Aquaculture for the Poor in Cambodia - Lessons Learned

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RICE AND FISH: THE STAPLE DIET IN RURAL CAMBODIA

Although poverty in Cambodia has declined by between 1% and 1.5% per annum over the last 15 years (World Bank 2006), 40% of the population of 13.7 million still lives in extreme poverty according to the latest poverty line benchmark (US$ 1.25 a day). The prevalence of malnutrition is high, with 36% of children estimated to be underweight, and 26% of the population malnourished in 2005 (FAO 2010).

The livelihoods of more than 74% of the population depend on agriculture and fisheries (NIS 2004). Food security in Cambodia has traditionally had two dimensions: rice and fish, with fish being a central aspect of rural livelihood strategies. More than 80% of the total animal protein in the Cambodian diet is estimated to come from fish and other aquatic animals, especially from inland water bodies, namely paddy fields, rivers, streams, natural lakes and community ponds (Hortle 2007). Cambodians are among the highest consumers of freshwater fish in the world, with annual per capita fish consumption estimated at 52.4 kg (Hortle 2007).

Cambodia has the most intensively exploited inland fisheries in the world. With an annual production between 300,000 and 450,000 tonnes, Cambodia's fresh water capture fisheries rank as the fourth most productive in the world after China, India and Bangladesh. Small-scale fishing, recognized as primarily a subsistence activity, is estimated to account for 60% of total inland fisheries production. The bulk of the catch comes from the Tonle Sap Lake. However, access to wild fish for direct household consumption is not evenly distributed across all provinces, with a number of fish-deficit provinces located far from major water bodies.

Capturing fish from natural water bodies is also a seasonal activity, with the peak fishing season starting at the end of the rainy season. While fish reproduction, growth and migration patterns are largely affected by temperature, rainfall and related hydrological patterns (Ficke et al. 2007), the effects of global climate change and the increasing number of dams for hydropower development upstream in the Mekong watershed will have a significant impact on Cambodian fisheries.

Although some natural fish stocks appear to have declined over the years, the overall fish catch from the Tonle Sap Lake actually doubled between 1940 and 1995, largely due to intensified fishing. However, it has been noted that the quality and the amount of fish caught per fisher have declined due essentially to the increased competition for the resources. The fish catch rate in the Tonle Sap region decreased significantly from 347 kg/fisher in 1940 to 116 kg/fisher in 2008, a 70% decrease over seven decades (So 2009a). Population growth (approx. 1.6% annual growth rate) is often cited as a major cause of the increased competition; another explanation is that some fishers using intensive fishing techniques (electric fishing gears, small mesh size dragnets, etc.) may be capturing a larger proportion of the total catch, while traditional fishers are catching less than they did in the past (Baran and Myschowoda 2008).

In any case, there is growing concern that a decline in capture fisheries would have immediate consequences for food security in rural Cambodia as the rural poor face an increasingly short supply of this staple food item in their traditional rice-fish diet. There is also growing hope that expansion of aquaculture production will at least partially compensate for any shortage in capture fisheries production, as it has in neighboring Thailand and Vietnam.

O.Joffre

Dry season refuge pond for rice field fisheries enhancement.
Broodstock are stocked in the delimited fish refuge by local community. Fishing is forbidden in the delimited area.

AQUACULTURE IN CAMBODIA - WHERE IS IT HEADING?

Current Status of the Sector

Despite being one of the fastest growing food production sectors in Cambodia, aquaculture currently contributes only about 10% of the country's total fish production. The potential for aquaculture to improve nutrition and augment family incomes through the sale of surplus is, however, increasingly recognized.

The Aquaculture Development Plan of Cambodia (2000-2020) (So and Nao 1999) projected a need to produce at least 300,000 tonnes of fish per annum by 2020 in order to maintain the annual per capita consumption level of at least 30 kg. In order to meet this demand, a significant increase in total aquaculture production is still necessary, given the reported production of around 40,000 tonnes in 2008.

In response to this projected demand, the government has been promoting a range of aquaculture approaches with strong potential for expansion in rural areas of the country, including rice-field fisheries, dry season fish refuge management, and school fish ponds. Recently, the government set a target of 180,000 tonnes of aquaculture production by 2020. While ambitious, this target is unlikely to meet demand, implying a significant future gap in the supply of fish, even to maintain current levels of consumption.

Production and Production Systems

An overview of aquaculture production systems in Cambodia is presented in Box 1. FiA statistics show that total aquaculture production reached 39,025 tonnes in 2008, representing 11% of total inland fishery production. Production systems in Cambodia are mainly based on inland cage culture – approx. 4,500 cages, on the Mekong River (33%), Tonle Sap River (17%), Bassac River (7%), and in the Tonle Sap Lake (43%) – contributing 70-80% of the country's aquaculture production (So and Haing 2007; Viseth and Pengbun 2005). The rest comes from pond-based production systems.

The number of ponds used for aquaculture increased from 3,455 ponds in 1993 to 56,234 ponds in 2009. However, the contribution of ponds to overall production remains limited because of the generally low productivity in low-input, extensive homestead fish ponds (So 2009b). Fish and seed production are centered near cities where the communication and market networks are well developed: Kandal province and Phnom Penh account for 49% of the total aquaculture production and 57% of the fingerling production (FiA 2007).

This market-oriented aquaculture employs semi-intensive and intensive culture systems, with high-value species such as snakehead (*Channa micropeltes*, *Channa striata*), Pangasius catfish (*Pangasianodon hypophthalmus*) and hybrid catfish (*Clarias batrachus* and *C. gariepinus*) and introduced fishes such as Nile tilapia (*Oreochromis niloticus*), Chinese carps (silver, bighead and grass carp), common carp, and Indian carps (catla, rohu and mrigal) (So et al. 2005). These production systems require considerable capital investment and access to inputs and markets, and are typically not accessible to the poor in rural Cambodia.

