#1807

DISSEMINATION AND EVALUATION OF GENETICALLY IMPROVED TILAPIA SPECIES IN ASIA

DEGITA

TECHNICAL REPORT

(November 1994 to June 1995)

July 1995

ICLARM
International Center for Living Aquatic Resources Management

Financed by the Asian Development Bank, RETA No. 5558

Library
1000019797

SH
206
P22
I57
1995

EXECUTIVE SUMMARY

The project designated as "Dissemination and Evaluation of Genetically Improved Tilapia Species in Asia (DEGITA)" commenced in June 1994 with funding support from the Asian Development Bank (ADB), and is being implemented by the International Center for Living Aquatic Resources Management (ICLARM) in collaboration with national institutes of Bangladesh, People's Republic of China, Philippines, Thailand and Vietnam. Following are the accomplishments/activities of the project for the period of November 1994 to June 1995.

• Development of a Unified Methodology

A unified methodology was developed to evaluate the performance of genetically improved tilapia strains in the five participating countries, integrating the disciplines of genetics, economics, sociology and environmental science. The methodology is a combination of *ex-post* and *ex-ante* evaluation techniques, and consists of the following activities:

a) national review of past performance and current status of tilapia industry;
b) on-station evaluation of GIFT and other check strains;
c) analysis of agro-ecological and socio-economic environments of project sites;
d) baseline survey of fish producers, consumers and traders;
e) on-farm trials of GIFT and local check strains; and
f) adoption survey

• Review of Past Performance and Current Status of Tilapia Industry

All the participating countries initiated the review of past performance and current status of tilapia industry in their respective countries. The findings reveal that tilapia culture is a profitable enterprise and even small farmers can afford to culture tilapia to augment their income. In fact, except in the central Thailand, most of the tilapia producers of this region are poor. Small farmers of Bangladesh can produce 1 ton per ha within 3-4 months without any external inputs. Price of tilapia is relatively low compared to other species. Though per capita fish consumption data are not widely available by species, limited data suggest that tilapia is consumed mainly by poor people, as they cannot afford to buy most of other species. Price elasticity of demand for fish is higher for poorer people than for the rich, implying that yield-increasing aquaculture technology would benefit mostly the poor. Income elasticity of fish is also very high for poorer people compared to the rich, implying that increase in income for the poor would increase the demand for fish substantially. Information on environmental impact of tilapia species and culture systems is not available. However, some of the anecdotal information suggests that, though the mossambicus tilapia created some environmental problems, the same is not so far experienced with Nile tilapia.

- **On-Station Experiments**

Bangladesh, Thailand and Vietnam initiated on-station trials, and Vietnam already completed the first cycle of the on-station trials. China conducted small-scale trials on the performance of GIFT fish. Results so far from all four countries indicate the superiority of GIFT strain over the checks used.

- **Plans for On-farm Activities**

Plans for on-farm activities in the participating countries have been finalized. Project sites representing a range of agroecosystems and aquaculture were selected in all participating countries; Bangladesh has chosen six sites, China four, Philippines fifteen, Thailand nine and Vietnam twelve.

- **Baseline Survey**

Bangladesh, Philippines and Vietnam initiated the baseline surveys of fish producers, consumers and traders. China and Thailand have finalized the plans for baseline surveys, and will be initiating the survey soon. Each country is planning to collect baseline information from 15 to 25 aquaculture farmers per site to characterize the farm households and their farming systems from socio-economic and ecological perspectives. Information on consumption and trade aspects will be collected through multiple visits (3 to 4 times a year) to 8 to 10 fish consumers and to more or less equal number of fish traders per site.

- **On-Farm Trials**

On-farm monitoring of GIFT and local strains were initiated in 80 ponds in Bangladesh, 90 ponds/cages in the Philippines, and 120 ponds in Vietnam. Thailand will initiate the trial soon. China is expected to initiate and complete the on-farm trials during 1996.

- **Review of DEGITA Activities**

Progress of DEGITA activities were presented and discussed during the Second Steering Committee Meeting of INGA held recently in Hyderabad, India. Encouraged by the progress of DEGITA, six carp producing Asian members of INGA - Bangladesh, China, India, Indonesia, Thailand and Vietnam - expressed interest in a similar collaboration on carps.

The next review is planned to be held in conjunction with the Third INGA Steering Committee Meeting scheduled to be held in May 1996.

1. INTRODUCTION

Recognizing the importance of genetic improvement in aquaculture production, the Asian Development Bank (ADB) provided a technical assistance grant (RETA No. 5279) to the International Center for Living Aquatic Resources Management (ICLARM) for implementing a collaborative aquaculture research project on Genetic Improvement of Farmed Tilapia (GIFT) in Asia, with the participation of the Philippines. Subsequently, the United Nations Development Programme (UNDP) provided supplementary funding to strengthen the project. Successful development of high yielding tilapia strains under the GIFT project has led to a new collaborative project on "Dissemination and Evaluation of Genetically Improved Tilapia Species in Asia (DEGITA)" as a follow-up activity. The project DEGITA become operative on 15 June 1994 with funding support from ADB (RETA No. 5558), and is being implemented by ICLARM in collaboration with national aquaculture research institutes of Bangladesh, People's Republic of China, Philippines, Thailand and Vietnam. The main objectives of the DEGITA Project are: 1) to carry out genetic, socioeconomic and environmental evaluation of the improved tilapia species in Bangladesh, People's Republic of China, Philippines, Thailand and Vietnam; 2) to disseminate the promising tilapia strains among small fisherfolk in the five selected developing countries; and 3) to transfer scientific knowledge and technology for tilapia genetics in order to assist the participating countries in planning national tilapia breeding programs.

An inception report, covering the activities of the project for the period of June to October 1994, was submitted to ADB by ICLARM in November 1994. This technical report discusses the accomplishments/activities of the project for the period of November 1994 to June 1995.

2. FORMATION OF NATIONAL TEAMS

All the participating countries formed national teams for executing DEGITA activities (Appendix 1). These national teams vary considerably in terms of expertise in different relevant disciplines (genetics, economics, extension, hatchery management and environmental science/ecology). Bangladesh has a good team of six biologists from the Fisheries Research Institute (FRI), but lacks economist and environmental specialist on its team. In addition to the core team of FRI, officials of four non-governmental organizations (Bangladesh Rural Advancement Committee (BRAC), "PROSIKHA", "BACHTE SHEKHA" and "JAGORONI CHAKRA") are helping in baseline surveys and on-farm activities. China has a multidisciplinary team of 10 members from the Shanghai Fisheries University (SFU) and from various fish seed farms. Bureau of Fisheries and Aquatic Resources (BFAR) is executing DEGITA activities in the Philippines in collaboration with regional offices of the Department of Agriculture. The core Philippine team has four members from BFAR, including one environmental specialist. Like in Bangladesh, Philippine team has no economist/social scientist. In Thailand, there is a multidisciplinary team of 5 scientists from the National Aquaculture Genetics Research

Institute (NAGRI) and Kasetsart University. There are three groups within the team, a genetics group, an ecology group and a socioeconomic group, who all have considerable field experience. Vietnam has two interdependent teams, one in Hanoi at Research Institute for Aquaculture (RIA) No. 1 and the other in Ho Chi Minh City at RIA No. 2. These teams consist of RIA personnel and local university specialists. Both teams have environmental specialist, but only North Vietnam team has economists.

The overall problem facing these participating countries is a lack of expertise in conducting socioeconomic impact study, and to some extent, in accessing data with regard to ecological impact of tilapia introductions. The Project Coordinator/Socioeconomist of DEGITA is helping national teams in conducting socioeconomic impact assessment. Project Environmental Specialist also visited all the participating countries, and assisted national teams in designing environmental impact assessment study.

3. DEVELOPMENT OF UNIFIED METHODOLOGY

A unified methodology was developed to evaluate the performance of genetically improved tilapia strains in the five participating countries, integrating the disciplines of genetics, economics, sociology and environmental science. The methodology is a combination of *ex-post* and *ex-ante* evaluation techniques, and consists of the following activities:

a) national review of past performance and current status of tilapia industry;
b) on-station evaluation of GIFT and other check strains;
c) analysis of agro-ecological and socio-economic environments of project sites;
d) baseline survey of fish producers, consumers, and traders;
e) on-farm trials of GIFT and local check strains; and,
f) adoption survey.

This section briefly discusses analytical framework and research protocol being followed.

3.1 *Analytical Framework*

The analytical framework being used is holistic in nature, and has the following specific components:

3.1.1. Development of Fisheries Household Model for Each Participating Country

The model consists of producer and consumer cores for the aquaculture sector of the country. The producer core follows the profit

maximizing behavior of aquaculture producers, and provides the fish supply and input demand (labor, feed, fertilizer, etc.) equations for the market. The consumption core is an abstraction of utility maximization behavior of consumers, and provides the demand equations for products in the market. The model would be estimated primarily with data being collected through baseline surveys. In addition, secondary data as well as baseline site specific data on agro-ecological and socioeconomic environments will be used in estimating the model. The fisheries household model will be used as a base for analyzing the impact of improved tilapia strain on different stakeholder groups (user and non-user fish farmer, consumer, landless laborer, middlemen, etc.) in various biophysical and socio-economic environments.

3.1.2. Construction of *Ex-ante* Impact Indicators

As the project duration is not long enough to capture the *ex-post* impact of genetically improved tilapia technology, *ex-ante* impact assessment method will be used in estimating gains from the technology. Data from on-station experiments, on-farm trials and from adoption survey will be used to construct *ex-ante* indicators of direct impact of genetically improved tilapia technology, such as yield improvement, cost reduction, quality enhancement, rate of adoption, and other value added measures like sustainability. Fisheries simulation model will be used to measure probable direct gain, like per hectare productivity change, under alternative environments and input use levels.

3.1.3. Analysis of Overall Impact

Measures of *ex-ante* impact indicators will be incorporated to the baseline model to estimate the welfare gain to the society in terms of productivity, self-sufficiency, food and nutrition security, sustainability, gender equity, poverty alleviation and income distribution.

3.2 *Research Protocols*

Though the protocols being followed to evaluate the performances of genetically improved tilapia species varies from country to country, efforts have been made to standardize the approaches as far as possible, to facilitate information exchange between countries and to help derive maximum information from intercountry comparisons. Protocols for on-station experiments were finalized during the initial planning meeting held in September 1994, and were discussed in the project inception report submitted to ADB in November 1994. Protocols for other activities (activities a,c,d,e,f) are presented in Appendix 2.

4. REVIEW OF PAST PERFORMANCE AND CURRENT STATUS OF TILAPIA INDUSTRY

All the participating countries initiated the review of past performance and current status of tilapia industry in their respective countries. Although a number of studies analyzed biological aspects of tilapia culture in different participating countries, very limited work have been done on socio-economic and environmental aspects of tilapia introduction and adoption, except in the Philippines. A technical report is being prepared on "economics of tilapia farming" in the Philippines, the provisional outline of which is given in Appendix 3. Most of the other participating countries have started collection of data on local tilapia industry more or less from "scratch". This section reports information so far collected on tilapia industry in participating countries, specifically on socio-economic status of tilapia culture.

4.1 *Farmed Tilapia Production*

Nile tilapia (*Oreochromis niloticus*) is one of the most popular farmed fish species in China, Philippines and Thailand. Nile tilapia also proved to be a suitable cultured species in Bangladesh and Vietnam. China is the world's largest producer of farm tilapia with 200,000 t, followed by the Philippines with 91,173 t. These two countries together account for 43% of global farmed tilapia production and 51% of Asia's contribution. Thailand, with production of 43,916 t, accounts for about 5% and 7% of global and Asian farmed tilapia production, respectively. Tilapia is the most important freshwater cultured species in the Philippines and Thailand, contributing to about 72% and 31% of national freshwater aquaculture production, respectively. Tilapia also ranks second to milkfish (*Chanos chanos*) in terms of fresh and brackishwater farmed fish production in the Philippines, contributing to about 26% of total aquaculture production (Table 1).

Tilapia is cultured mostly in freshwater ponds in all the five participating countries. It is also cultured in cages, pens and brackish water ponds in the Philippines, in rice fields in China, and in brackish water areas and sewage-fed areas in Vietnam (Table 2). Monoculture is the main tilapia culture system in Bangladesh, Philippines and Vietnam. While China and Thailand culture tilapia in polyculture system, with Chinese carps in China, and with silver barbs, Chinese carps, striped catfish and other carp species in Thailand (Table 2).

Farmed tilapia production in the Philippines increased from 30,800 t in 1983 to 91,200 t in 1992, with a growth rate of 13%. per annum (Table 3). The contribution of freshwater farmed tilapia to total farmed tilapia production rose from 55% during 1983-86 to 84% during 1991-92. This is mainly because of consumers' and producers' preference for *O. niloticus,* which is grown in freshwater areas. The growth in freshwater farmed tilapia came from freshwater ponds and cages. Tilapia production

from freshwater ponds and cages grew at 17% and 23%, respectively, during 1983 to 1992, and presently contributing about 53% and 32% of total farmed tilapia production, respectively.

Tilapia culture is growing very rapidly in Thailand; production of farmed tilapia has increased from a marginal 5.5 thousand t in 1981 to 44 thousand t in 1992 (Table 4). In Thailand, nearly 80% of total farmed tilapia production comes from pond culture, the rest is from paddy fields and ditch culture (Table 5). The central region is the main freshwater tilapia producing area due to the availability of good irrigation schemes in the region. Tilapia culture, particularly Nile tilapia, is not very common in the coastal region. Though tilapia is cultured by all types of farmers, large commercial tilapia farms, with the average size of 4 ha per farm, dominate tilapia production in areas surrounding Bangkok. A recent survey of tilapia farmers in the central region revealed that more than 60% of fish farmers used to grow rice before switching to aquaculture for higher income, and more than 50% of sample farmers considered fish farming as their main occupation.

4.2 *Cost of Production*

Nile tilapia and silver barb are two main species that are cultured in seasonal ponds in Bangladesh. Though silver barb is more popular among consumers and commands higher market price, analysis carried out at the Fisheries Research Institute (FRI), Bangladesh showed that the profitability of Nile tilapia culture was higher than that of silver barb culture (Table 6). Another recent study carried out by ICLARM found similar results (Ahmed et al. 1995). Small fish farmers prefer Nile tilapia for culturing in their seasonal ponds as it requires no or very limited external inputs, and is resistant to disease like epizootic ulcerative syndrome (EUS). Profitability of tilapia culture varies from location to location due to the variation in soil and water quality, temperature, input use levels and others. Farmers can harvest up to 2 t/ha from monoculture of tilapia in seasonal ponds within 5 months. Even with 1 t/ha yield, achievable without any external inputs, farmers can earn an income of US$400 within 5 months.

Tilapia farming is a profitable enterprise in the Philippines. Survey conducted by ICLARM in Luzon during 1994 showed that the net profit from tilapia culture was about PHP5646 (US$225.84) per 100 m^2 in cage and PHP269 (US$10.76) per 100 m^2 in pond. With an average farm size of 0.22 ha for cage and 1.95 ha for pond, per farm per season net income from tilapia culture was about PHP 124220 (US$4969) for cage and PHP52455 (US$ 2098) for pond. While the farm gate price of tilapia was about PHP45 per kg, total cost of production was PHP16/kg in cage culture and PHP19/kg in pond culture (Table 7). Cash expenses amounted to 89% and 72% of total cost in ponds and cage system, respectively. The cost of feed comprised the bulk of total cash cost constituting about 61% of total cash cost in cage system and about 48% in pond system. Other major cash expense items were cost of fry and fingerling (30-35%) and hired laborer cost (8-10%). Bimbao and Ahmed (1994) summarized the

results of some economic studies for 1979-93, and showed that tilapia farming gave encouraging, through variable, return on investments.

The Office of Agricultural Economics, Ministry of Agriculture and Cooperative, Thailand, conducted a survey on tilapia and catfish farming in the Central Thailand in 1992. Comparative cost and return figures for tilapia and catfish culture are given in Table 8. Though catfish culture gave higher net income compared to tilapia culture, rate of return on investment is higher for tilapia culture. Catfish farming is highly capital intensive. Surveyed farms spent 2851 Baht per 100 m^2 pond for catfish culture, which was 10 times more than what was required for tilapia farming. Net return over cash cost and net profit from tilapia culture were Baht 348 (US$14.50) and Baht 246 (US$10.26) per 100 m^2, respectively. Feed cost was the most important expense for tilapia farming in Thailand, comprising about 28% of total cost (Table 9). Other major cash expense items for tilapia culture were cost of fingerlings (20%) and hired labor cost (17%).

