

**Report of Second Mission on Aquaculture and Environment
(STS/ TSS-2)**

for

**UNDP/FAO Project VIE/93/001
Freshwater Fish Culture Extension**

by

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Bangkok, 23 July 1997

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1. Introduction

The prime objective of the UNDP/FAO Project VIE/93/001 - Freshwater Fish Culture Extension is to assist national efforts in establishing a sustainable system of extension services in aquaculture in northern and central Viet Nam. Since its start in January 1995, the Project has been successful in developing and strengthening an extension network consisting of a Transfer of Technology Centre, four Sub-Centres, 24 Demonstration Farms and 12 Integrated Fish Farms (VAC sites). This Project is considered to be a core element of a programmatic framework for Technical Assistance to Environment and Natural Resources Management in Viet Nam, which was formulated by the UNDP office in Viet Nam, in accordance with the National Plan for Environment and Sustainable Development (NPESD), to introduce economic alternatives and sustainable rural practices to reduce environmental degradation.

Within the Project framework, emphasis has been given to socio-economic and environmental considerations in aquaculture extension activities in the provinces covered by the Project. In order to integrate both socio-economic information on farm households practicing aquaculture and information on positive and negative environmental impacts of aquaculture into ongoing and future extension activities and approaches, the Project has commissioned the preparation of two studies (which have been carried out by national expert teams during 1995-1996):

- Study on Environmental Impacts of Aquaculture, prepared by Dr T.T. Thanh and co-workers of the Department of Ecology and Environment, Faculty of Biology, University of Hanoi; and
- Socio-economic case studies on small family-size integrated farming system (VAC)-Sustainable Aquaculture Development through Promotion of VAC Integrated Farming Models, prepared by Dr. D.K. Chung and co-workers of the Faculty of Agricultural Economics, Hanoi Agricultural University.

In addition, the Project provided for a TSS-2 consultancy, split into two missions, on environmental assessment of aquaculture and extension activities. The reporting officer visited the Project in June 1995, and this report covers his second mission in July 1997. The Terms of Reference for this consultancy are given as follows:

Terms of Reference:

Post title: Consultant on Environmental Impact

Duration: Six man-weeks split into 2 missions, one of four weeks and one of two weeks (mission period subject to adjustment)

EOD: September 1994

Duties:

The consultant will work under the technical supervision of the competent FAO unit, in support of the Lead Consultant and in close collaboration with the project authorities, in particular with the NPD and the Deputy NPD. Close liaison should be established with the RIA No.1 Environmental Study Laboratories (ESL) strengthened under VIE/86/011. In particular, the consultant will perform the following duties:

- (i) study and analyze potential negative environmental impacts of the project in particular and of the extension of new technologies to inland fisheries in general;
- (ii) study and analyze opportunities lying within the project framework, which, if implemented, would have a positive environmental impact;

- (iii) formulate and forward recommendations, in line with the results of duties (i) -(ii) above, to improve the overall environmental impact of the project;
- (iv) prepare TORs for national consultants to constantly monitor the environmental impact of the project and of the extension of new technologies to inland fisheries.
- (v) Work with the ESLs and the national consultants recruited under (iv) to analyze the results of the 12 socio-economic studies of VAC and the results collected through the monitoring in (iv). Combine to provide assessment of the environmental impact of the project and extension activities;
- (vi) based on assessment under (v), provide follow- up recommendations.

The first mission covered above items (i) - (iv) , and this mission addressed items (v) and (vi) with a view to consolidate findings of both missions undertaken. This report summarizes the findings conclusions and recommendations derived from above mentioned studies, as well as findings from both missions undertaken, including information provided by experts of the Research Institute for Aquaculture No.1 and additional documentation consulted in July 1997.

The officer arrived in Hanoi on 5 July and departed on 20 July. Annex 1 of this report contains the officer's itinerary and a list of persons met during the second mission. On 4 July, the officer was briefed on current progress by the Project, by Mr D. Kumar (Lead Consultant) and Messrs M. Choudhury and M. Doeff of FAO's Regional Office for Asia and the Pacific (RAP). The reports of the above-mentioned studies were received in RAP on 27 June 1997, and handed over to the Lead Consultant and the reporting officer during the briefing of 4 July.

