

LAO/97/007
Provincial Aquaculture Development Project

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1 Introduction

This report is intended as a resource document for readers who wish to know more about the status of rural aquaculture development and to a lesser extent aquatic resource management issues in Lao PDR.

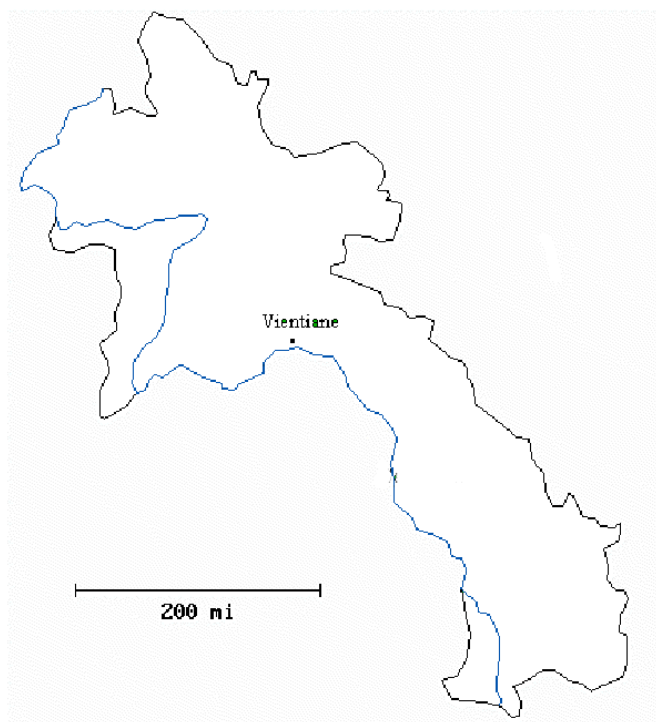
This report is a final output by the Aquaculture Development Advisor to the “Provincial Aquaculture Development Project, LAO/97/007”. Whilst there are frequent references to the work of this project, this document does not aim to provide a comprehensive review of the project activities and impacts. More complete information on various project related activities can be found in the extensive LAO/97/007 field documentation listed in Annex I.

These documents are recorded on CD-Rom media and copies of file should be available through FAO Regional Office Bangkok, FAO Library Rome or FAO Representation in Vientiane. Additional copies are also lodged with the Lao Living Aquatic Resources Research Centre and Livestock and Fisheries Development Division.

2 Background to the fisheries sub-sector in Lao PDR

2.1 A general description of Lao PDR

Lao PDR spans about 1000 kilometres at its longest length in a northwest to southeast direction. The upper half of the country is broader than the south with a maximum width of about 470 kilometres and a total land area of 236,800 square kilometres, of which only 6% is used for agriculture and pasture¹, whereas 54% is forest or woodlands. About 4/5 of the of the land is sloping and mountainous land. The climate is monsoonal with average rainfall in the range of 1000-1500 mm annum, drought and flooding are common.



More than 85 per cent of the land area of Lao PDR is in the Mekong River Basin, with two discrete areas which lie outside the Basin, part of Phongxali province and Hooa Phan province in northern Laos.

About 35% of all water in the Mekong River originates from watersheds within Lao PDR. These watersheds form 26% of the total watershed area of the Mekong Basin. In the context of the Lower Mekong Basin, the Lao PDR watersheds provide about 60% of all the water.

The population of Lao PDR is estimated to be around 5.1 million people (1998) of which 83% lives in rural areas². Population density is, around 20 persons per square kilometre, but considering the limited area of arable land³ the pressure on the land is similar to more densely populated Thailand. It is estimated that the area under cultivation and pasture could be doubled or quadrupled although about half is expected to have some soil fertility constraints. It should also be noted that at a fertiliser consumption of 4.2 kg per ha of arable land, Lao PDR has the lowest fertiliser applications in the region⁴ (MAF 1999).

¹ This figure varies depending on if this includes shifting cultivation in the estimate of agricultural land.

² Vientiane Municipality alone accounts for most of urban population and in the other provinces over 90% live in rural areas.

³ Around 56% is too steep for agriculture (>15% slope) and for other reasons an additional 12% is unsuitable for agriculture making only 32% of land potentially suitable for agriculture, some 3.6-7.6 million ha. Other estimates (e.g. by ADB) are more conservative and consider 2.0-2.3 million ha potentially suitable.

⁴ Statistics for Cambodia were not available.

Lao PDR have a young population where just under 45% of the population is under 15 years old. In 1995 Lao PDR ranked 138 (out of 174) on the UNDP Human Development Index (similar to Myanmar and above Cambodia). In rural areas the poverty incidence⁵ is 53%, over twice that in urban areas. Laos has one of the lowest levels of infrastructure development compared to the other countries in the region. Only 15% of its road systems is paved and its piped water diffusion rate is 43% (Table 1). A total of 41% of all rural villages had a development project running in 1997/98.

Life expectancy in Laos is only 51 years and infant mortality (under one year of age) is 91 per 1000. The ratio of number of people per doctor is 4,450. Educational infrastructure is underdeveloped and in 1993-94 the elementary school attendance rate was 70% with a national literacy rate of only 55%.

In terms of food security Lao PDR is, on a national level, almost self sufficient in rice. However approximately half of all rice farming households need to buy additional rice, i.e. are not self sufficient. Rice consumption surveys show an intake of around 2200 calories per day in rural areas which is approximately the daily calorie requirement. There is little incidence of acute malnutrition, but 40% of children under 5 are underweight⁶. Total food production per caput decreased slightly during the period 1979-1993 (MAF 1999). Crops are, however, showing increase in production over the last 8 years, whilst livestock production shows signs of a decrease in total production.

Table 1: Social and economic indicators (Asiaweek, 1999)

Indicator	Cambodia	Lao PDR	Thailand	Vietnam
Population	11.4 million	5.0 million	61.4 million	78.7 million
Population growth	2.5%	2.9%	1.5%	2.3%
Urban population	16%	22%	36%	21%
GDP per capita	US\$ 270	US\$ 370	US\$ 2,450	US\$ 1,705
Life expectancy	53 years	53 years	69 years	68 years
Child mortality⁷	105	91	26	34
People per doctor	9,523	4,381	4,361	2,298
Literacy	38%	57%	94%	92%
Paved roads	N/a	15%	97%	13%
Piped water diffusion	N/a	43%	81%	83%

The Lao economy is basically agrarian, with the agriculture sector accounting for 52% of the GDP and over 85% of the total employment (1997). The estimated proportion of rural households that market goods range between 35-75% and 25% of households are considered purely subsistence. The lack of market and transport infrastructure is hindering economic development where only 10 % of villages have a market and over 40% are over 6 km from a main road.

The estimated cash income rural of Lao households varies greatly depending on the measurement criteria. This is the result of the fact that most rural areas are predominately a subsistence economy, with only a small portion of production being marketed.

⁵ Based on the 1995 World Bank assessment where the poverty line was Kip 11,472 per person per month.

⁶ This is a sign of longer term malnutrition, not affected by acute crisis such as food shortage (UN 1996).

⁷ Child deaths with in the first year per 1000 live births.

Sale of livestock and fish is a major income earner of income making up 47% of marketed agricultural production. In addition some 44% of rural households gets revenue from some type of business (LECS 2 1999).

Declining share of agriculture in the GDP (fallen from over 10% between 1987 and 1997) reflecting fast growth in manufacturing and slow growth in agriculture. This implies a widening gap between rural and urban incomes.

2.2 Fisheries sector in Lao PDR

The fisheries sector in Laos is often considered being of minor importance with only the major tributaries to the Mekong and the Mekong River itself, together with Nam Ngum reservoir, being the major contributors of fish and aquatic animals. Catch landing estimates are not very reliable, since the commercial catch that is registered at landing sites is only making up a small proportion of the total catch.

An official estimate based on theoretical production from various aquatic habitats (Table 2) indicates an annual production of around 38,000 tonnes. This is likely to underestimate the total production since it is based on assumed production from the various habitats, rather than derived values from research and investigations.

Table 2: Estimates of the area and fish production of different types of water resource in Lao PDR (DLF 1997).

	Large reservoirs (e.g. hydro)	Shallow irrigation reservoirs	Rivers (large.)	Swamps and wetlands	Rice fields (rainfed & irrigated)	Stocked rice-fields	Fish ponds	Small natural ponds, oxbows, irrigation weirs
Productivity (kg/ha)	23	20	67	30	16	120	2,499	573
Total area (ha)	46,696	34,460	254,000	27,029	413,437	4,564	3,017	6,519
Estimated Total Production (tonnes)	1,060	689	16,986	811	6,454	548	7,540	3,737
Total Production	37,825 tonnes							

In the last few years more information has become more available as research into production from various aquatic resources in Lao PDR. Research on yields from reservoirs⁸ suggests that the production is more than double the earlier figure, and monitoring of small-scale aquaculture ponds⁹ suggests that the actual production from most ponds is about a third of what is indicated in the 1997 estimate. In addition, village ponds and small irrigation reservoirs¹⁰ were found to have a production of around 200 kg/ha, and production estimates from ricefields are likely to be too low¹¹.

More recent production estimates combined with the estimated production area of the various aquatic habitats in Lao PDR indicates a substantially higher production of almost 60,000 tonnes per year (Table 3).

⁸ MRC Reservoir Management Project research data.

⁹ Survey and monitoring data from Lao/97/007

¹⁰ Survey and monitoring data studies from Savannakhet by Imperial College, London University.

¹¹ Research estimates from Cambodia and Thailand indicate a production between 25-150 kg/ha/year in rainfed lowland rice paddies.

Table 3: Revised estimates of the area and fish production of different types of water resource in Lao PDR.

	Large reservoirs (e.g. hydro)	Shallow irrigation reservoirs	Rivers (large,)	Swamps and wetlands ^a	Rice fields (wet season rainfed & irrigated) ^b	Stocked rice- fields ^c	Fish ponds ^d	Small natural ponds, oxbows, irrigation weirs
Productivity (kg/ha/year)	57	200	67	30	30	120	800	573
Total area (ha)	46,696	34,460	254,000	95,686	477,176	3,050	10,300	12,934
Estimated Total Production (tonnes/year)	2,662	6,892	17,018	2,870	14,315	366	8,240	7,411
Total Production	59,774 tonnes							

^a the area estimate is based on a partial inventory conducted by Mekong River Commission (MRC 2000)

^b estimated are under cultivation in 1999 (IRRI 2000).

^c estimated from 6,100 households stocking ricefields of an average area of 5,000 m²

^d estimated from 51,500 households with fish ponds and average size of pond being 2,000 m²

Although fishing and fish culture is not common as a main occupation, it is a common part-time activity involving between 71-92% of rural households (LECS 2 1999, Agricultural Census 2000). This is reflected in that fishing takes up around 10 % of the time spent on all income generating activities in rural areas (estimated at 6.6 hours per person per day), which is dominated by tending rice cultivation followed by fishing and tending animals (Table 4). The importance of fishing is also reflected in that 66% of all rural households own one or more fishing nets (LECS 2 1999).

Table 4: Average time spent by adults in rural areas (LECS 2 1999).

Activity	Rural areas with access to roads	Rural areas without access to roads	Rural Areas (average)
Tending rice	1.9	1.9	1.9
Fishing	0.4	0.9	0.6
Tending animals	0.6	0.6	0.5
Hunting	0.2	0.4	0.3

It is also interesting to note that poorer people spend more time fishing than other groups, and overall greater time is spent fishing than tending animals (Table 5). It is also noteworthy that all villages in rural Laos produce fish, poultry, fruit and vegetables.

Table 5: Average time spent by classes of poverty (LECS 2 1999).

Activity	Very Poor	Poor	Non-Poor	Average
Tending rice	1.9	2.2	1.5	1.7
Fishing	0.7	0.6	0.6	0.6
Tending animals	0.6	0.5	0.5	0.5
Hunting	0.4	0.3	0.2	0.3

There is some evidence that the government is increasingly recognising the importance of fisheries for Lao PDR, such as that the government's strategic vision for the agriculture

sector states that the livestock and fisheries sub-sector has been under-funded¹² and is indicating that more resources will be made available for the development of the sub-sector in the future (MAF 1999).

2.3 Extent of rural aquaculture

Aquaculture in Lao PDR is currently expanding and in particular small-scale rural aquaculture. The practice has been promoted through various initiatives over the last 30 years, however it is only recently that it has received much attention. Recent estimates suggests that some 55,000 rural households (or 8%) in rural areas are practicing some form of fish culture (Agricultural Census 2000). One of the main constraints is the lack of fish seed for stocking and many ponds are not stocked but farmers attempting to cultivate the existing wild stock. Development of decentralised seed production has stimulated fast development of fish culture in some areas and is viewed as a successful intervention to address the constraint of lack of seed (AIT 1997). Other limitations are the high cost of pond construction and limited amounts of inputs (feed, fertiliser, etc.) available locally.

Although aquaculture practices are far from wide-spread, there are a variety of culture systems. The Agricultural Census (2000) indicates that pond culture is by far the most common form, with over 92% of all households practising fish culture having ponds as the culture unit. According to the same census 11% of the households undertaking fish culture practice ‘rice-cum-fish’ (mainly in the northern provinces). Interestingly the provinces with the highest number of households practicing aquaculture are Hooa Phanh (34%) followed by Xieng Khouang (25%) and Borkeo (12%). This may be due to high incidence of traditional practice of aquaculture among ethnic Tai groups.

Although there are localised ‘booms’ of cage culture facilities, especially along the Mekong River culturing tilapia (*Oreochromis nilotica*), outside urban areas this is not a common practise.

There is a potential for fish culture in rice fields particularly in irrigated areas, and with a total wet-season irrigated area of over of 200,000 ha (MAF 1999), it can be seen as a method for increased production. A major constraint to this is that intensification of such systems is difficult and flooding and theft are common problems.