Detail analysis of cost and return of tilapia farming in China and Vietnam are not available. Data collected during the field visit of the DEGITA Coordinator (Madan M. Dey) reveal that tilapia farming is a profitable activity in China and Vietnam; with a net income of about US$4000 per ha per two years in China and about US$350 per ha per farming season (6-8 months) in Vietnam. Even in the Central and Northern China (between 25°N to 35°N latitude), farmers are increasingly culturing tilapia to earn extra income by harvesting tilapia during the period when carps are not available in the market (August to October).

4.3 *Tilapia Prices*

Among all DEGITA participating countries, only Philippines and Thailand have time-series data on prices of fish species. Tables 10 and 11 show prices of popular fish species in the Philippines and freshwater fish species in Thailand, respectively, for the period of 1987 to 1992. In the Philippines, tilapia prices were higher than frigate tuna (*Auxis ssp*), roundscad (*Decapterus macrosoma*) and slipmouth (*Leiognathus spp*), but were lower than milkfish, grouper, cavalla (*Carengoides spp*), threadfin bream and Indian mackerel. In Thailand, tilapia prices were higher than striped catfish (*Pangasius spp*), but were lower than snakehead, silver barb, common carp and golden price carps. Tilapia prices (in US$) have increased in the Philippines during 1987 to 1992, but have remained more or less constant during the same period in Thailand. The ratio of tilapia price to milkfish price has increased in the Philippines from 0.68 in 1987 to 0.76 in 1992. While the ratio of tilapia price to catfish (*Clarias batrachus*) has remained more or less constant at around 0.37 during 1987 to 1992.

Information on fish prices collected by the DEGITA Project Staffs during 1992 from different locations of Bangladesh, China and Vietnam showed that prices of tilapia were relatively moderate compared to high price species. In Bangladesh, average tilapia price was US$1.25/kg, which was one third of the price of Indian major

carps. In China, tilapia prices were lower than crucian carp, black carp and bream, but higher than Chinese carps. In Vietnam, prices of small size tilapia (with an average size of 100 gm/fish) were very low (US$0.45/kg) compared to other common species like Indian carps (US$0.75/kg). However, bigger size tilapia (an average size of >250 gm per fish), which had very limited supply in the country, commanded high market price (US$1/kg).

4.4 *Fish Consumption*

Time series per capita fish consumption data are not available by species in any participating country. Only Bangladesh has time series data on per capita consumption of fish by income class for a reasonably long period of time.

Table 12 reports monthly per capita fish consumption data by income class for the period of 1981/82 to 1988/89 in Bangladesh. Though the average per capita fish consumption is increasing, the per capita fish consumption for the poorest quartile of rural people remained constant. In fact, per capita fish consumption of the poorest decile of rural population decreased considerably over the last decade. There is a wide variation in per capita fish consumption among various strata of the society, and the gap is widening over the years. In 1981/82, an average consumer within the poorest quartile of rural populace consumed 42% of the quantity of fish consumed by an average consumer within the richest quartile of urban population; by 1988/89 the figure dropped to 33%. There is also variation in the type of fish consumed by different classes of the society. Only a small wealthier segment of the population can afford to buy the larger carp species. Rural poor consumes smaller varieties of fish found in the rivers, ponds and in flooded paddy fields.

Limited information available from other participating countries suggest that per capita fish consumption is very low for poorer people compared to the rich (Table 13), and tilapia is one of the species consumed by poor people.

4.5 *Elasticity of Demand*

The gain from research in any commodity and its distribution among various strata of the society depends on, among others, the elasticities of demand for the commodity with respect to prices and income. Recent estimates on price and income elasticities of demand for fish by income classes are available only for Bangladesh.

In Bangladesh, price elasticity of demand for fish is elastic; an increase in fish price by 1% would decrease fish consumption by 1.03% (Table 14). And poorer people are more price responsive than the rich. Within the same income bracket, rural consumers are more price responsive than their urban fellows. An increase in fish price by 1.83% would decrease fish consumption of the poorest quartile of rural consumer by 1.83% and that of the richest quartile of urban consumer by only 0.96%. Income elasticity of fish is elastic for lower income groups, but not for the richer income groups

(Table 15). Increase in per capita income of the poorer segment of the society would increase the demand for fish sustainability. But an increase in per capita income of urban rich is not expected to substantially increase fish demand.

4.6 *Environment Impact*

Information on environmental impact of tilapia species and culture system is not available. However, some of the anecdotal information suggests that, though *O. mossambicus* created some environmental problems, the same is not so far experienced with *O. niloticus* and hybrids tilapia.

5. ON-STATION EXPERIMENTS

On-station experiments were initiated in one site in Bangladesh, two sites each in Thailand and Vietnam. Vietnam already completed the first cycle of the on-station experiment in one site, Hanoi. China conducted small-scale trials on the performance of GIFT fish. Plans for on-station experiments in five sites in China have been finalized. Table 16 shows on-station experimental sites of participating countries. These sites represent five out of seven FAO-designed agroecological zones in Asia. Two other zones - warm arid and semi arid tropics and cool subtropics - are not environmentally suitable for tilapia culture.

5.1 Bangladesh

To compare the GIFT strain with the existing *O. niloticus* stock in Bangladesh, a study was conducted with a Completely Randomized Design (CRD) both in cisterns ($5m^3$) and pond hapas ($5m^3$). In both cases, there were two treatment groups (GIFT strain vs. existing stock) with three replicates at a stocking density of 5 fish/m^3. The experiment was initiated on 19 August 1994 in the cisterns and on 06 September 1994 in the pond hapas. The initial weights of the GIFT strain and the existing stock were 9.90 and 9.25g, respectively, in the cisterns and 11.19 and 11.36g in the hapas. The fish were fed twice a day with a mixture of rice bran (50%), mustard oil cake (20%) and fish meal (30%) at 10% body weight. Growth sampling (weight and length) of all stocked fish was made at every 15-day interval. After 3 months, both the experiments were terminated. The growth data from the hapas and the cisterns are given in Tables 17 and 18. The data from both the systems indicated that the average weight gain in GIFT strain was significantly better (40%) than that of the existing stock.

Breeding experiments of both GIFT and existing strains were set up in 6 earthen ponds (1000 m^2 each) on 15 October 1994. The stocking size of breeders was 22.0 g for GIFT and 21.5 g for existing stock. The fry produced was roughly estimated and transferred to cisterns before stocking in a series of hapas for nursery trials. This

preliminary experiment revealed that the GIFT strain was more efficient in fry production than the local check.

A comparative nursery trial of GIFT and existing strains was initiated on 21 January 1995 in a series of hapas (2 m^3) with four replicates. The hapas were stocked with fry of GIFT (0.97g size) and existing strains (1.01g size) at a stocking density of 150 fry/m^3. The fry were fed with a mixture of rice bran (25%), wheat flour (30%), mustard oil cake (15%) and fish meal (30%) at 8% body weight. The ground feed was sieved to give a range of particle sizes (<250 - 750 micron). Beginning with smallest particle, the size was increased as the fish grew. The fry were given feeds through a hanging metal tray 3-4 times a day. The amount of feed ration was adjusted by estimating the weight of biomass based on the fortnightly sub-sampling of the fry. Two months after stocking, the experiment was terminated. The results are presented in Table 19 . It is observed that the mean weight gained by the GIFT strain is significantly higher ($P<0.05$) than those gained by the existing stock.

5.2 China

A small-scale trial on the performance of GIFT fish was conducted at the Genetic Resources Experimental Station of the Shanghai Fisheries University. Three strains were evaluated (GIFT, the 1978 and 1988 introduced strains) in tanks (28 m^2) through communal stocking. The experiment was terminated after 45 days. The results are given in Table 20. In terms of absolute growth rate (g/day), the GIFT strain showed best performance. However, in terms of incremental growth rate, the 1988 introduced strain was the best. The seemingly contradictory results have arisen mainly due to the differences in initial weight, which suggests that if initial body weight of different strains differ substantially, necessary statistical tools should be utilized to eliminate the influence of initial body-weight difference. Plans for on-station experiments of GIFT and other check strains (Egypt, 1978 introduced, 1988 introduced) in five different sites (Shanghai, Shandong, Zhejiang, Anhui, and Guandong) have been finalized.

5.3 Thailand

Studies on the comparative growth performance of GIFT, Chitralada and Chitralada 1 strains are being conducted in two different locations (Kampangphet Inland Fisheries Station, and Nakornpanom Inland Fisheries Station) in Thailand. The experiment was initiated on 11 January 1994 in the Kampangphet Station without any replication and on 15 March 1995 in the Nakornpanom Station with two replications. In both cases, fingerlings were stocked at a rate of 1 fish/sq. m. The duration of both the experiments will be 6 months. The growth performance of the three tilapia strains for 3 months at the Kampangphet Station and for 2 months at the Nakornpanom Station are given in Tables 21 and 22, respectively. Results seemed to indicate genotype x environment interactions; the Chitralada I is showing better performance in Kampangphet, while the GIFT is emerging as the fastest growing strain in Nakornpanom.

5.4 Vietnam

Comparative evaluation of GIFT, Egypt, and Vietnam strains was carried out at the Research Institute for Aquaculture (RIA) No. 1 station from 30 May 1995 to 05 December 1994 in two phases: nursery trials (30 May 1994 to 04 July 1994); and grow-out trials (04 July to 05 December 1994).

The nursery evaluation was conducted with a Randomized Complete Block Design (RCBD) in pond hapas (1.2 m^3) with four replications. Hapas were arranged in 2 ponds (two replications per pond), and the fry were stocked at a rate of 55 fry per hapa. The fry were fed with a mixture of rice bran (60%), fish meal (20%), and soya powder (20%) at 10% body weight.

The grow-out experiment was carried out through communal stocking in 2 ponds (600 m^2 size) at a stocking density of 1 fish/ m^2. Fishes were individually tagged before transferring from hapas to ponds. The fish were fed once a day with a mixture of rice bran (65%), soya bean powder (20%) and fish meal (15%) at 3% body weight. The growth performance data from the nursery and grow-out trials are given in Tables 23 and 24, respectively. Overall, the GIFT strain emerged as superior strain than the Egypt and Vietnam strains, both in terms of growth rate and survival percentage.

6. ON-FARM ACTIVITIES

Plans for on-farm activities in all participating countries have been finalized. The on-farm activities consists of: 1) analysis of agro-ecological and socio-economic environments of project sites; 2) baseline surveys of fish producers, consumers, and traders; 3) on-farm monitoring of GIFT and local strains; and, 4) post-adoption survey.

Project sites representing a range of agroecosystems and aquaculture systems were selected in the five participating countries; Bangladesh has chosen six sites, China four, Philippines fifteen, Thailand nine and Vietnam twelve. All the participating countries initiated collection of project level information on agro-ecological and socio-economic environments. Appendix 4 provides general characteristics of all the project sites.

6.1 Baseline Survey

The details of the methodologies to be followed in and information to be collected through baseline surveys have been finalized following consultations with respective country collaborators, and country specific survey schedules were prepared accordingly. Survey schedule prepared for the Philippines has been given in appendix 5 as an example.

Bangladesh, Philippines and Vietnam initiated the baseline surveys of fish producers, consumers and traders. China and Thailand have finalized the plans for baseline surveys, and will be initiating the survey soon. Each country is planning to collect baseline information from 15 to 25 aquaculture farmers per site to characterize the farm households and their farming systems from socio-economic and ecological perspectives. Information on consumption and trade aspects will be collected through multiple visits (3 to 4 times a year) to 8 to 10 fish consumers and to more or less equal number of fish traders per site.

6.2 On-farm Trials

On-farm monitoring of GIFT and local strains were initiated in 80 ponds in Bangladesh, 90 ponds/cages in the Philippines, and 120 ponds in Vietnam. Thailand will initiate the trials soon. All participating countries, except China, are expected to complete on-farm trials during 1995. China is unable to conduct on-farm trials this year because of climatic and logistic constraints, and so will initiate and complete in 1996.

GIFT and check strains are being stocked in different but more or less homogenous ponds. Each country will have equal number of ponds for local and GIFT strains (e.g. Bangladesh has 40 ponds for GIFT and 40 ponds for local check).

7. REVIEW OF DEGITA ACTIVITIES

Progress in DEGITA activities were presented and discussed during the 2nd Steering Committee Meeting of the International Network for Genetics in Aquaculture (INGA) held from 20-23 June 1995 in Hyderabad, India. Eight representatives from all the five participating countries were around. Twelve presentations were made covering various aspects of the Project activities, which were well received. The program and list of participants are given in Appendix 6. Several attendees commended the efforts of the participating institutions including ICLARM for the progress so far made. Inspired by the progress of DEGITA, six carp-producing Asian members of INGA - Bangladesh, China, India, Indonesia, Thailand and Vietnam - expressed interest in a similar collaboration on carps.

The next review is planned to be held in conjunction with the third INGA Steering Committee Meeting schedule to be held in Egypt in May 1996.

Table 1. Importance of Tilapia Aquaculture in DEGITA Member Countries

Countries	Production of Farm Tilapia from Aquaculture				
	Ton (1992)	% of World Production (1991)	% of Production from Asia (1991)	% of Country's Fisheries Output (1992)	% of Country's Freshwater Aquaculture Output (1992)
Bangladesh	-				
China	200,000	26	31	1	4
Philippines					
Aquaculture	91,173	17	20	3	26[a]
Freshwater Aquaculture	83,403	-	-	-	72
Thailand	43,916	5	7	1	31
Vietnam	-				

[a] percentage of aquaculture production

Table 2. Major tilapia culture system in DEGITA Member countries

Country	Ecosystem	Aquaculture Farming System
Bangladesh	Freshwater seasonal pond	Monoculture
China	Brackishwater pond	Polyculture
	Freshwater pond	Polyculture
Philippines	Freshwater pond	Mono and polyculture
	Brackishwater pond	Mono and polyculture
	Freshwater cage	Monoculture
	Freshwater pen	Monoculture
Thailand	Freshwater pond	Polyculture
Vietnam	Freshwater pond	Monoculture
	Brackish area	Monoculture
	Sewage-fed area	Polyculture

Table 3. Tilapia production from aquaculture by culture system, Philippines, 1983-1992 (t)

Year	Production by System				
	Aquaculture	Freshwater Ponds	Freshwater Cages	Freshwater Pens	Brackishwater Ponds
1983	30,800	11,300	4,700	0	14,800
1984	32,000	11,600	7,100	0	13,300
1985	43,800	13,900	7,200	9,400	13,300
1986	55,800	14,100	8,900	16,300	16,500
1987	75,800	26,800	16,800	14,300	17,900
1988	75,000	30,100	17,200	9,500	18,200
1989	81,700	30,900	18,500	9,200	23,100
1990	76,100	35,200	18,200	3,900	18,800
1991	76,600	37,400	21,000	4,100	14,100
1992	91,200	48,000	29,600	5,800	7,800
Growth Rate (%)	13	17	23	-6	-7

Table 4. Production from freshwater culture by species in Thailand , 1981-1992 ('000 t)

Year	Total	Fish									Giant fresh water prawn
		Sub-Total fish	Tilapias	Com-mon carp	Silver carp	Sepat siam	Catfish	Snake head fish	Catfish (Swai)	Other fish	
1981	48.1	47.9	5.5	1.3	4.2	11.0	6.1	8.7	8.3	2.8	0.2
1982	45.8	45.5	7.1	1.5	4.6	13.2	3.5	5.7	8.0	1.9	0.3
1983	47.0	45.8	12.1	1.9	5.1	9.3	3.0	4.8	6.9	2.7	1.2
1984	50.4	47.3	7.9	1.2	4.9	11.2	4.6	4.9	8.2	4.4	3.1
1985	75.3	72.8	15.1	1.5	7.3	16.6	6.4	7.4	13.8	4.7	2.5
1986	89.3	84.8	18.4	1.9	8.8	16.1	15.8	6.0	12.6	5.2	4.5
1987	89.8	78.0	17.0	2.1	11.1	14.3	13.9	3.3	11.8	4.5	11.8
1988	102.1	91.2	18.8	2.5	13.0	14.9	12.6	4.0	20.4	5.0	10.9
1989	91.7	83.8	21.1	2.0	13.4	13.2	12.4	3.7	13.5	4.5	7.9
1990	103.8	97.3	22.8	2.1	14.6	12.8	17.9	3.8	13.3	10.0	6.5
1991	122.7	114.9	28.1	2.5	16.3	13.3	29.1	5.6	14.5	5.5	7.8
1992	142.1	131.6	43.9	2.4	23.8	13.0	23.8	4.7	14.2	5.9	10.3

