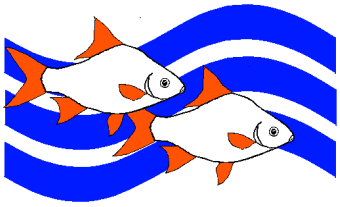

Low input aquaculture systems in Lao PDR

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By definition very low input aquaculture systems have the least level of management intervention and are probably the least independent from external influences. Low input rural aquaculture in Lao PDR has many typical features that are found in subsistence farming systems world-wide.

Low productivity

Lack of agricultural surpluses from subsistence farming systems limits the productivity of fish ponds (typically 500 – 1,000 $kg.ha^{-1}$). In many cases on farm agricultural surplus may be used for other livestock production. This may be due to the higher investment made in buying the livestock for on-growing or its more exclusive use for income generation.

The low stocking densities employed reflect the low feed input regime (typical 1-2 $fish.m^2$).

Increased production is possible through increased fertilization, however the additional labour for collection and movement of the manure may be unattractive. Additional side issues are the taste of greenwater reared fish and the lack of penning of livestock which prevents point sources of manure. This issue of other livestock needing to forage explains that lack of uptake of integrated livestock and fish culture. Animals penned over water must be fed completely and this is not possible in the subsistence system.

Vulnerability to external impacts

Shallow aquaculture ponds are liable to a variety of natural impacts that the farmer has limited capacity to control.

Shallow ponds (50cm water depth) will only fill in the monsoon season and dry out quickly after the rains stop. If the monsoon rains are inadequate then the growing season may be curtailed and production falls. Other water quality problems include high temperatures and pondwater fouling due to lack of exchange.

Monsoon rains may cause flash flooding and some ponds are vulnerable to this. Barrage ponds constructed across valley streams will be washed out if the dam is too small or runoff channels are not provided. Flooding of ponds in rice paddies is common.

Theft a significant cause of loss in rural aquaculture in Lao PDR. Since aquaculture is not a widespread activity, there is no strong social taboo on theft of fish. This may also be encouraged by the extensive tradition of fishing in both streams and paddy fields amongst rural Lao.

Minimization of risk to the family.

This means that total or partial loss of the crop (due to theft, disease, flooding, dry weather, failure to sell, predation) should not significantly impact the following:

Food security – the rural household requires other sources of food and staples such as rice, cassava and corn take precedence. Protein sources are derived from fishing, livestock and hunting. Typically the fish pond has a dual role for both food and income. This flexibility means that aquaculture integrates well to subsistence farming systems.

Economic liability – investment in the pond is usually minimal but purchase of fingerlings and other pond inputs can be significant. If the aquaculture operation is drawing resources from other farm activities such as pig or chicken rearing then the income derived from fish sales must replace that lost opportunity from other livestock.

Time – Excessive time spent guarding a pond or in other management activities may impact on other farm chores. It is generally considered that usually fish culture impacts on non-essential chores. All day guarding of a pond is unusual.

Seed supply

If fingerlings for stocking are not available at the early part of the monsoon season, then fish culture in seasonal ponds may be unattractive. The time investment in pond construction and feeding may not be offset by the returns from the pond. Fingerling supply is often a critical bottleneck for aquaculture expansion and erratic supply of fingerlings, high mortality (due to small size, transport stress, disease etc.) may deter farmers from becoming involved.

The production of fish fingerlings is a relatively specialized business that is usually extremely profitable. Transportation of fingerlings to farmers may employ middlemen and with increasing distances and numbers of links in the distribution chain, quality inevitably deteriorates.

Where wildfish are not or cannot be excluded from the system, predation is a serious problem. In this case the only feasible management method is to stock fingerlings at a size large enough to be unattractive to predators. Production of such large fingerlings is rarely done by hatcheries (the grow out time is excessive and the nursery area required is too great). Farmer based nursing can be a successful strategy to improve fingerling quality prior to stocking.

In countries with better infrastructure, the nursing of fingerlings may become a specialized business. The increased price of nursed fingerlings may be a deterrent to subsistence farmers who would prefer to buy smaller cheaper fingerlings and nurse them themselves.

What is the future and potential for change in this system?

It is wrong to assume that productivity is the goal of aquaculture at this level. The priority for rural subsistence farmers is diversity and risk minimization. Typical production per family are in the order of 10 – 60 kg, pond sizes are typically 100 - 400 m^2. The fish produced can provide a significant proportion of a families' fresh fish consumption, alternatively this represents a significant proportion of the families cash

income. These systems are extremely versatile in both production and economic terms the goal being minimal burden to the family.

Impacts from these systems are negligible due to small scale and diffuse nature. However, these systems are vulnerable to external impacts such as disease. Since the supply of fingerlings to these systems may be derived from a similar source as semi-intensive or intensive aquaculture, the risk of disease transmission via fingerling supply is significant. Issues such as competition for land are probably overstated. What is certain is that as land pressure increase there will be a tendency to intensify all parts of the farming system and this will favour the intensification of the aquaculture system.