2.4 Production systems, culture species and facilities

Livestock production is the main form of animal protein food security and income generation for rural Lao farmers¹³. Small livestock such as chickens, ducks and pigs are raised in extensive systems, relying on foraging for a significant part of their feed. Supplemental feeds consist of rice bran, broken rice, fermented rice wastes, cassava and corn. The extent of supplemental feeding depends on the availability of feeds as on-farm resources. Purchase of supplemental feeds is not common and depends on how much income is generated from the livestock production activity

¹² Livestock and fisheries contribute 40% to agricultural GDP and substantially to unofficial exports and is the main source of cash income and rural assets for farming households. Despite this it receive 3-5% of MAF local resources, whereas Irrigation gets 66%, additionally foreign public investments have been focused on irrigation (45%) and forestry.

¹³ Virtually all rural households raise some form of livestock.

A central feature of the livestock production system is the minimization of risk, particularly economic risk. Livestock disease is common in Lao PDR and this is exacerbated by the lack of vaccination and free-range production system. Permanent penning of animals is uncommon and this also predisposes to the rapid transmittal of contagious diseases. The Department of Livestock and Fisheries (DLF) considers disease currently the main constraint to increased productivity of livestock in rural areas (Phonvisay pers. comm.). Large livestock are also raised and play a dual role providing draught power and are a cash reservoir when larger amounts of money are required.

Within the livestock system, aquaculture is often adopted for both food production and income generation. Attractive features of aquaculture include; lack of serious disease epidemics and low feeding requirements. The high value of fish and seasonal shortages provide a good potential for income generation. Since fish are smaller than any other form of livestock, partial harvesting for home consumption is common, thereby allowing other livestock animals to be used solely for income generation.

Pond culture is the most common form of aquaculture, although examples of cage and pen culture exists as well. In some areas culture of fish in rice paddies has been practiced for some 200 years, although this is restricted mainly to some upland communities in northern Laos. Culture of fish in communal water bodies is common in certain areas (particularly Khammouan and Savannakhet provinces), and management of these resources is often a parallel development.

Overall management practices are basically low input systems often constrained by limited access to fingerlings for stocking and water shortages in the dry season. The amount of time and resources that farmers will devote to a fish pond are determined by the relative value that they attach to the pond in relation to other components of the farming system.

2.4.1 Seed/fingerling supply and stocking practices

In most areas fingerling production is confined to the single provincial fish hatchery. These hatcheries are generally unproductive, often producing less than 300,000 fingerlings per year. A main constraint to these hatcheries is the inability to distribute fingerlings widely during the main stocking season, due to lack of roads and supporting infrastructure. As farmers often only buy a few hundred fingerlings each, the lack of critical mass also limits the financial viability of such centralized production methods. Other issues that limit these hatchery's productivity is the lack of suitable water supplies, lack of electrification and limited financial support. The hatcheries are actually run as commercial enterprises by the Province and they are expected to cover all costs. Provincial budget allocations are in the range of \$100 - \$200 dollars per year and all other expenses must be found by revolving income from fingerling sales. Any substantial profits made by the hatchery are also retained by the Provincial Agriculture Office, leading to dis-incentivisation of the hatchery staff. Unofficial sales from the hatcheries are probably widespread and reporting of actual production is deliberately vague. Reported fish sales are therefore lower than actual, but even taking this into account, these hatcheries are incapable of producing sufficient fingerlings and distributing them to where they are needed. This requires a decentralised production approach that can only be achieved through development of the private sector.

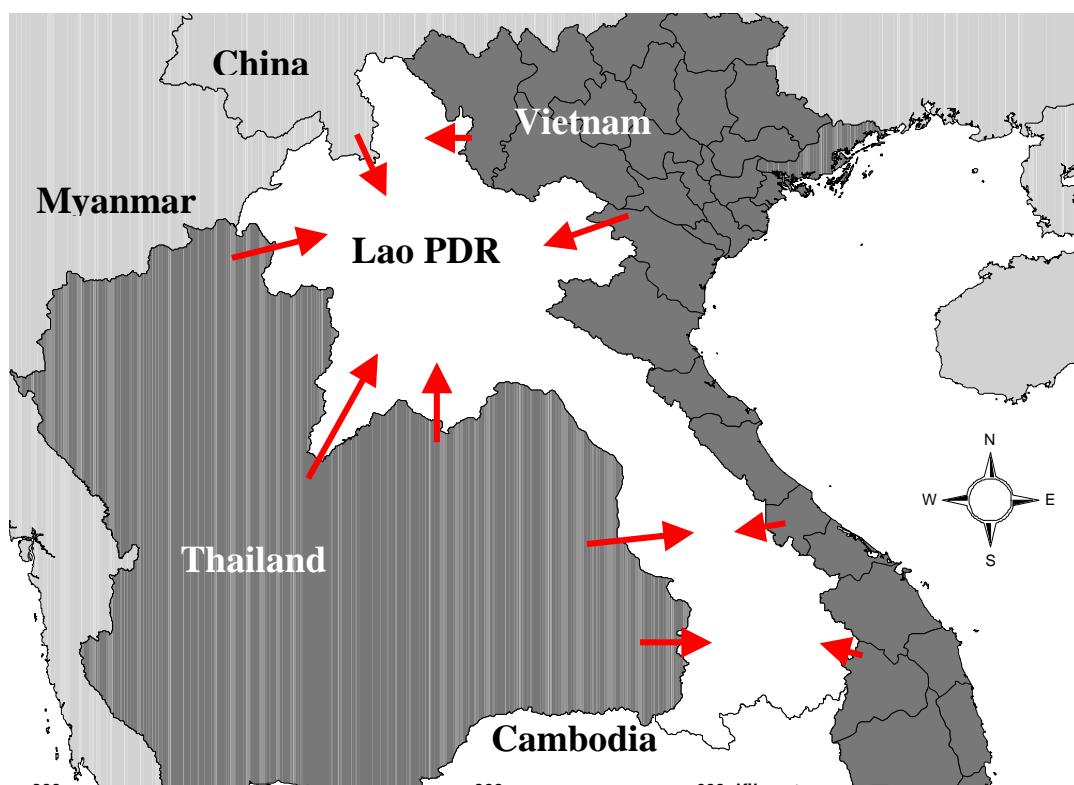
The principal species produced by the provincial hatcheries are common carp (*Cyprinus carpio*), tilapia (*Oreochromis nilotica*, *O. mossambica*), Chinese carp¹⁴, Indian carp¹⁵ and

¹⁴ These are generally silver carp , bighead carp and some grass carp.

common silver barb (*Barbodes gonionotus*). Since provincial hatcheries do not fulfil the demand of fingerlings within the province, there is also regular importation of fingerlings from neighbouring countries¹⁶ by traders (see Figure 1). The quality and species composition of the imported fingerlings often results in low survival and farmers often express their dissatisfaction with the imported fish. Wherever local farmer-based fingerling production is established, the demand for imported fingerlings decreases, since the better quality of the local production is quickly realised. The income generation potential from this activity is also considerable and within one of two years, farmers that start fingerling production are soon deriving the majority of their cash income from the activity

Grow-out of the larger species of Chinese and Indian carp is not particularly efficient since most fish ponds are seasonal, retaining water for only six months each year. These ponds are better suited to production of silver barb, common carp and tilapia, as these can be eaten at a small size and are popular with rural people. Indian carp (Rohu) are often stocked as it is relatively easy to produce in the provincial hatcheries and is thus available in peri-urban locations. Increased availability of silver barb fingerlings has, in some provinces, seen a shift towards preference for this species. Silver barb fingerlings are also available from Thailand while Chinese and Vietnamese traders generally import Chinese carp species.

Figure 1: Known and points of fish fingerling importation to Lao PDR (Source: Funge-Smith & DuBeau, 1999)



¹⁵ Mainly Rohu and Mrigal.

¹⁶ Thailand, China and Vietnam.

Usually farmers do not regularly stock ponds, but rely on recruitment of wild species or the natural breeding of tilapia. The pond is part-harvested on an ad-hoc basis and a final harvest, when the pond begins to dry out after the end of the monsoon season.

Stocking of ponds is also limited by the availability of fingerlings at the early part of the monsoon season. The lack of availability of fingerlings can be identified as a principal constraint to the further development of fish culture since it deters farmers from investing time and effort in pond construction.

Farmers often stock more than one species depending upon what is available when they purchase the fingerlings. This is a form of polyculture, however often not done in order to exploit the different feeding niches but rather a result of availability and choice in terms of culture preference (ease of culture, taste and/or price).

2.4.2 Pond culture

Feeding and management

Fish ponds are generally small to medium size (400 - 1000 m²) and may be located close to the household. The proximity to the household is a significant factor in determining the extent to which farmers are prepared to invest time and resources in fish culture. This is because theft of fish is extremely common and therefore there is little point in investing valuable resources into something that may not yield a benefit due to theft. Another important factor is the ease of feeding and looking after the pond. If the pond is located close to the house women and children are often responsible for the feeding the fish. Usually these small ponds owned by households hold water for only part of the year and need restocking on an annual basis, making seed availability a major constraint to expansion.

There is limited awareness amongst farmers of the need to feed and fertilize fish ponds to increase production. Ponds are often under-fertilized as a result of the dispersed nature of animal manure (livestock are rarely permanently penned). Farmers are also unaware of the benefit of pond fertilization, and the methods of increasing the natural food in the pond through promoting phytoplankton growth ('green water'). Since ponds are shallow and rainfed, stocking of common carp also results in muddy water, which limits phytoplankton productivity.

Increased productivity can be achieved by the application of supplemental feeds for the species under culture. Floating rice bran on the water surface (a typical feeding technique) tend to favour the small wild *Rasbora spp.* while the cultured cyprinid species will often derive little benefit. Making moist, sinking feeds can overcome this and significantly increase production of the species stocked for culture. This however requires some effort in preparation and is dependent on the amount of time the farmer is willing to invest in fish culture.

Typical production rates from ponds such as those described above, range between 285-1,359 kg/ha/year (Table 6). As ponds are small the total household harvest was in the range of 28-130 kg/year. Whilst this may appear low, this is still a significant contribution when compared with other small livestock production – equivalent to one pig or 40 chickens per year. The value of this production is also important.

Table 6: Pond production in selected provinces of Lao PDR.

Province	Pond Production (kg/ha/year)	Household production (kg/household/year)	Source of data
Sayaboury	912	76	PADP survey data 1997
Xieng Khouang	814	107	PADP survey data 1997
	367	28	LAO/89/003 data 1996
Oudomxay	789	87	PADP survey data 1997
	932	132	PADP survey data 1997
Savannakhet	285	49	PADP farmer data 1999
	1,500	N/A	RDC farmer data 1999
Sekong	809	84	PADP survey data 1997
	1,359	28	PADP farmer data 1999

From a household survey, 40% of families with a fish pond returned that they sold part of their crop and this yielded average 16% of the overall family cash income for that year (Funge-Smith 1998). The sparing effect¹⁷ on other livestock is also not included in this.

In most ponds there is also wild fish entry resulting in a polyculture effect. Wild species that are often found in aquaculture ponds include snakehead (*Channa spp.*), catfish (*Clarias spp.*), *Rasbora spp.*, freshwater shrimp (*Macrobrachium spp.*), freshwater snails, frogs, eels. Depending upon their value, these by-catch species may be eaten or marketed along with the stocked cultured fish. The by-catch from wild recruitment is an additional benefit from the pond that is appreciated by farmers. As such, exclusion of these species is often not practised and this presents some problems when stocking fingerlings for culture. The best results are achieved when relatively large fingerling are stocked which are less susceptible to predation. Since large fingerlings are not produced by hatcheries or sold by traders, significant success has been achieved with the nursing of fingerlings in small net cages (hapas) prior to their release to the open pond.

Pond construction

The requirements for fish culture are land suitable for pond construction and the cash for the cost of fingerlings to stock the pond with. Ponds are usually hand constructed and are shallow. Water supply from small streams may be available in the monsoon season, but most ponds are filled by rainfall and runoff. This means that the majority of ponds are seasonal, holding water during the monsoon season, which is retained for a few months into the following dry season. Deeper ponds can be constructed using mechanical excavators (e.g. backhoe), but this is very unusual in situations where machinery is not already present in the area and is only common in association with earth is being excavated for road construction or in areas where mechanical excavators are present for other construction activities. This is due to the high transport cost of the machinery and limited availability of machinery in rural areas. Additionally the excavation cost is high (about US\$ 1.00-1.50 per m³), about two to three times that of Thailand, which further restricts the use of machinery for pond excavation.

2.4.3 Communal ponds

The stocking of fish into communal water bodies is practised in some areas, sometimes as a result of development project intervention, or experience of the activity from a neighbouring

¹⁷ This refers to the fact that having fish available to eat allows for either not eating some of the poultry, which can be sold, or be able to spend less of the income from selling other livestock on food items.

country¹⁸. Although stocking of a water body is relatively simple, the subsequent management of what is a collective and often open access resource, can be difficult. Communal ponds often require substantial further community development activities to rationalize the management of the resource and how fish or income generated is to be distributed in an equitable manner. There are examples where this has been achieved (notably Khammouan and Savannakhet province) and these may serve as examples of how to initiate this process in other areas. It is fairly certain that the wholesale transfer of a management system that works in one communal pond to that in another area is likely to fail, since it will not be sufficiently responsive to the particular situation into which it is being introduced.

Small communal ponds can be fertilized or fed to improve productivity, however the arrangements for achieving this communally are extremely complex. A more common approach is for the communal pond to be stocked annually or every two to three years and then the management process merely deals with the method of fishing or harvesting of the production. Either by declaring some areas of the pond a “no fishing zone” or banning fishing and having annual “fishing days”. In these circumstances the pond is behaving as a culture-based fishery. Typical production levels for such systems are in the order of 200 kg/ha/year.