The reporting officer met the project staff of VIE/93/001 on 8 July. Meetings were held with Dr Le Thanh Luu, Deputy National Project Coordinator, to discuss current situation of the project, the forthcoming Tripartite Review Meeting, requirements for Project Performance Evaluation Report, purpose of this mission, and the reports¹ of the Study Teams on environmental impact and socio-economic assessment. Unfortunately, it was not possible to meet with the study team leaders during this mission, because they were travelling in Viet Nam and abroad

Project VIE/93/001 is proving to be very successful. This has been reiterated during various meetings with the project staff as well as with Messrs M. Messier (FAOR, Hanoi) and P.G Truc (National Professional Officer, FAO) and Messrs N.T. Tung (National Programme Officer,) and G. Johnson (Senior Advisor Environment and Natural Resources), UNDP, Hanoi. It is evident that there is a need and demand for continued efforts and support to aquaculture extension activities in northern Viet Nam, for the benefit of often very poor farm households including in particular those farmers living in the mountainous areas of this region.

The reporting officer reviewed both reports prepared by the Study Teams. The reports contain valuable information and are an important contribution to ongoing efforts by the Project to further develop, refine and adjust extension practices and approaches to farm household conditions. The research efforts by both Study Teams merit full appreciation by the Project, also in view of logistical and language problems faced (e.g. transportation, English proficiency), which, however, are commonly experienced in Viet Nam. It is suggested that the Socio-economic Study be finalized (some language editing is required) and printed, since it provides information which is highly relevant, not only to the Project, but also for aquaculture extension and research work in other countries. The Environment Study required considerable language editing. In addition, the Study Team faced some logistical, technical and methodological problems. It is suggested that the Team finalizes the report in Vietnamese. Technical suggestions and comments have been prepared by the reporting officer to assist the Team in this task.

Upon request by Messrs Luu and Tung, the reporting officer reviewed a preliminary draft proposal for a project on brackish water aquaculture in northern and central provinces of Viet Nam, with a view to provide suggestions on proposed project approach and activities as related to key project components on environmental monitoring and management. The draft proposal envisages field testing and extension of environmentally sustainable aquaculture methods, based on collaboration between Vietnamese and Thai experts and, possibly, on support by the Government of Thailand and UNDP.

1.1 Meeting of 17 July 1997 at the Ministry of Fisheries, Hanoi

A meeting was held on 17 July 1997 at the Ministry of Fisheries, hosted by Dr Ta Quang Ngoc, Minister of Fisheries, and attended by Dr Vu Van Trieu, Deputy Director-General, International Cooperation Department, MoF, Dr Le Thanh Luu (RIA No.1) and the reporting officer. Dr Ngoc, Minister of Fisheries, identified several priority areas for technical collaboration and financial assistance for increased fish production through aquaculture and inland fisheries. He stressed that the poorest people in Viet Nam live in the mountain areas, including ethnic minorities. In addition, there are significant problems of migration and resettlement of more than one million people in the highland provinces of northern Viet Nam. These people urgently require that alternatives of economic activities are provided. Highest priority is therefore being given to poverty alleviation, food production and job creation in these areas. Aquaculture in ponds and cages as well as fishery practices in reservoirs and lakes, are seen as very suitable and viable opportunities to enhance production of much needed animal protein. In addition, the creation of alternative sources of food and income through aquaculture and fishing can help reducing ongoing deforestation in mountainous areas resulting from unsustainable logging practices by very poor people.

It was felt that Project VIE/93/001 has shown very satisfactory results. However, given the demand for fish, the proven viability of fish production in present integrated aquaculture-agriculture farming systems, and the great acceptance of these methods by the farmers, it was emphasized that there is much scope in expanding the activities of the established aquaculture extension network. More support is needed to expand the coverage of this network, with a view to carry out additional extension activities, particularly at the district levels of all target provinces, as well as at the level of communes in mountainous regions. The Ministry of Fisheries would expect that continued support will be provided by UNDP and FAO to the efforts of the Ministry in the areas of freshwater aquaculture and inland fisheries.

Dr Ngoc also referred to significant opportunities for increased fish production and income generation from aquaculture development in coastal areas. He mentioned the recently concluded Coastal Aquaculture Development Study, supported by the Asian Development Bank. Unfortunately, no internationally supported project activities have been initiated so far to provide financial and technical assistance for the implementation of actions proposed.

The Minister emphasized that there is a need in coastal aquaculture to shift from extensive production systems to investment into more intensive types of aquaculture production. Intensification of coastal aquaculture practices is being prioritized for reasons of increasing competition for limited land resources, economic efficiency of improved and intensified practices, and reduced conversion of coastal wetlands. It was stated, however, that such intensification should be supported by appropriate disease prevention and other fish health management measures, application of adequate feeds

and feeding techniques, and good farm management practices, so as to ensure that this sector develops in a sustainable manner. Dr Ngoc advised that technical support by FAO on sustainable coastal aquaculture development, including aspects of technology and management, would be very welcome.