Source: Department of Fisheries, Ministry of Agriculture and Cooperative, Thailand

Table 5: Production of tilapia by cultural system and region, Thailand, 1992

Unit: metric ton

Region	Pond	Paddy field	Ditch	Total
North	4,827	14	7	4,848
Northeast	3,420	364	1	3,785
Central	25,817	8,665	194	34,676
South	607	-	-	607
Whole Kingdom	34,671			

Source: Department of Fisheries, Thailand

Table 6. Economics of tilapia and silver barb cultivation in seasonal water bodies in Bangladesh, 1991-1993

Location	No. of Pond	Species	Production (kg/ha)	Culture Period (month)	Cost Prod. (US$/kg)	Net Profit (US$/ha)
Tangail	3	Nile tilapia	1653	3-5	0.19	737
	3	Silver barb	763	3-5	0.38	273
Rangpur	12	Nile tilapia	1494-2407	5	0.16-0.20	1046-1785
	9	Silver barb	1307-1333	5	0.32-0.34	754-918
Rajshahi	12	Nile tilapia	1008-1084	4.5-5.5	0.29-0.39	378-623
	12	Silver barb	1100-1170	4.5	0.39-0.51	755-978
Mymensingh	6	Nile tilapia	1933	4	0.30	1285
(Trisal)	3	Silver barb	1372	5	0.21	1115

Source: FRI (1994). Fisheries Development Techniques: Fisheries Research Institute 1994, Mymensingh, Bangladesh

Table 7. Cost and return of tilapia culture in the Philippines by culture system, 1994

Item	Fish Cage	Fish Pond
1. Return		
Production (kg/100 m^2)	189.40	10.50
Value of Production (Peso/100 m^2)	8672.78	470.44
2. Cash Cost (Peso/100 m^2)	2195.30	179.04
Labor	164.51	18.50
Fry	647.37	62.56
Fertilizer	-	6.60
Feed	1332.15	85.82
Fuel/electricity	25.74	3.15
Others	25.53	2.41
3. Non cash cost (Peso/100 m^2)	831.11	22.34
Family labor	201.71	12.43
Fry	-	5.98
Depreciation	629.40	3.93
4. Total Cost (Peso/100 m^2)	3026.41	201.38
5. Net Profit (Peso/100 m^2)	5646.37	269.06
6. Cast Cost (Peso/1 kg fish)	11.59	17.05
7. Total Cost (Peso/1 kg fish)	15.98	19.18

Source: Field Survey, ICLARM, 1994

Table 8. Yield, cost and profitability of tilapia and catfish culture in Thailand, 1992

Item	100 m^2		1 Kilogram	
	Catfish	Tilapia	Catfish	Tilapia
Variable Cost (Baht)	2,978.20	317.60	14.90	5.71
Fixed Cost (Baht)	73.90	67.20	0.40	1.21
Total Cost (Baht)	3,052.10	384.80	15.30	6.92
Cash Cost (Baht)	2,851.80	283.00	14.30	5.09
Yield (kg)	199.50	55.60	1.00	1.00
Price (Baht/kg)	20.25	11.35	20.25	11.35
Revenue (Baht)	4,039.90	631.10	20.25	11.35
Net revenue (Baht)	1,061.70	313.50	5.35	5.64
Net profit (Baht)	987.80	246.30	4.95	4.43
Net return over cash cost (Baht)	1,188.10	348.10	5.95	6.26
Rate of return (%)	32.40	60.90	32.40	60.90

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, Thailand

Table 9. Cost structure of tilapia production per 100 square meters of pond culture in Thailand, 1992

Item	Cash	Non-cash	Total	%
1. Variable Cost (Baht)	268.70	49.00	317.70	82.5
Interest and opportunity cost	26.50	3.60	30.1	7.8
Fry	74.30	2.90	77.20	20.1
Feed	92.80	14.30	107.10	27.8
Labor	36.20	28.20	64.40	16.7
Medicine	3.70	-	3.70	1.0
Fuel	20.00	-	20.00	5.2
Farm equipment	2.00	-	2.00	0.5
Maintenance	5.70	-	5.70	1.5
Others	7.50	-	7.50	1.9
2. Fixed cost (Baht)	14.40	52.80	67.20	17.50
Land use	14.40	29.40	43.80	11.40
Depreciation	-	23.40	23.40	6.10
TOTAL	283.10	101.80	384.90	100.00

Source: Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, Thailand

Table 10. Wholesale price of major fish species in the Philippines, 1987-1992 (US$/kg)

Fishes	1987	1988	1989	1990	1991	1992
Milkfish	1.12	1.14	1.46	1.55	1.67	1.86
Grouper	1.39	1.61	2.09	-	-	2.76
Tilapia	0.77	0.70	-	-	-	1.41
Frigate tuna	0.68	0.67	0.81	-	-	0.98
Roundscad	0.68	0.66	0.83	0.81	0.85	0.86
Cavalla	1.16	1.30	1.55	-	-	2.08
Slipmouth	0.68	0.78	0.98	0.91	0.90	0.77
Threadfin bream	0.92	0.95	1.14	1.15	1.34	1.35
Indian mackerel	0.85	0.88	1.15	1.05	1.18	1.23

Source: Bureau of Agricultural Statistics, Philippines

Table 11. Farm prices of freshwater fish in Thailand, 1987-1992 (US$/kg)

Species	1987	1988	1989	1990	1991	1992
Batrachian walking catfish (*Clarias batrachus*)	0.99	1.18	1.11	1.22	1.16	1.26
Gunther's walking catfish (*Clarias macrocephalus*)	1.64	1.72	1.50	1.48	1.44	1.33
Striped anake-head (*Ophice phalus straitus*)	1.17	1.30	1.24	1.47	1.62	1.80
Tilapia (*Tilapia nilotica*)	0.36	0.42	0.41	0.47	0.44	0.47
Striped catfish (*Pangasius sutchi*)	0.35	0.31	0.34	0.35	0.35	0.38
Thai silver carp (*Puntius gonionotus*)	0.61	0.64	0.51	0.69	0.72	0.73
Jullien's golden price carp (*Probarus jullieni*)	0.58	0.66	0.88			0.76
Common carp (*Cyprinus carpio*)	0.98	0.76	0.87	0.63	0.68	0.89

Source: Office of Agricultural Economics, Thailand

Table 12. Monthly per capita consumption of fish in Bangladesh (kg)

Year	Income Class				
	1st Quartile (low income)	2nd Quartile	3rd Quartile	4th Quartile (high income)	All
			R U R A L		
1981/82	0.45	0.67	0.86	1.33	0.81
1983/84	0.48	0.74	0.95	1.44	0.87
1985/86	0.54	0.89	1.12	1.69	1.04
1988/89	0.52	0.77	1.08	1.69	1.00
			U R B A N		
1981/82	0.53	0.84	1.22	1.81	1.06
1983/84	0.61	1.03	1.34	1.96	1.18
1985/86	0.76	1.26	1.62	2.02	1.38
1988/89	0.81	1.32	1.87	2.44	1.55
			B A N G L A D E S H		
1981/82	0.46	0.69	0.90	1.41	0.85
1983/84	0.50	0.75	0.99	1.52	0.90
1985/86	0.56	0.91	1.19	1.76	1.08
1988/89	0.53	0.80	1.17	1.85	1.06

Source: Reports of the Household Expenditure Survey, 1981/82, 1983/84, 1985/86, 1988/89. Bangladesh Bureau of Statistics.

Table13. Monthly per capital consumption of fish in the Philippines (kg), 1982

Annual Per Capita Income Class (Peso)	Average Monthly Per Caput Consumption			
	Fresh Fish	Fresh Cuttle Fish	Dried Fish	Fish and Sea Food Preparation
0-249	0.81	0.39	0.30	0.30
250-499	1.59	0.12	0.39	0.39
500-999	1.65	0.66	0.36	0.48
1000-1999	2.40	0.48	0.36	0.42
2000-3499	2.40	0.51	0.36	0.45
3500-6999	2.46	0.66	0.36	0.36
7000 and above	2.43	0.57	0.33	0.51
All Class	1.97	0.51	0.36	0.42

Source: Food and Nutrition Research Institute: Second Nationwide Nutrition Survey, 1982

Table14. Price elasticity of demand for fish in Bangladesh

	Income Class			
	1st Quartile (low income)	2nd Quartile	3rd Quartile	4th Quartile (high income)
Rural	-1.83	-1.40	-1.19	-1.13
Urban	-1.38	-0.90	-1.29	-0.96
Overall Bangladesh	-1.74	-1.23	-1.17	-1.03

Source: Goletti, F. and H. Boroum (1992). "Preliminary Estimation of Food Demand Parameters from the Bangladesh Household Expenditure Survey 1988-1989", IFPRI, Washington, D.C.

Table 15. Income elasticity of fish by expenditure group in Bangladesh

	Year		
Expenditure Class	1981/82	1983/84	1985/86
	RURAL		
Group 1 (low)	0.45	0.91	1.25
Group 2	0.66	0.96	1.28
Group 3	0.83	0.93	1.12
Group 4	0.88	0.86	0.93
Group 5 (high)	0.83	0.74	0.70
	URBAN		
Group 1	1.03	1.22	1.50
Group 2	1.02	1.02	1.10
Group 3	0.92	0.92	0.87
Group 4	0.70	0.75	0.63
Group 5	0.47	0.42	0.11

Source: Zohir S. and Shahabuddin (1992). "Preliminary Demand Parameters for Bangladesh". Bangladesh Institute of Development Studies.

Table 16. On-station experimental sites of the DEGITA Project

Country	Name of Station & Place	Agro-ecological Zones
Bangladesh	1) Fisheries Research Institute, Mymensingh	warm humid tropies
China	1) Shanghai Fisheries University, Shanghai	warm cool humid subtropics
	2) Guangzhou National Tilapia Seed Farm, Guandong	warm cool humid subtropics
	3) Huzhou Aquatic Seed Farm, Huzhou, Zhejiang Province	warm cool humid subtropics
	4) Jinzhou National Tilapia Seeds Farm, Oingdau, Saudony	warm arid and semiarid subtropics
	5) Taipinghu Reservoir, Anhui	warm subhumid subtropics
Thailand	1) Kampangphet Inland Fisheries Station	warm subhumid tropics
	2) Nakornpanom Inland Fisheries Station	
Vietnam	1) Research Institute for Aquaculture No. 1 (RIA No: 1)	warm humid tropics
	2) Research Institute for Aquaculture No. 2 (RIA No: 2), Ho Chi Minh City	

Table 17. Average length and weight of GIFT and existing strain of *Oreochromis niloticus* in hapas in Bangladesh, 1994

Sampling Date	GIFT Strain		Existing Stock	
	Average Weight (g)	Average Length (cm)	Average Weight (g)	Average Length (cm)
06-09-94	11.19[a]	8.34	11.36[a]	8.69
21-09-94	35.00[a]	11.74	34.38[a]	11.87
05-10-94	53.25[a]	13.50	46.77[a]	13.34
20-10-94	90.48[a]	15.94	72.05[b]	15.60
04-11-94	99.57[a]	16.55	74.90[b]	15.66
19-11-94	116.61[a]	17.55	82.54[b]	16.17
04-12-94	134.09[a]	18.99	95.48[b]	17.62

Significant at 5% level

Table 18. Average length and weight of GIFT and existing strain of *Oreochromis niloticus* in cistern condition in Bangladesh, 1994

Sampling Date	GIFT Strain		Existing Stock	
	Average Weight (g)	Average Length (cm)	Average Weight (g)	Average Length (cm)
19-08-94	9.90[a]	7.70	9.25[a]	8.48
03-09-94	20.33[a]	9.91	19.06[a]	9.93
18-09-94	34.75[a]	11.91	30.26[a]	11.53
03-10-94	57.67[a]	13.89	44.12[b]	13.02
18-10-94	73.39[a]	15.39	47.81[b]	13.82
02-11-94	78.73[a]	15.44	55.97[b]	14.25
17-11-94	88.86[a]	16.59	63.55[b]	15.10

Significant at 5% level

Table 19. Average length and weight of fry attained in nursery trials of GIFT and existing strain of *Orechromis niloticus* in Bangladesh, 1995

Strain	Initial		Final	
	Length (cm)	Weight (gm)	Length (cm)	Weight (gm)
GIFT	3.82	0.97	7.59	8.38[a]
Existing	3.78	1.01	6.56	5.50[b]

Significant at 5% level

Table 20. Results of a small-scale trials of 3 strains of tilapia (45 days) in Shanghai, China, 1994

	GIFT		1978 Strain		1988 Strain	
	1	2	1	2	1	2
Initial weight (g)						
Mean	31.1	35.5	26.8	25.8	16.6	15.5
SD	7.8	7.19	7.45	8.05	3.99	4.72
Pooled mean	33.3		26.3		16.0	
Final Weight (g)						
Mean	64.5	66.5	58.0	51.6	44.3	40.9
SD	13.00	12.00	13.44	15.00	10.36	12.51
Pooled mean	65.5		54.8		42.6	
Gain	32.3		27.5		26.6	
IGR in weight (%/day)	2.15	1.85	2.27	2.04	2.89	2.85
Pooled mean	2.00		2.16		2.87	
Absolute growth rate						
in weight (g/day)	0.98	0.91	0.92	0.76	0.81	0.75
Pooled mean	0.95		0.84		0.78	
in length (mm/day)	0.74	0.60	0.73	0.68	0.99	0.88
Pooled mean	0.67		0.71		0.94	

Table 21. Length and weight of three tilapia strains under on-station grow-out trial at Kampangphet Inland Fisheries Station, Thailand (11 January to 11 April 1995)

Strains	Days After Stocking			
	0	30	60	90
	Total Length (cm)			
Chitralada	6.39 ± 1.10	13.42 ± 1.37	16.61 ± 0.81	16.84 ± 1.00
Chitralada I	4.89 ± 0.57	14.25 ± 1.20	18.13 ± 1.23	19.35 ± 1.34
GIFT	6.49 ± 1.01	15.30 ± 1.38	17.70 ± 1.19	18.38 ± 1.63
	Weight (g)			
Chitralada	8.80 ± 0.00	47.63 ± 11.89	76.17 ± 12.38	86.00 ± 16.50
Chitralada I	4.23 ± 0.00	61.63 ± 14.50	102.42 ± 27.01	140.03 ± 29.68
GIFT	9.00 ± 0.00	71.80 ± 19.90	100.00 ± 21.64	121.50 ± 30.42

Table 22. Length and weight of three tilapia strains under on-station grow-out trial at Nakornpanom Inland Fisheries Station, Thailand (15 March - 15 May 1995)

Strains	Replication	Days After Stocking 0	30	60
			Total length (cm)	
Chitralada	1	4.50 ± 0.53	10.35 ± 0.87	12.94 ± 1.29
	2	4.50 ± 0.53	10.75 ± 0.75	15.41 ± 0.96
	Mean	4.50 ± 0.00	10.55 ± 0.20	14.18 ± 1.23
Chitralada I	1	4.29 ± 0.31	10.01 ± 0.71	14.98 ± 1.23
	2	4.29 ± 0.31	9.93 ± 0.92	14.19 ± 0.88
	Mean	4.29 ± 0.00	9.97 ± 0.04	14.59 ± 0.39
GIFT	1	4.98 ± 0.71	11.14 ± 0.83	15.60 ± 0.80
	2	4.42 ± 0.38	10.55 ± 0.77	15.42 ± 1.61
	Mean	4.70 ± 0.28	10.85 ± 0.29	15.51 ± 0.09
			Weight (g)	
Chitralada	1	1.45 ± 0.00	27.43 ± 7.91	51.83 ± 8.61
	2	1.45 ± 0.00	32.30 ± 6.42	77.00 ± 13.14
	Mean	1.45 ± 0.00	29.87 ± 2.43	64.42 ± 12.58
Chitralada I	1	1.50 ± 0.00	26.43 ± 7.25	74.33 ± 14.01
	2	1.50 ± 0.00	24.73 ± 6.84	61.83 ± 8.51
	Mean	1.50 ± 0.00	25.58 ± 0.85	68.08 ± 6.25
GIFT	1	1.77 ± 0.00	34.30 ± 6.13	77.00 ± 11.37
	2	1.24 ± 0.00	31.37 ± 6.74	85.57 ± 16.62
	Mean	1.51 ± 0.26	32.84 ± 1.46	81.29 ± 4.28