2.4.4 Rice-fish culture

Upland areas

There is a long tradition¹⁹ of rice-fish culture in Xieng Khouang and Hooa Phan Provinces in the north of Lao PDR. This indigenous system was probably brought with some of the Tai tribes as they migrated from China and Vietnam into Lao PDR and the practice has not spread widely outside this ethnic group.

Upland rainfed and irrigated rice paddies built on sloping land require terracing, which limits the size of the fields. Farmers are reluctant to cut channels or construct refuges in these fields due to the subsequent loss of rice production area. In rainfed fields the only modifications are raising the walls to increase water depth, and in some cases a small channel will be constructed to facilitate fish capture. Typical growing periods are 90-100 days. Harvest size varies according to the size stocked and farmers prefer larger fish (5 - 10g), although sometimes, smaller fish are stocked due to cheaper price.

Stocking densities are typically low, reflecting the high price of fish fingerlings and the limited amount of money available to the farmers. The fish produced from this system is mostly consumed in the home and this is another limitation since little income is generated and thus purchasing of fish fingerlings is often not possible. Farmers that are able to sell their produce are more able to reinvest in subsequent crops. Stocked species include *Cyprinus carpio*, *Carassius auratus* and *Oreochromis spp.* *Barbodes gonionotus* also do well when stocked in this system.

Where irrigation is present (usually from stream diversion) rice fish culture is more successful, principally due to the increased availability of fish fry. Typically, *Cyprinus carpio* and *Carassius auratus* spawn naturally in the rice fields and adjoining ponds. This activity is popular since cash is not required for fish seed. Few modifications are performed on the paddies other than the raising of walls. Fish produced in this system can be harvested and transferred to adjoining ponds for on-growing. This increases the marketability of the fish and

¹⁸ Thailand in particular, where the practices of ‘Village fish ponds’ has been adapted to the Lao context in some areas.

¹⁹ Perhaps over 200 years.

income can be generated from the activity provided the farm is close to the provincial or district market.

There is little reliable data available concerning production levels from rice-fish culture in Lao PDR, but productivities of 125 - 240 kg/ha/year have been recorded for upland rice-fish production systems. The variations appears to be due largely to the size of fingerling stocked at the beginning of production and not on stocking density. Small fingerlings (2-5 cm) results in low production due to high predation and limited growing season. Highest productions were obtained by stocking 5-10 cm fish. This emphasizes the importance of stocking large fingerlings, which reduces the likelihood of predation.

Lowland areas

Lowland areas of Lao PDR are mostly confined to the Mekong river plain. Rice fields are larger but have more constraints with water availability. Where soils are relatively impermeable, rice-fish culture may be practised in rainfed rice fields. Drying out of rainfed rice fields increases the risk of losing the fish stock, thus increasing the perceived risk of the system. The rapidly increasing area of irrigated rice provides potentially a good opportunity for the development of rice-fish systems.

The production system in lowland rice does not involve on-growing in ponds, due to the lack of water following the rice production season. Since the lowland areas are warmer growth rates are higher than the cooler uplands, but overall, production from lowland rice fish culture is reportedly in the same range as upland areas.

Constraints in rice-fish culture

Rice fish culture is popular with farmers due to the integrated nature of the system, however there are some constraints. Theft²⁰ of fish from fields is a frequent complaint since the fields are not close to the house. The “open fisheries” nature of rice fields also means that actual ownership of the fish in the field may not be recognized by the community as a whole (See box).

Flooding is a serious problem in some areas. The mountainous topography makes the runoff following rainfall is high and often sudden, causing problems in some areas. Fish loss following flooding has deterred some farmers from pursuing rice-fish culture. In Xieng Khouang farmers in one village had a simple solution to this issue. Farmers whose paddies were the lowest on the slope did not stock fish, but relied on escapees and occasional flooding from stocked paddies higher up to provide the fish for their fields!

Due to the lack of large livestock culture and limited amounts of feed for livestock, the production of manures is limited. However, rice straw is consumed by cattle and buffalo in the fields providing natural manure. Supplemental feeding is rare in traditional rice-fish culture since the fish are still susceptible to theft. Facing this potential risk, the increased investment of resources (time and feed) is not attractive.

Pesticides are not widely employed in upland areas due to their cash cost, however, they are increasingly being used in the richer lowland areas and this is a potential risk in the future.

Since there is little water available during the dry season the maintenance of broodstock fish is difficult during the dry season, this often prevents farmers from producing their own fingerlings, constraining the number of farmers that are able to become involved in this activity. The high cost of fish fingerlings (50-150 Kip each, US\$ 0.006 - 0.02 each), lack of

²⁰ Or poaching.

cash economy and limited availability during the stocking season, currently limits the number of farmers able to perform rice fish culture. In areas which also have fish ponds that hold water all year round, broodstock can be maintained and the home production of fingerlings can occur. Considerable success has been achieved with farmers who have these two resources and adoption is extremely rapid, since the farmers are able to overcome the fingerling constraint by themselves, without relying on the erratic supply of fingerlings by traders or hatcheries.

Ownership issues in rice -fish

A community in Xieng Khouang which has engaged in traditional rice-fish culture explained that whilst the fish (both wild and stocked) in the rice paddy are the property of the paddy owner, other products such as frogs (which are usually hunted at night with torches) are a more common access resource. This community mentioned that within their valley where rice fish had been more recently taken up, theft was a serious problem initially. Apparently, once sufficient numbers of families had taken up rice-fish culture, the perception of ownership was better developed and the problem decreased. Experience from LAO/97/007 in Oudomxay has been similar. In this situation ethnic Leu have been introduced to rice fish culture (not previously practised in the area). Rapid take-up occurred in the trial area, but by the second year it was apparent that many farmers would not repeat the activity in the same way since children were poaching fish when the rice became too high to see their heads! In this case, it was suggested that the children were not from the same community as the owners of the rice fields.

2.4.5 Cage culture

Cage culture is practised in some reservoirs and the Mekong River. This is confined primarily to two reservoirs in Vientiane Province and close to towns like Savannakhet. Nam Houm is a shallow irrigation reservoir that has relatively fertile greenwater all year round. Silver carp are reared in cages utilizing the natural productivity of the water. Supplemental feeding is not considered essential and fish growth rates are good. There has been an increase in the number of cages in this reservoir and there are occasional reports of production related problems. These may be related to water quality (the reservoir becomes shallow at the end of the dry season) or possibly disease.

In Nam Ngum reservoir, which has rather oligotrophic waters, cage culture started with the production of giant snakehead (*Channa micropeltes*). One reason being that fingerlings of this species can be caught by fishermen in the reservoir and stocked into cages, thus fingerling availability dictates the species cultured. A second reason is that the giant snakehead is carnivorous and is fed on fish caught from the reservoir. A small clupeid species (“Pa gaew”) that is caught in large quantities in the open waters of Nam Ngum reservoir. Cage owners either catch the fish themselves or buy from local fishermen. The economics of this are marginally profitable since the market for giant snakehead is limited and food conversion is poor, while dried “Pa gaew” is a marketable commodity (due to its ease of transport) commanding a price of up to \$5 per kg.

There is a possibility for improving this situation by either changing the species cultured (which would require the availability of suitable fingerlings) or the manufacture of a simple mixed feed (probably broken rice, rice bran and fresh pa gaew). It is anticipated that some of these alternatives will be attempted in the future.

In peri-urban areas and occasional in rivers, Tilapia are raised in small cages, usually around 5m x 5 m and fed on pelleted feed or a mix of feeds. This culture focuses on the restaurant market and the cages are often part of the restaurant. Sometimes the tilapia are raised in earth ponds and transferred to the cages for a period of time - this improves flavour and allows the owners to charge premium prices for “river fish”.

2.4.6 Integrated aquaculture

It is frequently recommended that livestock and fish ponds be integrated, however, without understanding the often complex issues that relate to livestock production in rural areas, this advice is more usually not adopted. Lack of penning of livestock so that they can forage for food, makes integrated culture of livestock and fish unfeasible in many areas. Livestock integration is only a realistic practice under conditions of land inavailability and where agricultural by-products are readily available on farm. Neither of these situations is typical in rural Lao PDR.

It is increasingly common to see integration in peri-urban areas where more intensive livestock production (pigs, chickens egg-layers) is being practised. Penning animals overnight beside fish ponds is an alternative and the routine feeding of pigs and chickens close to a fish pond has a similar effect. The degree to which farmers can adopt and practice this is largely determined by the proximity of the pond to the house. Ponds in fields away from the home are not usually able to benefit from livestock integration, which is more typically kept closer to the house (small livestock rearing is typically an activity of women).

2.4.7 Peri-urban aquaculture

The demand for fish and aquatic animals in Lao PDR is undersupplied almost all year round. This becomes particularly acute during the long dry season (November – April). Ponds that retain water all year round (deep ponds, irrigated areas, stream fed), can be used to culture fish into the dry season. Prior to Lao New Year (around April) prices are optimal for fish and harvesting at this time maximizes income. Culture of fish in this way is more common in peri-urban areas, where marketing of fish for income is not as affected by transportation and infrastructural constraints. Since income is generated from the culture activity, the purchase of basic feeds (bran and broken rice) is possible although the intensity is still relatively low compared with other countries. Fish ponds in peri-urban areas may be integrated into a small restaurant operation. The price of fish in these restaurants is considerably more than the local market price and the economics of the operation are attractive. It is unlikely that most Lao towns could support a very large number of operations such as this.

3 Role of aquatic resources in rural small-holder livelihoods

The importance of aquatic animals in the rural household food security strategy cannot be underestimated. Basis for the diet in rural areas is rice together with supplemental animal protein, of this, fish and aquatic products make up a significant proportion although the exact proportion varies geographically.

3.1 Food security

Rural households in Lao PDR have a nutritional staple based on rice, this is reflected in that the government often equates rice security with food security (MAF 1999). From this perspective Lao has achieved practical food security as the estimated consumption is approximately 220 kg/caput/year in rural areas (equivalent to 350 kg padi/caput/year), providing approximately 2,200 calories per day (considered to be almost 100% of the energy requirement). It should be noted that the distribution of this production is not even and there are areas with shortage and others with production surplus. This calculation only takes into consideration the energy (calories or kJ) aspect of nutrition. It is also true that most of the protein is originating from rice²¹, but rice is not nutritional complete and is lacking in some of the essential amino acids²², particularly lysine²³, which fish is rich in. Additionally many important vitamins are not available in a rice only diet, of special importance is vitamin A and iron.

Consumption of vegetables and leaves of various kinds provides much of the required vitamins and minerals. There is little information on the consumption of these foods, but in general they can be considered as important supplements of vitamins and minerals as they do not contain high levels of energy nor proteins.

Fish and aquatic animals are very complementary to the rice based diet, providing high levels of lysine, minerals (particularly small species which are eaten whole), and in some cases vitamin A (particularly if the eyes are eaten). Consumption of fish varies greatly and survey averages ranges from 15 to over 57 kg/person/year (Table 7). An overall average for most of the provinces lies between 15-25 kg/person/year, which is confirmed by extrapolating the values presented in LECS 2, which indicates a consumption of around 15 kg/person/year in rural areas.

²¹ Which contains 7% protein by weight.

²² Amino acids, the building blocks of proteins, which humans cannot synthesise. Of the 21 (20?) different amino acids nine (10?) are essential.

²³ Only approximately 60% of the required lysine content are present in rice, and it is thus important that populations consuming rice as their main staple supplement with lysine rich sources.

Table 7: Consumption of aquatic animals in rural Lao PDR.

Province	Aquatic products as estimate of total protein ^a	Total animal products (kg/person/year)	Total aquatic products (kg/person/year)	Source
Average for 5 Provinces	37.0%	58.6	21.7	
Oudomxay	26.6%	64.5	17.1	
Savannakhet	40.7%	59.6	24.2	FAO PADP 1998
Sayaboury	37.3%	40.5	15.1	
Sekong	57.1%	37.2	21.2	
Xieng Khouang	39.6%	64.6	25.6	
Nam Ngum Reservoir	60.6%	94.2	57.1	MRC 1999a
Luang Pabang Province	42.2%	66.3	28.0	MRC 1999b
Savannakhet			19	Garaway 1999
Nation wide ^b			11	LECS 2 1999

^a Measured as total animal product or % protein.

^b Extrapolated value from expenditure survey (Reported only as “fish” and may exclude other aquatic products)

Fish, meats and eggs are important in balancing this rice based diet. Although the diet in rural Lao may be seen as almost complete with respect to energy intake, it may be lacking in some parts such as essential amino acids, vitamins or minerals. This is reflected in the high incidence of underweight among children under 5 years old. Children are sensitive to a diet lacking a complete protein balance (affecting growth) as well as vitamins and minerals, whereas women are affected by vitamin A deficiency and lack of iron.

In trying to better identify the role of fish in the diet, a hypothetical rural diet was calculated based on survey results²⁴ (Table 8). It shows that the average daily energy intake per person is 9.6 MJ (2340 calories) and the average daily protein intake is just under 55g. Information on the anthropometric values of the Lao population was unavailable, but assuming that the diet is of a 40-year-old man weighing 65 kg having moderate physical activity, than the recommended energy intake is 10.6 MJ/day. The actual intake of 9.6 MJ/day is 1 MJ lower than the recommended, which means that only 90% the energy requirements are met. The recommended protein intake is 1g kg/bodyweight/day, which means 65 g/day since he weighs 65 kg. Thus, 84% of the overall protein requirements are met.

Table 4: A hypothetical average daily consumption per person in rural areas of Lao PDR.