Dr Ngoc mentioned that he had attended the 1995 FAO/Japan Conference on the Sustainable Contribution of Fisheries to Food Security. He inquired if FAO's Special Programme for Food Security could support current aquaculture development efforts in Viet Nam. He reiterated that aquaculture has great potential to contribute to food security in many provinces of Viet Nam, and that it can generate substantial benefit to poor people particularly in mountainous areas. He referred in particular to the application of the Vietnamese VAC system and other practices of integrated aquaculture-agriculture, which have proven to be quite effective in contributing to food security. He noted, however, that food security can be achieved not only through increased production, but also through aquaculture of high value species such as, for example, freshwater turtles, generating income equivalent to 30-40 kg rice per kilogramme of turtle produced. The Minister further emphasized the importance of post-harvest aspects in aquaculture, such as handling, processing, distribution and marketing of aquaculture products.

In concluding, it was indicated that the assistance provided so far by FAO and UNDP is appreciated. However, it was also stated that it is hoped that FAO, UNDP and other relevant institutions would give due consideration to the provision of continued support and technical advice for the enhancement of fish production through aquaculture in inland and coastal areas.

A debriefing meeting was held on 23 July in Bangkok, attended by Messrs P. Choudhury (FAO-RAP), Luu, Kumar and the reporting officer. The meeting discussed the content of the mission report, and agreed with the findings and recommendations of the mission.

The reporting officer wishes to express his sincere appreciation for the kind collaboration and attention received during his stays in Viet Nam. The assistance by the staff of RIA No.1 is especially acknowledged. Support and useful information was also provided by staff of FAO and UNDP offices in Hanoi, as well as by the Project's Lead Consultant, Dr D. Kumar, and Messrs M. Choudhury and M. Doeff of FAO's Regional Office for Asia and the Pacific.

2. Summary overview of socio-economic and environmental assessments

2.1 The role of aquaculture in food supply and rural development

Fish is one of the most popular sources of animal protein in Viet Nam. It is estimated that some 30-35% of protein consumption of Vietnamese people is derived from fish products. Production of fish through aquaculture practices has traditionally played a very important role in providing fish to rural and urban populations. It is estimated that aquaculture production has increased by about 5-7% per year over the past decade. The demand for fish in recent years has grown substantially with increasing incomes. The Government of Viet Nam plans to increase per caput fish consumption from currently 10 -12 kg to 13 -15 kg by the end of the century (Ngoc, 1995).

However, it is important to note that about 80% of Viet Nam's population lives in rural areas. Despite increasing average incomes, most rural people still face problems of poverty and limited opportunities to improve their living conditions.

It is generally recognized that there is great potential for aquaculture development in Viet Nam. Opportunities exist for pond and cage based aquaculture production as well as for rice-fish cultivation, and culture-based fisheries in larger water bodies, including reservoirs and lakes. There is also growing interest for development of coastal aquaculture, particularly shrimp culture development.

According to the Master Plan for Aquaculture Development (published in 1996 by the Ministry of Fisheries), Viet Nam has around 1.4 million ha of inland and coastal waters suitable for aquaculture purposes. It is estimated that this total of available water surface includes low-lying rice fields (39.8%), reservoirs (28.7%), perennial tidal flats (21.1%), lagoons (6.2%), and small lakes (4.2%). Only one third of the available water surface (530.000 ha) is already being used for aquaculture activities. About 61% (325.000 ha) is considered suitable for fish culture while the remaining 38.9 % (205.000 ha) is considered suitable for shrimp production. Of 325.000 ha used for freshwater aquaculture, more than 90% are under pond culture and the rest is used for rice-fish cultivation.

Aquaculture practices in rural areas are being promoted for several reasons. It is expected that fish production through aquaculture and culture-based fisheries will contribute to :

- increased household food security and supply of fish in farming communities; nutritional benefits for individuals in many cases can be substantial,
- significant increase of incomes of farmer households through sale of market size fish or fish seed,
- diversification of existing agricultural practices, particularly in highland zones and remote mountainous areas,

- reduction of migration of rural people to urban centres, by providing additional sources of income and food,
- reduction of environmentally damaging practices of deforestation and poor agricultural practices resulting in soil erosion, by providing alternatives for income generation and food production,
- greatly reduced dependence on application of pesticides in rice paddies through improved rice-fish cultivation methods.