Table 23. Growth rate of fingerling of three tilapia strains reared in Hapas at Habac Station, Vietnam (30/5/1994 to 4/7/1994)

Pond No.	Strain	Stocking Stage		Harvest Stage		Percentage of Survival (%)
		Total No. Stocked	Mean Weight (g)	Total No. Harvested	Mean Weight	
F1	GIFT	220	1.4	208	23.0	94.5
	EGYPT	220	2.0	200	22.2	90.9
	VIETNAM	220	1.2	212	20.1	96.4
F2	GIFT	220	1.4	204	18.8	92.7
	EGYPT	220	2.0	204	16.9	92.7
	VIETNAM	220	1.2	216	17.3	98.2

* - 12 Hapas arranged in each pond (into 4 blocks)
- Area of each is 1200 m^2

Table 24. Weight and length of three tilapia strains under on-station grow-out trial at Habac Station, Vietnam, 1994

Pond	Strain	Stocking Stage		Harvesting Stage				Remarks
		Total No. Stocked	Bulk Weight (kg)	Total No. Harvested	Total Weight (kg)	Mean Weight (gm)	Mean Length (cm)	
1	GIFT	200	4.6	147	38.1	259.3	22.8	10 died due to tagging
	EGYPT	200	4.4	82	17.3	210.9	20.9	20 died due to tagging
	VIETNAM	200	4.0	136	31.5	231.8	22.1	
2	GIFT	200	3.8	135	32.6	241.6	21.8	5 died due to tagging
	EGYPT	200	3.4	84	16.9	201.3	21.1	18 died due to tagging
	VIETNAM	200	3.5	140	30.2	215.7	21.4	

Appendix 1

National Teams

Members of National Teams of DEGITA

BANGLADESH

NAME	EXPERTISE	INSTITUTION
1. Dr. M. G. Hussain	Geneticist	Fisheries Research Institute (FRI)
2. Mr. Shahidul Islam	Geneticist	FRI
3. Mr. A. H. M. Kohinoor	Aquaculturist/Extension Specialist	FRI
4. Mr. S.C. Mahata	Hatchery Specialist/ Geneticist	FRI
5. Ms. M. B. Tanu	Aquaculturist	FRI
6. Mr. Zulfikar Ali	Aquaculturist	FRI

CHINA

NAME	EXPERTISE	INSTITUTION
1. Dr. Li Sifa	Geneticist	Shanghai Fisheries University (SFU)
2. Mr. Li Jiale	Geneticist	SFU
3. Mr. Li Chenghong	Geneticist	SFU
4. Mr. Zhao Jlnliang	Geneticist	SFU
5. Mr. Lu Guoging	Geneticist	SFU
6. Ms. Lu Yong	Economist	SFU
7. Mr. Han Fenjian	Hatchery Manager/Engineer	Jinzhou National Tilapia Seed Farm
8. Mr. Chen Peixiang	Hatchery Manager/Engineer	Huzhou Aquatic Seed Farm
9. Mr. Ye Fei	Hatchery Manager/Engineer	Guangzhou National Tilapia Seed Farm
10. Mr. Pei Wmanyi	Aquaculturist	Fisheries Bureau of Huangshan, Anhui

PHILIPPINES

NAME	EXPERTISE	INSTITUTION
1. Ms. Simeona Aypa	Aquaculturist	Bureau of Fisheries and Aquatic Resources (BFAR)
2. Mr. Ruben Reyes	Geneticist/Hatchery Specialist	BFAR
3. Ms. Prescilla Regaspi	Aquaculturist	BFAR
4. Mr. Abundio Galicia, Jr.	Environmental Specialist	BFAR

VIETNAM (North)

NAME	EXPERTISE	INSTITUTION
1. Mr. Nguyen Cong Dan	Geneticist	Research Institute for Aquaculture (RIA) No. 1
2. Mr. Dinh Van Trung	Geneticist	RIA No. 1
3. Dr. Pham Van Dinh	Economist	Hanoi Agriculture University (HAU)
4. Dr. Do Kim Chung	Economist	HAU
5. Dr. Mai Dinh Yen	Environmental Specialist	HAU
6. Dr. Nguyen Huu Tuong	Environmental Specialist	HAU

VIETNAM (South)

NAME	EXPERTISE	INSTITUTION
1. Dr. Nguyen Van Hao	Geneticist	Research Institute for Aquaculture (RIA) No. 2
2. Mr. Pham Khan	Aquaculturist	RIA No. 2
3. Mr. Hoang Minh Duc	Aquaculturist/Hatchery Specialist	RIA No. 2
4. Mr. Nguyen Van Tu	Aquculturist/Extension Specialist	Thu Duc Forestry and Agriculture University (TDFAU)
5. Dr. Trinh Troung Giang	Environmental Specialist	TDFAU

THAILAND

NAME	EXPERTISE	INSTITUTION
1. Dr. Nuanmanee Pongthana	Geneticist	National Aquaculture Genetics Research Institute (NAGRI)
2. Mr. Pinit Sihapitukkiat	Geneticist	NAGRI
3. Dr. Sarun Wattanutchariya	Economist	Kasetsart University
4. Dr. Somkit Tugsinavisutti	Economist	Kasetsart University
5. Dr. Yont Musig	Environmental Specialist	Kasetsart University

Appendix 2

Research Protocols

Appendix 2

RESEARCH PROTOCOLS FOR DEGITA

This appendix provides an outline of research protocols being followed to carry out different DEGITA activities, except for on-station experiments.

A. National Review of Past Performance and Current Status of Tilapia Industry

The review will cover the following important aspects:

1. ***Introduction***: History of tilapia introductions: (species, dates introduced, reasons for introductions, present status of introduced species and strains). Note any natural barriers/constraints to tilapia introductions or spread in the country.

2. ***Distribution of tilapia***: Present day distribution of tilapia in the country, including locations and major ecosystems, agro-ecological farming systems and aquaculture systems. To consider the following aspects:

   a) Ecosystems where tilapia exists (species, watershed, lakes or reservoirs, coastal area) (give surface areas if possible). Clarify on a map.

   b) Aquaculture and agro-ecological systems (indicate the major aquaculture farming systems (monoculture or polyculture) where tilapia can be found, give numbers and surface areas of ponds, cages, etc. and details of the agro-ecological and ecological systems where these aquaculture facilities are located).

3. ***Past trend***: Production, yield and culture area trends by region and farming/culture system.

4. ***Socioeconomic status of tilapia culture***: The review may cover the following aspects:

   a) farm size and tenural status of tilapia farmers by region/province/district;
   b) input use by culture system (labor, fertilizer, fingerling, feed, etc.)
   c) input prices;
   d) fish price (tilapia and other important species) by month/season;
   e) cost, return and profitability by farm size group and culture system;
   f) constraints of tilapia culture, gap between experimentation station yield and farmers' yield by culture system;
   g) attitude towards tilapia production and consumption by socioeconomic groups.

5. ***Tilapia consumption marketing and trade***: The following aspects are important:

a) per capita consumption of fish (tilapia, fin fish, inland fish, marine fish) by income class;
b) tilapia marketing channel and marketing margin;
c) export and import of tilapia (physical quantity and prices).

6. ***Environmental impacts of tilapia species***: Documentation of any positive and negative environmental impacts of tilapia fish species. Where possible include any quantified social and economic impacts (e.g. groups affected and economic gains or losses). In all cases, note any measures taken to reduce negative impacts and enhance positive impacts. To consider the following aspects:

a) depletion/displacement of capture fisheries stocks;
b) depletion/displacement of stocks in aquaculture facilities;
c) introduction of pathogens and parasites (occurrence of disease)
d) changes in natural habitats;
e) genetic interactions with existing tilapia stocks.

7. ***Environmental impacts of tilapia culture systems***: Documentation of positive and negative environmental impacts of tilapia culture systems. Where possible include and quantified social and economic impacts. In all cases, note any measures taken to reduce negative impacts and enhance positive impacts. To consider the following aspects:

a) effects on water/soil quality (e.g. nutrients, organic material, plankton);
b) effects on water use patterns and water use conflicts;
c) effects on ecological systems (e.g. lakes and reservoirs);
d) effects on agro-ecological systems;
e) effects on aquaculture systems;

8. ***Government policies***: Note here any government policies (now and planned future) in relation to the introduction and dissemination of tilapia species within the country.

9. ***Future developments***: Give details of the future tilapia culture planning for your country, indicating the major resource systems, culture systems and other information on the anticipated future usage of tilapia. Note here any information gaps to define future plans and lack of information in relation to the environmental data required above.

B. Analysis of Agroecological and Socioeconomic Environments of Project Sites

This activity will begin after finalization of project sites for on-farm testing of GIFT and other check strains. The following give some indicative information on the details to be collected from each project site through review of secondary data sources and/or rapid rural appraisal:

1. ***Site description***

   a) river and drainage system (how does the natural aquatic ecosystems link to farms practicing aquaculture);
   b) local climatic conditions;
   c) soil type;
   d) prevailing farming system.

2. ***Socioeconomic environment***

   a) average farm size;
   b) land tenure system;
   c) population density;
   d) infrastructure - road/market/electricity;
   e) food habit;
   f) religion;
   g) tilapia marketing system (both for hatcheries and grow-outs).

3. ***Tilapia farming system***

   a) source of tilapia/species/time of introduction in the watershed;
   b) aquatic environment already colonized by tilapia;
   c) potential area in the watershed for tilapia colonization.

4. ***Environmental impact***

Similar data on environmental impact of tilapia culture will be gathered at ecosystem level to what is collected at country level. A major problem is that often there is no local detailed data available except for a few specific areas in each country. Therefore, in many cases, country teams will have to simply describe potential local environmental impact based on data collected at country level. An important component of this analysis will be to identify indigenous species which might be vulnerable to competition from tilapia. Country teams may need to rely on anecdotal information from farmers, local government and NGO officials.

C. Baseline Survey of Fish Producers, Consumers and Traders

The baseline survey covers: a) production (both socio-economic and ecological dimensions); b) consumption; and, c) marketing and trade aspects of existing and potential tilapia industry. The following give some indicative information on the type of data to be collected through field survey. Information on basic household structure of aquaculture farmer and on aquaculture production will be collected through one time survey; while consumption and marketing data will be collected periodically, three to four times in one year.

1. ***Characterization of aquaculture farmers and their farming activities***: Within each site, teams are hoping to choose a cross-section of 15 to 25 farmers for baseline survey to characterize aquaculture farmers and their farming systems from a socio-economic and ecological perspectives. In total, 80 to 150 farms would be surveyed in this way for each country. The following information would be collected for each farm.

a) basic information of farm household (profile of household members, household size, land use pattern, household income, annual expenditure pattern);
b) availability of bioresources for aquaculture;
c) farming system (including "costs and return" data for important agricultural activities);
d) aquaculture system (general characteristics of all ponds/cage, frequency of fish escapes into local water systems due to flooding and other causes, general nutrient status, pond/cage management regime);
e) stocking, input use, harvesting and disposal of fish for each representative pond/cage/ditch;
f) highest and lowest tilapia production in one representative unit during the last 10 years;
g) input and output prices;
h) farm-operators perspective (impact of tilapia in local water bodies/farm, attitude to future involvement in tilapia farming, tilapia production constraint).

2. ***Fish Consumption Survey***

Within each site, 8 to 10 fish consumers from different strata of society will be chosen to collect information on fish consumption. The following aspects are important:

a) household size;
b) household income/annual expenditure;
c) food consumption (physical quantities and prices);
d) nonfood consumption;
e) fish consumption by species;
f) prices of fish and fish substitute;
g) preference pattern for fish (species wise).

3. ***Survey of Tilapia Traders/Sellers***

Marketing survey is aimed to analyze structure, conduct and performance of tilapia and other fish markets. The following give some indicative information on the details to be collected from fish traders:

a) quantity and sources of various types of fish sold;
b) buying and selling price of fish;
c) transportation and other marketing cost.

D. On-farm Trial of GIFT and Other Check Strains

From within the group of about 20 farms per site, between 6 to 10 farms will be chosen for experimental testing of GIFT fish together with local strains. Farms for GIFT fish trials will total between 30 to 50 farmers per country. On-farm trials data would be collected in two levels: a) additional baseline data on ponds/lakes; b) regular sampling during the period of experiment.

1) Extra baseline data collection on ponds

   a) Pond drainage system (inlet/outlet) and how it connects to local, natural, aquatic ecosystems;

   b) Pond soil samples for detailed analysis (at beginning and end of experiment)

   c) Quantitative phytoplankton and zooplankton samples from pond; Qualitative benthic samples; Chlorophyll a biomass

   d) Water analysis of inflow/outflow and pond (very dependent on resources available to teams); suggestions are: 1) pH, conductivity; 2) alkalinity; 3) total dissolved solids (TDS); 4) dissolved organic matter (DOM); 5) if possible, nitrogen, ammonia and phosphorous levels.

      In some cases only part of this limnological data may be collected because sites are remote. Being far from laboratories means water samples are likely to deteriorate before analyses can be done. Also many teams do not have metering equipment or even basic chemical kits to do simple analyses; so monitoring of water quality is problematic.

2) ***Regular sampling during the period of the experiment*** (monthly, if possible)

The following was suggested:

   a) Farmers will establish a local unit of measure for pond inputs which can easily be converted into kg (e.g. basket, sack, etc.). With farmer's help researchers will monitor pond inputs (including labor use, if possible) during period of experiment.

   b) Monitoring of bioresource availability on-farm during period of experiment (emphasis on resources available as inputs for aquaculture).

   c) Water analysis (inflow/outflow, pond): pH, conductivity, alkalinity, TDS, DOM, Temp, secchi disk (recorded by researcher); Water depth, water colour, possibly secchi disk (recorded by farmer). What the farmer can record will vary between countries. In Thailand and Vietnam, for example, it seems farmers will have little trouble recording many simple physical parameters during the experiment. Nitrogen and phosphorous can only be measured where equipment is available and ease of access to labs for analyses.

d) Biological sampling is problematic. This has been left to the decision of the country teams. In most cases, it is unlikely they will be able to do primary production. The minimum suggested was chlorophyll a biomass and phytoplankton samples. If teams have the resources to collect more, then they can do zooplankton, etc.

e) Fish will be marked where possible. Samples for weight and length will be collected at regular intervals. Hopefully two ponds on each farm will be used. One will contain GIFT fish and one local tilapia strains for comparison. Farmer will note any tilapia escapes during experiment.

f) All fishes will be harvested at the end of experiment and weighted.

E. Adoption Survey

Adoption survey would be conducted after completion of on-farm trials to observe the adoption pattern of GIFT technology in project sites. The adoption survey aims to identify factors affecting farmers' decision to adopt or not to adopt the technology, and to measure the yield gap between the farmers' management practices and the recommended management practices.

Appendix 3

An Outline for the Proposed Technical Report on "Economics of Tilapia Farming in the Philippines"

Appendix 3

A Provisional Outline for
the Proposed ICLARM Studies and Reviews/Technical Report
on
Economics of Tilapia Farming in a Dynamic Environment: The Case of Philippines

prepared by:
Madan Mohan Dey

Chapter 1. Introduction (Editors, yet to be finalized)

The introductory section would: (1) explain the term "environment", which includes both biophysical and socioeconomic environments; (2) discuss how the Philippine experiences would be useful to other countries; and, (3) provide rationale for other chapters.