Food item	Intake (g day ⁻¹ pers ⁻¹)	Energy ¹ KJ/100 g	Energy derived KJ day ⁻¹ pers ⁻¹	Protein ² g/100 g	Protein derived g day ⁻¹ pers ⁻¹
Sticky or glutinous rice	600	1491	8946	7.0	42
Fish	40.0	556	222	19.0	7.6
Meats	31.4	1301	408	17.2	5.4
Vegetables ³	173.8				
Total	859.8		9576		54.9

¹ Energy intake of the food item in question

² Protein content of the food item in question

³ No information is available on energy and protein content of “vegetables”

²⁴ Results from LECS 2 1999, LAO/97/007, MRC were used to calculate the diet.

The bulk of the protein is derived from the rice (76%), which is nutritionally incomplete and lysine is the main limiting amino acid in a rice based diet. The lysine content of rice is around 35 mg/g protein whereas it is 97.6 mg/g protein in fish (Garrow and James, 1993). It is estimated to be 75 mg/g protein, on average, in other meat products. Calculating the lysine intake we find that it is 48 mg/g protein (Table 8).

Table 8: Lysine content of a hypothetical rural diet.

Food stuff	Calculation	Amount of lysine
Rice	42 g protein*35 mg lys/g protein	= 1470 mg lysine
Fish	7.6 g protein*97.6 mg lys/g protein	= 742 mg lysine
Other meats	5.4 g protein*75 mg lys/g protein	= 405 mg lysine
Total lysine intake per person per day		= 2617 mg lysine
Lysine intake per g protein:	2617 mg/54.9 g protein	= 48 mg/g protein

The recommended intake of lysine is 58 mg/g protein, which represents 82% of the daily requirement of lysine. If the fish consumption were to be replaced by meats in terms of protein the lysine deficiency would drop to 76% of the daily requirement. A lysine deficient diet would cause malnutrition in children (as it is important in the growth functions) and lower general health of adults.

Although almost sufficient in energy, a rough estimation of the rural Lao diet indicates that rice provides the main energy and protein staple, but that fish, being high in lysine, is very important in providing this amino acid that the rice lacks. It should be noted that the amount of fish assumed to be consumed in the hypothetical diet (14.6 kg/person/year) is in the lower range of what was found in the various surveys and the amount of rice is a national average where active adults may consume more, it is thus likely that actual diets are more complete in terms of energy and protein. These calculations do not take into account the important aspect of intra-household distribution of food.

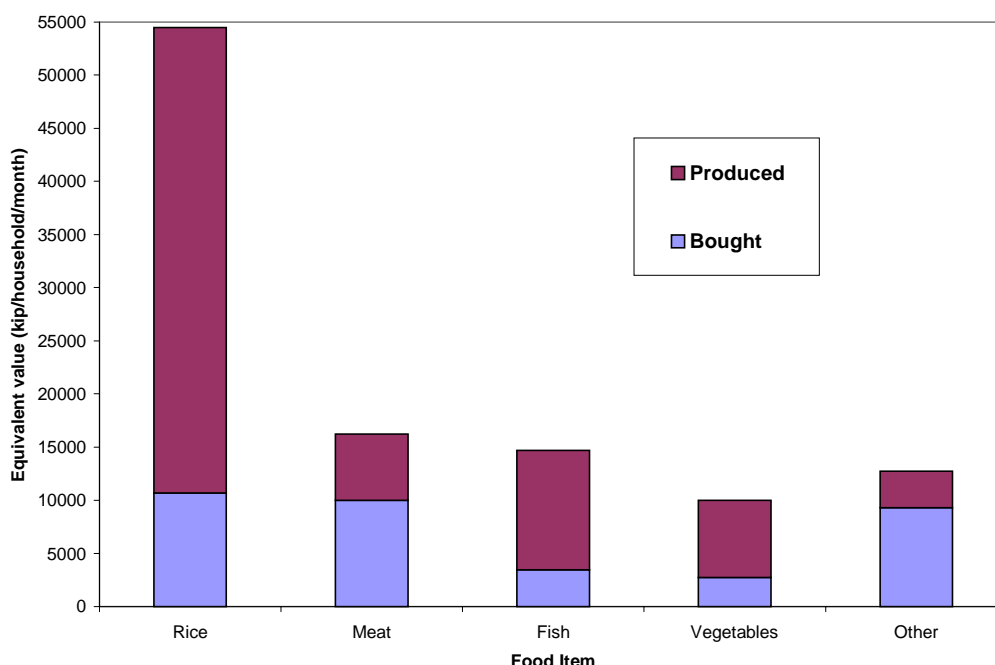


Figure 2: Origin of food items consumed (purchased or own production).

In the context of overall rural food security it is also important to note the origin of the animal protein as meat is more often purchased, whilst fish is more often caught or raised (Figure 2).

This is presumably a reflection of the fact that raising livestock is mainly intended for the market, resulting in meat being bought on a regular basis whereas home-produced livestock are sold rather than eaten. Fishing and raising fish fills a different niche in the food security strategy being able to bridge the needs for own consumption and at the same time provide opportunities for cash income generation (see next section). Overall, of the agricultural production intended for home use (i.e. own consumption or as animal feeds), crops account for 65%, fish 17% and meats 5% (LECS 2 1999). This illustrates the importance of fish in the rural household food security strategy.

3.2 Cash income generation

Lao PDR is gradually moving from an agrarian subsistence economy, once dominated on the macro level by a socialist command economy, towards a more market-oriented cash economy. Integration of rural households into the cash economy is constrained by poor infrastructure (roads, market access, etc.) and low surplus production, which results in lack of access to and high prices for agricultural inputs (fertiliser, improved seed, vaccines, animal feeds, etc). Livestock and fisheries can play a pivotal role in taking the first steps in opening and developing such rural economies.

Livestock²⁵ production is generally seen as a cash income generating activity, in contrast to rice production which is mainly for food security. This is evident in that 90% of the cattle and pig production is marketed, whereas only 13% of rice production reaches the market. Fish production is intermediate with 27% reaching the market. In addition, livestock is by far the principle form of rural savings.

When fish is marketed it commands a high price, surpassing most meats (free range chicken being an occasional exception) in fresh weight equivalent (MAF 1999b).

As mentioned earlier, statistics of the livestock sub-sector are showing signs of decreasing production. It is difficult to ascertain the causes of this due to the poor quality of national statistics and that the trend is probably due to a combination of events. Firstly, the drop in the value of the Lao currency in 1997-1998 urged many farmers to use livestock as payments for agricultural inputs. Secondly, de-regulation of Thai import restrictions in 1997 (following ASEAN regulations) made this a preferred export market (this actually led to Lao PDR putting restrictions on exports in 1998). Finally, prior to the 1998/99 Agricultural census, there had not been a proper census for a long time and numbers of livestock reported were often estimated using production formulas rather than actual enumeration (Phonvisay pers. comm.).

Fish production is in a pivotal position for providing cash income generation for rural households due to its great level of acceptance, small units (compared to cattle, buffaloes and pigs) and relatively high price. This versatility allows it to play an important role in the household food security strategy as well as be an excellent source of cash once food requirements are satisfied.

Production of fish not only serves as an excellent entry point into cash income generation where the surplus can be sold, but it can also be part of the households overall food security strategy. This is an important point in providing a strategy for increased cash income

²⁵ For the purposes of this document aquaculture is not included in livestock and fishing is separated from hunting.

generation. Evidence from aquaculture extension initiatives show that initially many rural households will consume the fish produced, but once a bit of confidence in culturing fish is established, marketing part of the production (10-30%) is common. Over time this leads to expansion of the activity leads in some households. Starting with livestock (especially larger livestock) means commitment to marketing the output, which increases economic risk, as it cannot play a dual role in food security and income generation.

Another advantage of fish by comparison with other livestock is the relatively low incidence of disease. DLF identifies that the main issue in improving livestock production is animal health, and within this vaccination, epidemiology and extension of basic animal health knowledge are key issues. In rural aquaculture, disease is generally a minor issue or none at all. Apart from mortalities among fingerlings and some mortalities related to poor water quality management, fish are ‘easy’ to raise, and disease is a rare problem.

Having said this, it should be noted that Lao PDR has no capacity whatsoever in aquatic disease diagnosis and should a serious problem arise is unequipped to even deal with simple disease issues. The future development of aquaculture and increasing intensification in peri-urban areas and fingerling producers warrants some attention in this area.

A final, important aspect of culturing fish is the relatively fast turnover and unlike most other livestock, is marketable at almost any size still fetching a reasonable price.

3.3 Diversification of the farming system

Fish production also provides an excellent opportunity for diversification of rural households’ farming systems²⁶. As mentioned earlier, it is relatively low-cost and less liable to losses from disease compared to raising livestock, providing a relative low risk diversification of the livestock production base. It is often possible to use on-farm inputs initially and once the farmer has confidence in culturing of fish incremental intensification is possible by adding standard agricultural inputs such as fertiliser and rice bran. This does mean that culturing of fish will compete for resources that might otherwise be used for other livestock raising (particularly pigs and poultry).

Having a small pond also assists in diversification of other parts of the farm, providing opportunities for vegetable growing as well as leafy water plants (an often underestimated resource), it also provides water for livestock.

The main constraints are the need for a pond or a cage (a culturing facility), and access to fingerlings for stocking. In effect availability of fingerlings (at a reasonable price) is often the main constraint. Availability of a culturing facility is a constraint that could potentially be addressed through credit, however returns to investment for pond digging will depend a lot on the construction cost which can be very high (section 2.4.2). Expanding a small pond is relatively effective and can be done over several seasons.

Flooding is a problem, particularly if it occurs after several months growth. The loss of resources invested in the ponds (particularly feed) and loss of economic potential is a problem. Restocking in the same year is often not possible due to shortage of fingerlings and lack of remaining time before the pond dries out.

²⁶ “The Government is committed to helping farmers to move rapidly toward agricultural diversification in field and horticulture crops and improving the livestock and fisheries sectors of the Lao PDR farming systems.”(MAF 1999)

3.4 Contribution to livelihoods of rural poor

Edwards (1999) suggests that aquaculture contributes to livelihoods of rural poor in the following ways (numbering does not indicate priority):

1. High nutritional value food, especially for vulnerable groups such as pregnant and breast feeding women, infants and pre-school children.
2. Employment through farming and seed distribution networks, including women and children.
3. Income through sale of relatively high value produce.
4. Benefit from common property resources particularly the landless through cage culture and enhanced fisheries in otherwise under-utilised resources.
5. Rice/fish culture as a component in integrated pest management.
6. Increased farm sustainability through construction of ponds which also serves as small-scale, on-farm reservoirs.
7. Increased availability of low-cost²⁷ fish in local markets.

In the context of rural Lao PDR some of these suggestions seem relevant, particularly number 2, 3, 6 and possibly 7 (although fish remains a relatively high value product), and is perhaps more accurate in terms of increased availability.

Small-scale aquaculture development benefits rural households in providing improved sustainability through diversification. Economic vulnerability is associated with limited access to a diversity of economic activities and providing an additional opportunity for cash income generation will increase the economic security of the household.

The rural household in Lao PDR is involved in a multitude of activities. The particular combination of use of natural, material/economic, human and social resources that any one household employs in order to secure food supply and generate cash income (or tradable goods) varies depending on the social and natural resources capital available to the family. Wysocki and Friend (1998) recognised that rearing fish does not impinge on other agricultural activities and can be economically viable with the use of on-farm inputs and with a very limited labour market as an economic option. Low yields from rice-fish and community fisheries may also be viable in the absence of other more profitable options. They also concluded that promotion of small-scale aquaculture is not limited by technology, but rather by the lack of capacity to reach farming households and the appropriate processes to stimulate its development.

This is the same conclusion reached by evaluations of LAO/97/007 and the RDC initiatives, which indicate that for the short and medium term the appropriate technologies for small-scale aquaculture development in rural Lao are available and suitable for poverty alleviation. The emphasis of any development initiative should focus on developing the capacity to reach rural households, create necessary preconditions (such as fingerling availability), promote networks of fish producing households and those providing services to these families. Development of marketing, post-harvest processing and credit seems to be the logical next steps in the medium term.

²⁷ This point is in apparent contradiction to point 3, although in a broader perspective in some areas cultured fish commands a lower price than other high quality animal protein.

3.5 Social and economical aspects

One limitation of small-scale aquaculture in terms of addressing the needs of the rural poor is the need for land. In total 70% of rural households own land and 93% have access to land. In these average figures some regional variation is hidden, where only 3% of households in Hooa Phanh own land but 98% have access to land. Ownership of land is of great importance as the most common forms of aquaculture is pond culture and rice-fish culture. Secure land tenure makes it possible for farmers to make decisions to invest in the operation. Land tenure in Lao PDR is under development and will be important in determining the scope for aquaculture development in the longer term.

Marginalised groups such as the landless or those without land suitable for pond construction are unlikely, or unable, to be included in project activities. General awareness of aquaculture is raised by the presence of extension activities within a village however farmers often adopt a precautionary approach to starting activities on their own. Many farmers expressed the need to observe successful, reliable aquaculture in their village before risking investment of labour or money in aquaculture.

Although the formation of groups for fish production has been successful in LAO/97/007, it should be remembered that the production unit is still the family, and the group is formed by people that has a common interest in producing fish. As mentioned in section 1.4.3 communal ownership in fish culture, while highly feasible, does have some limitations constraining its development. It is very important that the focus is on improving a common resources for the benefit of all major stakeholders.

Murray *et al.* (1998) concluded that although there is great interest among women farmers towards aquaculture, but that there are high labour and financial entry costs for pond based culture which limit involvement. Both women and men are involved in aquaculture, although each often have separate roles at different stages of the fish production cycle.

There are few cultural constraints to women's participation in most aquaculture activities, but men often select the site for pond construction and as heads of households are regarded as owners of ponds.