2.2 Diversity of aquaculture practices

Aquaculture practices in northern Viet Nam are very diverse. Freshwater aquaculture is traditionally integrated with crop production, horticulture and livestock husbandry. Chung and co-workers of the Faculty of Agricultural Economics, Hanoi, studied the various types and levels of aquaculture / agriculture integration in different agro-ecological zones of northern Viet Nam, including lowland, midland and highland regions and the northern provinces of northern central part of Viet Nam. For the purposes of their study, fish farms were grouped as to belonging into four categories:

- **VAC farms** are those whose farming system consists of all VAC components, whereby V = *vuong* - gardens (horticulture); A - *Ao* - ponds (aquaculture) and C = *Chuong* - animal sheds/pens (livestock husbandry);
- **Aquaculture/livestock farms** include those *mainly* engaged in aquaculture and livestock husbandry;
- **Aquaculture/horticulture farms** are those *mainly* practicing horticulture and aquaculture; and
- **Rice - fish culture farms** are those *primarily* engaged in rice-fish culture.

However, as pointed out by Chung and co-workers, the levels of aquaculture/agriculture integration are very different from region to region and from farm to farm. Moreover, it should be noted that farm households growing fish, while being grouped into one of the three latter categories, in many cases would still be engaged in a range of other agricultural activities (including livestock husbandry, horticulture, and rice production), however to a lower degree. In addition, other freshwater aquaculture methods practiced also include cage culture, cultivation of aquatic plants as animal feeds (water spinach, water hyacinth and water taro), and, in a limited number of cases, rearing of soft shell turtles, frogs and snakehead.

There is a wide diversity of species grown. However, most farmers (95% of farmers surveyed) are practicing polyculture raising grass carp, silver carp, common carp, bighead carp, rohu, mrigal, mud carp, and sometimes tilapia, in varying compositions. Farmers practicing monoculture are utilizing cages in water bodies of the highland and midland zones.

Based on their socio-economic survey, Chung and co-workers conclude that :

- The most common and efficient model for aquaculture/agriculture integration is VAC farming, followed by rice-fish culture, then aquaculture/livestock husbandry (primarily pig rearing), and finally aquaculture/horticulture integration;
- VAC farming appears to be the best model of aquaculture/agriculture integration, in terms of on-farm input use, productivity and gross margins;

- The VAC, aquaculture/livestock and rice-fish integrated farming systems help the farmers in obtaining higher returns, achieving best use of on-farm inputs, lessening their dependence on purchased inputs and sustaining patterns of farm resource use;
- Aquaculture plays an important role in these integrated farming systems, in providing farm income, using on-farm inputs, creating employment and reducing risks for the farm household;
- These systems play an important role in food supply, job creation and sustainability of rural economy. They also provide opportunities and directions for farmers to diversify the traditional rice-based production patterns into more sustainable farming systems that enable farmers to obtain better quality of life with less environmental damage and health risk.

2.3 Current constraints to sustainable aquaculture practices

Results from the socio-economic survey indicate that aquaculture is practiced as a main farming activity by only 28.4% of farmers surveyed, while crop production and livestock rearing are the main occupation of more than 60% of total respondents. In most farm households, aquaculture is regarded as a minor farming activity to supply food for household members. This can be attributed to lack of knowledge and practice in aquaculture, and also to unavailability of ponds or cages.

The socio-economic survey evaluated farmers' perceptions about general problems in VAC farming and specific problems in aquaculture. The problems identified include:

- constraints due to present land use policy
- lack of capital/credits
- natural hazards
- serious fish diseases
- lack of good quality seeds; reliance on market for seeds
- lack of technical know-how
- poor pond management
- pouching
- unchangeable water

2.3.1 Land use regulations and access to credit

Constraints due to present land use policy and regulations are related to many time-consuming formalities involved in obtaining permission from provincial authorities to utilize land used for rice production for purposes of VAC farming, including aquaculture. Further, ponds are allocated to farmers for too short a period of 4-5 years which seems to discourage farmers from long-term improvements in pond management (maintenance and operation) or pond development (expansion). Access to credits is a problem for many farmers because interest rates are too high and terms of payment too short. Thanh and co-workers (Environment Study) in their assessment of VAC farming systems in Bacninh, Vinphu and Sonla provinces noted that insufficient investment for fish culture purposes does result in low productivity and income.

2.3.2 Flooding

Natural hazards identified include cool weather in winter and, in particular, flooding. Chung and co-workers suggest that appropriate pond construction, and increasing the height of pond dikes can help minimizing losses due to flooding. However, rehabilitation of ponds and re-construction of pond dikes following floods may result in additional maintenance costs of about 20%, as noted by Thanh and co-workers (Environment Study). In some cases, flooding patterns may have to be considered in aquaculture site selection or pond development. This should apply in particular to developments in new areas or to expansions of existing pond culture areas.