The integration of aquaculture into the farming system is an essential feature. To improve the productivity of the aquaculture system, other parts of the farming system must be flexible enough to allow the change. Potential changes would include:

Increased feeding of the pond to increase fish production.

This would require additional inputs that would be drawn away from other livestock. If marketing of fish and fish production suitable compensated for this then this would be acceptable to most farmers. Increased agricultural production would also allow increased feed inputs. In this case it is the use of cash for fertilizer purchase that would stimulate this. The cash income from the increased agricultural production might in part be provided by the additional fish produced. The starting point of these developments is found in the increased accessibility of markets, potential for borrowing money, increasing cash economy in rural areas, road and irrigation development.

Pond deepening to increase water retention and extend the growout season

This would require some sort of income generation from the system. Manual construction is typical but opportunistic mechanical construction can occur. In cases such as this road construction or earth excavation for construction leaves deeper water ponds.

Fingerling nursing to limit early predation losses

Simple net cage based nurseries or shallow ponds can significantly improve survival of fingerlings after stocking. This activity is relatively specialized and requires farmers to produce or purchase fingerlings, it is therefore more likely that experienced farmers who are already pursuing aquaculture for some form of income generation would be come involved.

Fingerling production

Lack of fingerling supply limits farmers entry to aquaculture. Local farmer based fingerling production can overcome distribution and production bottlenecks. Such a problem is not as significant in countries which have relatively well developed communications networks and good rural accessibility.

Shift from food security to income generation

Movement from aquaculture as a part of a diverse farming system, to a specific income generating activity may occur in situations where the marketing and communications aspects of the system are guaranteed. If credit for expansion is not

available then the gradual conversion of the system is the more typical scenario. The timescale for this conversion can be in excess of 10 years.

Management activities in the low input rural aquaculture system in Lao PDR (column 2 represents increasing degrees of management intervention)

Management activity	Degree of management intervention	Comments
Construction of pond	Modification of existing natural pond Barrage ponds damming streams Manual excavation of shallow ponds Modification of paddy fields Mechanical excavation	Pond is often seasonal, unless supplied by stream Often seasonal and water depth less than 50 cm Either for rice-fish culture or conversion to pond Excavation cost may be repayable, but small pond size and limited number of units make plant transport non-viable.
Use of basic water control structures	Water outlet Water inlet Outlet screens Inlet screens	Prevent uncontrolled flooding and loss of stock Diversion of streams Prevent loss of stock Prevent entry of wildfish
Pond preparation	Pond filling Drying out Fertlization Liming	Monsoon rains, overflow from higher land or streams. Seasonal ponds dry naturally, permanent water ponds are rarely dried Animal manures may be applied. If water is use for household purposes, greenwater production may be unacceptable Rarely practised, due to lack of lime and it must be bought
Stocking	Wildfish naturally recruited Active stocking of wildfish Active stocking of hatchery produced fish Active exclusion of non-introduced (wild fish) species	Highly desirable for consumption, free – farmers are often reluctant to exclude Wildfish harvested from ponds or rivers transferred to pond for on-growing Wildfish supplemented with aquacultured species Exclusion of wildfish due to undesirable traits such as predatory nature (catfish, snakeheads, frogs), precocious reproduction (rasbora), small size (rasbora)
Feeding	No feeding Rice bran/Cooked bran/rice/cassava Other bi-products (fermented rice, beer waste, vegetable waste)	Common in situations where pond or paddy is remote from house Requires some rice surplus in the family. Rice bran is also fed to chickens and pigs, therefore there is competition for the resource. Feeding may not be daily.
Theft	Resource is not guarded	Pond or paddy too far from home. Crop losses are expected and little inputs are made to system on this assumption. Often such ponds are remote from the family home.

	Anti cast net device (sticks in pond) Watching pond	Deters occasional theft This usually accompanies stocking and feeding practices since an investment has been made. The crop value is usually significant to the family at this stage. Ponds such as this are often near the home or a family member is resident.
Harvesting	Occasional netting of pond Pond dry-out at end of season Batch harvest	Different methods select different species, often wildfish rather than stocked species. Fish are consumed All fish in the pond are removed (some may be transferred to other ponds for ongrowing to broodstock). Wildfish are consumed and stocked species may be sold. More common in cases where fish are grown for income. The fish are left to grow until they reach an acceptable market size.
Use of fish produced	All consumed Small fish and wildfish consumed, larger high value aquaculture fish sold Majority of fish sold All fish sold and other activities secondary to fish production	Pond a part of families food security Fish can provide source of income for purchase of commodities Fish culture a significant form of income generation for family Fish production is a livelihood and staples such as rice etc are purchased with the income form the fish. This is uncommon in Loa PDR