The distance of the pond from the house is often a constraint to women being involved culture activities and other domestic activities may conflict with feeding and management of fish ponds. Men often make the major decisions regarding the production system and are usually responsible for routine feeding and harvesting the overall yield while women often part-harvest fish for household consumption and children often assist with feeding.

Women control the cash income from the selling of fish at the pond site and in the market, although consults with their husbands on household expenditure. Income distribution within the household is relatively equitable, so income generated from aquaculture is likely to benefit entire households. There are some differences between ethnic groups regarding management of household incomes.

Women's access to aquaculture training and extension is often limited because of gender biases in extension services, and the establishment of women fish farmer groups and that gender sensitive aquaculture promotion should be pursued either through existing extension structures or through organisations such as Lao Women's Union (Murray *et al.* 1998). Whilst often not involved directly in fish culture, the decision to start the activity was often prompted or supported by women in the household.

3.6 Environmental issues

Small-scale inland aquaculture in rural areas has little environmental impact in terms of effluent or effect on soil or ground water. In the context of the Lao PDR Tan *et al.* (1999) found that current (measurable) effects on the environment by promotion of small-scale aquaculture are almost non-existent, apart from occasional very local effects from fish escaping during flooding and discharge of nutrient rich waters into small waterbodies. It should be said that these effects are so far very limited in scope.

There is the issue of exotic species used in aquaculture and their potential effect on the indigenous fish fauna. The current impact is probably limited and the exotic species generally promoted (*Oreochromis spp.* and *Cyprio carpio*) are already established in the region (Welcomme 1999). Further introductions should not be encouraged and development of local species and existing exotic strains is desirable.

Longer-term effects are due to disease and genetic dilution risks through sustained or increased importation of fish seed from the neighbouring countries. There are no enforced controls or clear standards for transport and importation of aquatic animals and this poses a potentially serious threat to the aquaculture fish stocks in Lao PDR. Furthermore, imported fish may be resistant to some diseases but they may also be carriers²⁸ of disease, which poses a potential threat to natural (and wild) fish stocks in the country.

A potentially positive environmental impact of promotion of rice-fish culture is that this may slow down and reduce the spread of pesticide use in rice cultivation with positive spin off effects for other aquatic animals and plants and the environment in general.

4 Role of aquaculture in development

4.1 Historical aspects

Aquaculture development in Lao PDR has a long history, and some areas have a long tradition in culturing fish (particularly in the highlands where culturing of carps in ricefields is traditional among some ethnic groups). Nationally, it is a new activity with few established practices. Until recently the availability of fish in lowland areas and in the rivers was such that culturing fish was rarely seen as a viable (or necessary) activity. Increasing population and degradation of the environment has started to place great pressure on the natural aquatic resources. Most families report decreasing catches and the greater amount of time it takes to find wild fish. Although catching wild fish from natural production is still the most significant source of fish for most households, aquaculture has an increasingly important role to play in certain areas where fish supply is falling well below the demand.

The following section is a short overview of the development initiatives to promote aquaculture development in Lao PDR.

4.2 Aquaculture development projects past and present

Technical assistance for aquaculture development in Lao PDR started with USAID in the 1970's. USAID constructed a number of hatcheries at locations throughout the country (Vientiane, Savannakhet, Luang Pabang, Pakse, Sayaboury). These hatcheries were located

²⁸ Referring to animals that carry the disease but are not affected by it.

on local water supplies and situated close to the provincial capital for ease of access. Nursery pond areas were small and the hatcheries were probably intended to supply a relatively local market. These hatcheries are still in operation today, however the quality of their water supplies has deteriorated and several of the hatcheries are now surrounded by urban developments.

Vietnamese and Chinese support for hatchery construction was also provided in the late 1970's (Hooa Phan, Xieng Khouang, Oudomxay provinces). Built on the Chinese design for mass production, these hatcheries are inefficient and suffer from poor water supplies and limited nursery pond area. They differ from the USAID hatcheries in the remoteness of their location (both Xieng Khouang and Hooa Phan hatcheries are over one hour's drive from the provincial capital), thereby limiting their impact for fingerling distribution to the surrounding district.

One large-scale technical assistance (TA) project involved the Mekong Committee in developing a 30 hectare fish farm at Tah Ngone in Vientiane Province. This farm was supplied with water from Nam Ngum river below the dam and was supplied by electricity for its large scale pumps. Originally a state owned venture, this farm is now largely privately operated. It is marginally profitable and has consistently lacked reinvestment for maintenance of the farm infrastructure.

FAO/UNDP TA was provided (LAO/82/014) to renovate and upgrade existing provincial hatcheries. Use of high volume pressurized filters which rapidly fell into disrepair and other mechanical solutions to poor water quality requiring reliable electrification or large pumps. Limited budget prevented maintenance or replacement which made impact short-lived. Due to the restricted area for expansion and poor quality water supply, there is little scope for further upgrading these hatcheries. Under this TA, integrated livestock/crop/fish was promoted with limited success.

Additional FAO/UNDP TA projects (LAO/89/003) focused on demonstrating feasibility of different types of fish culture systems in several areas of Lao PDR. This project was able to demonstrate that fish culture was possible and introduced modern aquaculture techniques to many provincial and national government officers. A problem in demonstrating feasibility of fish culture, is that there is often a need to work with those farmers who wish to collaborate. It is possible to demonstrate that an activity can be successful in a particular area, but there is often a problem with up-scaling. The major challenge is the transfer of this lesson to a wider audience of farmers, who are less innovative and often have less suitable resources. Overall impact of these TA projects was also constrained by the extremely poor communications and travelling environment of the time that they were implemented.

More recently, an AIT supported Provincial level Aquaculture Outreach project was initiated in 1993. This project drew on previous experiences from neighbouring North-East Thailand and modified them to suit the local Lao situation. The AIT project initially focused on the issue for fingerling production and distribution and initiated a fingerling nursing network for distribution and onward nursing. The intention was to improve the access of more remote areas to the fry produced by the provincial hatchery. This initiative has changed gradually over the following years and is now a more generalized capacity building project working in the livestock and fisheries sector, although fingerling production and distribution is still a significant activity. The project now involves six southern Lao provinces and named the Regional Development Co-ordination (RDC) for Livestock and Fisheries.

There have been other aquaculture development initiatives as part of integrated rural development projects and general community development projects. In these situations the

aquaculture component was often included at the request of participating communities. The technical support to these interventions has often relied on provincial livestock staff capacity and this has led to disappointing results in a number of different areas.

JICA TA to aquaculture will commence with the recently signed “Aquaculture Improvement and Extension Project” project is intended to last three years in its first phase. This project will renovate the Nong Teng hatchery (Vientiane) and construct a hatchery and research facility at Nam Souang (Vientiane Province). The research facility will look into appropriate methods for fish breeding and fish culture using on-station trials. It is also intended that district and provincial livestock officers will attend training courses in aquaculture technology.

During discussions between JICA formulation missions and LAO/97/007 areas of collaboration have already been identified. It is anticipated that the JICA project will take advantage of provincial level capacity and knowledge of rural aquaculture in the design of their training program. The project has identified areas where technical upgrading of provincial and district counterparts is required through the provision of specialized training from the JICA project.

4.3 Provincial Aquaculture Development Project

The current UNDP/FAO Provincial Aquaculture Project (LAO/97/007) has initiated a process for developing an extension system for Lao PDR that does not take a technical issue as a starting point, but rather works with the resources that are currently available to farmers. Subsequent identification of constraints and a collaborative approach to overcoming these is part of the extension system. In this way the resources available to a farmer are not a constraint to participation, they merely influence the extent to which the aquaculture operation can be further developed or improved. Following the lessons of the AIT/RDC, this project also relies on the constraint in fingerlings supply for stocking ponds as a starting point for involving farmers and working together. Resolution of this issue through decentralization of fingerling production (away from the provincial hatchery) to more remote rural areas is a significant achievement of the project.

The Provincial Aquaculture Development Project (LAO/97/007) was funded (Nov 1997 – Dec 2000) as part of a UNDP country programme for rural development responding to the Government’s Rural Development initiative, one of the eight national priorities under the National Socio-Economic Development Plan. It was one of the first fully national-execution (Nex) projects under the Department of Livestock and Fisheries (DLF), with technical assistance supported by Food and Agriculture Organisation (FAO).

The main justification of the project is that it addressed relevant food security issues, potentially providing income generation and adding to the diversification of the farming system. Rural aquaculture can also be seen as a significant entry point into other rural development initiatives.

Since its inception in November 1997, LAO/97/007 developed experiences gained from previous UNDP/FAO aquaculture development projects that had rehabilitated a number of hatchery stations, established model fish farmers and started fish culture at the village level. LAO/97/007 operates in five provinces: Xieng Khouang, Oudomxay, Sayaboury, Savannakhet and Sekong covering 14 districts and including 98 farmer groups with a total number of 1,072 families.

The Project aimed to improve the income and nutrition of low-income farmers²⁹ with special consideration towards gender and ethnic groups through the introduction of fish culture. The ultimate objective of the Project is to facilitate a self-sustaining aquaculture development programme that was within the capabilities of the executing agency to replicate within provinces not included in this Project. Institutional capacity strengthening and human resource development of both the government staff and the village community were considered to be an essential part of this process.

The Project, nationally executed, utilised existing government mechanisms and emphasised an effective extension interface between the district technicians and selected fish farmers. It was successful in its pragmatic people-centred consultative approach, by responding to their perceived needs, instead of applying strict scientific solutions. The provincial capacity in providing technical and management support to the district was a major priority item for the project. Examples of concrete accomplishments at the national level included:

- successful try-out of a transferable aquaculture development methods that were within the capability of the fish farmers to adopt,
- substantial increase in awareness in the target and adjacent provinces through the development and dissemination of aquaculture extension materials,
- first-time establishment of a comprehensive aquaculture training programme that forms the basis of the aquaculture extension appropriate to the unique conditions of rural Lao PDR, with particular emphasis on the use of participatory methods
- establishment of a linked process of fry production, fingerling distribution and table-fish production through providing supports to state hatcheries and private smallholders.
- developed documentation in the form of notes or guides from stakeholder analysis and consultative approaches at the field level, as part of the national aquaculture extension programme.
- Initial establishment of a participatory impact monitoring and evaluation system based on participatory RRA and development of a concise logical framework matrix.

LAO/97/007 strengthened government capacity at three levels: central planning and management, provincial extension planning and implementation and district development officers. This capacity is the ability of the Lao government to target and direct appropriate livestock extension services to rural subsistence farmers.

Throughout the agriculture and forestry sector, most government officers training has been confined to specialized technical areas. General extension skills³⁰ have never been taught, or officers have lacked the opportunity to develop the skills and experience. Through on-going activities and training, key skills that are now being routinely used by the government counterparts include participatory methods for the analysis of problems and the development of solutions. Mechanisms for participatory planning and monitoring were also established.

²⁹ Since most rural farmers are “low-income” due to lack of markets and their subsistence farming livelihoods; for project purposes target groups are divided as 30% should be in resources poor category, 50% in resource sufficient and 20% in resource secure.

³⁰ This is now part of the Government policy, particularly at the district level, but also as a back-stopping specialisation at the provincial level.

These methods will ultimately enable participating farmers to identify their requirements and make plans for achieving them. This farmer-driven extension service (now policy in MAF) is appropriate to their needs and reduces reliance on external assistance by finding locally available solutions. This is a strong sustainability feature of LAO/97/007.

As part of this process, farmers are empowered with knowledge and skills to develop fish culture further and overcome the constraints that limit other farmers' ability to diversify out of rice farming into the livestock and aquaculture sector. The formation and empowerment of farmers groups is the starting point for community strengthening since this requires the development of skills such as planning and analysis of problems together with some degree of problem solving. The ability of district staff to facilitate this process with farmers' groups is still in its earliest stages and requires additional reinforcement.

The strength and sustainability of the farmers groups developed under LAO/97/007 activities varies between groups according to the extent to which they share a common interest. Social and ethnic factors were also involved in some cases with social-cohesion a primary factor. Typically it is not expected that the group continue activities together after the project ceases routine backstopping support, this is because the individually owned fish pond is not a common resource and does not require the existence of the group for its success. Should the group need to be contacted then it can be reformed when required. Equally, if the old members of the group have a problem or require further support it is likely that they would act together to request support from the district. This would be the context for further activities in the fields of post harvest processing, marketing or credit training. Should the group develop as a producers/marketing group or access credit as a group then it could be expected for the group to retain its cohesion.

LAO/97/007 is not the only intervention that has developed and used participatory approaches in rural agriculture and livestock extension. There are many examples of this in Lao PDR, however most are relatively local, confined to a district or province perhaps with the exception of RDC, which operates in the six southern provinces in Laos³¹. LAO/97/007 differs from these other interventions because it is the only case which involves and works through all levels of the government system, from centre to farmer. Government execution ensures ownership, sustainability, and by working through existing government structures, provides a strong potential for institutionalisation of the LAO/97/007 approaches.

LAO/97/007 strongly promoted the use of native species, principally by facilitating the production and availability of the common silver barb. This species is preferred by many farmers, but hatcheries have not been able to produce this fish in significant quantities. Promotion of the ease of culture of silver barb and discouragement of the less suitable exotic species has seen a dramatic change in hatchery and farmer attitudes and choice of species for culture. This emphasis is also slowly being recognized as provincial feedback to the centre increasingly emphasizes the suitability of smaller fast growing, native species.