2.3.3 Fish disease

The main fish disease problem reported for all regions studied is red spot disease in grass carp causing large mortalities in both ponds and cages. It is said that this disease spreads in waters of irrigation canals or rivers affecting many aquaculture units over wider areas. RIA No.1, through the Project KN-04-12, has developed a herbal medicine which seems to be quite effective in preventing the occurrence of this disease problem, as recorded by Thanh and co-workers (Environment Study).

2.3.4 Lack of good quality seeds

Lack of fingerlings is a major problem for farmers, particularly in highland and midland zones. Fingerlings are supplied from different sources (market/middlemen, hatcheries, home production and neighbours). Only about 37% of the farmers surveyed obtain their seed from hatcheries. About 44% of the farmers stated that they lack seed of good quality. There is a heavy reliance on seed marketed by middlemen at high price, which are said to be of low quality resulting in high mortality rates. Farmers lack experience in recognizing seed in terms of species and good quality. Small fish remaining from last harvest are sometimes re-stocked into ponds for the next grow-out period.

2.3.5 Lack of technical know-how and poor pond management

The Socio-economic Study indicates that only about one third of the farmers were skilled to efficiently manage their VAC system. Overall, about 65% of the fish farmers lacked technical experience in aquaculture. In many cases ponds are not being utilized to grow fish, but for cultivation of aquatic plants being fed primarily to pigs.

Ponds are often stocked at an inappropriate composition/ratio of fish species, with too high stocking densities of common carp, grass carp and silver carp, and too low densities of rohu and tilapia. The inadequate ratio of species stocked causes that food organisms and nutrients available in the pond are not fully utilized. However, stocking densities applied are generally higher than recommended. Further, fingerlings being stocked are generally too small. Overstocking and small stocking size often lead to small marketable size and low farm gate prices. Problems of seed supply often result in sub-optimal stocking times i.e. too early or too late in the year, and not when water temperatures are most suitable for stocking of fingerlings.

About 81% of all farmers utilize on-farm feeds (rice bran, grass, garden leaves, manure, domestic washing, kitchen wastes, night soil) to fertilize their ponds. However, only 20% of farmers applied these inputs in an appropriate way. The low productivities recorded across all farming systems and regions may well be due to inefficient feeding techniques and sub-optimal stocking structure and densities.

Thanh and co-workers (Environment Study) recorded water quality data in ponds and cages. The preliminary results may indicate that sometimes there may be some water

quality problems, although the data collected may need further validation. However, some farmers stated that one of their problems is "unchangeable water" (see above). This may indicate that water quality problems occur, or that farmers wish to intensify their production, which would require more frequent or even regular water exchange. It is noted that ponds are often drained only once a year (50% of farmers drain their ponds after final harvest in December - February), or even only every two years. Practices of frequent or regular water exchange are found only in a relatively small number of cases, e.g. in the Sonla Demonstration Farm or the farm at Hum village, both located in the highland zone, where water exchange through gravity is possible. Effluent quality data collected (Environment Study), even though preliminary, would indicate increased phosphorus concentrations, which however are not likely to have significant effects. Likewise, no significant adverse effect would be expected for cage culture practices studied, as indicated by preliminary water quality data recorded outside the cages located in Red River and Hoabinh reservoir sites.

2.3.6 Metal concentrations in meat of fish grown in sewage-fed Duongsat Lake

In their study of sewage-fed aquaculture practices in Thanhtri district, Thanh and co-workers (Environment Study) recorded elevated concentrations of copper, cadmium, lead and nickel in rohu, silver carp and tilapia grown in Duongsat Lake. The concentrations of these metals found in fish meat are **above** the levels considered to be safe by the Ministry of Health and WHO / FAO. These recent data contradict the findings of the First Mission of the reporting officer in June 1995 (see 1995 Mission Report Section 4.3 , page 10, and paragraphs 111-113, page 40). Dr Dalsgaard, in his draft report on "Public Health Aspects of the Reuse of Wastewater in Aquaculture in Vietnam", states that " it is likely that the accumulation of toxics in fish and aquatic macrophytes raised in sewage-fed ponds in some areas of Thanhtri district may pose an actual health problem when such produce is consumed" (Section 7.2, page 56; Dalsgaard, draft report of November 1995).

Even though it is said (Luu, pers. communication) that most ponds in Thanhtri district are being fed with sewage from domestic sources, and not from industrial sources, it appears that the issue of accumulation of toxic substances in fish products must be addressed. In fact, the Master Plan for a Water Drainage System in Hanoi, approved in 1995, contains plans to channel sewage waters of the To Lich River directly to the Nhue River and Red River, which may help reducing exposure of fish culture areas to toxic substances (see also Section 4.9, page 29 in Dalsgaard, 1995).

