1. Introduction

The role played by aquaculture in meeting needs for freshwater fish in Vietnam, and elsewhere in Asia, has increased in importance over the last decade. During the late 1980's, a time of rural liberalisation in the Red River Delta (RRD), production, trading and stocking of fish seed increased tremendously in this area. It stimulated the development of privately owned hatcheries and many hatcheries owned by the state were progressively divested and moved towards private sector management, resulting in a noticeable increase in hatchling production (Little and Pham, 1996). The RRD comprises 9 provinces: Hung Yen, Ha Tay, Nam Dinh, Thai Binh, Ha Nam, Ninh Binh, Bac Ninh, Vinh Phuc and Hai Duong. In terms of describing the status and potential for aquaculture the RRD has been defined in agroecological terms as intensive rice growing areas (based on high rice yields); lowland, lower areas of the Delta prone to prolonged flood, suburban and coastal (Demaine and Chung, )

In the RRD, aquaculture has become of significant importance over the last two decades Most rural households grow wet rice and a range of field crops in the RRD but it is now as common for farmers to integrate livestock and horticulture around fishponds, such systems being known as VAC (Vuong= ; AO= , Chung ). One study (AIT/RIA 1; 1998) estimated that 30% of all rural households cultured food fish in the RRD and that between 10 and 33% of the households raising fish, depending on location and resource base, now considered food fish production to be their main occupation. Vietnamese Government policies aim to improve livelihoods of the poor and focus on the densely populated areas of the country such as the RRD and food fish farming is believed to be a potential component
of this strategy, both through increasing fish available for household subsistence and as a potential source of income.

Since aquaculture development has been closely linked to increasing availability of fish seed to farmers increasing awareness of deteriorating seed quality has become a major cause of concern. A recent stakeholder analysis (AIT/RIA 1, 2000) highlighted this as a major issue among those involved in aquaculture in the region. An improved understanding of fish seed production and distribution in the RRD is critical in understanding the nature of the problem and for directing research and policy.

Previous studies,( Little and Pham, 1996, AIT/RIA 1, 2000) have described the current network of producers and traders of fish seed in the RRD. Both identified one commune, Mao Dien, located in Thuanh Thanh District, Bac Ninh Province, as being a traditional centre of fish seed production and marketing for the whole of Northern Vietnam and beyond. A better understanding of the historical development and status of this community could inform both promotion of aquaculture and the current issue of poor fish seed quality. This study was a component of the DFID-funded Fish Seed Quality Project (R ).

The principal objectives of the study were to

produce an overview of the seed production techniques within Mao Dien commune, including an understanding of the involvement of the family members in the different activities at the household level.

increase our understanding of the seed production network and the relationships that link its different actors.

analyse the strategies used for marketing fish seed.

assess the relative wealth of the commune and the importance, at the household level, of fish seed production to total income.

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1 This project is funded by a grant from the Aquaculture Research Programme to the Asian Institute of Technology, Pathum Thani, Thailand and this sub-component is based on field work undertaken in March-
2. Methodology

An initial approach was made to the commune through the commune committee, and a member of the committee introduced the researchers to commune residents throughout the course of the study.

A total of 82 households were interviewed and were classified depending on their role in the fish seed network as:

- fish seed nursery operators (57 households).
- households nursing fish seed and trading their stock outside the village (9).
- households trading hatchling, fry or fingerlings (8).
- food fish producers (5)
- individuals supplying fertilisers (nightsoil) (3)
- hatchery operators (3).

In order to survey all the different actors of this network several methods were applied. Three different draft questionnaires soliciting information on household activities and resources were prepared and tested with nurseries, traders, and the hatcheries located in the village (Appendix 1). Each interview, which took place in the home of a household member, took around 40 minutes. Households involved with other related activities were
surveyed as well such as night soil dealers and food fish farmers. At each interview a seasonal calendar was used to understand activity cycles through the year.

Additional interviews were also carried out informally with seed traders met along the road outside the commune. These encounters were typically brief and focussed on establishing place of residence, destination and other information about their transporting techniques.

A community timeline (Townsley, 1997) was used with key informants (15 individuals) the person interviewed that were judged to have some knowledge or education to collect information on historical trends.

Households engaged in seed nursing, the most common aquaculture activity, were sampled randomly for interviews in transect walks through the community.