Further detailed evaluation of LAO/97/007 impacts are available in the final "Annual Project Report" (Provincial Aquaculture Development Project 2000)

4.4 Other projects in the aquatic resources & fisheries sector

MRC has a large fisheries programme which deals not only with capture fisheries, but is involved in culture based fisheries in reservoirs and small scale aquaculture. Note that MRC

³¹ RDC focuses on coordinating the development of livestock and aquatic resources.

components are regional in scope and have only part of their activities implemented in Lao PDR. All fisheries initiatives under MRC are funded by Danida. In relation to aquaculture development Lao PDR it is noteworthy that the MRC Fisheries Programme is not promoting aquaculture development activities in the so called ‘central plains’ of the Mekong River basin (which includes most of lowland Lao) since “the aquaculture development potential is to a large extent addressed by the national governments with support from regional and international organizations such as the AIT Aqua(culture) Outreach Programme and the *FAO/UNDP* supported aquaculture extension project in Lao PDR” (MRC 1999).

The MRC fisheries components that have direct relevance to Lao PDR are:

The “Aquaculture of Indigenous Mekong Fish species” component aims to develop economically feasible aquaculture systems using indigenous Mekong fish species, which may complement or replace the use of exotic species for culture purposes (MRC 2000).

The "Management of Reservoir Fisheries - Phase II" component is developing reservoir management methods (particularly co-management) and is using the Nam Ngum reservoir as a study area in Lao PDR.

The “Assessment of Mekong Fisheries” component is a research initiative aimed at describing the importance of the Mekong fisheries with a long term view to influencing policy decisions concerning activities that might impact the fishery.

Under the Environment Programme of MRC the “Inventory and management of Wetlands” project is addressing assessment and management issues related to aquatic habitats, although not directly addressing fisheries, it is dealing with management of aquatic resources in the broader sense.

The establishment of the Lao Aquatic Resources Research Centre (LaRReC) is part of a Danida funded project with assistance through the Mekong River Commission. Through LaRReC, Lao PDR is participating in several regional fisheries components of the Mekong River Commission (MRC) Fisheries Programme, as described above. The funding for these activities is wholly provided by Danida.

A recently signed Danida funded project - “Integrated watershed management in Xieng Khouang and Hooa Phan provinces” will commence activities shortly. It is anticipated that this project will have some activities relating to aquatic resources management or aquaculture development, but this is still exploratory. It is also likely that this project will also be working with one of the LAO/97/007 district counterparts.

The International Development Research Centre of Canada (IDRC) funded the "Indigenous Fishery Development Project" based in the Champassak Provincial Livestock Office. The project had several components including a study of the migration of Mekong River species in the southern region of the country. Induced breeding and fry production of commercially important indigenous species was developed and staff trained at several provincial fish farms in both northern and southern Lao PDR. This project has been completed and the results published.

The second phase of this project is currently underway and is researching the effects of stocking fish into small water bodies (backswamps). The second phase is co-funded and now receives most of its funds from ACIAR (Australian Council International Applied Research).

ICLARM is implementing a project addressing “Legal and Institutional Framework, and Economic Valuation of Resources and Environment in the Mekong River Region: A Wetlands Approach” beginning in mid-2000 running initially for three years. This is a regional project with activities in the sector particularly in relation to the economic

importance of fish and its role in the livelihood strategies of rural poor. The institutional aspects of this project will deal with the lack of clarity in terms of governmental responsibility for the management of aquatic resources. Its main collaborators in Lao PDR are under the Ministry of Agriculture and Forestry.

4.5 Entry points into rural development

4.5.1 Aquaculture

Aquaculture is a great entry point into rural development initiatives as it is very easy to stimulate interest in fish production among rural households. Since over 70% of rural households undertake some fishing their interest in increasing fish production is understandable.

Barring a few constraints mentioned earlier (section ?) the perception is that raising fish is easy “you just need to feed them twice a day” (Murray *et al.* 1998), further it is also seen that “fish had few disease risks, were easy to feed, readily marketed and convenient³² to have around the household” (Tan *et al.* 1999).

This makes it relatively easy for the district staff to initiate activities on fish production. If this dialogue is fostered in the right direction it is then relatively simple to broaden the scope of the work into other (initially production oriented) activities. There are some preliminary trial of using households who have been successful in aquaculture production to broaden out into improvement of small livestock (chickens) and try on fruit tree production.

Although it is still too early to critically evaluate how effective aquaculture promotion is as a starting point for other rural development initiatives, the indications so far are positive and worth pursuing in the medium term.

4.5.2 Aquatic resources production and management

LAO/97/007 focused on the promotion of small-scale (robust) aquaculture, suitable for a substantial proportion of rural households. However, the project has all along argued that aquaculture is not accessible to everyone. To become involved there is a minimum requirement of suitable resources, land, water, some access to fry/fingerlings and ideally some available inputs. Not only are these assets needed, they need to be available in the right context. Aquaculture will never be as widespread such as rice cultivation or even chicken raising (over 72% of all rural households³³), it does however have great linkages to aquatic animal production as a whole.

One change for a second phase of the project would be to shift the emphasis from identifying where aquaculture can be successful to a needs/opportunity assessment of aquatic animal production. In this way the target group that can be reached by the project is greatly increased and is of relevance for most of the rural population in Lao PDR.

³² One reason being that fish were quiet and did not make noises if one forgot to feed them, compared to other livestock such as pigs.

³³ Chicken raising was found in over 82% of all households engaged in livestock raising.

4.5.3 Post Harvest processing – food security, income generation & health

Post-harvest processing is an area not solely confined to aquaculture that has opportunities for households that engage in fishing activities³⁴. In one survey of a Luang Pabang province, 95% of households in 63% of villages engaged in fishing and collection of aquatic animals for subsistence (MRC 2000). Post harvest processing is predominantly a woman's activity in Lao PDR and women would certainly form the majority of participants in these types of activities. LAO/97/007 pilot activities in Sayaboury province attracted a large number of women during an aquaculture training course. Other farmers groups have expressed a desire to become involved in processing since it presents income-generating potentials. It is notable that some ethnic groups do not have a tradition of fish preservation or processing and lack the basic knowledge to become involved.

The prevalence of human liver fluke infection in Lao PDR is extremely high (36 – 60% results of three studies 1991 & 1999) and can lead to debilitation, susceptibility to other disease and liver disease. Although easy to treat, re-infection is almost immediate due to poor food preservation techniques (insufficient fermenting), preference for raw fish and lack of latrines. Effective processing coupled with hygiene messages could positively impact this health issue. Preliminary inter-department (Livestock & Fisheries and Health Department) collaboration has already taken place during a recent one year FAO technical co-operation project.

Preservation of aquatic products during times of plenty ensures food security during periods of low food availability. Food preservation also provides significant opportunities for income generation and women are predominantly involved in this aspect of aquatic resource utilization. Women's involvement can be greatly enhanced though a more holistic approach to the role of aquatic resources in rural livelihoods.

Widespread capacity to organize and train women in post harvest processing does not currently exist in Lao PDR but partnerships with institutions such as Lao Women's Union could develop such capacity.

4.5.4 Marketing – processed aquatic products, fingerlings, table fish

LAO/97/007 farmers groups that have been established for several years and which have increased the numbers of ponds and their production output are increasingly interested in the potential for income generation. Many groups are in locations that are not easily accessible to provincial markets, although they could reach district markets. Marketing support to these groups could enable groups to develop small regular (weekly, monthly) marketing days for their products (fresh fish preserved fish) and attract buyers. Such markets would also offer the spin-off opportunities for marketing other products.

Fingerling and fry producers do not generally have problems in marketing their product due to high local demand. The fry and fingerling producers are natural extension channels as are fry traders (although currently limited in number in Lao PDR, there are fingerling traders in Savannakhet that the LAO/97/007 counterparts have identified for assistance). Trading networks for fingerlings are essential for further development of aquaculture in rural Lao PDR.

³⁴ According to Lao Agricultural Census 1998/99, 71% of rural households are engaged in fishing other than agriculture, and 56,000 holdings have some form of aquaculture (8 %) (Agricultural Census 2000).

Since marketing capacity does not exist in the Livestock & Fisheries Sections, it would be necessary to form partnerships with other government institutions to deliver these services. Marketing support and post-harvest processing could all be introduced as components within a LAO/97/007 type framework.

4.6 Impact on national economy

Aquaculture production potential for by rural smallholders should not be seen in terms of total tonnage produced for Lao PDR on a national scale, but rather what pivotal role it can play in bridging the opportunities for moving from subsistence to marketing more of the household production. It addresses food security while allowing for cash income generation.

It is difficult to see rural small-scale aquaculture production having a great impact on overall national production of aquatic animals. For now and the foreseeable future the bulk of the aquatic animals consumed in Lao PDR are originating from the natural aquatic resources.

Recent statistics indicates that over 8% of the rural households are currently engaged in aquaculture, this is equivalent of 55,500 households (Agricultural Census 2000). The total production from these households are probably between 3,600-5,400 tonnes³⁵. The estimated annual consumption of aquatic animals is in the order of 100,000 tonnes³⁶. The contribution of cultured fish to the total fish production (including imported but excluding exported fish) is thus about 4% of the total.

Despite this rather modest contribution to the national fish production small-scale aquaculture is far more important than what these figures indicate. To the 55,500 families (8% of the Lao population), it contributes significantly to the households' food security strategy and provides potential for income generation.

³⁵ Based on an estimated household production of between 66-97 kg per year.

³⁶ Based on an estimated average consumption of 20kg/person/year and a population of 5.1 million.

5 Institutional aspects

5.1 Government strategy for the aquatic resources sub-sector

During 1998-1999 the Ministry of Agriculture and Forestry (MAF) developed “A Strategic Vision for the Agricultural Sector” (MAF 1999). The objective was to ‘explain the government’s policies, strategies and linkages for the agricultural sector over the next 10 years’. It is intended that this strategic vision will provide a clear basis for the precise needs for particular types of development initiatives. A schematic diagram of the roles of the various levels of government in the agriculture sector is presented in figure 1.

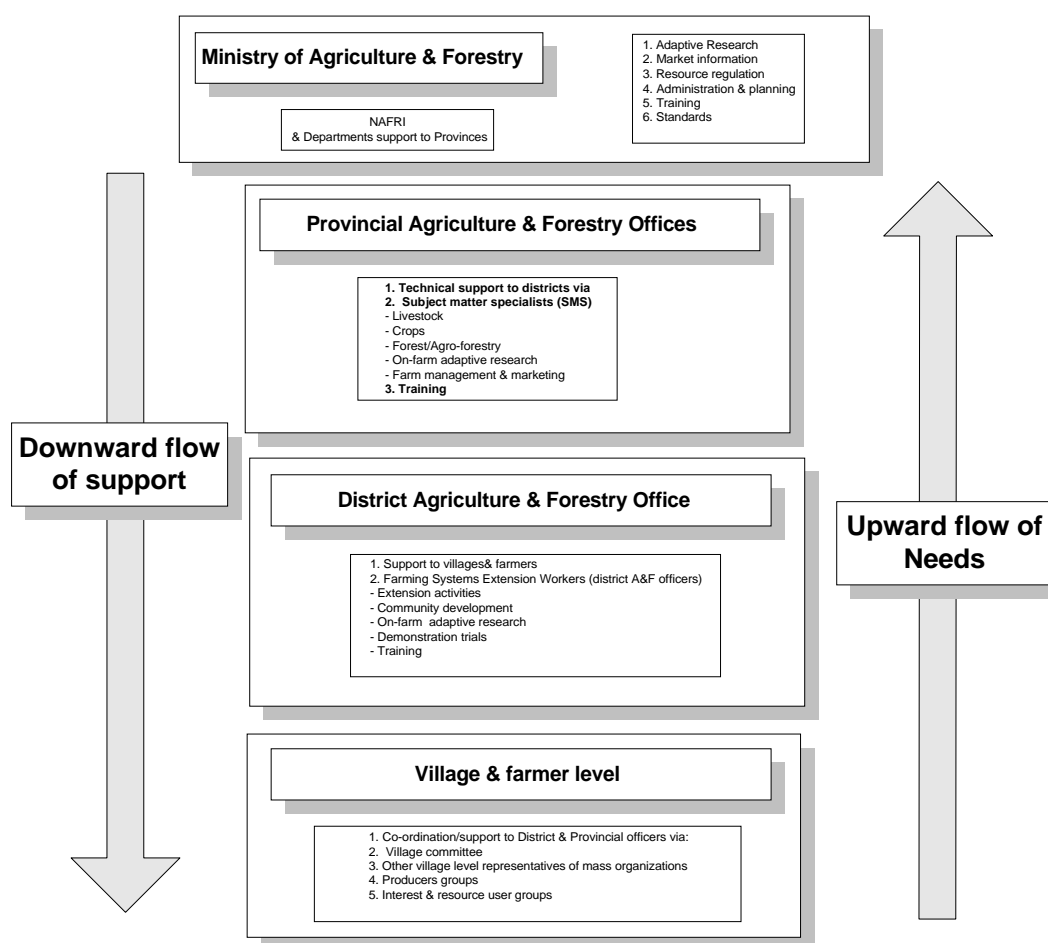


Figure 1: Ministry of Agriculture’s decentralised Agriculture Services Support system to provide Technical support and supervision to manage and co-ordinate the movements and activities of the Farming systems Extension workers (District Officers).

The overriding focus of the strategic vision targets poverty alleviation, developing productive farming systems and improvement of the social and economic livelihoods of the people of Lao PDR. Also high on the agenda is the conservation of natural resources and biological diversity for the benefit of future generations. Presently, Lao PDR can barely produce enough food to feed its people, thus a main priority is to improve food security. The main agency responsible for improving this situation is MAF.

Although there are indications that it is being recognised that fish is one of the most important sources of animal protein in the Lao diet, the Lao government lacks a strategy for development and management of aquatic resources. A feature of the “Strategic Vision for the Agriculture Sector” is that initiatives for management and development of aquatic resources are under-emphasized, indeed the whole livestock and fisheries “sector” is not very well emphasized. This is due to a combination of poor appreciation of their importance in rural livelihoods and a tendency to take the availability of these resources for granted. Historically, awareness of the importance of a resource only comes once it has significantly degraded. This often leads to an ‘investment’ intervention through promotion of aquaculture, justified in terms of replacing the loss of what was earlier caught from the ‘wild’. While this may be true in some cases, this is missing the real importance of promotion of small scale aquaculture in rural areas, which lies in its role in food security strategies targeting poorer households, diversifying the farming system and providing cash income generating opportunities.