PART I: PAST EXPERIENCES

Chapter 2. An overview of tilapia industry in the Philippines (Belen/Maan)

This chapter would explain the dynamic nature of the Philippine tilapia industry. We should be able to explain why tilapia, inspite of being an exotic species, is the 2nd most important inland species. This chapter may be organized with the following sub-topics:

- share of Philippines in the world tilapia production (from 1960s to 1990s);
- history of tilapia introduction;
- cultured tilapia species;
- tilapia hatchery operation;
- tilapia farming practices;
- contribution of tilapia to agricultural GDP, fisheries production and aquaculture production (time series analysis);
- changes in tilapia production by system, region and species;
- factors affecting the growth of tilapia production (may be a descriptive section);
- tilapia research and development (historical analysis);
- tilapia marketing and trade (historical analysis);
- government policies affecting tilapia industry;
- environmental impact of tilapia farming and species (based on existing literature).

Chapter 3. Philippine tilapia economics in retrospect (Maan)

The chapter may have discussions on the following issues:

- role of various institutions in analyzing the economics of tilapia industry/farming (BFAR, ICLARM, Universities, etc.);
- changes in hatchery operations and their economics;
- changes in the socio-economic profile of tilapia farmers (based on existing literature);
- changes in farming practices, input use levels, production, productivity, and profitability (based on existing literature);
- factors determining productivity and profitability. We need to find out why productivity and profitability differ over time and space. (Do we have enough number of studies to run regression/multivariate analysis?);
- changes in tilapia and other fish prices (based on time series BFAR/BAS data);
- impact of production on prices and profitability (inverse demand function analysis);
- changes in tilapia marketing and trade.

PART 2: PRESENT STATUS

Chapter 4. Tilapia hatchery and growout system: a macro level analysis (BAS/Gaspar)

This descriptive chapter based on the BAS Census data may discuss:

- statistical framework used by BAS in the fisheries census 1992;
- profile of tilapia hatchery operators by region (number, farm size, strain used, experience, etc.);
- area, yield and production of tilapia by region and culture system (pond/pen/cage, poly/monoculture);
- number of tilapia producers and their farm size by region and culture system;
- growing period and stocking density by region and culture system.

Chapter 4 should also serve as an introduction to Chapters 5-7, particularly in reference to sampling design described in those chapters.

Chapter 5. Tilapia farming and farmers: a microlevel analysis (Gaspar/Madan)

This chapter would be based on the results of descriptive analysis of data collected from sample households covered under the stage II of BAS-ICLARM survey, and may include discussions on the following issues:

- socioeconomic profile of tilapia farmers;
  (age/education/training/experience/household size/source of income/occupation/tenancy etc.)
- farm environment;
  (proximity to road/household, water sources, etc.)
- tilapia farming practices;
  (culture system, growing period, yield, harvesting practices, etc.)
- tilapia marketing practices;
- farmers' perspective.

Chapter 6. Economics of tilapia farming: present status (Madan/Gaspar)

As cost and return data are not available for rice-fish and polyculture systems, this chapter would report the results of analysis of data from 72 mono-culture farms, and may focus on the following sub-topics:

- input use level by system and farm size;
- capital requirement by system and farm size;
- production and profitability by system and farm size (also test the hypothesis of "small is beautiful" in the context of tilapia aquaculture);
- factor payment and factor share by system;
- comparison with other major farm enterprises (rice, catfish, etc.)

Chapter 7. Efficiency of tilapia farming (Madan/Gaspar)

This chapter would discuss the results of econometric exercise on the following issues:

- estimation of frontier production function;
- estimation of farm specific technical, allocative and economic efficiency;
- determinants/sources of efficiency/ineffeciency.

PART 3: FUTURE OUTLOOK

Chapter 8. Nature of GIFT Technology (Eknath, et. al.)

This section may: 1) briefly discuss the technology generation process followed by the GIFT team; and, 2) analyze the nature of GIFT technology based on on-farm trial data. The chapter may have following sub-sections:

- introduction to GIFT technology;
- nature of technology/technical change;
  - embodied/disembodied
  - input use biasness
  - comparative profitability;

- comparison with green revolution technology.

Chapter 9. Economics of tilapia culture: future outlook (Madan)

The chapter may include discussions on:

- experiences of green revolution;
- potential impact of GIFT technology;
- a framework to analyze the impact of genetically improve tilapia species.

Chapter 10. Conclusion and future policy implications (editors)

Note: Names in the parentheses indicate the " lead" person(s) responsible for drafting various chapters. Chapterwise authorship would be decided later by the group depending on the level of contribution of different persons involved.

Appendix 4

General Characteristics of On-farm Study Sites

Appendix Table 1. On-farm study sites and their characteristics in Bangladesh

	SITES/DISTRICTS					
	Rangpur	Mymensingh	Manikgong	Comilla	Jessore	Khulna
Land alleviation	Medium low	Medium low	Low	Low	High	Medium low
Floodplain	Tista	Old Bramaputra	Jamung	Meghna	Ganges	Tidal saline
Mail soil type	Non-calacareous grey (non-saline)	Non-calcareous dark grey	Non-calcareous grey (non-saline)	Non-calcareous dark grey	Calca-reous dark grey	Non-calcareous grey (seasonally saline)
Agro-ecological zones	3	9	8	19	11	13
Rainfall total: mean (mm)	2154	2253	1671	2165	1625	1853
No. of months with rainfall 7200 mm	5	5	5	5	4	4
Mean annual temperature (^{o}C)	24.6	25.3	25.4	25.6	25.8	26.7
Date when min. temp. fall <15^{o}C (mean)	25 Nov.	01 Dec.	30 Nov.	06 Dec.	23 Nov.	07 Dec.
Date when min. temp. fall <15^{o}C (St. D)	7	7	8	12	9	10
Last date when min. temp. fall <15^{o}C (mean)	03 Mar.	19 Feb.	13 Feb.	01 Feb.	11 Feb.	19 Jan.
Last date when min. temp. fall <15^{o}C (St. D)	25	12	16	17	17	14
Length T min. <15^{o}C: mean (days)	97	80	75	57	80	42
Length T min. <15^{o}C: St. D (day)	28	14	18	19	19	20

Appendix Table 2. On-farm study sites and their characteristics in China

	Sites			
	Shandong	Zhejiang	Anhui	Guandong
River System	Yellow	Changjiang	Changjiang	Pearl
Agroecological zones	warm arid and semi arid sub tropics	warm cool humid sub tropics	warm sub humid sub tropics	warm cool humid sub tropics
Annual average temperature (°C)	12.8	15.9	16.4	22.0
Yearly precipitation (mm)	400-800	1000-1500	1000-1500	1600-2000
Tilapia culture system	pond, cage	pond, cage	pond, cage	pond
Consumption of aquatic products (kg/caput/year)	1.58	1.50	10.16	9.94

Appendix Table 3.On-farm study sites and their characteristics in the Philippines

Region/Province	Climatic Zone Type	% Exposure to Typhoon	Major Tilapia Culture System(s)
I			
Pangasinan	I	32	Pond (poly and monoculture)
III			
Nueva Ecija	I	16	Pond (poly and monoculture), cage mono culture, rice-fish
Tarlac	I	16	Pond (monoculture)
Pampanga	I	16	Pond (monoculture)
Bulacan	I	16	Mono (monoculture)
IV			
Rizal	I	16	Cage (monoculture), pond (monoculture)
Laguna	I	16	Cage (monoculture)
Batangas	I	16	Cage (monoculture)
V			
Albay			
- Eastern Part	II	19	Pond (monoculture),
- Western Part	IV	16	Cage (monoculture)
Camarines Sur			
- Eastern & Nothern Part	II	19	Cage (monoculture), Pond (monoculture)
- Southern & Western Part	IV	16	
VI			
Iloilo			
- Northern Part	I	19	Pond (mono and polyculture)
- Southern & Western Part	I	7	
Negros Occidental			
- Northern Part	III	7	Pond (monoculture)
- Western, Central & Southern Part	I	7	

Appendix Table 3 . (continued)

Region/Province	Climatic Zone Type	% Exposure to Typhoon	Major Tilapia Culture System(s)
XI			
Davao Norte			
- Eastern Part	II	1	Pond (monoculture)
- Western Part	IV	1	
Davao Sur			
- Eastern Part	II	1	Pond (monoculture)
- Western Part	IV	1	
South Cotabato	IV	1	

Type I - There are two pronounced seasons: dry from November to April; wet during the rest of the year. The localities of this type are protected from the northwest (NW) monsoon; some are protected from the trade winds by mountain ranges. However, the controlling factor is topography in those areas open only to the Southwest (SW) monsoon and cyclonic storm.
Average temperature : 27.0°C
Average rainfall : 100.56 in

Type II - There is no dry season with a very pronounced maximum rain period from November to Janaury. These regions are along or very near the eastern coast which are sheltered neither from the Northeast monsoon and the tradewinds nor from cyclonic storms.
Average temperature : 26.8°C
Average rainfall : 129.08 in

Type III - Seasons are not very pronounced; relatively dry from November to April and wet during the rest of the year. The maximum rain periods are very pronounced, with the short dry season lasting only from one to three months. These localities are only partly sheltered from the northeastern monsoon and trade winds and open to the southeast monsoon or at least to frequent cyclonic storms.
Average temperature : 27°C
Average rainfall : 77.26 in

Type IV - Rainfall is more or less evenly distributed throughout the year
Average temperature : 26.8°C
Average Rainfall : 101.84 in

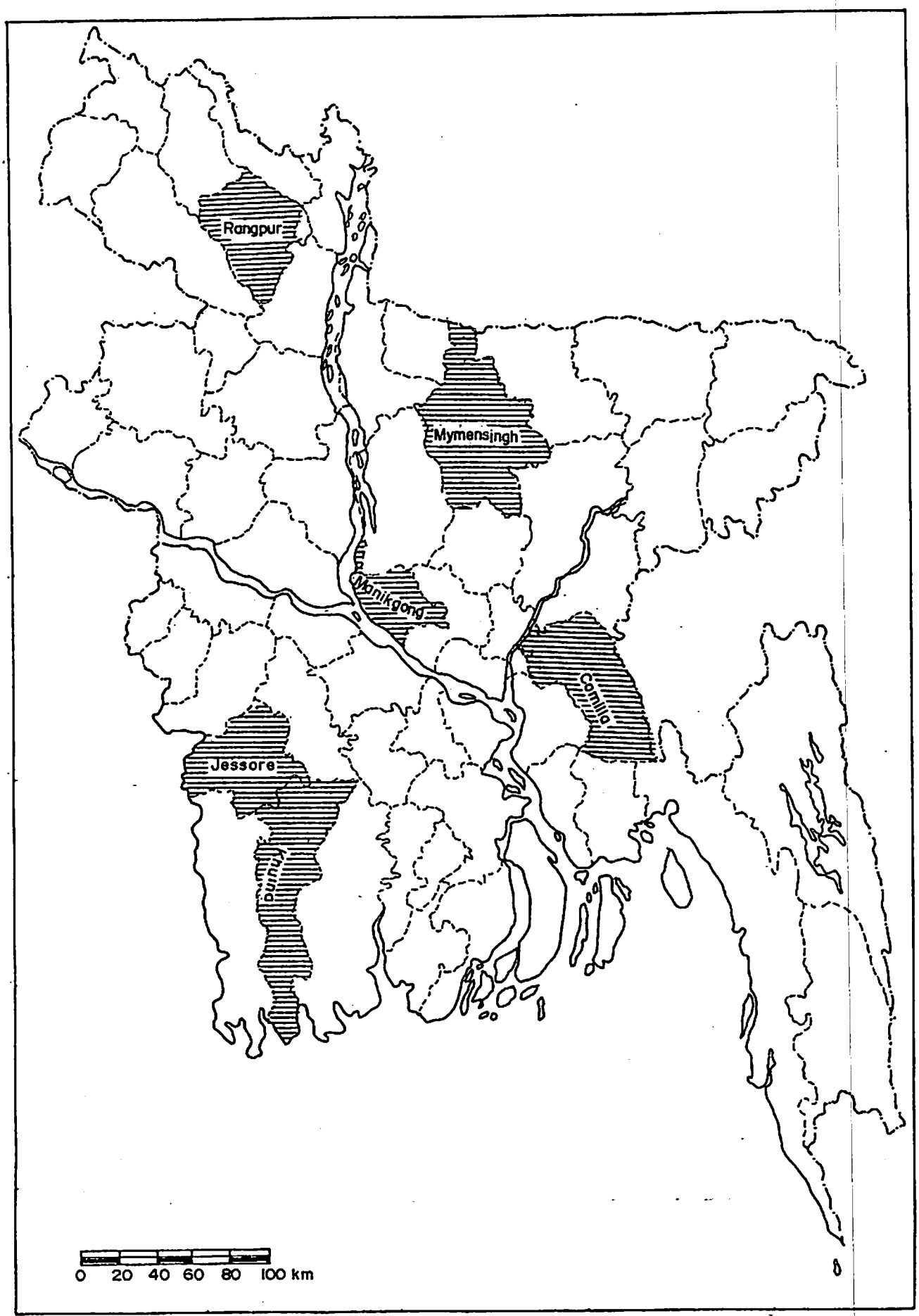
Appendix Table 4. On-farm study sites and their characteristics in Thailand

Sites/Provinces	Major Culture System	Average Farm Size (ha)	
		Pond	Paddy cum fish
Northern			
Chiang Rai	pond	0.20	-
Chiang Rai	pond	0.09	-
Phetchabun	pond, paddy cum fish	0.23	3.82
North-Eastern			
Nakhon Phanom	pond, paddy cum fish	0.13	0.36
Nong Khai	pond	21.00	-
Udon Thani	pond, paddy cum fish	0.26	1.45
Central			
Chachoengsao	pond, paddy cum fish	0.79	5.62
Chon Buri	pond	0.74	-
Samut Prakarn	pond, paddy cum fish	2.72	6.02
Regional Average			
Northern	pond	0.16	1.66
Northeastern	pond, paddy cum fish	0.21	0.61
Central	pond, paddy cum fish	0.96	5.82
South	pond	0.05	-

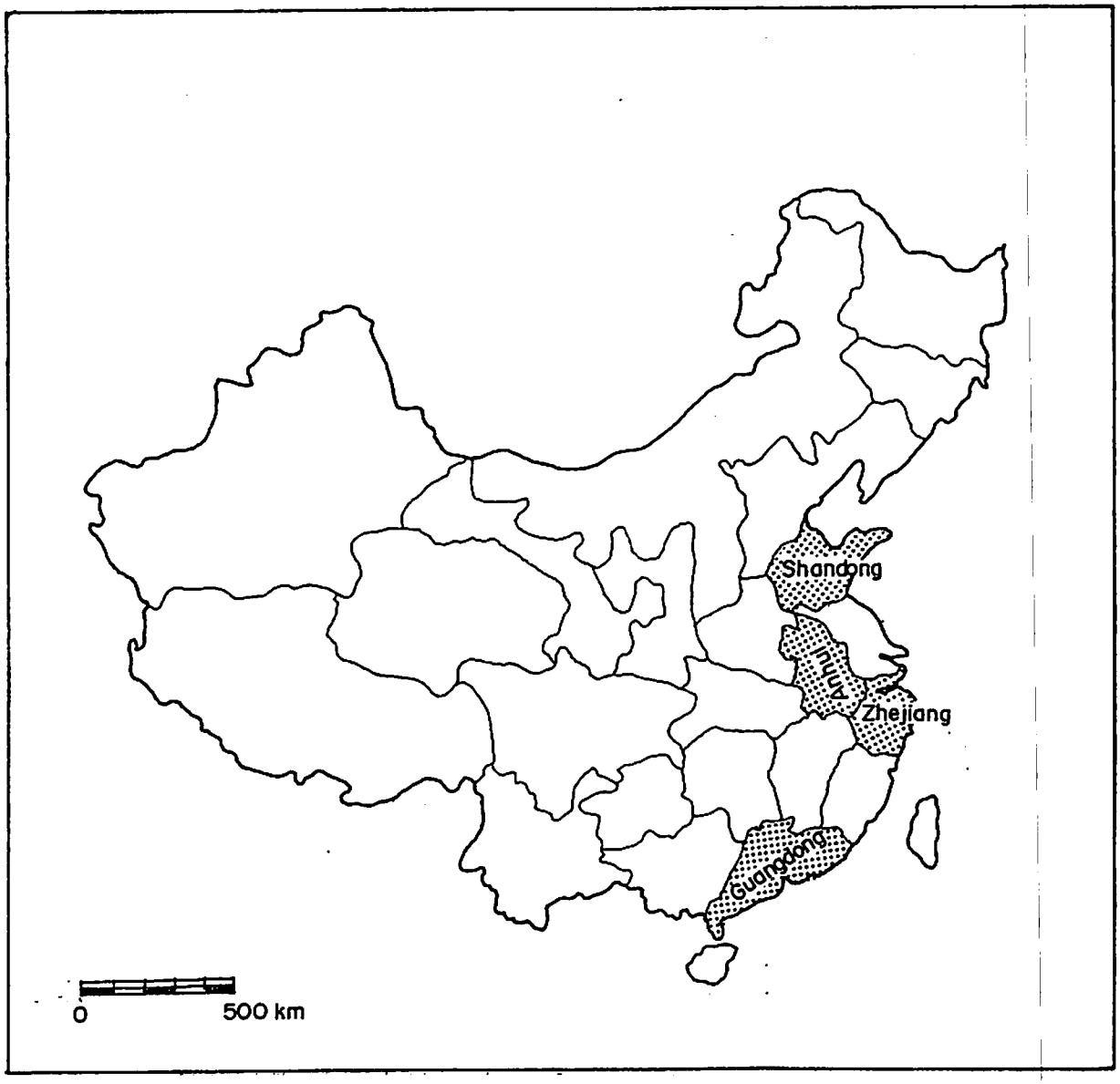
Source: Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand

