feed utilisation.

(ii) To identify and make contact with collaborating institution in the chosen target countries.

(iii) To provide NRI with a baseline of expertise in small-scale aquaculture and farming systems in these important post-communist developing countries.

Terms of Reference

The mission should address the following:

1. Quantify the rates of growth of aquaculture in the Laos and Vietnam and identify the current and future likely demand scenarios. This should include information on who grows and who consumes these products.

2. Identify current and potential feed sources, their utilisation, and the key constraints to further utilisation within existing farming systems. Consideration should be given to competition from other livestock and human sectors for these feed sources.

3. Assess feed sources, technology and materials against marketing, financial and socio-economic criteria such as opportunity cost. Identify which have most potential for subsequent development work.

4. Characterise current practices and farming systems for aquaculture in the target agro-ecological zones.

5. Assess the likely financial cost and benefits to the farmer of on-farm fish feed production and indicate whether the economic benefits of on-farm or commercial fish feed production are likely to be positive.

6. Appraise the likely role of and impact upon women of farming systems that have increased emphasis on aquaculture production.

7. Assess the likely costs of NRI's inputs to such development work.

8. Identify possible collaborators including Government and Non Government bodies and regional funding institutions.

9. To identify other possible areas where NRI comparative advantage could be usefully applied.

Costs

It is proposed that the mission would take place in the spring of 1992 and would consist of a feed technologist and a socio-economist/social anthropologist. Approximate costs are as follows:

	£'s
Staff time: Two SSO grade x 1.5mm (2 weeks in Vietnam, 2 weeks in Laos plus 2 weeks write up in UK)	18,270
Subsistence:	991.12
Internal travel: say	300
Contingencies: @ 10%	1,956
Total	21,517

D. Project Proposal: Feeds for Freshwater Prawn in Bangladesh

Introduction

During a recent mission to Bangladesh, a request was received from BRAC for assistance in the formulation and manufacture of freshwater prawn feeds. This has been identified as a constraint to improving prawn production by low income and landless groups being aided by BRAC. Currently, prawns are grown in a polyculture system with carps, in order to provide a source of cash income.

Statement of problem:

BRAC has been encouraging small farming groups to stock prawns as a means of boosting incomes. However, attempts to increase yields have met with limited success. Intensification through feeding has not proved effective for a number of reasons. The use of composted water hyacinth as feed was not successful due to problems with de-oxygenation. Purchased feeds are too expensive and are generally over-specified for the intended use. The return from feeding compounded feeds is generally not sufficient to justify their use.

BRAC has tried to make use of locally available materials for prawn feeds, but were unsuccessful as they did not have the access to the necessary information on how to formulate and manufacture suitable feeds. The specification for such a feed would be that it should be made with the minimum of equipment, minimum fuel inputs and should not require a large amount of labour to collect and process materials. The feed will also need to be inexpensive, give a good return and be water stable for some hours.

It will be difficult to make such a feed in Bangladesh without the need for a substantial proportion of purchased inputs. This will create an additional problem of capitalisation for small farmers, but this is already addressed by BRAC.

Scope of the problem:

The basic problem of creating income generating activities is widespread throughout Bangladesh. Incomes for small farmers and landless groups are very low, and opportunities for employment are often limited. Some groups have secured access to ponds suitable for aquaculture through NGO's such as BRAC or the Grameen Bank. In-country expertise to solve the problems of small-scale aquaculture is limited.

Purpose of the programme:

The overall objectives of the project will be:

(i) To increase the incomes of small-scale aquaculture groups through increased yields of freshwater prawn;

(ii) To adapt existing knowledge of small-scale, on-farm feed manufacture to the preparation of prawn feeds using ingredients available in Bangladesh and to carry out on-farm feeding trials;

(iii) To evaluate the costs and benefits of feeding as part of the production of prawns in semi-intensive systems.

How the objectives will be achieved:

Trials are already conducted by BRAC to evaluate and implement potential recommendations for farmers. There is a three stage process:

Experimental - these are largely untried, high risk ideas. Initial trials are carried out on BRAC's own experimental farm. When extended to farmers, a high degree of support is provided to cover some of the risk. Extension services, labour, feed and other inputs may be provided free of charge.

Pilot - these are tested ideas that still carry some risk. Farmers are provided with credit to enable them to adopt such ideas, but this is not repayable in the event of a loss.

Proven - these are well tried and tested ideas which have proved successful with farmers. Farmers are supplied with credit which is paid back with interest.

As it is proposed to work through BRAC, the above methodology will be adopted. It is expected that initial trials would count as experimental and therefore high risk. Subsequent trials would be expected to become pilot schemes. The implementation of proven ideas would be left for BRAC to carry out.

Formulation of feeds will rely on existing literature, with modifications to take account of local problems of raw material availability and the need for water stability. After initial testing of manufacturing methods at NRI, trials will be conducted with BRAC staff to modify methods to suit local conditions. Having established promising formulations through experimental trials, the project will broaden out to test the findings through a pilot scheme while developing and improving ideas through further experimental trials.

Possible collaborators:

F K Bhuiya, Bangladesh Rural Advancement Committee, Dhaka

Proposed implementation:

Contacts with BRAC have already been established, and a formal request for this work has been received by NRI and BHC, Dhaka.