Households that were not nursing fish seed and were having other types of activities such as seed trading, night soil dealing or food fish rearing, were identified after consultation with the commune committee and selected for interview based on their availability.

The commune committee gave general information about the commune and its history. The committee in Mao Dien and nearby communes contributed to assessing the importance of the different activities using matrix ranking (Townsley, 1997). Three different persons in each commune were asked to independently score the activities according to their importance for the commune as a whole using paper and tokens.

Household wealth was obtained as secondary data from the communes. Household wealth is assessed annually as one of five categories based on an assessment of total household income made by the commune committee. This information is collected on the same basis in each commune and allowed a comparison of the wealth between communes. The information collected from households and commune committees was triangulated wherever possible (Gosling et al., 1996) by comparing information obtained from at least three sources to make sure it was reliable.

### 3. Results and Discussion
3.1 Background history of fish seed nursing in Mao Dien

Fish nursing is a traditional activity in Mao Dien. The foundation of the villages that now constitute Mao Dien commune is estimated at the beginning of the 11th century. Later families started to move from areas near Ha Noi to form the village of Thuy Mao. Unlike Thuy Mao, the first parts of the village were founded away from the sides of the river Duong had to dig the ground in the way to build their houses. I DON’T UNDERSTAND THIS

The origins of nursing fish seed and the techniques used are disputed. The commune committee claim that the first experiences of nursing in the commune date from 900 years ago and originated through contact with Nam Ha Province, located 70 Km south of Hanoi city (Mao Dien committee, 1994). Others report that the techniques for catching hatchlings from the river, nursing and fish trading started to appear in the mid-19th century by way of traders from Mao Dien bringing back techniques learnt in Cau Duong, Gia Lam district close to Ha Noi. There is little to explain as to why Mao Dien should have initially developed as a centre of for fish seed production in the region. Its proximity to an area of the Red River in which wild spawn could be easily accessed is one explanation, but this would not explain why other similar communities did not develop the techniques independently. Initially, when wild fish supplies from the river and floodplain dominated supply, demand for fish seed for stocking would likely be erratic and linked to more general trade. Under such circumstances, the communes central location within the RRD and good connections would have been an advantage. Livelihood diversification has been a common strategy in the RRD for centuries, where historically high population densities made reliance on agriculture alone a risky strategy. Adger (1999) argues that, in Vietnam rural livelihoods associated with rice production and lowland agriculture have been
periodically subjected to stress and shocks, such as floods, throughout history and that these have stimulated diversification. Nursing fish seed could have been considered as a good alternative for minimising the impact of the stress occurring on agricultural production. Specialisation in a non-agricultural trade is a well known part of this diversification strategy in villages within the RRD. Di Gregorio (1994) describes how production and trade in certain handicrafts or types of waste recycling is dominated by certain communities. Quoting Gourou’s study characterising peasant industries in rural northern Vietnam, Di Gregorio concludes that the principal characteristics of peasant industries are still evident today (Table ...). Thus, the concentration of fish seed nursing in Mao Dien and its role as a centre for itinerant trading of seed reflects a wider pattern of livelihood diversification found through the RRD. It demonstrates both Gourou’s ‘internal’ nature of peasant industries that produce ‘goods’ for sale outside, and the ‘external’ where traders are working mainly outside their village, returning more or less frequently. An important aspect of the success of this strategy is retaining specialist knowledge within the community (DiGregorio, 1994). Fish seed production is also characterised by specialisation, with some households carrying out some tasks but not others. According to Lê (1997), villages in the RRD were originally settled by closely related families and that modern day communities remain based on such clans.

The other question is how did the knowledge spread within Mao Dien. The way villages were founded and the close relations that were, and still are, linking the people could be a way to explain this phenomenon. Gourou (1955) suggested that chance explained the initial beginning of many peasant industries and the exclusivism of village life ensuring the rapid spread through the village but retaining the secrets within the village.). Thus, one focus of
interest in the current study was to investigate if there was evidence for knowledge about fish seed production and distribution to spread from Mao Dien to surrounding communes. A key resource that supported the development of amo Dien as a centre for nursing fish seed was the ready availability of hatchlings. Until lately the people in Mao Dien were using wild fish seed from the Red River nearby. With the increase of the population density and the demand of seed fish, the catch from the river slowly became insufficient to meet the requirements and hatcheries have become the main source of hatchlings. Figure 1 illustrates when nursing was adopted by households and their source of hatchling over the years.