Small-scale aquaculture systems in Cambodia vary with the agro-ecological and socio-economic conditions across the provinces. The northern and northeastern provinces are characterized by rugged terrain and are prone to drought. In contrast, provinces adjacent to the Tonle Sap Lake and in the central plains are prone to flooding during the rainy season. The production performance of aquaculture systems in these areas, characterized by small pond sizes and low inputs, remains low: pond production is typically less than 200 kg per household per year (So 2009b). However, the role of these systems as a source of protein cannot be underestimated in rural Cambodia where alternatives are limited.


So Nam

Farmer operating his small scale hatchery

USAID Cambodia MSME Project

Heavy Dependency on Wild Fishery Resources

Aquaculture in Cambodia still relies heavily on inputs from capture fisheries, with 26% of the fish larvae and fingerings used being collected from rivers, lakes, flooded rice fields or reservoirs, rather than purchased from hatcheries (So and Haing 2007). In semi-intensive and intensive systems, local wild fisheries supply fish of low commercial value as aquaculture feed, as quality manufactured fish pellets are difficult to obtain and are often too costly for most small-scale fish farmers. Growing concern over the negative impact of using other fish as aquaculture feed and over-harvesting of wild fingerings in the Tonle Sap led the government to ban the culture of snakehead (*Channa micropeltes* and *C. striata*) in 2004 (So and Haing 2007; Edwards 2008).

Scope of this Review

Although small-scale aquaculture aimed at improving the livelihoods of poor communities has been promoted widely by government and non-government organizations, the effectiveness of these interventions in addressing rural poverty varies with the share of aquaculture in food security and household income.

We review a number of the experiences documented by GOs and NGOs in order to understand the diversity of approaches and the different results they have had in aquaculture development. The review primarily covers inland fish farming development and coastal aquaculture projects targeted at poverty alleviation and food security. We focus on approaches aimed at developing low cost systems, and less on high-input aquaculture systems that are usually inaccessible to poor farmers.

CHALLENGE FACING POOR PEOPLE TO ADOPT FISH FARMING IN RURAL CAMBODIA

Small-scale aquaculture typically requires having a pond to raise fish. Pond construction costs are estimated at between 200 and 300 USD for a small sized pond of less than 300 m^2 (So 2009b). Access to water can be problematic and may require additional investment in a water pump and gasoline to operate the pump. Poor farmers may not have sufficient homestead land to dig a pond, or sufficient cash or access to cash for the pond inputs and operational costs. For example, fertilizer for pond preparation and fingerlings for every growth cycle may prove too costly (most farmed species do not spawn in the pond, which frequently dries out during the dry season). Fish need additional feeding and on-farm food may not be available all the time. In this case, farmers will need to purchase feed or collect substitutes (duck weed, insects etc.). Inputs such as organic fertilizers are needed to fertilize agricultural crops before farmers consider fertilizing their fish ponds.

Even with a readily usable pond, farmers may prefer using it to temporarily hold wild fish or to stock fingerlings caught in rice fields because of the lower investment and risk. In poor households, the rainy season provides more diverse wage labor opportunities (rice transplantation, rice harvest) and farmers tend to choose other income generating options over fish culture.

Box 1: The main aquaculture systems in Cambodia (based on So et al. 2007; So et al 2005; Viseth and Pengbun 2005)

Cage and pen culture

Cage culture of fish in Southeast Asia evolved in Cambodia, possibly more than a century ago. Traditionally, cages were used to hold captured fish alive with some supplementary feed until they were sold. Fish culture in floating cages made of wood and bamboo is common in Cambodia's major rivers and the Tonle Sap Lake. Cage sizes in the lake vary from 48 to 540 m^3 for Pangasius catfish culture with smaller units being used for snakehead (18m^3 – 180 m^3). Seed is caught from the wild. Average stocking densities vary between 5 and 25 kg of 80-150 g fingerlings/m^3 for Pangasius and 6-40 kg of 50-250 g fingerlings/m^3 for snakeheads. Feed is based mainly on low commercial value fish (the only food given to snakeheads), cooked rice bran, corn or aquatic plants, according to the species. For Pangasius the average yield is between 28 and 90 kg/m^3 and 75-150 kg/m^3 for snakehead cage culture. Cage operations are usually operated by 1 to 5 hired workers, according to the scale of the farm, when the owner and family members are not directly involved in technical operations.

Intensive pond culture

Pond sizes in intensive culture systems may range from a few hundred square meters to 10,000 m^2 (average 2,400 m^2), with a depth of 2 to 3 meters, and permanent access to a water source. The catfish *Pangasianodon hypophthalmus* is the main cultured species in ponds around Phnom Penh. On average the stocking density is 9 individuals/m^2 and the culture period is 8-12 months. Feed is based on rice bran and dried fish. Yields vary from less than 20 tonnes to 100 tonnes/ha (average 67 tonnes/ha) with a feed conversion ratio (FCR) of 4-5:1. Ponds are also mainly operated by hired workers.

After the ban on farming snakehead in 2004, hybrid catfish became very popular, although the main feed is also small-sized fish. The stocking density varies as widely as the size of the fish stocked and the ponds, ranging from 10 to 188 fish/m^2, with an average fish size of 7 cm. Depending on pond management strategy, hybrid clariid catfish farmers can obtain 2 to 4 crops/harvests per year. Yields range from 8 tonnes to 300 tonnes/ha/year, with an FCR of 5.

Extensive homestead pond culture

This is the most common fish culture approach promoted by NGOs and donor projects aiming at improvements in food security and livelihoods. Carp polyculture, tilapia, Pangasius catfish, silver barb (*Barbonymus gonionotus*), walking catfish (*Clarias batrachus*) and climbing perch (*Anabas testudineus*) are the main species raised in small homestead ponds (80-300 m^2), with no permanent access to water and depths maintained at >2 m. Fish are fed with on-farm products (rice bran, duckweed, etc.) and production is less than 100 kg/100 m^2. Ponds are mostly rain-fed, fish being stocked during the rainy season (May to October) and the final harvest dictated by a shortage of water in March or April. Farmers rely mainly on wild seed to stock their ponds and the production is mostly for household consumption. Community or collective ponds such as village, school or pagoda ponds, have also been used for extensive fish culture.