Within the livestock and fisheries sector, aquaculture is recognized as an appropriate entry point for working with the rural poor (Wysocki and Friend 1998). The reasons for this are related to the high cultural significance of fish and aquatic products in Lao PDR, unsatisfied rural demand, rapid yield and flexibility for food security or income generation. These features are highly significant in terms of which intervention to use for developing capacity and systems in the agricultural sector. There is no other form of livestock rearing that has such a small unit size, high market value, high disease resistance and rapid yield.

Promotion of small-scale aquaculture, whilst relevant and appropriate, is unable to reach some parts of the rural population as there are certain preconditions for households to incorporate the activity in the farming activities. In instances such as this, the promotion of community-based fisheries (natural or enhanced stocking) may be an approach to assist households in benefiting from increased fish availability. Alternatively, the community management of some of the natural aquatic resources may assist in enhancing the amount fish caught in common property areas such as swamps, in and around rice fields and streams. Under the new Agricultural Services Support System it is important that the dialogue with farming households and communities explores the various needs and opportunities and does not simply look for areas where existing solutions can be applied.

The strategic vision does recognise that the livestock and fisheries sub-sector has been under-funded³⁷ (both from national resources and international investment) and indicates that more resources will be made available for the development of the sub-sector in the future (MAF 1999). This is appropriate since the sub-sector contributes to some of the central issues in rural livelihoods, which the government wishes to address.

The development of aquatic resources deserves to be given a higher priority by the Lao Government, being a key component in improving food security in the country. Additional reasons for prioritising aquatic resources are the potential to; generate cash income, develop employment opportunities and diversify the agricultural system. All of these features are high on the government’s agenda for the agricultural sector.

³⁷ Livestock and fisheries contribute 40% to agricultural GDP and substantially to unofficial exports and is the main source of cash income and rural assets for farming households. Despite this, it receives only 3-5% of MAF local resources, whereas Irrigation gets 66%. In addition, foreign public investments have principally focused on irrigation (45%) and forestry.

5.2 Government capacity

The government's involvement in aquaculture development is implemented at both national and provincial levels.

5.2.1 National level – Livestock & Fisheries Development Division

At the national level the Department of Livestock and Fisheries (DLF) of the Ministry of Agriculture and Forestry (MAF) implements aquaculture development projects through its Livestock and Fisheries Development Division (LFDD). The principle role of the DLF is to act as a technical advisory body assisting MAF in the development of policy and planning. DLF obtains its information regarding the provinces from a variety of channels, which vary from simple reports of livestock numbers, to relatively detailed verbal accounts collected through field visits to the provinces by DLF staff. This information is then synthesised and reported to MAF for use in policy and planning. It should be noted that this information system is neither systematic nor comprehensive and is in need of further improvement.

Technical capacity of the central level is limited and tends to be confined to experiences in aquaculture rather than fisheries, therefore the actual role of the fisheries officers at the LFDD is better suited to management and co-ordination of provincial activities rather than aquaculture extension. There is no direct central government support to aquaculture and fisheries extension.

The recently established the Living Aquatic Resources Research Centre (LARReC) under the National Agriculture and Forestry Research Institute (NAFRI) is now charged with the responsibility for technical research into aquatic resources issues. Whilst LARReC has the responsibility for development of improved techniques through research, it is the responsibility of the Department of Livestock and Fisheries to (technically) support provincial development of aquaculture and fisheries. The creation of NAFRI has resulted in some institutional changes in the relationship between extension (one of the roles of the DLF) and research (now the role of LaRReC). The result of creating two institutions, where there was previously one, is a loss of co-ordination between research and extension. This issue is currently being addressed, however there is not yet a working example of: how the institutions will establish research priorities; how the results of research will be disseminated and how this research will be relevant to extension activities.

5.2.2 Provincial level

At the provincial level, the Livestock and Fisheries Section (LFS) of the Provincial Agriculture and Forestry Services Office (PAFSO), undertakes extension activities and also operates provincial hatcheries.

The role of the provincial level officers is to provide technical support and some training to district staff. These officers are now termed "Subject Matter Specialists" (SMS) in recognition of their specialization in a particular agricultural sub-sector. The SMS's report to the provincial livestock sections and are also in occasional contact with the Livestock & Fisheries Development Division. The majority of Provincial Livestock & Fisheries Section (LFS) staff have a background in basic veterinary or livestock practice rather than aquaculture or fisheries. In some LFS's there is some aquaculture and fisheries technical capacity, built through TA and research projects over the past 25 years. One main limitation of these PLFS officers is the expectation that they should be technically competent in more intensive forms of aquaculture. This leads to a tendency to rely on theoretical methods for aquaculture ("by the book"), rather than what is actually feasible in an area. This is also a risk when

developing an extension system that is over-reliant on “training of trainers” without sufficient supporting practical experience.

The private sector does access the LFDD and LFS for technical information and assistance but these institutions have a limited ability to respond to their needs. The lack of a consultative network tends to limit officers to knowledge within the province rather than being able to access knowledge on a national basis.

Support to aquaculture development is largely confined to establishment and support of provincial hatcheries. These hatcheries are currently under provincial government control and although they have been privatised in the past the hatcheries were transferred back under government control approximately four years ago.

Provincial hatcheries produce fish fingerlings for sale to farmers and the proceeds are used to support hatchery activities during the seed production season. After this season the hatcheries produce fish for consumption using nursery ponds for grow-out. Income is thus generated from both fingerlings and table fish production. The Provincial Agriculture and Forestry Office PAFO or PLFS controls the profits from the hatchery operation.

Profits support the hatchery staff and allow for minor improvements, but in general the hatcheries do not retain sufficient funds from their operating profits to allow for reinvestment in infrastructure, leading to gradual deterioration of the systems and ponds.

The market environment for the provincial hatcheries is not conducive to profitability, due to poor road infrastructure and over-dispersed market for fingerlings.

Although possessing knowledge in fingerling production and aquaculture in general most hatchery managers do not see themselves as extension workers or trainers. It is not in their immediate interest to see farmer based fingerling production in their area as this may limit their own market. This is probably groundless, since the hatcheries’ ability to produce species that farmers cannot breed still gives them a competitive advantage. The role of the provincial hatcheries in producing and maintaining broodstock should be strengthened in the future.

There is no support to aquaculture at district level, except in cases where TA projects have developed district officer capacity. Extension capabilities are rare due to lack of training, or the opportunity to undertake extension.

5.2.3 District level

Under the “Strategic Vision for the Agriculture Sector”, district level staff have had their role redefined as Farming System Extension Workers (FSEW’s). This is both a change from their original sub-sectoral specialization and also a recognition of the fact that they often have broad responsibilities not confined to their original discipline. Significant up-grading of these officers will be necessary if they are to perform their new function. These officers will require training and experience in a broad range of rural development skills, including community development and participatory techniques. Within this new role, the district officers will provide villages with support for establishment of their development plans and liaise with the province in seeking access to relevant services.

The district level is the first level where the process of enabling villagers to express their needs and other requirements to the government. It is here the dialogue between the government and its people can begin and allow for rural people to influence the direction of overall development of rural areas.

5.3 Private sector and NGOs

The private sector in aquaculture consists mainly of artisanal small-scale aquaculture operations. There are some more intensive operations surrounding the larger towns and cities these, however, are the exceptions rather than the rule. Even these more intensive farms are often integrated with some other activity (section 2.4.7) since the infrastructure to support a stand alone fish farm of a reasonable size does not yet exist anywhere outside of Vientiane (*e.g.* reliable supply of agricultural by-products, cold storage/ice, roads, electricity, large volume market). This means that semi-intensive fish culture is unlikely to make a rapid and significant contribution to the *tonnage* of fish production in Lao PDR in the foreseeable future. The poor infrastructure and lack of road transport limits the range of such operations as, realistically only a small market area around the operation can be reached with a perishable product such as fish.

NGOs have often included aquaculture as a component of many rural development interventions. Aquaculture is often mentioned during needs assessment activities, however the means by which it can be implemented is poorly understood. Digging ponds and stocking fish does not guarantee continued involvement. Often, the act of bringing fingerlings to an area is sufficient to stimulate aquaculture activities, but unless the supply of fingerlings is assured, the ponds will slowly become trap-ponds and yield little fish. It should be mentioned however, that once dug, a pond is never ignored completely (section 2.4.1). Attention to fingerling supply concurrent with pond construction is essential, if the initial momentum that can often be generated through aquaculture is to be sustained.

Lao villages have several means for mobilizing villagers. Mass organizations such as the Lao Women's Union and the Youth Union can facilitate targeting of specific groups. The village headman and the Council of Elders are an alternative. Under the government plans for decentralization, all of these organizations are expected to be active in the formulation of village development plans.

During the activities of LAO/97/007, the functional unit at village level was a farmers group. The formation of this group was a useful tool for the preliminary contact between the project and the farmers and may be retained as an initial activity in new areas.

As activities diversify, there are occasions where a farmer's interest group is not the most appropriate structure for implementing activities. In cases such as this, entire villages or simply individuals might be the more appropriate functional unit. The mass organizations are another channel by which targeting and implementation can be made more effective for some activities. The functional unit for activities should not be confined to a single model but should be determined by what is appropriate for the particular situation.

5.4 Support services

5.4.1 Credit (formal and informal)

Formal credit for aquaculture is relatively difficult to access due to high interest rates and requirement for collateral on individual loans. The Agriculture Promotion Bank (APB) does not have a nation-wide policy on lending for aquaculture and loans are discretionary, often on a case-by-case basis. The APB itself does not yet accept that aquaculture is a sufficiently low risk activity to allow extension of credit to farmers groups. This is partly due to the tendency

for farmers to consume their production rather than take it to market. This attitude may change due to high fish prices and increasing rural access to local markets.

The APB is effectively the only source of formal credit for rural farmers and has a group-lending scheme, which offers an opportunity for women since the requirements for collateral have been removed. However the current requirements for group formation and travel to provincial centres to pay interest on loans can be regarded as a considerable obstacle to obtaining credit for aquaculture ventures. The short lending periods (usually less than 12 months) are an additional deterrent to borrowing.

The diversification from purely subsistence livelihoods into some form of income generating activity is often accompanied by a requirement for credit. Generally, the type of credit which is required is for the further development of an activity that is already income generating and relatively low risk. Examples of this in the aquatic resource sector are food processing, fingerling production and intensified fish pond production.

It is part of the Ministry of Agriculture and Forestry's strategy to strengthen state owned banks' (SOCB's) credit services and a broadened framework of LAO/97/007 would be an appropriate channel to facilitate credit access. It cannot be expected that Provincial Livestock and Fisheries sections administer credit, but the ability to form groups, identify individuals and facilitate access to banking services could be a potential role.

Overall there is often little requirement for credit to stock a fish pond, since the money required can often be found within the household, being equivalent in value to 1–2 chickens for a typical small pond.

Borrowing for pond construction or farm improvements is an issue that arises as farmers develop increasing experience of aquaculture. There is little ability to borrow for this either, since the payback time is usually in excess of 5 years and banks will not lend for such an extended period. Often entrepreneurs/farmers have raised expectations of what can be produced by a pond in terms of fish and/or income. Construction of the aquaculture pond is only the first step and stocking and management are important considerations. Issues such as theft, flooding, lack of feeding (often due to shortage of on-farm inputs), short growing season (dry out of rainfed ponds) lower production and cannot be controlled by the pond owner. These factors all contribute to the uncertainty of borrowing. The most successful rural aquaculture operations start small and develop gradually by reinvesting income from the operation back into the farm over a period of years. In this way credit may have an increasingly important role in expanding existing operations.

There is little information regarding informal credit systems in aquaculture and it is probably fair to assume that borrowing sums large enough for pond construction is not possible in rural subsistence farming areas. Borrowing for stocking is extremely unlikely for the reason given above. Alternative mechanisms do exist, such as fingerlings for stocking being paid for after harvest. Farmers may "borrow" broodstock to breed fingerlings and repay with some of the fingerlings produced. These informal mechanisms are known in areas where aquaculture projects have been active and farmers (sometimes with the assistance of project counterparts) develop their own solutions to the constraints facing them.

5.4.2 Educational institutions

There are three agriculture colleges in Lao PDR that offer some basic learning in aquaculture (Pak Xuan–Luang Pabang, Nah Bong–Vientiane and Pakse Agriculture College-Champassak). The colleges all have access to basic aquaculture facilities for practical demonstrations. Students that specialize in the aquaculture course also have a period of work experience at a

private farm or more usually a Provincial hatchery. The graduates from the colleges may enter government service with this grounding in aquaculture. Further studies in Nah Bong to degree level are also possible. Lecturing staff for the aquaculture course have been drawn from the Livestock & Fisheries Development Division in the past.

There have been some initiatives to dig school fish ponds, which have met with varying degrees of success or failure, largely due to lack of management and that they rarely provide cash income to maintain input levels. The intention of these ponds is to improve fish consumption of the schoolchildren, although the contribution is low. A more likely impact is awareness raising amongst children as to the possibilities of aquaculture.

5.4.3 Research

The newly created Lao Aquatic Resources Research Centre (LARReC) is intended to be the focal point for research into living aquatic resources in Lao PDR. LARReC has a small aquaculture unit (2 persons), and is currently identifying researchable issues. In the short to medium term, there are few researchable issues that will directly impact small-scale aquaculture development. Farmer-based experimentation affords more opportunities for locally appropriate research and this can more easily be incorporated into extension activities.