Appendix Table 5. On-farm project sites and their characteristics in Vietnam

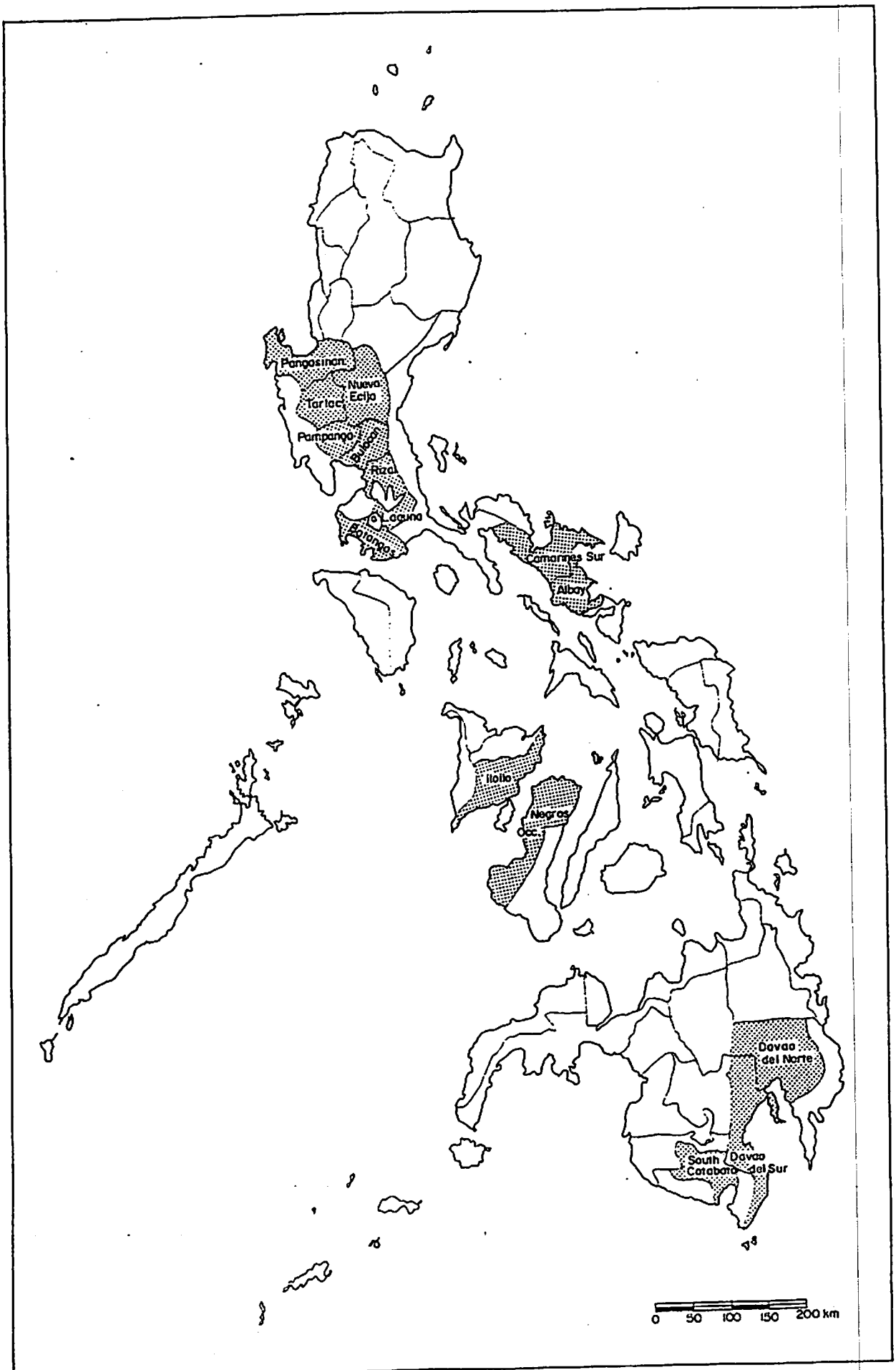
Study Site	Province	Ecology
	North Vietnam	
1. Do Son	Hai Phong	brackish water area
2. Thuy Nguyen	Hai Phong	brackish water area
3. Dong Mai	Quang Ninh	brackish water area
4. Thanh Tri	Hanoi	sewage area
5. Huu Bi	Nam ha	village pond (low land)
6. Vu Di	Vinh phu	village pond (mid land)
7. Song Cau	Habac	village pond (low land)
8. Lang Giang	Habac	village pond (low land)
	South Vietnam	
9. Can Gio	Ho Chi Minh City	brackish water area
10. Thu Duc	Ho Chi Minh City	village pond (suburban)
11. Cai Be	Tien giang	delta
12. Tan Uyen	Song Be	village pond



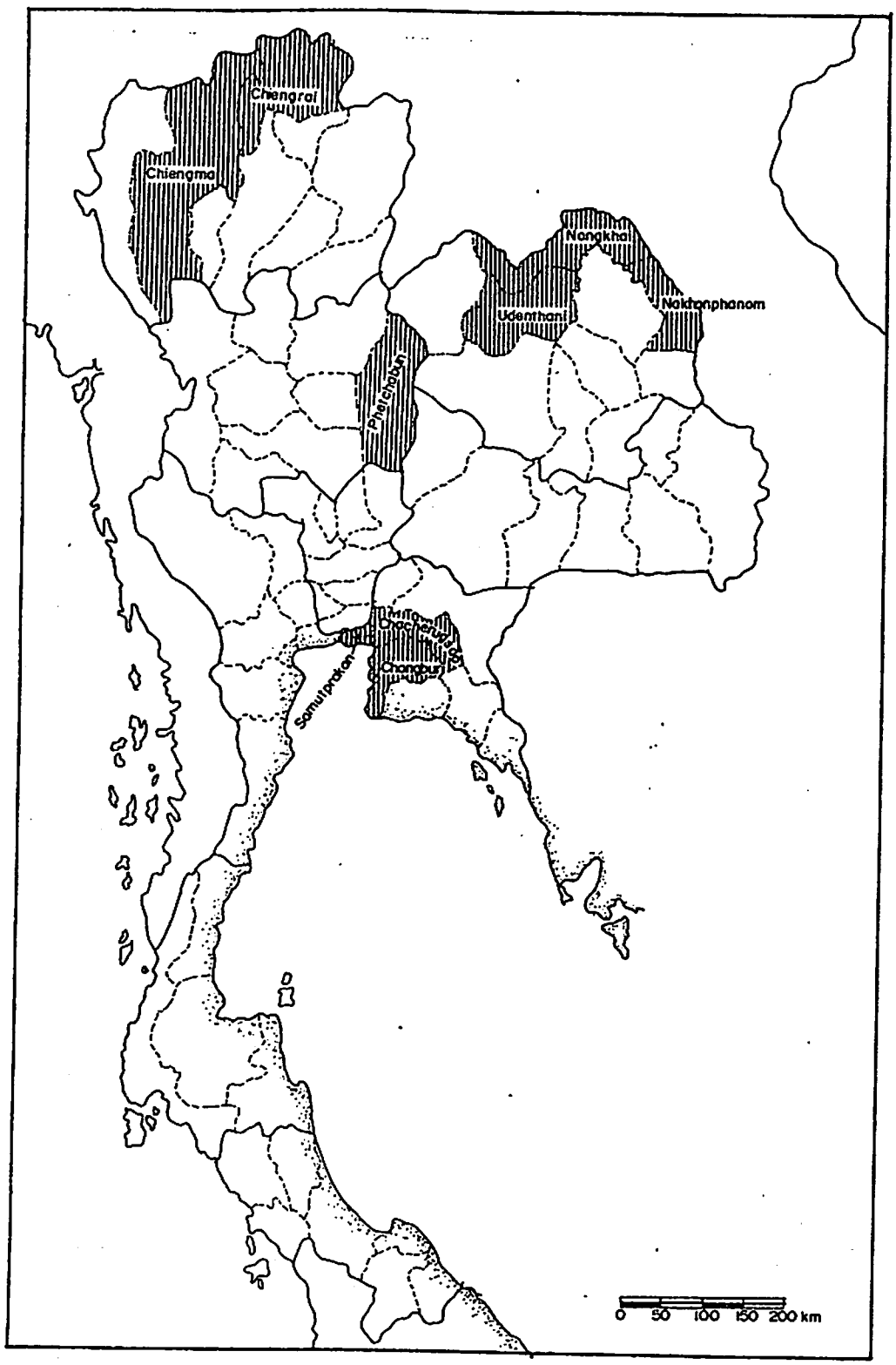
Map 1: On-farm study sites in Bangladesh



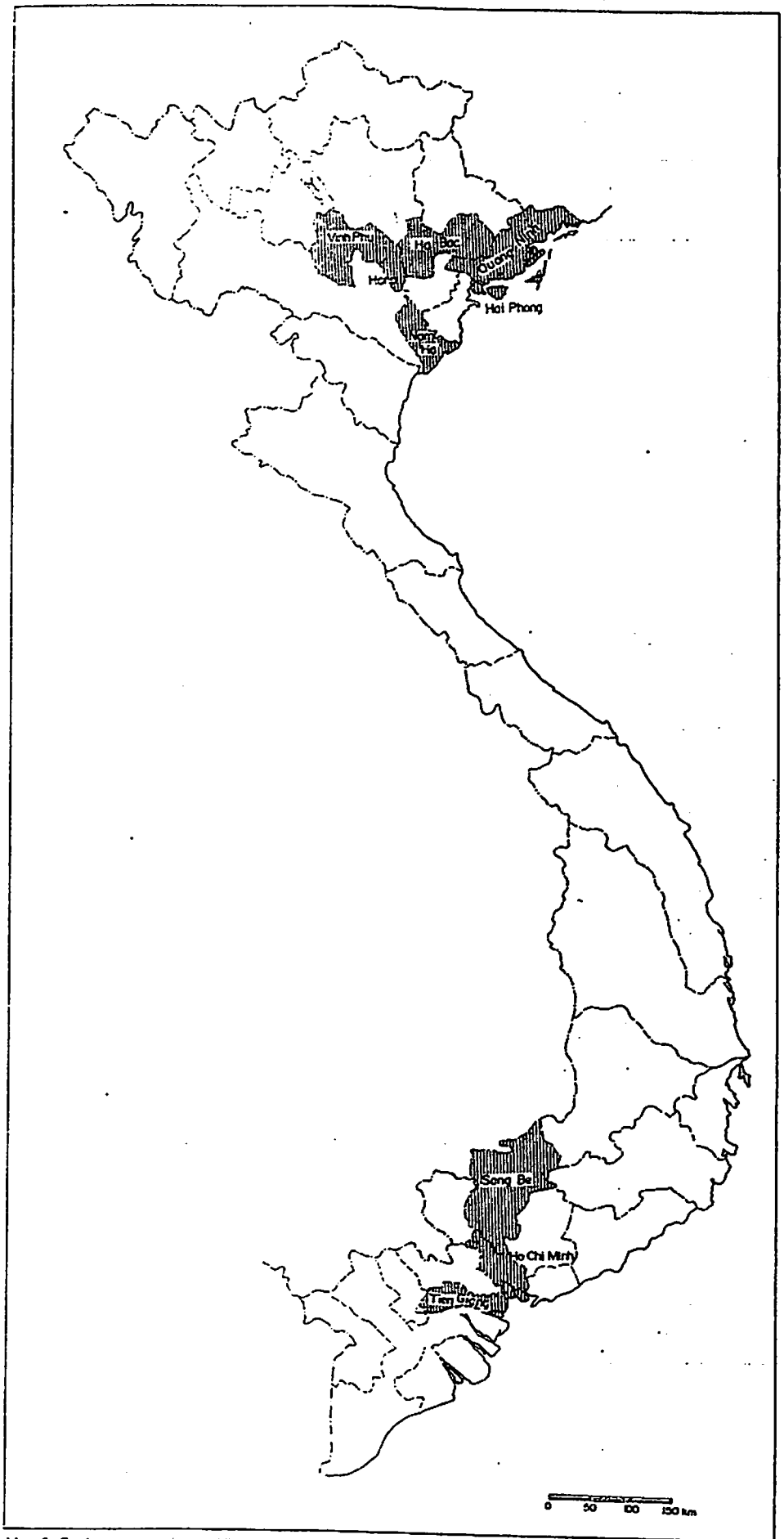
Map 2: On-farm study sites in China



Map 3: On-farm study sites in the Philippines



Map 4: On-farm study sites in Thailand



Map 5: On-farm study sites in Vietnam

Appendix 5

Survey Schedule for the Philippines

SURVEY SCHEDULE A

BASELINE SURVEY OF FISHERIES HOUSEHOLD
PHILIPPINES
(Reference Year: 1994)

A Joint Undertaking of
the Bureau of Fisheries and Aquatic Resources (BFAR), and
the International Center for Living Aquatic Resources Management (ICLARM)

Name of the household head	:
Household serial number	:
Barangay	:
City/Municipality	:
Province	:
Name of respondent	:
Relationship with household head	:
Name of interviewer	:
Date of interview	:

A. BASIC INFORMATION OF THE FARM HOUSEHOLD

1. Profile of Farm Operator

Age :
Sex : (male/female)
Education (years of formal education) :
Primary occupation :
Secondary occupation :
[Occupation:
crop farming
livestock rearing
fish culture
fishing (capture)
hatchery
gardening/nursery/agroforestry
salaried employment/wage labor
self-employment (business/trading/
rural industry)
housekeeping
student
Others (specify)]

Number of working days available for agriculture:
Number of working days available for aquaculture:

2. Profile of the Other Members of Household Engaged in Agriculture:

Serial No.	Sex	Age	Occupation		No. of working days available (per year)	
			Primary	Secondary	Agriculture	Aquaculture

3. Household Size

No. of Adults: male _____ female _____
No. of Children: male _____ female _____

(Definition of household size: people who regulary eat food cooked from same stove/at same table)

4. Land Use Pattern

Land Use Type	owned (ha)	rented in (ha)	rented out (ha)
Homestead Garden/plantation Cultivated crop land Areas for aquaculture pond lake/river (cage/pen culture) Others (specify)			
Total			

5. Household Income (cash only)

Crop Production	Peso/year
rice	_____
corn	_____
____	_____
____	_____
Livestock rearing	_____
Poultry production	_____
Fishing (capture)	_____
Fish culture	_____
Hatchery	_____
Salaried employment/wage labor	_____
Business/trading/rural industry	_____
Leasing of property/equipment	_____
Others (specify)	_____
TOTAL	_____

B. HOUSEHOLD ANNUAL CONSUMPTION EXPENDITURE

1. Food Items

	Amount Consumed		Peso/kg
	Self	Purchased	
rice (kg)			
vegetables (kg)			
fish (kg)			
dry fish (kg)			
meat (kg)			
milk (li.)			
egg (no.)			
sugar (kg)			
cooking oil (kg)			
salt (kg)			
bread (kg)			
other bakery foods (Peso)			
Fruits:			
coconut (no.)			
banana (no.)			
papaya (kg)			
mango (kg)			
other (specify)			
Other food items (specify) (kg/Peso)			