Community Fish Refuge ponds (CFR)

This approach, developed by AIT-Aqua Outreach, is based on stock enhancement of the rice field fishery with perennial ponds that are protected as dry season refuges for fish and are managed by the local community. Broodstock of mainly so-called "black fish" such as snakeheads, clariid catfishes, climbing perch, and gouramis, that are stocked in the sanctuaries migrate and spawn in rice fields during the seasonal floods when pond and rice fields are connected. Fishing is prohibited in the refuge ponds, providing a sanctuary for fish in the dry season. Development of such systems is increasingly popular among GO/NGOs. For example, JICA FAIEX has supported 22 CFRs.

Integrated rice–fish farming

The term rice-fish culture is applied to the practice of raising fish within rice fields alternately or concurrently with rice production. In alternate systems, fish are raised between rice crops, while rice fields are flooded. In concurrent culture, fish are stocked while rice fields are cultivated, requiring a ditch around the rice plot as shelter for fish. Rice-fish culture is not yet common in Cambodia. The technique is recent, and is usually reliant on stocking of Pangasius catfish, silver barb (*Barbonymus gonionotus*), tilapia (*Oreochromis niloticus*), or common carp (*Cyprinus carpio*). Production is between 100 and 300 kg/ha for a stocking density of 0.03-0.45 individual/m^2. Because irrigation is limited, fish are stocked in a pond connected to the rice field and the practice requires improvement of dike systems and the allocation of rice land for a ditch system.

Shrimp farming

Shrimp farming in Cambodia is not widely practiced compared to Vietnam or Thailand, with less than 100 tonnes produced in 2003. The main species are *Penaeus monodon* and *P. mergersiensis*. Intensive farms (Koh Kong and Sihanoukville provinces) reached production levels of 7-8 tonnes/ha in the early 1990s, with high-level investment and technology, but also encountered a high incidence of disease, resulting in a decline of the sector. Extensive shrimp farming in Kampot province relies on natural seed supplies, with no artificial feed inputs, and productivity remains less than 100 kg/ha/yr.

Other forms of marine aquaculture, such as mud crab fattening developed by SEAFDEC, also face technical challenges such as feeding and disease control. In Koh Kong province, culture of green mussel (*P. viridis*) on poles is expanding due to the relatively low risk (natural and human) and low cost. However, prices are dependent on market demand in Thailand.

Marine finfish culture

Marine finfish culture has been strongly promoted in Cambodia to meet the increasing domestic demand for marine fish at restaurants. However, demand is partially met by imported fish from neighboring Thailand and Vietnam, and domestic production remains limited. Most farmers face various technical problems in marine finfish culture, including lack of access to quality fish seed, lack of proper culture techniques, poor management and disease outbreaks. The government has emphasized the need for more research and development in order to support this newly growing sector, and some external assistance is being provided by SEAFDEC and JICA.

A typical practice is to catch wild juveniles or purchase fingerings of groupers (*Epinephelus sp*.), snappers (*Lutjanus malabaricus*) and seabass (*Lates calcarifer*) and fatten them in net cages on feed comprised entirely of marine trash fish. The total number of floating cages increased to 2,300 in 2009 in response to increasing local market demand. Seabass fingerlings (7-10 cm) are imported from Thailand at an average price of US$ 0.3/piece, while most grouper fingerlings are collected from the sea. Marine finfish culture can be very profitable, but requires significantly higher investment in seed and feed inputs, and more advanced technology than freshwater finfish aquaculture.

Workers feeding **catfish in intensive system** with a mix of trashfish and rice bran.

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SMALL-SCALE AQUACULTURE DEVELOPMENT INITIATIVES: KEY EXPERIENCES

Diverse Approaches and Objectives

There are many reasons why aquaculture is promoted to assist poor people in Cambodia, and a variety of approaches are employed to meet the objectives of the proponent. Common objectives include increasing food security, diversifying livelihood strategies, and increasing household incomes.

Several projects (APHEDA[1], AIT-Aqua Outreach[2], PADEK[3]) in the 1990s focused on development of small-scale aquaculture in homestead ponds for food security, mainly in the rice growing southern provinces (Takeo, Kampot, Prey Veng, Svay Rieng, Kampong Speu), accompanied by hatchery development. Later, the same approach was followed by other agencies (JICA/FAIEX[4], AIDA[5] or FLD[6]). Some organizations integrated aquaculture within broader "livelihood" projects that included livestock or vegetable production (CARE, CONCERN) and water and sanitation programs (German Agro Action[7]), expanding to some of the more northern provinces (Stung Treng, Kratie, Battambang, Preah Vihear, Ratanakiri, Siem Reap).

The potential of small-scale aquaculture to become an income generation option has yet to be realized in Cambodia. There are only a few examples of aquaculture interventions aimed at income generation. UNV[8], for example, supported cage culture of Clariid catfish and Pangasius for diversification of incomes, together with other income generation activities (vegetables, mushroom production) in fishing villages around the Tonle Sap Lake. In coastal areas, the PMMR[9] project developed several pilot trials for marine cage culture of sea bass, grouper, snapper, crab fattening and mussels for income diversification in fishing villages in Koh Kong province. The economic viability of these approaches is questionable as they are subsidized by external financial assistance.