There are a number of externally funded research projects (TA, Universities) investigating aquaculture; culture based fisheries and other aquatic resource issues. These projects are based either in LARReC or are operating in the provinces under the nominal jurisdiction of LARReC.

6 Conclusions and recommendations

The main occupation in rural areas of Lao PDR is growing staple crops for food security, in which rice security is central. This food security strategy is complemented by production fish, eggs and meat. Proportionally more meat is bought and more fish is home-produced (raised or caught). The rice-based diet, is nutritionally incomplete, lacking lysine but this is largely balanced by consumption of lysine-rich fish. Based on available survey data and census statistics the diet in rural Lao PDR seems to be almost complete in terms of energy, protein and essential amino acids.

Livestock is the main source and opportunity for cash income generation in most rural households. Since much of the livestock production is sold, fish serves as an intermediate, important for food security, but also a potential source of cash income. Fish is central to food security and provides a relatively low risk option for cash income generation, complementing other livestock options.

Small-scale rural aquaculture provides an excellent starting point for rural development initiatives and can play a pivotal role in developing rural Laos. It provides a popular starting activity, which then can be built upon by additional development initiatives, initially in related sub-sectors such as livestock rearing.

Rural smallholder aquaculture will not replace capture fisheries in the foreseeable future, but will provide an important complement to this adding to the existing fish availability. There is little incentive to stop fishing just because one begins to grow fish, so it is also unlikely that successful promotion will significantly reduce the pressure on the natural stocks. However, the convenience of fish ponds is highly attractive, in reducing the amount of time spent fishing. This time saving allows diversification into other activities closer to the home.

The importance of small-scale rural aquaculture in general and in Lao PDR in particular is not in its contribution in total tonnage to the national fish production but who and how it impacts at the household level. Small-scale rural aquaculture can benefit the rural poor by adding to the food security strategy and provide opportunities for cash income generation in a relatively low risk way. It also provides an excellent opportunity to begin rural development initiatives due to the high interest among the majority of rural households in increase the production of fish.

Diversification of uses of aquatic resources also provide good potential opportunities for rural subsistence farmers. Such diversifications include the improved management of common water resources, processing of aquatic resources in times of plenty and increased interaction with cash economies through marketing of aquatic products (fresh and preserved).

Development of intensified aquaculture to supply urban areas has good economic potential, although the private sector is more than capable of developing this. This activity is still constrained to some extent by the limited supply of quality fish fingerlings and formulated fish feeds. The number of aquaculture operations such as this that could be developed do not yet make it attractive for large feed companies to become significantly involved.

The gradual incorporation of subsistence farmers into the cash economy can be seen as a strong force for development in rural areas. As yet, livestock and fisheries are the only realistic (low risk) income generating options for most of the country's subsistence farmers, but to date the sub-sector has been marginalized as a result of excessive donor and government focus on infrastructure development (irrigation and other) and forestry.

Extension processes in Lao PDR are constrained by lack of manpower and limited experience of farmer driven extension. This attitude has changed somewhat through the activities of the Provincial Aquaculture Development Project (LAO/97/007), but is still in its infancy and needs substantial further support before it could be considered adopted nationally.

7 Bibliography

- Agricultural Census 2000 Lao Agricultural Census, 1998/99 – Highlights. Agricultural Census Office, Ministry of Agriculture and Forestry and National Statistics Centre, Vientiane, 62 pp
- AIT 1997 Issues in developing fish seed supply. Policy Paper No. 1, AIT Aqua Outreach, Asian Institute of Technology, Bangkok, 4 pp.
- Asiaweek 1999 Economic and Social Indicators, Asiaweek Web Pages.
- DLF 1997
- Funge-Smith, S. J. 1998 Small-scale rural aquaculture in Lao PDR. Field document 11, Provincial Aquaculture Development Project LAO/97/007, FAO/UNDP, Vientiane, 16 pp.
- Funge-Smith S. J. & DuBeau, P. 1999 Aquatic Animal Health Management- issues in rural aquaculture development in Lao, 12 pp
- Garaway, C. 1999 Small water body fisheries and the potential for community led enhancement: Case study in Lao PDR. Ph.D. Thesis Imperial College of Science Technology and Medicine, University of London, London, 413 pp.
- Garrow, J.S. and W.P.T. James (eds.) 1993 *Human Nutrition and Dietetics*, 9th ed., Churchill Livingstone, Edinburgh, London, Madrid, Melbourne, New York and Tokyo
- GPAR 2000 Information pamphlet of the Governance and Public Administration Reform Programme, UNDP, Vientiane.
- LECS 2 1999 The households of Lao PDR – Social and economic indicators from the Lao Expenditure and Consumption Survey 1997/98. National statistics Centre, State Planning Committee, Vientiane, 67 pp.
- MAF 1999 The Government's Strategic Vision for the Agricultural Sector. Ministry of Agriculture and Forestry, Vientiane, 76 pp.
- MAF 1999b Agricultural Statistics of Lao PDR – 1998. Permanent Secretary Office of the Ministry of Agriculture and Forestry, Vientiane, 146 pp.
- MRC 1999 MRC Programme for Fisheries Management and Development Cooperation (1999-2000). Mekong River Commission Secretariat (MKG/R. 95063, Rev. 4), Phnom Penh.
- MRC 1999a *unpublished data from survey in Nam Ngum reservoir by MRC Reservoir Management Project.*
- MRC 2000 *Draft report of unpublished survey data from Luang Prabang Province by MRC Assessment Project.*
- MRC 2000b Final Component Description to Fisheries Sector Programme Support – Aquaculture of indigenous Mekong fish species. Mekong River Commission, NCG and Danida.
- Murray, U., Sayasane, K. & Funge-Smith, S.J. 1998 Gender and Aquaculture in Lao PDR: A synthesis of a socio-economic and gender analysis of the UNDP/FAO Aquaculture Development Project LAO/97/007 (Edited: Eva Jordans), FAO, Rome.

- Provincial Aquaculture Development Project (2000) Annual Project Report, LAO/97/007, Vientiane, Vientiane, 35 pp.
- Tan, B., Choundara, H and H. Guttman 1999 Mid-term evaluation report of LAO/97/007, FAO STS Field document 8, Provincial Aquaculture Development Project LAO/97/007, Vientiane, Vientiane, 92 pp.
- UNESCO 1994 Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, Iran 2.2.1971), as amended by the Protocol of 3 December 1982 and the Amendments of 28 May 1987, as of July 1994. Office of International Standards and Legal Affairs, UNESCO. [Online].
Available: http://www.iucn.org/themes/ramsar/key_conv_e.html [1998, March 3].
- Welcomme, R. and C. Vidthayaonon 1999 Report on the impacts of introduction and stocking in the Mekong basin and policies for their control. Mekong River Commission, Vientiane, 66 pp. [DRAFT]
- Wysocki, J. and R. Friend 1998 Aquatic Resources and Rural Livelihood. Report to the ToR 'Regional Aquaculture Approach Assessing Potential for Poverty Reduction'. DFID, 39 pp.
- UN 1996 Country Strategy Note – Lao PDR and the UN until 2000. United Nations and the Committee for Investment and Cooperation (Lao PDR), Vientiane, 44 pp.
- UNDP 2000 Overcoming Human Poverty – Poverty Report 2000. United Nations Development Programme, New York, 138 pp.

8 Glossary

Broodstock – adult fish that are kept to use for spawning to produce fry

culture-based fishery – a fishery in a communal or open resource that is dependent on stocking of fingerlings for the recruitment

grow-out – the part of the fish production cycle that involves growing fingerlings to table size fish ready for sale

happas – small net cage to nurse fry to fingerlings for stocking

oligotrophic – describing a body of water (e.g. a lake) with a poor supply of nutrients and a low rate of formation of organic matter by photosynthesis

peri-urban – around the edges of towns

polyculture – culturing more than one species of fish simultaneous in the same pond or cage

trap-ponds – small ponds dug to trap fish as they return to the permanent water bodies during draw down of water that inundated large areas during the wet season

Annex I

All project outputs are available as Acrobat (.pdf) files that can be read on any operating system. These documents are recorded on CD-Rom media and copies of file should be available through FAO Regional Office Bangkok, FAO Library Rome or FAO Representation in Vientiane. Additional copies are also lodged with the Lao Living Aquatic Resources Research Centre and Livestock and Fisheries Development Division.

Technical reports and manuals

- "Mini-Hatchery Development", Samruay Meenakarn (1998), Consultancy report, FAO Mini-hatchery Consultant, (8-23 May, 1998), Provincial Aquaculture Development Project (LAO/97/007) STS Field Document 1. 19pp.
- "Small-Scale Fish Hatcheries for Lao PDR", Samruay Meenakarn & Simon Funge-Smith (1998), FAO Mini-hatchery Consultant, (8-23 May, 1998), Provincial Aquaculture Development Project (LAO/97/007) STS Field Document 3. 62pp.
- "Socio-economics and Gender in Aquaculture", Úna Murray & Kesone Sayasane (1998), Consultancy report, FAO Gender consultants, Provincial Aquaculture Development Project (LAO/97/007), STS Field Document 2. 103pp.
- "Gender and Aquaculture in Lao PDR: A synthesis of a socio-economic and gender analysis of the UNDP/FAO Aquaculture Development Project LAO/97/007", Úna Murray, Kesone Sayasane & Dr. Simon Funge-Smith, Edited by Eva Jordans (1998), Provincial Aquaculture Development Project (LAO/97/007), STS Field Document. 40pp.
- "Intra-household dynamics of food security in Lao PDR: An aquaculture case study", Nouhak Liepvisay, Úna Murray & Kesone Sayasane (1998), Paper presented at FAO Technical Consultation, Intra Household Dynamics and Rural Household Food Security, Bangkok, Thailand, 15-18th September, 1998, FAO RAPA Bangkok, Thailand.
- "Broodstock and Hatchery Management", Francois DeMoulin, Consultancy report, FAO Broodstock Management Consultant, (5 January - 6 February 1999) Provincial Aquaculture Development Project (LAO/97/007) STS Field Document 4. 29pp.
- "Guidelines for Broodstock and Hatchery Management", Francois Demoulin, FAO Broodstock Management Consultant, (5 January - 6 February 1999) Provincial Aquaculture Development Project (LAO/97/007), STS Field Document 5. 61pp.
- "Farmer training in small-scale hatchery techniques", Samruay Meenakarn, FAO STS Small-scale hatchery Consultant, (2-16th May, 29th May - 9th June 1999), Provincial Aquaculture Development Project (LAO/97/007), STS Field Document 6. 22pp.
- "Small-scale rural aquaculture in Lao PDR (Part I) ", Simon Funge-Smith, FAO Aquaculture Newsletter, August 1999, No. 22, pages.
- "Mid-Term Evaluation Report", Brett Tan, Hans Guttman & Han Choundara, FAO Consultants, (September 1999), Provincial Aquaculture Development Project (LAO/97/007), STS Field Document 8. 87pp.
- "Aquatic Animal Health Management Issues In Rural Aquaculture Development In Lao PDR", Simon Funge-Smith & Pierre Dubeau (1999), Proceedings of DFID/FAO/NACA Regional Scoping Workshop on Primary Aquatic Animal Health Care in rural, Small-scale Aquaculture Development in Asia, 27-30th September, 1999, Dhaka, Bangladesh.
- "Small-scale rural aquaculture in Lao PDR (Part II) ", Simon Funge-Smith, FAO Aquaculture Newsletter, December 1999, No. 23, pages 17-21.
- Development and Training for Participatory Extension Techniques with the Provincial Aquaculture Development Project (LAO/97/007), Participatory Development Training Centre, FAO Consultants,

(15th February - 8th April 2000), Provincial Aquaculture Development Project (LAO/97/007), STS Field Document 7. 31pp.

- “The role of aquaculture in rural subsistence livelihoods in Lao PDR, Hans Guttman & Simon Funge-Smith, Provincial Aquaculture Development Project (LAO/97/007), STS Field Document 9. 34pp.
- “Provincial Aquaculture Development Project Phase II Formulation Mission”, Hans Guttman, FAO Consultant (28th July – 18th August, 2000), Provincial Aquaculture Development Project (LAO/97/007), STS Field Document 10. 69pp
- "Low input aquaculture systems in Lao PDR", Simon Funge-Smith (2000), Provincial Aquaculture Development Project (LAO/97/007) STS Field Document 18

Progress Reports

- Quarterly Report – January 1998
- Quarterly Report – March 1998
- Quarterly Report – June 1998
- Annual Report 1998
- Project Progress Evaluation Report 1998
- Quarterly Report – January 1999
- Quarterly Report – April 1999
- Quarterly Report – July 1999
- Annual Project Report 1999
- Advisor’s Presentation to Tripartite Review 1999
- Quarterly Report – January 2000
- Quarterly Report – April 2000
- Quarterly Report – July 2000
- Annual Project Report 2000

Other material

There is considerably more project output material included on the CD-Rom. This includes:

- Baseline survey Database and tables
- Extensive baseline and monitoring data (as Excel files and also tables)
- Donor and review meeting presentations
- Photo archive (JPG files)
- Line drawings for extension manuals
- Lao Language translations of technical manuals (fish breeding, broodstock management, gender and aquaculture)
- Lao language extension manuals (rice-fish culture, nursing of fingerlings, small pond culture, carp breeding, silver barb breeding)
- Scripts for extension videos
- Additional reports not listed above (Provincial Hatchery renovations, extension strategy)
- Other “grey literature” for aquatic resources sector projects in Lao PDR (Indigenous fish, Assessment Mekong Fisheries, Reservoirs, Development theory)

Annex II – Institutional relationships

Diagrammatic representation of LAO/97/007’s interface with the Lao Government agencies in supporting the development and strengthening of the government’s decentralised approach to rural development in the agricultural sector.