2.3.7 Expansion of pond culture into riverine habitats

Thanh and co-workers have studied the effects of pond developments along River Bui, Bacninh province. Expansion of ponds into the river course in some sections of the river has resulted in narrowing its width to 10 meters, while other sections are usually 30-60 meters wide. As a consequence, ponds and other areas belonging to Bui and Laidong communes are frequently being flooded. Rehabilitation of flood-prone ponds is incurring additional costs to fish farmers. In addition, the decline of natural fish resources in River Bui is being attributed to overfishing and expansion of pond areas. Pond expansion into Hong Ngoc River, Haiphong province, has also been noted during the First Mission of the reporting officer (see 1995 Mission Report, page 8, and page 38, paragraph 98). Due consideration should be given to potential consequences and long-term sustainability of such pond developments.

3. Assessment of environmental impact of Project and extension activities

Based on the socio-economic and environmental assessments carried out within the framework of Project VIE/93/001, it can be concluded that the majority of current aquaculture practices in northern Viet Nam is not likely to cause significant adverse impacts on the aquatic environment. In fact, most fish culture practices are based on utilization and re-use of on-farm feed/nutrient resources, often requiring very little renewal of water, with species being grown which feed low on the aquatic food chain and which are net protein producers. In addition, many farming practices found in northern Viet Nam show a relatively high level of aquaculture/agriculture integration. In fact, integrated aquaculture/agriculture farming systems are frequently being promoted in other regions because they are known to guarantee a very high level of environmental compatibility.

The Project, through its extension activities, is assisting many fish farmers in improving their integrated farming methods, and is therefore contributing to the adoption and expansion of environmentally sustainable aquaculture practices.

4. Recommendations for follow-up

Based on the findings and recommendations of the Study Teams, and the findings of the two missions by the reporting officer, a set of consolidated recommendations is given below.

4.1 Farmers' needs for technical advice

Chung and co-workers (Socio-economic Study) asked farmers about their most important needs in terms of technical advice and technology. Most farmers across all regions prioritized their most important needs as follows:

- disease control
- VAC management
- fish seed selection
- pond management
- fingerling nursing

Given that many farmers still lack experience and lack of technical know-how, it is suggested that current (and future) extension efforts continue their focus of activities on provision of technical advice on above needs. More specifically, continued technical advice would be appropriate on following aspects:

- stocking methods (including seed quality, stocking size of fish, stocking ratios, stocking density)
- feeding techniques, i.e. on adequate preparation and use of on-farm inputs including in particular manure and nightsoil (eg. Thanh and co-workers recommend that livestock manure be treated before being applied to ponds; see also below)
- fish health management (e.g. reducing stress, avoiding overstocking, safe and effective use of chemicals)
- water quality management (e.g. use of inorganic fertilizers, avoiding over-feeding, pond preparation)
- site selection (e.g. avoidance of natural hazards, risks of disease transmission and threats of external pollution)
- basic record keeping (monitoring of inputs, outputs, and management measures; accounting for benefits and costs)

4.2 Seed supply

There is a continued need for additional hatcheries in lowland, midland and highland areas, as well as for a more decentralized seed supply system that reaches the small scale farmers (Chung and co-workers).

4.3 Extension, education and research

Both Study Teams identified the need for continued provision of advice to farmers and additional support to ongoing extension services.

Thanh and co-workers give following recommendations:

- further technical training programmes are needed for extensionists working at both district and provincial level, and

- it is essential to promote aquaculture extension activities at the district level.

Chung and co-workers stress that existing extension systems should be further strengthened, and that extension programmes should give further emphasis to increased participation of farmers in technology design and transfer.

Chung and co-workers also note that women play an important role in VAC farming. While men are involved in making decisions of fish species to be raised, timing of stocking, buying fingerlings, netting and harvesting, women are often involved in daily feeding and pond management, including gathering of grass, garden leaves, collecting of manure for the pond, and feeding rice bran to fish. Extension activities should consider these important gender aspects, and provide advice to women and men by targeting their specific roles in aquaculture practice.

Thanh and co-workers suggest that there is a need to provide a short training course to fish farmers on aquacultural techniques and their effects (i) on the quality of water and soil within the pond, and (ii) on the environment. This would enhance the farmers' awareness of important aspects and requirements to safeguard environmental health and safety within and outside their farm household.

The activities of the Project are proving to be very successful, and continued support to further increase the capacity of the existing aquaculture extension networks and their activities is recommended. It appears that there will be a continued need to train extensionists in specific technical fields, particularly in those fields being prioritized by the farmers (see 4.1).