1 Australian People for Health, Education and Development Abroad
2 Asian Institute of Technology
3 Partnership for Development in Kampuchea
4 Japan International Cooperation Agency – Freshwater Aquaculture Improvement and Extension Project
5 Ayuda Intercambio y Desarollo
6 Farmer Livelihood Development
7 Welt Hunger Hilfe
8 United Nations Volunteers, UNDP/GEF Tonle Sap Conservation Project (TSCP)
9 Participatory Mangrove Management Resources (now called Participatory Management of Coastal Resources)

Approaches to improve the post harvest value chain of aquaculture products, rather than production of fish itself, have emerged lately. For example, the USAID Cambodia MSME project[10] (2007) promoted aquaculture value chain development, creating market linkages between fish seed producers, fish producers and fish traders and included the private sector among its project partners. CONCERN's project on livelihood diversification included marketing studies and organization of fish farmers to facilitate better marketing and market access. Together with improved value-adding such as processing (dry fish, smoked fish), grading and packaging, this kind of approach shows some promise. However, there is insufficient experience in the fisheries sector from which to draw lessons.

Culture Systems in Use

Fish culture systems are not particularly diversified in Cambodia (Box 1). Even if their significance in terms of total fish production has not been fully assessed, small-scale aquaculture is the dominant type of fish farming in terms of numbers of households involved. Most small-scale aquaculture projects use low-input, extensive fish culture techniques that rely heavily on on-farm resources, mainly crop and animal byproducts such as rice bran, kitchen waste, livestock and poultry manures. The occasional application of lime and chemical fertilizers is also practiced. Culture systems range from improved trap ponds based on self-recruited species (wild fish trapped in ponds during the flood including some species that are able to reproduce in ponds) to extensive carp polyculture, tilapia, Clariid catfish or Pangasius culture in small homestead ponds (less than 1,000 m^2).

Small pond-based systems are the most commonly used methods in NGO projects for introducing aquaculture to areas where people have no prior experience of fish culture. When homestead ponds are not readily available, school ponds and pagoda ponds may be used.

Lessons Learned

✧ Simple, low cost technologies for subsistence-oriented aquaculture are more likely to be successfully adopted by farmers living in remote areas with limited access to inputs, fingerlings, and technical support.

✧ Small-scale aquaculture embedded within broader "livelihood diversification" projects can benefit from the other project activities, such as water supply and sanitation, collective approaches to marketing and knowledge sharing, and the use of crop byproducts as fish feed.

Selection of Participants

Aquaculture techniques are typically transferred to households via individuals. The selection of project beneficiaries varies according to the technology to be used and project objectives. Often the first criterion used to select households is need, i.e. households are selected because they are poor and vulnerable to food and income insecurity.

A further set of criteria is often used to increase the chance that the new technologies and activities will be successful and sustainable. These criteria may be based on environmental and physical characteristics and household assets (e.g. the presence of an existing pond, willingness to set aside land for a fish pond and to invest in building a new pond, pond water retention, the frequency and magnitude of floods in the target area – essential conditions that make aquaculture possible). Other key factors often considered include the relative wealth of target households, the availability and the capacity of participants to implement the newly introduced activities, and the presence of village institutions for knowledge transfer and sharing.

Some NGO projects (CRS[11], PADEK, CARE, FLD) have used such criteria as household wealth in order to target households that were more likely to continue fish culture after the project support had ended. Experience shows that very poor farmers are sometimes unable/unwilling to continue investing in aquaculture after project support ends, as they cannot afford the cost of continuing to purchase fingerings and feed inputs, or choose to focus on other livelihood options with short-term, or higher economic returns, such as seasonal migration for wage labor, fishing or rice farming labor. The availability of human resources for pond maintenance is another possible selection criterion, as well as the distance between the pond and the house so as to protect the fish from theft.

10 USAID Cambodia MSME Project is implemented by DAI

11 Catholic Relief Services


So Nam

Farmer nursing fingerlings in hapa net, before the growout period in pond

Access to resources such as land and water can limit poor farmers' ability to adopt aquaculture. The involvement of very poor farmers is often hindered by a lack of land. Securing a water supply, when fees and/or specific equipment (e.g. motor pump and wheels) are needed, can also be a constraint for the poor.

Although the techniques are typically transferred to individuals, aquaculture projects can be introduced as a collective or community-based approach via self-help groups (CARE or UNV), farmer groups, village organizations (CONCERN), or community fisheries groups (PMMR) to promote knowledge sharing and shared accountability. CARE originally began by transferring fish farming techniques to individuals and then later modified their approach to self-help groups, aiming for a broader impact and higher level of commitment and accountability than required from individual participants.

Lessons Learned

✧ Collective or group approaches (self-help groups or community-based organizations) can foster knowledge-sharing and economic links among stakeholders and can overcome some of the constraints (technical, economic, access to inputs) faced by individuals.

Selection of Target Communities

A similar rationale applies to the selection of target villages or communities. Broader socio-economic criteria at the community level, such as a clear land tenure regime and village organization, can be particularly important. When houses are closely clustered together, as in Siem Reap province, there may be less land available for each household for homestead ponds. Fish farming in rice fields is also constrained as rice fields are often far away from homes and it is difficult to guard the fish. This is not the case in villages where households own sufficient land to dig homestead ponds and rice fields are adjacent to the farmers' houses, as in Prey Veng (CRS).

For the JICA FAIEX project (2005-2010), a comprehensive set of environmental and socio-economic criteria was used to select target villages and beneficiaries where the project would have a higher likelihood of achieving its objectives. In a value chain approach, the USAID Cambodia MSME project selected target villages with the highest density of existing fish producers for a greater impact and sustainability of the activities, as there is a greater chance to develop the aquaculture value chain in areas with an already dynamic aquaculture sector.

Lessons Learned

✧ Aquaculture for income generation is possible only in areas with specific socio-economic conditions that facilitate the marketing of farmed fish and for those farmers who have adequate economic and other resources. Nevertheless, more developed value-chains for aquaculture products may provide indirect opportunities for the poor, for example employment in fish nursing networks or commercial aquaculture farms.