At the end of the 1960's the first hatchery was established in Bac Ninh province (Ngu hatchery) providing an alternative to riverine hatchlings and hatcheries progressively developed in the area in the 1970's-1980's. In 1986 reforms called Doi Moi were introduced in Vietnam favouring agricultural growth, and an increase of the nursing activity in Mao Dien occurred at this time. At the same time, government hatcheries were being divested to the private sector (Little & Tuan, 1995). Another positive government action for fish seed production was the passing in 1993 of the Land Law that allowed long-term, tradeable lease of land from the state (Adger, 1999).

### 3.3 Present status of Mao Dien Commune

At the present time population in Mao Dien has an estimated population of about 12600 people within 2748 households. The commune is divided into 13 villages and covers 608 ha of which more than half is ricefields (319 ha). There are approximately 1600 ponds covering an area of 52 ha. According to the commune committee 95% of the households nurse fish seed.

Table 2. List of the different villages and their population
<table>
<thead>
<tr>
<th>Village</th>
<th>Households</th>
<th>People</th>
<th>Households surveyed</th>
<th>Households surveyed (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thuy Mao</td>
<td>366</td>
<td>1757</td>
<td>5</td>
<td>1.36</td>
</tr>
<tr>
<td>Xom Noi</td>
<td>280</td>
<td>1277</td>
<td>10</td>
<td>3.57</td>
</tr>
<tr>
<td>Xom Tao</td>
<td>190</td>
<td>937</td>
<td>5</td>
<td>2.63</td>
</tr>
<tr>
<td>Xom Cong</td>
<td>187</td>
<td>961</td>
<td>2</td>
<td>1.06</td>
</tr>
<tr>
<td>Xom Bang</td>
<td>379</td>
<td>1864</td>
<td>7</td>
<td>4.48</td>
</tr>
<tr>
<td>Xom Dinh</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xom man</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xom Ngoi</td>
<td>417</td>
<td>2111</td>
<td>2</td>
<td>1.91</td>
</tr>
<tr>
<td>Xom Ho</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xom Tung</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xom Ba</td>
<td>366</td>
<td>1743</td>
<td>19</td>
<td>5.2</td>
</tr>
<tr>
<td>Xom Luy</td>
<td>382</td>
<td>1942</td>
<td>5</td>
<td>3.4</td>
</tr>
<tr>
<td>Xom Hau</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Every year, households are taxed according to the actual household area based on. To calculate the taxes a household has to pay a difference is made between the built area and its surroundings. Taxes asked for the built area are four times higher THAN WHAT? IS RICEFIELDS AND PONDS THE SAME?. It is asked, per m² and per year, about 6 times more for the built area when compared with the area surrounding it. The interesting point is the increase two years ago of this specific rate, showing the commune policy to minimise the use of land for construction. With an increasing population and a limited commune area, use of land of use is becoming a critical issue in Mao Dien and could have an influence on livelihood activities in the future.

Since the 1980's the commune has been protected from floods by a dike, improving the stability of peoples’ livelihoods.

### 3.4 Summary of hatchery Activity

Three hatcheries are established in Mao Dien, 1 state hatchery and 2 private-owned hatcheries. One of the private hatcheries actually belongs to Hoai Thuong Commune but uses ponds belonging to Mao Dien. The main species produce are grass carp.
(Ctenopharyngodon idella), grown in monoculture, silver carp (Hypophthalmichthys molitrix), rohu (Labeo rohita) and mrigal (Cirrhinus mrigala) grown in polyculture. Common carp (Cyprinus carpio), tilapia and back carp are produced in smaller amounts.

Most of the production of these hatcheries is purchased for nursing in Mao Dien but some of the nursers identified problems with the quality of hatchlings produced by hatcheries in Mao Dien. Poor management of broodfish and possible inbreeding were identified as well as the use of LHRH in both private and state hatcheries to induce spawning in the early season. This is believed to be a major cause of poor seed quality.