RIA No. 1, as the Transfer of Technology Centre (TOTC) of the existing aquaculture extension network, will certainly have to respond to an increasing demand for technical backstopping by Sub-Centres and extensionists in northern Viet Nam. RIA No. 1 is making every effort possible to continue upgrading its technical competence in a range of technical fields (MoF/RIA No.1, 1995). However, it should be recognized that additional financial and technical assistance to RIA No. 1 will be essential in order to ensure that extensionists and farmers will be benefitting from technical advice which is up-to-date and which meets their immediate needs.

4.4 Rice-fish culture

Chung and co-workers highlight the fact rice-fish intercropping helps to significantly reduce the use of pesticides. Collaboration with experts on Integrated Pest Management should be continued with a view to strengthening extension activities on rice-fish culture.

4.5 Development of new fish ponds

Based on their assessment of the expansion of ponds into the course of River Bui, Thanh and co-workers recommend that the department of agriculture and rural development of Bacninh province initiates, in collaboration with other relevant institutions, an overall planning programme for sustainable aquaculture development in these areas.

Given that a strong interest for new pond developments also exists in other areas, it may be convenient to consider approaches for assessment, planning and allocation of resource uses which cover wider agro-ecological zones such as the Red River Delta.

It should be noted that Thu and Demaine (1996) have applied GIS analysis to define areas in the Red River Delta with potential for (i) rice-fish rotation, (ii) intensification of small pond culture, and (iii) pond culture with access to additional, urban-derived inputs.

4.6 Use of wastewaters in aquaculture

It is suggested that the findings on potentially harmful metal concentrations in fish meat from Duongsat Lake be brought to the attention of the Ministry of Health.

Based on their study of sewage-fed aquaculture systems in Thanhtri district, Thanh and co-workers recommend that further research and improvement of the systems be focused on following aspects:

- i Evaluation of the importance and effectiveness of a wastewater-fed fish pond system in terms of its wastewater treatment capacities as compared to conventional sewage treatment practices,
- ii Improvement of the technology of wastewater reuse in aquaculture systems in terms of (a) fish species (especially tilapia) and its composition, (b) design and management of wastewater-fed fishpond systems and (c) management requirements in fish ponds utilized for different production systems,
- iii Improvement of the wastewater supply system for aquaculture production,
- iv Assessment of the potential risks to public health of wastewater reuse in aquaculture (including both aquaculture producers and consumers of aquaculture products).

Edwards (1996a) has recently proposed a project to determine the social, environmental, technical and economic aspects of low-cost sewage treatment integrated with food production. It should be noted that Dr A. Dalsgaard will be visiting Viet Nam in August of this year, on the occasion of a DANIDA funded project formulation mission, with a view to identifying key activities for a major project on the assessment and verification of human health risks associated with sewage-fed aquaculture systems as well as on the improvement of these systems for increased quality and production of fish grown in these systems. Following additional technical documentation may be useful for those concerned with human health aspects of wastewater-fed aquaculture in Viet Nam: Edwards (1996b), Dalsgaard (1995), Mara et al. (1993), Edwards and Pullin (1990). It should be noted that human health aspects of wastewater-fed aquaculture will be addressed during the forthcoming WHO/FAO/NACA Workshop on Food Safety Issues associated with Aquaculture Products. The Workshop will also discuss the Proposed Draft Code of Hygienic Practice for the Products of Aquaculture - Codex Alimentarius Commission (FAO/WHO, 1996).

4.7 Environmental assessment and management

4.7.1 Awareness

Vietnamese experts are well aware of important environmental issues in aquaculture development. This was clearly demonstrated during the 1994 Workshop on Aquaculture and the Environment (MoF/NACA, 1995). The report and proceedings of this workshop, which include numerous technical presentations as well as conclusions and recommendations, have been published in both Vietnamese and English. It is suggested that the findings of this workshop be made available to experts and officials in research institutions and provincial and district authorities concerned with aquaculture development, resource planning and management, and environmental protection.

It was noted that staff of RIA No.1 was not aware of the existence of the FAO Code of Conduct for Responsible Fisheries (FAO, 1995) and related Technical Guidelines (see References). It is suggested that this documentation be distributed to interested institutions.

4.7.2 Training in environmental assessment

It was noted that there is a need to provide additional training on environmental assessment methodology. Emphasis may be given in particular to training on planning and conduct of sampling and monitoring techniques, presentation of data, analysis and interpretation of results. Such training should provide for a broader understanding of purposes and requirements of environmental assessments in the wider context of resource assessment, planning and management for aquaculture development. Consideration of environmental and resource use issues, both at local level and at the level of agro-ecological zones, should be included in curricula of such training programmes.