Access to Water

Water quality and availability is essential for fish culture in Cambodia, where rainfall occurs primarily during May to November. In Cambodia, homestead ponds used for aquaculture are around 2 meters deep and according to several surveys (FAIEX, CARE) rely primarily on rainfall, with only 25 to 50% using additional sources of water. This implies that in most cases, fish culture cannot be conducted throughout the year. The average duration of fish culture is between 8 to 9 months. If water for aquaculture is available only for 5 to 6 months during the rainy season, fish may not grow to a commercial size.

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Fish nursery in Kandal province

The lack of access to water and poor pond water retention have been documented by fish farming projects in Svay Rieng, Prey Veng, and Kampong Speu provinces where it resulted in limited grow-out periods and poor water quality during the dry season (PADEK, CARE, CRS). According to the FAIEX baseline survey (So 2005) conducted in the southern provinces, the average pond water depth during the dry season was only 76 cm, which is too shallow to raise fish due to high water temperatures and low dissolved oxygen levels.

On the other hand, rice-fish systems are prone to disruption from excessive flood water (CRS). This system of cultivation requires regular seasonal flooding to replenish water, but if the dikes around the rice fields are not sufficiently high, water may overflow and allow fish to escape.

Water quality is a key constraint in practicing cage culture both on the Tonle Sap Lake (water quality degrades during dry season due to low water level) and in coastal areas (low salinity during rainy season) (UNV, PMMR). In areas with acid sulphate soil, such as Svay Rieng province, aquaculture can face unfavorable water quality conditions, such as low pH, and iron and aluminum toxicity (CRS).

Lessons Learned

✧ The bio-physical environment (access to water, flood, water quality, soil type, etc.) is an important factor to consider in seasonal rainfall-dependent aquaculture systems with unreliable water availability.

Access to Seed

The lack of quality fish seed is probably the biggest constraint to the establishment of a small-scale aquaculture sector in rural Cambodia. NGOs and international agencies supported the digging of many ponds for aquaculture in the late 1990s, but a failure to secure a stable seed supply undermined prospects for success (Demaine 1999; Phillips 2002). Rural development efforts today are more cautious in advocating the adoption of small-scale aquaculture in some areas due to this persistent challenge. The principal problems are due to:

- access to seed, both in terms of physical access and price;
- quality of the seed;
- viability of local hatcheries as business enterprises.

Local private hatcheries account for only 18% of the total fish seed supply, while wild fish seed collected from local water bodies (26%) and fish seed imported from outside (55%), particularly from Vietnam (for Pangasius and Clarias fingerlings), account for over 80% (So and Haing 2007).

A total of 165 micro hatcheries have been recorded in 22 provinces. However, many have become defunct due to lack of economic viability. Small-scale village hatcheries operate using modest facilities and lack quality brood-stock to maintain the quality of fish seed they produce. They also lack access to inputs (hormones), adequate and clean water, as well as technical expertise. In 2009, there were 14 government-run fish hatcheries throughout Cambodia. Yet, most of these hatcheries are not functioning because they lack facilities and technical expertise (poor genetic quality and immature broodstock, lack of a broodstock management plan to maintain stock integrity and seed quality).

To continue fish farming, fish farmers need to buy new fingerings from hatcheries every growing cycle because most of the commonly farmed fish do not naturally reproduce in the farming environment. Among the house-holds supported by APHEDA's project, 40% abandoned fish culture after one year due to limited access to finger-lings. In other projects located in the northern provinces, fingerlings were not available locally and had to be purchased in Phnom Penh. Transportation costs and the high mortality rate during transportation from hatcheries to ponds severely limit fish culture efficiency and profitability, making it difficult for fish farmers who grow fish primarily for home consumption and not for additional cash income to continue investing.

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Rice Fish Culture pond, with a trench around the rice field for fish polyculture

To address the above problems, several projects in more recent years have included the development of small-scale hatcheries and support of government hatcheries (APHEDA, CARE, CRS, FLD, JICA). These projects acknowledge that hatchery owners often lack marketing plans and business management skills – especially needed in southern provinces where local seed producers face competition from Vietnamese middlemen selling imported fingerings at lower prices. According to JICA/FAIEX experts, successful development of small-scale hatcheries requires support in technical, marketing and organizational aspects, including:

- Promotion of specialization in one or two species to limit technical constraints;
- Development of seed producer networks to promote exchange of technical and market information and exchange of broodstock;
- Development of networks between seed producers and fish farmers via farmer-to-farmer training;
- Target production of seed for the peak demand season, particularly for rain-fed systems

FiA experts also emphasize the importance of maintaining the quality of seed produced at small-scale hatcheries in order to sustain demand from farmers. Having to purchase low quality seed prone to disease and slow growth discourages farmers from continuing. By ensuring the availability of high quality seed, hatcheries are more likely to sustain and even increase local demand for fish seed.

Lessons Learned

✧ Access to good quality seeds is essential to ensure high survival rates and the growth of fish to a marketable size. Targeted areas need ready access to hatcheries or local nurseries.

✧ Appropriate small-scale hatchery development, coupled with aquaculture promotion, can be effective in ensuring seed supply at the local level, given marketing plans are in place, economic management skills are developed, and linkages between seed producers and fish farmers are established.

Access to Feed and Fertilizer Inputs

Aquaculture ponds require feed and/or fertilizers to promote fish production. Fertilizer inputs, including both inorganic (DAP, urea) and organic fertilizers (pig, cow, chicken manure), increase plankton blooms in the water for fish to eat. Feed requirement depends on the type of fish species raised: carnivorous fish that eat other fish and animals (e.g. snakehead), omnivorous fish that eat a variety of animals and plants (Pangasius catfish, common carp, tilapia), herbivorous fish that eat plants (silver carp, silver barb or grass carp). Fish feeds may be sourced on-farm or purchased (see Box 1).