The project will divide into three phases:

Phase 1

Initial survey of the problem, to include identification of potential feed ingredients, preliminary assessment of the technical constraints to on-farm production of prawn feed and analysis of the likely returns from the adoption of various feeding recommendations.

Establishment of the roles of NRI and BRAC and the areas of responsibility.

Identification of suitable farmer groups for experimental trials.

Phase 2

Examination of raw material properties at NRI and testing of feed manufacturing methods.

In-country feed manufacturing and commencement of experimental feeding trials with BRAC farmers groups.

Monitoring of results from experimental trials and evaluation (biological and economic) of results.

Identification of farmers groups for pilot trials and for second experimental trials.

Phase 3

Continue in-country experimental trials refining promising ideas from Phase 2.

Pilot trials to be conducted with farmer groups.

Overall assessment of the value of feeding.

Dissemination of findings.

Note: if economic, social or technical factors indicate that the project is not likely to achieve its aims, it may be terminated at Phase 1 or Phase 2.

Costs

Phase 1

Initial survey:

Feed technologist 0.5 mm at £6090	3045
Socio-economist 0.5 mm at £6090	3045
Subsistence 2 x 14 days actuals	840
Flights UK to Dhaka return x 2 at £1930	3860
Post visit report 1mm at £6090	6090
Phase I Total	16880

Phase 2

NRI

Raw material processing trials:

Feed Technologist 2mm at £6090	12180

In-country trials:

Feed technologist 1.5mm at £6090	9135
Subsistence 45 days actuals	1350
Flight UK to Dhaka return	1930
Post visit 0.5 mm at £6090	3045

Monitoring:

Feed technologist 0.5mm at £6090	3045
Socio-economist 0.5 mm at £6090	3045
Subsistence 2 x 14 days actuals	840
Flight UK to Dhaka return 2 x £1930	3860
Post visit 1mm at £6090	6090
Phase 2 Total	44520

Phase 3

In-country experimental and pilot trials:

Feed Technologist 1.5mm at £6090	9135
Subsistence 45 days actuals	1350
Flight UK to Dhaka return	1930
Post visit 0.5 mm at £6090	3045

Overall assessment and final report

Feed Technologist 0.5mm at £6090	3045
Socio-economist 0.5mm at £6090	3045
Subsistence 2 x 14 days actuals	840
Flight UK to Dhaka return 2 x £1930	3860
Post visit 2mm at £6090	12180
Phase 3 Total	38430
Project Total	99830
Plus 10% contingencies	9983
Total funding requested	109813

E. Concept Note: Collaborative Research Programme Between NRI and AIT

Introduction

Both AIT and NRI have a common area of interest in the development of simple fish feeds based on minimal purchased inputs and maximum use of on-farm resources. Work conducted by the NRI Feed Technologist has demonstrated the feasibility of this approach, and it is intended to carry out a short on-farm trial to test the benefits from feeding. This project is intended to take the work into a wider area of application in SE Asia.

Statement of the Problem:

Feed availability in SE Asia is limited by a number of factors. Logistical difficulties in transporting commercially manufactured feeds can be overcome, but the increased cost due to transport often places an already expensive feed beyond the reach of poor farmers. Additionally, feeds which are a long time in transit are at risk from spoilage.

Lower prices for fish in rural areas may mean that commercial feeds are not cost effective. There is a need for a cheap, yet nutritionally adequate supplementary feed in rural areas, but the market is often so dispersed as to make the local, commercial production of feed uneconomic. Two options are available to the farmer. Fish may be simply fed on any available material, including fresh green leaf. This is a simple option, but some feeds, especially those in the form of a meal, are wasted, being dispersed into the water column and bottom mud. Such feeds probably act as much through their value as fertiliser as direct nutritional benefit. The second option is to mix feed materials together to make a simple, compound feed. This has benefits in terms of providing a more balanced diet which is more efficiently utilised by the fish.

Certain feeds may be available in excess at some times of the year, and yet at other times, there may be a net deficit of all feed materials. By processing raw materials so that they may be stored and brought into use in times of need.

Scope of the problem:

Fish farming is widely practiced in SE Asia, and many of the countries share common problems of transport difficulties and non-availability of suitable feeds. Some raw materials are common to the region and is expected that some common solutions may be possible. From studies in NE Thailand, it is apparent that some potential feed materials are currently under-utilised.

Purpose of the programme:

Note: further discussions with AIT on this proposal are expected to take place in July/August 1991. Firm proposals will be drawn up after these discussions.

The general objectives of this project will be:

(i) To investigate methods of on-farm feed production;

(ii) To examine the nutritional value to fish of potential raw materials;

(iii) To carry out on-farm feeding and manufacturing trials with farmers to examine the socio-economic constraints to on-farm feed production and to determine its costs and benefits.

How the objectives will be achieved:

Details of this will be drawn up after further consultation with AIT. It is anticipated that a number of existing AIT programmes will spin-off into this project, and the likewise, this project will provide an input into some AIT programmes.

It is expected that the fish nutrition component of this project will be relatively small, as some of the work is already being undertaken at AIT. The principal area for investigation will be through the conduct of feeding trials through interactive development with farmers, initially in NE Thailand, possibly extending to Laos as a next step.

Possible collaborators:

Prof P Edwards, Asian Institute of Technology

N Innes-Taylor, AIT NE Thailand Outreach Project

Proposed implementation:

This will be discussed with AIT