2. Non-food Items

Items	Amount spent (Peso)
clothing	
housing (maintenance)	
medicare	
schooling	
festival and social ceremonies	
maintenance of assests and equipment	
purchase of durable assets (TV, bicycle, radio, etc.)	
purchase of land	
others (specify)	

C. AVAILABILITY OF BIORESOURCES FOR POND/CAGE INPUTS

1. Rice Bran

Total production (kg) :
Quantity used as/for
Animal/poulty feed (kg) :
Fish feed (kg) :
Other uses (kg) :
Quantity sold (kg)
Price (Peso/kg) :

2. Cow/buffalo Dung

Total production (kg) :
Quantity used for
Farm activities (kg) :
Aquaculture (kg) :
Other uses (kg) :
Quantity sold (kg) :
Price (Peso/kg) :

3. Chicken/duck manure

Total production (kg) :
Quantity used for
Farm activities (kg) :
Aquaculture (kg) :
Other uses (kg) :
Quantity sold (kg) :
Price (Peso/kg) :

4. Kitchen waste

Total production (kg) :
Quantity used for
Poultry/duck raising (kg) :
Aquaculture (kg) :
Other uses (kg) :
Quantity sold (kg) :
Price (Peso/kg) :

5. Others (specify)

Total production (kg) :
Quantity used for
Farm activities (kg) :
Aquaculture (kg) :
Other uses (kg) :
Quantity sold (kg) :
Price (Peso/kg) :

D. MAJOR FARM PRODUCTION ACTIVITIES (OTHER THAN AQUACULTURE)
(collect information on cost/return of three most important agricultural activities)

1. Crop _____ Season _____ Land allocated _____

Inputs/outputs	Quantity	Price/unit
Labor (day)		
family		
hired		
Animal labor (day)		
family		
hired		
Seed/seedling (kg/Peso)		
self		
purchased		
Organic fertilizer (specify) kg		
self		
purchased		
Power tiller (days)		
self		
hired		
Chemical fertilizer (kg)		
16-20-0		
14-14-14		
45-0-0		
Others (specify)		
Pesticides (liter/kg)		
Irrigation (Peso)		
Rent for farm equipment, if any (Peso)		
Land rent (for rented-in land only) Peso/year/season		
Total production (kg)		
Quantity sold (kg)		
By product (kg)		
Quantity sold (kg)		

2. Crop _____ Season _____ Land allocated _____

Inputs/outputs	Quantity	Price/unit
Labor (day)		
family		
hired		
Animal labor (day)		
family		
hired		
Seed/seedling (kg/Peso)		
self		
purchased		
Organic fertilizer (specify) kg		
self		
purchased		
Power tiller (day)		
self		
hired		
Chemical fertilizer (kg)		
16-20-0		
14-14-14		
45-0-0		
Others (specify)		
Pesticides (liter/kg)		
Irrigation (Peso)		
Rent for farm equipment, if any (Peso)		
Land rent (for rented-in land only) Peso/year/season		
Total production (kg)		
Quantity sold (kg)		
By product (kg)		
Quantity sold (kg)		

3. Crop _____ Season _____ Land allocated _____

Inputs/outputs	Quantity	Price/unit
Labor (day)		
family		
hired		
Animal labor (day)		
family		
hired		
Seed/seedling (kg/Peso)		
self		
purchased		
Organic fertilizer (specify) kg		
self		
purchased		
Power tiller (day)		
self		
hired		
Chemical fertilizer (kg)		
16-20-0		
14-14-14		
45-0-0		
Others (specify)		
Pesticides (liter/kg)		
Irrigation (Peso)		
Rent for farm equipment, if any (Peso)		
Land rent (for rented-in land only) Peso/year/season		
Total production (kg)		
Quantity sold (kg)		
By product (kg)		
Quantity sold (kg)		

E. AQUACULTURE SYSTEM

1. General Characteristics of Ponds/Cages/Pens

Serial No.	Type Pond/ Cage/ Pen	Size (effective area in 00 sq.m)	Tenural Status	Single/Joint Ownership	Seasonal/ Perennial	Minimum Water Retention Level (meter)		Does the pond get flooded under normal condition (yes/no)	Distance of pond/cage from the household (meter)	Mono/Poly Culture
						Dry Season	Wet Season			
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

2. Pond/cage Management

Note: 1) Group ponds/cages/pens into homogeneous categories;
2) Select one representative pond/cage from each category;
3) There are probably variation among various ponds/cage in terms of number of growing season. Collect information for all growing seasons of 1994.

a. Unit No.: _____ Area: _____ Growing Season: _____

(i) Stocking

Species	Number/Quantity Stocked	Size Stocked	Time Stocked (week/month)	Sources of Fingerling	Price (Peso/kg/1000)

(ii) Input Use

Inputs/Outputs	Quantity	Price/Unit
Preharvest labor (man-day) Family: Hired:		
Duck/chicken Manure (kg) Self: Purchased:		
Cow/carabaoManure (kg) Self: Purchased:		
Kitchen trash (kg) Self: Purchased:		
Rice bran (kg) Self: Purchased:		
Commercial feed (kg)		
Chemical fertilizer (kg) 16-20-0 14-14-14 45-0-0		
Lime (kg)		
Pesticides (kg/liter)		
Land rent (Peso/season)		

Inputs/Outputs	Quantity	Price/Unit
Other pond specific cost (specify) _____ _____	_____ _____	_____ _____
Harvesting cost: Labor (man-days) Hired Family Other (Peso)	_____ _____ _____	_____

(iii) Harvesting and Disposal of Fish

Species	Month of Harvest	Type of Harvest (intermediate/ final)	Quantity of Harvest (kg)	Average size of fish (no./kg)	Disposal (kg)			Price if Sold (Peso/kg)
					Cosumed	Sold	Given Away	

b. Unit No.: _____ Area: _____ Growing Season: _____

(i) Stocking

Species	Number/Quantity Stocked	Size Stocked	Time Stocked (week/month)	Sources of Fingerling	Price (Peso/kg/1000)

(ii) Input Use

Inputs/Outputs	Quantity	Price/Unit
Preharvest labor (man-day) Family: Hired:		
Duck/chicken Manure (kg) Self: Purchased:		
Cow/carabaoManure (kg) Self: Purchased:		
Kitchen trash (kg) Self: Purchased:		
Rice bran (kg) Self: Purchased:		
Commercial feed (kg)		
Chemical fertilizer (kg) 16-20-0 14-14-14 45-0-0		
Lime (kg)		
Pesticides (kg/liter)		
Land rent (Peso/season)		

Inputs/Outputs	Quantity	Price/Unit
Other pond specific cost (specify) _____ _____	_____ _____	_____ _____
Harvesting cost: Labor (man-days) Hired Family Other (Peso)	_____ _____ _____	_____

(iii) Harvesting and Disposal of Fish

Species	Month of Harvest	Type of Harvest (intermediate/ final)	Quantity of Harvest (kg)	Average size of fish (no./kg)	Disposal (kg)			Price if Sold (Peso/kg)
					Cosumed	Sold	Given Away	

c. Unit No.: _____ Area: _____ Growing Season: _____

(i) Stocking

Species	Number/Quantity Stocked	Size Stocked	Time Stocked (week/month)	Sources of Fingerling	Price (Peso/kg/1000)

(ii) Input Use

Inputs/Outputs	Quantity	Price/Unit
Preharvest labor (man-day) Family: Hired:		
Duck/chicken Manure (kg) Self: Purchased:		
Cow/carabaoManure (kg) Self: Purchased:		
Kitchen trash (kg) Self: Purchased:		
Rice bran (kg) Self: Purchased:		
Commercial feed (kg)		
Chemical fertilizer (kg) 16-20-0 14-14-14 45-0-0		
Lime (kg)		
Pesticides (kg/liter)		
Land rent (Peso/season)		

Inputs/Outputs	Quantity	Price/Unit
Other pond specific cost (specify) _____ _____	_____ _____	_____ _____
Harvesting cost: Labor (man-days) Hired Family Other (Peso)	_____ _____ _____	_____

(iii) Harvesting and Disposal of Fish

Species	Month of Harvest	Type of Harvest (intermediate/ final)	Quantity of Harvest (kg)	Average size of fish (no./kg)	Disposal (kg)			Price if Sold (Peso/kg)
					Cosumed	Sold	Given Away	

d. Unit No.: _____ Area: _____ Growing Season: _____

(i) Stocking

Species	Number/Quantity Stocked	Size Stocked	Time Stocked (week/month)	Sources of Fingerling	Price (Peso/kg/1000)

(ii) Input Use

Inputs/Outputs	Quantity	Price/Unit
Preharvest labor (man-day) Family: Hired:	_____ _____	
Duck/chicken Manure (kg) Self: Purchased:	_____ _____	
Cow/carabaoManure (kg) Self: Purchased:	_____ _____	
Kitchen trash (kg) Self: Purchased:	_____ _____	
Rice bran (kg) Self: Purchased:	_____ _____	
Commercial feed (kg)		
Chemical fertilizer (kg) 16-20-0 14-14-14 45-0-0	_____ _____ _____	_____ _____ _____
Lime (kg)		
Pesticides (kg/liter)		
Land rent (Peso/season)		

Inputs/Outputs	Quantity	Price/Unit
Other pond specific cost (specify) _____ _____	 _____ _____	 _____ _____
Harvesting cost: Labor (man-days) Hired Family Other (Peso)	 _____ _____ _____	 _____

(iii) Harvesting and Disposal of Fish

Species	Month of Harvest	Type of Harvest (intermediate/ final)	Quantity of Harvest (kg)	Average size of fish (no./kg)	Disposal (kg)			Price if Sold (Peso/kg)
					Cosumed	Sold	Given Away	

3. Other Farm Specific Cost of Aquaculture

Item	Cost (Peso/Year)
Gasoline/Kerosene/Diesel	
Electricity/light	
Irrigation fee	
License fee	
Equipment rental	
Others (specify)	

4. Highest and Lowest Tilapia Production during the last 10 years in <u>one representative</u> Pond/Cage/Pen

	Highest			Lowest		
Unit no. of pond/cage and area (sq.m) (refer to table 1 under section E)						
Year						
Time stocked						
Species stocked, their quantity and size	[species]	[quantity] [kg./no.]	[size/gm]	[species]	[quantity] [kg.no.]	[size/ gm.]
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____

	Highest	Lowest
Input use: Chemical fertilizer (kg) 16-20-0 14-14-14 45-0-0		
Manure (kg): chicken/duck manure carabao/cow dung kitchen trash		
Rice bran (kg)		
Commercial feed (kg)		
Pesticides (kg/liter)		
Others (specify)		
Quantity harvested (kg)		
Harvesting time (week, month)		
Reseasons for highest/lowest yield		

F. FARMER-OPERATOR'S PERSPECTIVE

1. Have you noted population of tilapia in local aquatic system? If so, when did you first note them.

_____
_____
_____

2. Have tilapia displaced local fish species in the local water body? Name the species being displaced and their economic importance.

_____
_____
_____

3. When did you start culturing tilapia?

_____

4. What problem/s have you encountered since you ventured into tilapia farming which limited your production or expansion? (Encircle code/s and rank problems from most to less severe one [from 1 to nth problems identified]).

	Code	Rank
None	10	____
Poaching	11	____
Bad weather (frequent storm occurrence)	12	____
Flood	13	____
Drought	14	____
Water supply unreliable/shortage	15	____
High cost of water	16	____
Polluted water	17	____
Sulphur upwelling	18	____
Net/pond destruction/vandalism	19	____
Poor/slow growth of fry/fingerling	20	____
High fry/fingerling mortality	21	____
Small size of fish at harvest	22	____
Uncertainty of access to present location	23	____
Proliferation of tilapia farms	24	____
High prices of fry/fingerlings	25	____
Increasing cost of inputs	26	____
Difficulty in obtaining credit	27	____
Lack of technical assistance	28	____
Limited management expertise	29	____
No skilled workers to hire	30	____
High capital requirement	31	____
High marketing cost	32	____
Disease	33	____
Cold	34	____
No buyers or market	35	____
Others (specify)	36	____

5. What solutions have you tried to overcome these problems?

6. What have been the results?

7. What is your attitude to your future involvement in tilapia farming? (enter code/s) _____

   1 = Expand
   2 = Continue
   3 = Shift to other species
   4 = Discontinue
   5 = Undecided

8. If expand/continue: List the encouragement factors.

9. If shift/discontinue/undecided: List the drop out factors.

10. Have tilapia displaced any species in your farm?

11. What are the effects of tilapia culture on water quality in your farm (both positive and negative)?

12. Can you think of any other (positive/negative) effects of tilapia on natural environment?

13. If a better tilapia breed will be available, are you willing to try it out in your farm? (enter code) _____

    0 = No 1 = Yes

    10.1 If yes, what percent of your farm area will be stocked? (in percent) _____

    10.2 If no, why not? _____

Enumerator's Assessment:
In a scale of 1-3, how do you rate the sample operator's . . .

1. . . . willingness and cooperation to give the desired information? (enter code) . . . _____

   1 = high 2 = medium 3 = low

2. . . . willingness to become a GIFT cooperator? (enter code) . . _____

SURVEY SCHEDULE B

Survey of Tilapia Traders/Sellers

Name of Interviewer: _____ Date: _____

1. Name of trader/seller:

2. Address:
   Market:
   Municipality/city:
   Province:

3. Quantity and sources of various types of fish brought for sale.

Species	Quantity		Source (Producer/ Wholesaler/ retailer)	Distance between market & source (km)	Mode of Transport	Time required to transport (hr)
	Brought	Sold (expected to sell)				
Tilapia (nilotica)						
Tilapia (mossambicus)						
Others (specify)						

4. Buying and selling price (Peso/kilo)

Species	Size (no./kg)	Buying Price (Peso/kg)		Selling Price (Peso/kg)	
		Present lot	Ave. of last month	Today	Ave. of last month
Tilapia (nilotica)					
Tilapia (mossambicus)					
Others (specify)					

5. Transportation Cost

Various Buying Places (reference period: last month)	Average Quality brought in each time (kg)	Mode of Transport	Time required to transport (hr)	Transportation Cost (Peso)	Own labor time spend in bringing the fish (hr)
1. 2. 3. 4. 5.					