Most organizations involved in promoting small-scale aquaculture emphasize the use of readily available on-farm resources (livestock manure, crop byproducts and kitchen waste) as pond inputs. Although use of such these materials minimizes input costs, fish yields are consequently low. The potential for intensifying small-scale aquaculture systems using on-farm manure and crop byproducts, thereby increasing production, is limited. However, use of manufactured inputs, such as mineral fertilizer or fish pellets, has not been widely adopted by farmers due to limited access to those products and the limited investment capacity of farmers (CRS, FLD). The use of manufactured pellet feed in cage culture proved unsuccessful among 20-30% of farmers in one particular project, as they opted for using inexpensive local trash fish (UNV).

Lessons Learned

✧ Improving productivity of small-scale aquaculture with manufactured mineral fertilizers is constrained if supplies of fertilizers and the investment capacity of farmers are limited.

Technical Assistance to Build Knowledge and Skills

Most new fish farmers need training on preparing and managing ponds and caring for the fish. The assumption that fishermen can easily learn how to raise fish is a commonly-held misconception. Raising fish requires a different skill set and inclination from catching wild fish, and is closer to growing crops or raising pigs. In extensive fish culture systems, the need for technical assistance is limited compared to high input systems, which require specific technical skills to manage higher stocking densities, feeding rates, quantity of feed, disease prevention, etc. However, managing extensive production systems also requires training and specialist knowledge, for example, managing pond water levels which are dependent on seasonal rainfall, and minimizing the fluctuations between flood and drought periods. Mismanagement of inputs has also been reported, for example, excessive use of organic fertilizer (manure) leading to poor water conditions (CRS). FAIEX found that the farmers who did not know to use fertilizer during pond preparation were those with no previous technical training.

Training on feeding fish for the farmers

USAID Cambodia MSME Project

A lack of knowledge and mismanagement of feeding was highlighted in cage culture systems (both inland and coastal) and mud crab fattening, resulting in lower economic returns. Pangasius and marine finfish culture face disease outbreaks, which, when combined with lack of local expertise in fish health care, limited economic returns of the enterprise (UNV; PMMR).

Basic knowledge of fish culture in rural Cambodia is low and access to information and technical services is very limited. Provision of technical assistance from the FiA is severely constrained by inadequate human resources and lack of effective extension systems. During the past decade, farmer-to-farmer extension and various other less conventional extension approaches and techniques have become increasingly popular. According to JICA/FAIEX, the farmer-to-farmer approach, with seed producers training fish farmers, has reached 10,000 farmers, with 80% of the beneficiaries following the recommendations that were given. CONCERN also decided to adopt this approach after realizing that conventional extension approaches were ineffective.

In addition to knowledge and skills for raising fish, farmers often lack other essential skills to start a new livelihood activity. Learning to manage financial and human resources to sustain necessary on-farm inputs can be challenging for those just beginning fish farming. Thus existing skills and knowledge can be one important criterion for selecting target communities and individuals for aquaculture projects (See Selection of Participants above).

Lessons Learned

✧ Fish raising is not easy for beginners and new initiatives need technical assistance. However, government extension services are limited in outreach. Projects require not only a training component but also development of knowledge sharing networks, based on "farmers' field schools" or "farmer to farmer" approaches. This can be costly and difficult to sustain beyond projects.

Opportunities to Sell the Fish

Several projects (CONCERN, CARE, the USAID Cambodia MSME project, CEDAC, PMMR) acknowledge that aquaculture requires more market linkages and the development of an entire value chain, both for access to seed and feed inputs as well as markets for farmed fish.

According to former CEDAC staff, earlier projects on small-scale aquaculture focused only on social and technical aspects and excluded economic and marketing factors. This limited the benefits from aquaculture to home consumption and consequently failed to create sufficient economic incentives for farmers to continue. CONCERN included a market component in their project after realizing that producers were dependent on middlemen to collect and sell fish elsewhere because at the village level, introduction of fish culture quickly saturated the fish supply in the local market. Alternative marketing strategies, such as the development of marketing groups, were tested and promoted primarily for local markets. An approach to cluster producers was adopted by the USAID Cambodia MSME project by selecting target areas where the density of producers was already high, in order to achieve higher efficiency in terms of the value chain and economies of scale.

Market-based, value chain approaches face a number of socio-cultural challenges in Cambodia. Researchers have found that market networks of fish and fish products are complex, and there is a wide range in the ability of individual fishers and fish farmers to operate successfully within this value chain (Bush 2005). For example, patronage and debt obligations often weaken the bargaining power of fishers to negotiate prices with middlemen. Small-scale fish producers are also dependent on middlemen, with the absence of storage or local post-harvest facilities. The dependence may be higher when production systems are determined by seasonal weather patterns, resulting in the timing of harvest overlapping with the peak period of wild fish catch (CRS). In areas near international borders, market price fluctuation may depend on neighboring country markets (Thailand or Vietnam) which can greatly influence the local market. Some technical choices can limit access to markets. For example, the use of integrated fish farming for Pangasius culture using human feces or pig manures limits market access in Cambodia because of consumer preferences.

Lessons Learned

✧ Without subsidies from external assistance, the current price of inputs (fingerlings, fertilizers or manufactured feed pellets) is beyond the investment capacity of most poor farmers.

✧ Investment in inputs is often not considered as an priority among other available livelihood options.

✧ Opportunities to sell farmed fish may be limited where value-chains are undeveloped and market access is limited.

✧ The market price is low during the typical harvest season in climate/rainfed-dependent aquaculture due to the competition with wild capture fish.

Role of Aquaculture in Food Security and Household Income

The effectiveness of small-scale aquaculture projects in improving household food security and income is not well documented. Only a few project evaluation reports have clearly monitored impacts on income generation or nutrition of the target beneficiaries. According to a CARE survey in 2004, households with homestead ponds achieved significantly higher levels of fish consumption, as more than 50% of the fish produced was for home consumption. Aquaculture can become a popular means of improving livelihoods among farmers, once it becomes widespread. CONCERN acknowledges that, among the set of different livelihood options proposed, small-scale aquaculture ranks second (after poultry) in farmers' preference. JICA-FAIEX also reported that fish culture is a more favored livelihood activity than other alternatives as it can directly improve food security and income for the family (So 2009b).