4.7.3 Institutional collaboration

There continues to be a need to facilitate and strengthen communication and collaboration among experts and officials in different research and government institutions dealing with aquaculture, inland fisheries, water resource management, agricultural and rural development, public health and environmental protection.

In view of increasing industrialization and urbanization, problems of environmental degradation of aquatic ecosystems and resources may soon become significant issues for aquaculture and inland fisheries experts. Collaboration with environmental experts and institutions should be continued and strengthened to ensure that appropriate advice on threats of aquatic pollution be provided to fish farmers and fishermen.

4.7.4 Intensification

It can be expected that certain types of aquaculture practice (e.g. cage culture) will be moving towards utilization of more intensive culture methods. Likewise, aquaculture of carnivorous species is likely to attract growing interest. Fish farmers employing such methods or species will need to be advised on the limits of intensification within their culture units. They will also need advice on measures to prevent that effluents from their farms exceed the environmental carrying capacity of receiving waters.

4.7.5 Coastal aquaculture

There is growing interest for shrimp culture development in northern Viet Nam. However, in other provinces there is significant evidence for cases of shrimp culture expansion which has led to low productivities and environmental damage resulting from uncoordinated development and lack of experience and technical skills.

It is felt that technical advice and research is and will be needed on sustainable coastal aquaculture practices in northern Viet Nam. Given the suboptimal conditions for shrimp culture development in northern Viet Nam, it is suggested that consideration is also given to the promotion of aquaculture of other species. RIA No.1 has conducted preliminary studies on the use of brackishwater areas for production of three consecutive crops of various species (e.g.: shrimp/tilapia/crab-mullet and other local species) which are selected according to their salinity and temperature preferences in view of the seasonal water quality fluctuations in coastal environments of northern Viet Nam.

It is suggested that financial and technical support be given to RIA No.1 to implement a pilot project on environmental assessment and management of small-scale coastal aquaculture-practices suitable for resource-poor farmers in northern Viet Nam.

It should be noted that the Asian Development Bank recently funded a Coastal Aquaculture Development Study (CADS) for the preparation of both a Coastal Aquaculture Sector Review and a Coastal Aquaculture Action Plan (ADB/MoF, 1996).

The recommendations and guidelines proposed by the CADS project team may be helpful in identifying opportunities and requirements for planning and coordination of coastal aquaculture developments, and it is suggested that the documentation developed by the CADS project be considered by relevant research and government institutions of the coastal provinces of northern Viet Nam. Unfortunately, to date there has been no concrete international support to follow-up on the CADS initiatives, and, so far, no project activities have resulted to provide financial and technical assistance for the implementation of the proposed actions.

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ANNEX 1

Annex 1. Itinerary and persons met

Itinerary:

- 3 July: Arrival in Bangkok
- 4 July: Briefing meetings at FAO's Regional Office with Messrs P. Choudhury, M. Doeff and D. Kumar
- 5 July: Travel Bangkok - Hanoi
- 20 July: Departure from Hanoi

Persons met in Viet Nam:

- Dr Ta Quang Ngoc, Minister of Fisheries, Ministry of Fisheries, Hanoi
- Dr Vu Van Trieu, Deputy Director-General, International Cooperation Department, Ministry of Fisheries, Hanoi
- Dr Tran Mai Thien, Director of Research Institute for Aquaculture No.1 (RIA No 1)
- Dr Pham Manh Tuong, Scientist, RIA No.1, and National Project Director of VIE/93/001
- Dr Le Than Luu, Vice-Director of RIA No.1, Deputy National Project Director of VIE/93/001
- Mr Nguyen Cong Dan, Head of Fish Breeding Department of RIA No. 1, assistant to Deputy NPD of VIE/93/001
- Mr Tran Van Vy, Head of Scientific and Technical Information Department of RIA No. 1
- Mr Dinh Van Thanh, Socio-economist, Socio-economics Department of RIA No. 1
- Ms Tran Anh Thu, Secretary to Vice-Director of RIA No. 1
- Mr Marcel J.G. Messier, FAO Representative in Vietnam, Hanoi
- Mr Pham Gia Truc, National Programme Officer, FAO, Hanoi
- Mr Stefano Bonezzi, Administration Officer, FAO, Hanoi
- Ms Vu Ngoc Diep, Librarian, FAO, Hanoi
- Mr Bruno J. Pouezat, Assistant Resident Representative, UNDP, Hanoi
- Mr Nguyen Thanh Tung, National Programme Officer, UNDP, Hanoi
- Mr Gordon Johnson, Senior Advisor Environment and Natural Resources, UNDP, Hanoi