6. Other Marketing Cost

Items	Cost
Quantity sold (kg./month)	
Permit (Peso/month)	
License (Peso/month)	
Rent of shop (Peso/month)	
Electricity (Peso/month)	
Ice (Peso/month)	
Storage (Peso/month)	
Labor cost: hired (man-days/month) wage (Peso/day) owned (man-days/month	
Other cost (specify)	

SURVEY SCHEDULE C

FISH CONSUMPTION SURVEY

Name of Interviewer: _____ Date: _____

1. Name of Household Head:

2. Address:

   Barangay: _____ City/Municipality: _____ Province: _____

3. Category: Fish Producers/Non-fish Producing Rural/Urban

4. Household size:

   No. of Adults: male _____ female _____
   No. of Children: male _____ female _____

5. Household Annual Expenditure:
   (To be collected only once. These questions will not be asked to fish producing households, as these have been included in the Survey Schedule A.)

a. Food Items

	Amount Consumed		Peso/kg (piece)
	Self	Purchased	
rice (kg)			
vegetables (kg)			
pulses (kg)			
fish (kg)			
dry fish (kg)			
meat (kg)			
egg (no.)			
sugar (kg)			
cooking oil (kg)			
salt (kg)			
bread (kg)			
other bakery foods (Peso)			
Fruits:			
coconut (no.)			
banana (no.)			
papaya (kg)			
mango (kg)			
other (specify)			
Other food items (specify) (kg/Peso)			

b. Non-food Items

Items	Amount spent (Peso)
clothing	
housing (maintenance)	
Medicare	
schooling	
festival and social ceremonies	
maintenance of assets and equipment	
purchase of durable assets (TV, bicycle, radio, etc.)	
purchase of land	
others (specify)	

6. Most/Least Preferred Fish Species

Household Member	Age	Sex	Most Preferred Species		Least Preferred Species		Preferred size of tilapia[c] (enter code)
			Species	Reasons[a] (enter code)	Species	Reasons[b] (enter code)	
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

a. Codes

1. taste good
2. reasonable price
3. easily available
4. easy to prepare
5. not easily perishable
6. others (specify)

b. Codes

1. taste is not good
2. high price
3. not easily available
4. difficult to prepare
5. easily perishable
6. others (specify)

c. Codes

1. 2-4 fish/kg
2. 5-7 fish/kg
3. 8-10 fish/kg
4. 10+ fish/kg

7. Fish Consumption During the Last Month
(to be collected three times a year to capture seasonality in fish consumption)

Species Consumed	Quantity	Source (Purchased/ Home Produced)	Price (Peso/kg)
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

8. Prices of Fish Substitutes During the Last Month
(to be collected three times a year)

Commodity	Peso/kg
chicken	
beef	
pork	
egg (Peso/dozen)	

Appendix 6

The Program and List of Participants of the 2nd INGA Steering Committee Meeting

The Second Steering Committe Meeting of **The International Network on Genetics in Aquaculture**

and

Special Planning Sessions on **Fish Biodiversity** and **Strategies for Fish Genetics Research**

20-27 June 1995
Hyderabad, India

PROGRAM
AND
PARTICIPANTS

PROGRAM

20 June 95 (Tue) — **Opening Session**

AM — *Chairperson: Dr. R.S. Paroda*

0930-0935	Welcome and Opening Remarks	**Dr. M.J. Williams**
0935-1000	Global Aquaculture Prospects and Challenges	**Dr. M.J. Williams**
1000-1030	*Inaugural Address*	**Dr. R.S. Paroda**
1030-1050	*Coffee Break/Group Photograph*	
1050-1120	Current Status of Aquaculture Research and Development in India	**Dr. P.V. Dehadrai**
1120-1200	INGA Coordinator's Report	**Dr. D.V. Seshu**
	Vote of Thanks	**Dr. P.V. Dehadrai**
1200-1315	*Lunch Break*	

PM — **INGA Research Progress - Tilapia**

Chairperson: Dr. M.J. Williams

o Evaluation of Tilapia Strains for Growth Performance in Selected Countries

1315-1335	Bangladesh (DEGITA)	**Dr. M.G. Hussain**
1335-1355	China (DEGITA)	**Dr. Li Sifa**
1355-1415	Indonesia	**Dr. A. Hardjamulia**
1415-1435	Philippines/ICLARM (GIFT/DEGITA)	**Mr. R. Reyes/ Dr. A.E. Eknath**
1435-1455	Thailand (DEGITA)	**Dr. N. Pongthana**
1455-1515	Vietnam (DEGITA)	**Dr. T.M. Thien**
1515-1535	*Coffee Break*	

o Breeding Tilapia Strains for Salinity and Cold Tolerance

1535-1555	Progress in Egypt	**Dr. A.R. El Gamal**
1555-1615	Progress in China	**Dr. Li Sifa**

1615-1700	o Highlights of ACIAR Tilapia Improvement Project (Australia/Fiji/Malaysia)	**Dr. P.B. Mather/ Mr. Satya Lal/ Mr. O.S. Selvaraj**
1930	*Dinner Reception by ICLARM*	

21 June 95 (Wed) **INGA Research Progress in Tilapia (cont'd.)**

AM *Chairperson: Dr. E.K.Abban*

o Selected Genetics Studies in Tilapia

0815-0835	Genetics of Growth-Related and Maturation Factors	**Dr. A.E. Eknath**
0835-0855	Application of Innovative Genetic Techniques	**Dr. M.A. Mazid/ Dr. M.G. Hussain**
0855-0915	-do-	**Dr. N. Pongthana**

o Genetic Characterization of Tilapias

0915-0935	Progress in Cote d'Ivoire	**Dr. Koffi Goli**
0935-0955	Progress in Ghana	**Dr. E.K. Abban**
0955-1015	Progress in Malawi	**Dr. H. Kabwazi**
1015-1030	*Coffee Break*	

o Socio-Economic Studies in Tilapia (DEGITA Project)

1030-1045	Bangladesh	**Dr. M.G. Hussain**
1045-1100	China	**Dr. Li Sifa**
1100-1115	Philippines	**Mr. G.L. Morales**
1115-1130	Thailand	**Dr. N. Pongthana**
1130-1145	Vietnam	**Dr. Tran Mai Thien**
1145-1200	ICLARM	**Dr. M.M. Dey**

PM **INGA Research Progress - Carps**

Chairperson: Dr. P.V. Dehadrai

o Breeding Improved Strains of Carps

1315-1335	Bangladesh	**Dr. M.A. Mazid**
1335-1355	China	**Dr. Li Sifa**
1355-1415	India	**Dr. S.D. Tripathi/ Dr. P.G.V.K. Reddy**
1415-1435	Indonesia	**Dr. A. Hardjamulia**
1435-1455	Thailand	**Dr. N. Pongthana**
1455-1515	Vietnam	**Dr. Tran Mai Thien**

1515-1530	*Coffee Break*	
	o Selected Genetic Studies in Carps	
1530-1550	Bangladesh	**Dr. M.G. Hussain**
1550-1610	India	**Dr. P.G.V.K. Reddy**
1610-1630	Vietnam	**Dr. Tran Mai Thien**
	o Genetic Characterization in Carps	
1630-1645	India	**Dr. S.D. Tripathi**
1645-1700	China	**Dr. Li Sifa**
1700-1715	Indonesia	**Dr. A. Hardjamulia**

22 June 95 (Thu)

AM — **INGA Future Plans**

Chairperson: Dr. Tran Mai Thien

Suggestions for Changes/Improvements in the Draft Documents on:

o Research Methodologies o Transfer Protocols	**Dr. A.R. El Gamal**
Plans for Exchange of Materials	**Dr. D.V. Seshu**
Cooperative Research in Carps	**Dr. S.D. Tripathi/ Dr. M.M. Dey**
Training	**Dr. A.E. Eknath**
Bilateral Projects	**Dr. Brian Davy**

PM — **Visit to Centre for Cellular and Molecular Biology (CCMB), Hyderabad -- (Dr. K. Majumdar)**

23 June 95 (Fri)

AM

0800-1030 Report Writing

Concluding Session

Chairperson: Dr. M.A. Mazid

1030-1200 Summary of Proceedings

o INGA Research Progress - Tilapia	**Dr. A.E. Eknath/ Dr. M.M. Dey**

24 June 95 (Sat)	**Special INGA Session on "Fish Biodiversity: Genetic Resources for Aquaculture"**	
AM	*Chairperson: Dr. R.S.V. Pullin*	
0845-0855	Welcome and Opening Remarks	**Dr. D.V. Seshu**
0855-0915	Purpose and Expected Outputs of the Meeting, Overview of Fish Biodiversity and Genetic Resources for Aquaculture	**Dr. R.S.V. Pullin**
0915-0930	Genetic Resources for Aquaculture, On-farm and in Open Waters	**Dr. R. Doyle**
0930-0945	Genetic Resources for Aquaculture and Enhanced Fisheries	**Dr. D. Bartley**
0945-1000	New Approaches to Characterizing Fish Populations	**Dr. W. Villwock**
1000-1015	*Coffee Break*	
1015-1030	Regional Overview for Africa	**Dr. E.K. Abban**
1030-1045	Regional Overview for South and West Asia	**Dr. P. Das**
1045-1100	Regional Overview for East and Southeast Asia	**Dr. Li Sifa**
1100-1200	*Lunch*	
PM		
1315-1415	Discussion on Specific Aspects such as Management of *ex-situ* and *in-situ* Conservation of Fish Genetic Resources (Discussant: Dr. P. Das)	
1415-1600	Workplans and Recommendations	

25 June 95 (Sun) **Free Day**

Planning Session on "Strategic Research Agenda for the Application of Genetics to Increase Sustainable Aquaculture Production".

26 June 95 (Mon)

AM

1. Aquaculture Production Environments - Setting the Development Context

Chairpersons: Dr. E.K. Abban and Dr. B. Davy
Rapporteurs: Dr. A. Hardjamulia and Dr. P.G.V.K. Reddy

0830-0845	Welcome and Introduction of Objectives	**Dr. A.E. Eknath**
0845-0945	Production Environments	**Dr. I. Csavas**
0945-1045	Socioeconomics and Equity	**Dr. M.V. Gupta**
1045-1100	*Coffee Break*	
1100-1200	Choice of Species/Systems	**Dr. B. Davy**
1200-1330	*Lunch Break*	

2. Identification of Constraints to Aquaculture Production and Definitiion of Critical Research Problem Areas

Chairpersons: Dr. S.D. Tripathi and Dr. E. Fimland
Rapporteurs: Dr. E.K. Abban and Dr. N. Pongthana

1330-1420	Constraints Specific to Farming Systems	**Dr. R.S.V. Pullin**
1420-1510	Constraints Specific to Target Specis	**Dr. D. Bartley**
1510-1530	*Coffee Break*	

3. Development of Criteria for Setting Research Priorities

Chairpersons: Dr. E.P. Cunningham and Dr. D.V. Seshu
Rapporteurs: Dr. Tran Mai Thien and Dr. M.V. Gupta

1530-1610	Lessons from Agriculture	**Dr. M.M. Dey**
1610-1650	Lessons from Animal Breeding	**Dr. E.P. Cunningham**
1650-1730	Approaches to Fish Genetics Research Prioritization	**Dr. G. Hulata**

27 June 95 (Tue)

AM **4. Genetic Techniques to Address Critical Research Problem Areas**

Chairpersons: Dr. R.W. Doyle and Dr. R. Dunham
Rapporteurs: Dr. Li Sifa and Dr. M.G. Hussain

0800-0840	Application of Selective Breeding Principles	**Dr. H.B. Bentsen**
0840-0920	Genetics and Equity-Breeding for Small Scale-Farmers	**Dr. R.W. Doyle**
0920-1000	Potential Applications of Biotechnology	**Dr. K. Majumdar**
1000-1030	*Coffee Break*	
1030-1200	Wrap-up (all four topics)	
	Vote of Thanks	

PARTICIPANTS

Australia

Dr. Peter B. Mather
Project Leader
School of Life Science
2 George Street
G.P.O. Box 2434
Brisbane Q 4001

Bangladesh

***Dr. M.A. Mazid**
Director
Fisheries Research Institute
Mymensingh 2201

***Dr. M.G. Hussain**
Chief Scientific Officer
Fisheries Research Institute
Mymensingh 2201

Canada

Dr. R.W. Doyle
Professor
Dalhousie University
Department of Biology
Halifax, Nova Scotia

China

***Dr. Li Sifa**
Director
Laboratory of Ecology and
Physiology in Aquaculture
Shanghai Fisheries University
334 Jun Gong Road
Shanghai 200090

Cote d'Ivoire

Dr. K. Goli
Director General
IDESSA, 01 BP 633
Bouake

Egypt

Dr. A.R. El Gamal
Director
National Aquaculture Center
Abbassa, Abou Hammad
Sharkia

Fiji

Mr. Satya Lal
Senior Scientist
Fisheries Division
Ministry of Agriculture,
Fisheries and Forests
Suva

Germany

Prof. W. Villwock
Universitat Hamburg
Zoologisches Institut und
Zoologisches Museum
Martin-Luther-King P1.3
200 Hamburg 13

Ghana

Dr. E.K. Abban
Head
Fishery Division
Institute of Aquatic Biology
P.O. Box 38, Achimota

India

Dr. R.S. Paroda
Director General
Indian Council of Agricultural
Research
Ministry of Agriculture
Krishi Bhavan, Dr. Rajendra
Prasad Road

Dr. P.V. Dehadrai
Deputy Director General
Indian Council of Agricultural Research
Ministry of Agriculture
Krishi Bhavan, Dr. Rajendra Prasad Road
New Delhi 110 001

Dr. S.D. Tripathi
Director
Central Institute of Fisheries Education
Jaiprakash Road
Versova, Bombay 400 061

Dr. P.G.V.K. Reddy
Principal Scientist
Central Institute of Freshwater Aquaculture
Kausalyaganga, Bhubaneswar
Orissa 751002

Dr. P. Das
Director
National Bureau of Fish Genetic Resources
Radhaswamy Bhavan,
351/28 Dariyapur
Talkatora Road, Rajendranagar
Lucknow - 226004
Uttar Pradesh

Dr. K. Majumdar
Scientist
Centre for Cellular and Molecular Biology
Uppal Road, Hyderabad 500 007

Indonesia

Dr. A. Hardjamulia
Research Coordinator
Research Institute for Freshwater Fisheries
Jl. Sempur 1, P.O. Box 150
Bogor 16001

Israel

Dr. G. Hulata
Department of Aquaculture
Agricultural Research Organization
Volcani Center
P.O. Box 6
Bet Dagan 50250

Malawi

Dr. H. Kabwazi
Head, Biology Department
University of Malawi
P.O. Box 278
Zomba

Malaysia

Mr. O.S. Selvaraj
Research Fellow
Institute of Advanced Studies
University of Malaya
Kuala Lumpur 58100

Norway

Dr. E. Fimland
Director
Institute of Aquaculture Research
Agricultural University of Norway
P.O. Box 5010, 1432 As

Dr. H.B. Bentsen
AKVAFORSK
Institute of Aquaculture Research
Agricultural University of Norway
P.O. Box 5010, 1432 As

Philippines

***Mr. G.L. Morales**
Director
Bureau of Fisheries and Aquatic Resources
860 Quezon Avenue
Quezon City, Metro Manila 3008

*Mr. R.A. Reyes
Officer-in-Charge
National Freshwater Fisheries Technology Research Center (NFFTRC)
Bureau of Fisheries and Aquatic Resources (BFAR)
Muñoz, Nueva Ecija

Thailand

*Mr. P. Sihapitukkiat
Director
National Aquaculture Genetics Research Institute
Chatuchak, Bangkok 10900

*Dr. N. Pongthana
Aquaculture Geneticist
National Aquaculture Genetics Research Institute
Chatuchak, Bangkok 10900

United Kingdom

Dr. Brendan McAndrew
Institute of Aquaculture
University of Stirling
Stirling FK9 4LA
Scotland

Vietnam

*Dr. Tran Mai Thien
Director
Research Institute for Aquaculture No. 1
Dinh Bang, Tien Son
Ha Bac

SIFR

Dr. Brian Davy
Executive Secretary
SIFR, c/o IDRC
250 Albert Street
P.O. Box 8500
Ottawa

FAO

Dr. D.M. Bartley
Fishery Resource Officer
Inland Water Resources and Aquaculture Service
Fishery Resources and Enrivonment Division
FAO/UNDP, via delle Terme di Caracalla
00100 Rome

Dr. I. Csavas
Regional Aquaculture Officer
FAO Regional Office for Asia and the Pacific
Phra Atit Road
Bangkok 10200

UNDP

Mr. P.S. Reynolds
Senior Programme Officer
Science, Technology and Private Sector Division
UNDP, 1 United Nations Plaza
New York, N.Y. 10017
U.S.A.

ICLARM

Dr. M.J. Williams
Director General
International Center for Living Aquatic Resources Management (ICLARM)
MC P.O. Box 2631
Makati, Metro Manila 0718
Philippines

Dr. R.S.V. Pullin
Director
Inland Aquatic Resouce Systems
Program
International Center for Living
Aquatic Resources
Management (ICLARM)
MC P.O. Box 2631
Makati, Metro Manila 0718
Philippines

Dr. A.E. Eknath
Project Leader
Aquaculture Genetics
International Center for Living
Aquatic Resources
Management (ICLARM)
MC P.O. Box 2631
Makati, Metro Manila 0718
Philippines

Dr. M.V. Gupta
Senior Aquaculture Specialist
ICLARM, House No. 20
Road #9/A (New)
Dhanmondi, R/A
Dhaka 1209
Bangladesh

Dr. M.M. Dey
Project Coordinator/Socio-Economist, DEGITA
International Center for Living
Aquatic Resources
Management (ICLARM)
MC P.O. Box 2631
Makati, Metro Manila 0718
Philippines

Dr. D.V. Seshu
Project Director, INGA/DEGITA
ICLARM Office at IRRI
International Rice Research Institute
P.O. Box 933, Manila
Philippines

* Members from DEGITA participating countries.