3.5 Nursing activity

a. Source of hatchlings

At present, as we can see in the figure 9, the main sources of hatchling for nursery operators are the hatcheries based in Mao Dien and traders from Mao Dien. Traders typically obtain hatchlings from hatcheries in Hay Duong (Bac Ninh, Hung Yen, Bac Giang and Vin Phuc provinces). Traders are themselves nursers in Mao Dien and sell hatchlings to their neighbours as a supplementary source of income. Only a small percentage of nursers travel and purchase their own hatchlings.

Figure 9. Preferred source of hatchlings by nursing operators in Mao Dien (n = 66)
b. Nursing practices

The species mainly nursed can be listed as following: common carp (*Cyprinus carpio*),
grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophtalmichthys molitrix*), and
the Indian carps, rohu (*Labeo rohita*) and mrigal (*Cirrhinus mrigala*). Although 2
species of silver carps are present in the Red River Delta, the native species (*H.
harmandii*) and a species introduced from China, people there call both of them under
the name of "Ca che" making difficult the specific identification of the species
cultured. Species like bighead carp (*Aristichthys nobilis*) and hybrid common carp
(hybrid between local, Hungarian and Indonesian strains) can be encountered as well.
Many factors will affect the nurser's choice of species, such as their personal estimation
of the market demand, variation in the availability of a certain species, or a specific
order from a trader. Nursing is of two types - short term nursing and overwintering.
Short-term nursing occurs early in the year, usually from February to July-
August during which time fish seed are raised for around 30 days and reach a size of
around 2 or 3 cm. The actual stocking density and duration of culture is affected by
local demand and market conditions

Over a typical 7 month season most nurser will produce 4 or 5 crops. Little and Tuan
(1994) found in their study that 4 to 8 crops of seed could be nursed through a season
depending on the stocked and final size of seed produced.

In the second part of a nursing year the fish will be kept over winter and sold at the end of
January, beginning of February, with a size between 5 and 8 cm. Even if these
overwintered fish are likely to be of poor quality, having spent a long time in poor quality
water, they will be sold at high price, as they are available early in the season for food fish
producers.
In the figure 10 are presented the different species nursed in Mao Dien all along the year.

Figure 10. Different species nursed over the year in Mao Dien.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>common carp</td>
<td>common carp</td>
<td>grass carp</td>
<td>silver carp</td>
<td>silver carp</td>
<td>grass carp</td>
<td></td>
</tr>
<tr>
<td></td>
<td>grass carp</td>
<td>silver carp</td>
<td>rohu</td>
<td>rohu</td>
<td>silver carp</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>mrigal</td>
<td>mrigal</td>
<td>mrigal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>hybrid cc.</td>
<td></td>
<td>bighead carp</td>
<td></td>
</tr>
</tbody>
</table>

Usually one species is cultured at a time in a water body, however, polyculture can be practiced with certain species. According to Li and Mathias (1994) competition for food between common carp and grass carp have been observed and nursing of these two species together is not suitable. Silver carp is more active in movement and aggressive in feeding than bighead carp and in polyculture food is insufficient for bighead carp. It is a common practice in Mao Dien to nurse both Indian carps together or grass carp and the Indian carps whilst silver carp and Indian carp are considered incompatible. Rohu and mrigal tend to spawned later in the season and represent the majority of the fish used for overwintering.

Theoretically before each cycle the ponds are prepared (Figure 11), a majority of the people drains their pond, leave it to dry for 2 or 3 days and lime (0.4 - 1.4 Kg per 100 m²). A minority will add fertiliser at this stage, but additional piscicides to eliminate any remaining fish are not used.
However it was often mentioned that sometimes the pond preparation procedure was not followed between cycles, because of the need to stock hatchlings that were available or just due to a lack in pond management. Hatchlings are stocked at variable densities averaging over 300 m$^2$ ($331 \pm 150$ m$^2$).

The people using small ponds tend to intensify even more their production by higher densities. The average survival rate was estimated at 53%, however, a difference must exist between short term nursing and overwintering.

During the first week of nursing the fish will be fed with rice flour, soybean flour or tofu at a rate of 0.73 Kg/100m$^2$/ day. After this first week the source of feeding will be natural feeds stimulated through fertilisation and rice bran. The origin of the feed can be the household itself or the local market (figure 12).
Figure 12. Sources of fish feed
(% of households)

- 64.5% Household
- 21.0% Household + Market
- 14.5% Market