However, for aquaculture to contribute to income generation the marketing constraints described above must be overcome. Donor projects typically distribute free fingerlings and other necessary inputs to target beneficiaries to start up fish farming activities, and even continue providing free or subsidized inputs for them to continue the activities. It is not well-documented however, how many of the participating farmers have continued with fish farming when the external support ended.

Lessons Learned

✧ Aquaculture may be considered a low priority activity if it cannot easily be integrated into existing livelihood and farming activities and if it does not fit within existing household divisions of labor.

RECOMMENDATIONS FOR FUTURE AQUACULTURE DEVELOPMENT AMONG POOR PRODUCERS

Small-scale, rural aquaculture is prevalent in many countries in Southeast Asia and has strong potential to meet the livelihood needs and improve the health of poor farming households in rural Cambodia, as demonstrated by a few successful projects. Low-input aquaculture can generate extra cash income at very little investment cost, making it an especially appropriate development strategy for extremely poor communities. Proven low-technology approaches are available that make it possible for the poor to take up fish farming with little financial risk.

Nonetheless, small-scale aquaculture is not a "silver bullet" solution to alleviating poverty in rural communities across the country. Many poor people are unable to benefit from aquaculture opportunities because of a lack of land or access to required inputs. Even so-called low-input aquaculture requires access to certain resources, such as

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Fish processing on floating house, Kandal province a steady supply of water, fish seed and off-farm feed when local sources are insufficient.

In order to make small-scale fish farming truly work for poor farmers in Cambodia, future research and project design must focus on addressing local socio-economic conditions and needs rather than solely emphasizing technical issues. Drawing on lessons documented above, key gaps that need to be addressed and recommendations for promoting the adoption of small-scale aquaculture in rural Cambodia are presented.

The following priority gaps need to be addressed:

The seed production sector should be developed

In addition to supporting new small-scale hatchery/nursery networks, strengthening the capacity of FiA facilities in broodstock management is crucial to the distribution of quality fish broodstock to small-scale hatchery operators. Likewise, devising simple broodstock management guidelines helps small-scale village fish hatcheries maintain seed quality. Market linkages between seed and fish producers are also needed, including business management and marketing training for seed producers.

More effective aquaculture extension techniques and institutional mechanisms need to be explored

Alternatives to conventional extension systems for knowledge and technology sharing are needed. Farmer to farmer extension, farmer cluster groups, mass media or school ponds have shown promising results in Cambodia.

Input and output market chains should be developed

Access to inputs and markets is a key factor to sustain aquaculture activities. The market chain for farmed fish, supply chain for inputs (including collective approach), and local knowledge sharing platforms must be considered during aquaculture project design. For example, a clustering approach toward the selection of fish farmers as well as linkages between seeds producers, nurseries, and fish farmers should be promoted to initiate local networks within the aquaculture sector. Development of aquaculture and management systems/practices needs to be based on understanding of local market demands and requirements, including seasonal price dynamics.

Target sites and beneficiaries should be carefully selected based on clear criteria.

Access to water, water quality, seasonal rainfall and flood patterns, and soil characteristics (toxicity and water retention) are the essential bio-physical criteria to consider during site selection. Socio-economic criteria should include access to fingerlings and other inputs and to markets, especially if the fish farming activities are to rely on existing services and markets. If new market and value chains are to be developed through the project in order to commercialize aquaculture for income generation, cluster approach, with concentration of effort in the most suitable socio-economic and agro-ecological contexts for aquaculture development, is recommended for a higher chance of success, rather than spreading effort in wide, remote area with dispersed farmers or unsuitable areas for fish culture.

Investment capacity and the compatibility of aquaculture with existing farming and other livelihood activities are also important criteria when targeting beneficiaries at the household level. The composition of households and their commitment to other livelihood activities that might compete with fish culture must be also considered. This should include consideration of the gender division of labor and role of women in household livelihood portfolio, in order to assess labor requirements (human resources) for aquaculture activities.

Criteria for selecting technical options should address local needs and conditions

The choice of fish farming methods should not be driven solely by the technology available. Technical options should be selected based on what is appropriate for local conditions and the needs and capacity of target beneficiaries. The investment capacity of participants, access to inputs and availability of on-farm inputs should all be considered when choosing among a number of technical options. Subsistence aquaculture based on "*cheap and easy*" technology is more appropriate for households with low investment capacity in remote areas. More intensive technology dependent on mineral fertilizers or cage culture can be developed in areas with better market linkages and within households able to invest in such technology.

More research and lesson sharing is needed

Small-scale aquaculture in Cambodia is still at an early stage of development and it is important to have a better understanding of the role small-scale aquaculture currently plays in rural livelihoods, including the diversity of production systems, the productivity and efficiency of those systems, and to articulate how its contribution to income, food and nutritional security can be enhanced. Efforts to promote small-scale aquaculture for rural development would be greatly served, for example, by better methods of determining which locations are most promising, what constraints should be addressed as priorities, and what kinds of technologies and investments are likely to bring the biggest payoff for local communities.

Research should look into ways of helping small farmers obtain the fish seed, feed, credit, and training they need to practice – and succeed in – aquaculture. Improved techniques for seed production of native fish species and the transfer of such techniques to local hatcheries might improve the local self-sufficiency for fish seed and reduce the ecological risk from further spreading exotic species into natural environments. Research on how to prevent genetic degradation of broodstock over time is another promising avenue, as it is a major cause of poor productivity in small-scale fish farming in Cambodia. Yet another is documenting and sharing best practices in small-scale aquaculture, especially the recent experiences in market-oriented aquaculture projects and their constraints and opportunities in improving the value chain of farmed fish.

Knowledge and experiences, including failures, from projects supported by external donors, NGOs, and government initiatives should be more systematically documented and shared. Monitoring and follow-up during and after the project implementation should be promoted. Lessons learned from ongoing and completed projects should be highlighted, analyzed and used to inform future project design and implementation, so that successful experiences are replicated and repetition of unsuccessful experiences is avoided. To improve capacity building and extension services, transparent project monitoring and reporting is needed, building on the knowledge acquired and supporting local stakeholder initiatives. Finally, moving beyond many ad hoc individual project initiatives to a better coordinated program approach with a longer-term vision for development of the sector would be beneficial.

Policies and an enabling environment is needed for promoting rural aquaculture

The Fisheries Administration's strategic planning process for the aquaculture sector includes setting production targets[12], as the expansion of this sector is a priority within the National Strategic Development Plan. The new Fishery Law (2006) also lists a large set of measures to regulate aquaculture for sustainable development of the sector. A more comprehensive policy and regulatory framework is needed to implement the principles outlined in the Fishery Law. However, without external technical assistance and investment, meeting these ambitious goals will present significant challenges to FiA, as its human and financial resources are too limited to fully implement the necessary actions.

The government's production targets also need to incorporate more specific growth strategies for the sector, through comparing various possible pathways to achieve targets, taking into consideration a set of overall sector development objectives. For example, in order to address the increasing domestic demand for fish in urban centers, what types of aquaculture should be promoted, where, and how? If the objective is to produce fish to be exported to Europe or Japan, what types of aquaculture should be promoted? Are more investments needed for small-scale hatcheries, or feed research, or more pond infrastructure? These questions are difficult to answer based on the current level of understanding of the sector.

More strategic analysis of the overall aquaculture sector is needed to identify and compare possible scenarios and strategies in support of achieving well articulated sector development objectives. Evaluating the different pathways for large or small-scale aquaculture development in Cambodia, and the social and economic implications of each of these pathways, is needed to design a strategy that will be most useful to Cambodian society and achieve poverty reduction and improved nutrition among large numbers of rural poor.

12 For example in the draft Strategic Planning Framework (SPF) for Fisheries (2009-2018), the aquaculture production target is 180,000 mt by 2018, with an increase of 15% per year during the first 3 years.

REFERENCES

Baran E. and Myschowoda C. 2008. Have fish catches been declining in the Mekong River Basin? Pp. 55-64 in Kummu M., Keskinen M. and Varis O. (eds). Modern Myths of the Mekong.

Bush S.R. 2005. Livelihoods, markets, and governance: market access and value-adding for small-scale fishers, farmers, and traders in the Lower Mekong Basin. Oxfam America, Phnom Penh, Cambodia.

Demaine H. 1999. Rural Aquaculture and the Alleviation of Poverty. AIT Aqua Outreach Programme. Asian Institute of Technology, Klong Luang, Pathumthani, Thailand.

Edwards P. 2008. Cambodian Government ban on snakehead farming enforced. Aquaculture Asia Magazine 13 (1): 40-44.

FAO 2010. FAO Country Brief Cambodia. http://www.fao.org/countries/55528/en/khm/ (webpage visited on August 25, 2010).

FiA, 2007. Fisheries Statistics. Fisheries Administration. Phnom Penh, Cambodia.

Ficke A.D., Myrick C.A. and Hansen L.J. 2007. Potential impacts of global climate change on freshwater fisheries. Review in Fish Biology and Fisheries 17:581-613.

Hortle K.G. 2007. Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin. MRC Technical Paper no 16, Mekong River Commission, Vientiane, Lao PDR.

NIS 2004. Cambodia's Inter-Censal Population Survey 2004 (CIPS) General Report National Institute of Statistics, Ministry of Planning Phnom Penh, Cambodia.

Philips M.J. 2002. Fresh water aquaculture in the lower Mekong Basin. MRC Technical Paper no7. Mekong River Commission, Phnom Penh. 62 pp.

So N. and Nao T. 1999. Cambodia Aquaculture Sector Review (1984-1999) and outline of aquaculture development plan (2000 – 2020). Department of Fisheries. Phnom Penh 73 pp.

So N. 2005. Baseline Survey Report, Kampong Speu, Kampot, Prey Veng and Takeo Provinces. Project FAIEX. Phnom Penh 136 pp.

So N, Eng T, Souen N and Hortle K.G. 2005. Use of freshwater low value fish for aquaculture development in Cambodia's Mekong basin. Department of Fisheries, Phnom Penh, Cambodia, 37 pp.

So N. and Haing L. 2007. A review of freshwater fish seed resources in Cambodia. In Bondad-Reantaso, M. B. (ed.) Assessment of Freshwater Fish Seed Resources for Sustainable Aquaculture. FAO Fisheries Technical Report Series 501. FAO, Rome. 628 pp.

So N, Ing T and Nao T. 2007. Overview of Marine Aquaculture in Cambodia. Fisheries Administration, Phnom Penh 11 pp.

So N. 2009a. Fisheries Resources in Cambodia - Current Status, Key Issues, Directions. Inland Fisheries Research Development Institute (IFReDI), Phnom Penh 25 ppt slides.

So N. 2009b. Impact Survey of the Freshwater Aquaculture Improvement and Extension Project (FAIEX). JICA/FAIEX, Phnom Penh 117 pp.

Viseth H. and Pengbun N. 2005. An overview of aquaculture in Cambodia. Department of Fisheries, Phnom Penh Cambodia. 48 pp.

World Bank, 2006. Halving poverty by 2015? Poverty Assessment 2006. World Bank East Asia and the Pacific Region, Report No. 35213-KH, February 7, 2006

FURTHER READING

Friend, R.F. and Funge-Smith S.J. 2002. Focusing Small-scale Aquaculture and Aquatic Resource Management on Poverty Alleviation. RAP Publication 2002/17. 34 p. FAO Regional Office Asia and the Pacific, Bangkok Thailand.

Tana T.S. 2002. The inland and marine fisheries trade of Cambodia. Oxfam America, Phnom Penh, Cambodia. 145 pp.

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Floating house and freshwater fish culture in cage, Kampong Chhnang province.

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