Current Status of Sustainable Aquaculture in Cambodia

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Abstract

In Cambodia, the extension of technologies in fish aquaculture is a vital activity that contributes to improving the daily livelihood of the rural poor farmer communities. Technology extension was introduced since 1994 through a project of the Asian Institute of Technology (AIT) and other local non-government organizations (NGOs) or international organizations (IOs) in some fish production deficient provinces. Prior to the introduction of such activities, wild fish were still abundant. From then to date, aquaculture extension is being done under the Freshwater Aquaculture Improvement and Extension Project Phase II of Japan International Cooperation Agency (FAIEXII-JICA), and Department for International Development/Danish International Development Agency (DFID/DANIDA) Projects.

Recently, aquaculture extension is one of the national policies under the National Rectangular Strategy Policies of the Government. There are several different freshwater aquaculture systems including floating cage/pen culture, earthen pond culture and rice-fish culture, and other fish culture in smallwater bodies or aquaculture-based fisheries in Cambodia as practiced in over 20 provinces and cities, with less development focused on coastal aquaculture.

Freshwater aquaculture production continued to grow over the past two decades and increased from 1,610 tons in 1984 to 20,760 tons in 2004, representing 11.9 times increase or growth of 16.3% per year This further increased to 74,000 tons in 2012, representing 11.9 times increase or a growth rate of 15% per year. However, aquaculture development in Cambodia is in its infancy stage compared to other countries in the region. It has encountered some problems and constraints during its development, which include inadequate and unreliable supply of good quality seed; lack of capital, fund or credit for aquaculture investment; inadequate knowledge of aquaculture technology; inadequate manpower for aquaculture extension service; and climate change, which have adversely impacted aquaculture development in Cambodia.

In order to achieve the goal of supplying the nation's future fishery requirements through aquaculture, the Cambodia Fisheries Administration (FiA) published the Strategic Planning Framework (SPF) for Fisheries (2010-2019). Within this framework, the scenarios for future fish demand-supply for 2019 suggest that aquaculture production will increase by 15% per year to 185,000 tons by the end of 2019.

Keywords: Cambodia, freshwater fish species, aquaculture extension, constraints, aquaculture development

Introduction

Cambodia is located in Southeast Asia between latitudes 10° and 15°N and longitudes 102° and 108°E, and has a mainland area of 181,035 km^2 extending approximately 580 km from east to west and 450 km from north to south with a total population estimated at about 14.1 million people in 2006 and a population growth rate of 2.4% per annum, reported to be the highest in Asia. Cambodia's coastal zone, which is located in the southwest of the country, has a total length of approximately 435 km.

Cambodia's climate is characterized by two major seasons: a dry season from mid-November to mid-May and a rainy season from mid-May to mid-November. The annual average temperature is 27°C, and rises to a maximum of 38°C in April or May and falls to a minimum of 14°C in December or January.

Agriculture is the major occupation for about 85% of the population, which can provide both rice and fish, which are the basic diet of Cambodian people. Fish is the most important source of animal protein for Cambodians, providing around 75% of total animal protein intake for the population. Moreover, fish not only plays a major role in the daily diet, but also in the economy of the people. Based on the National Statistics of the country, the average fish consumption of Cambodian people is 52.4 kg/person/year while an average household consumes between 60-66 kg/person/year, and households around Tonle Sap Lake consume between 67-80 kg/person/year. In recent years, an annual estimate of freshwater capture fisheries production ranges from 405,000 to 445,000 tons in 2010 and 2011. The change in productivity in freshwater capture fisheries is closely related to the change in flooding level that occurs on an annual basis. Meanwhile, marine capture fisheries production is about 60,000 tons annually.

Since 2000 when Cambodia adopted reforms in the fisheries sector, inland fisheries took off rapidly and freshwater aquaculture production continued to show growth over the past two decades and increased from 1,610 in 1984 to 20,760 tons in 2004, representing a 12-fold increase or 16.3% increase per year. Production continued to increase to 74,000 tons in 2012, also representing a 12 times increase or a growth rate of 15% per year. Therefore, Cambodian aquaculture has expanded, diversified and intensified. Its contribution to aquatic food production has increased gradually. It is highly diverse and consists of a broad spectrum of systems, practices and operations, ranging from simple backyard small household pond systems to large-scale, highly intensive, commercially-oriented practices. However, aquaculture development in Cambodia is in its infant stage of development compared to other countries in the region. It has some problems and constraints encountered in development including: (a) inadequate and unreliable supply of good quality seed; lack of capital, fund or credit for aquaculture investment; (b) inadequate knowledge of aquaculture technology; (c) inadequate manpower for aquaculture extension service; and (d) climate change. All of these have impacted aquaculture development in Cambodia.

Recently, aquaculture extension is one of the national policies under the National Rectangular Strategy Policies of the government. There are several different freshwater aquaculture systems including

floating cage/pen culture, earthen pond culture and rice-fish culture, and other fish culture in small water bodies or aquaculture-based fisheries which have been practiced in Cambodia in over 20 provinces and cities, while there is less development of marine aquaculture.

In order to achieve the goal of aquaculture fish production and to supply the nation's future fish requirements, the Cambodia Fisheries Administration (FiA) has already prepared its 10-year Strategic Planning Framework (SPF) for the Fisheries Sector (2010-2019). Within this framework, the scenarios for future fish demand-supply for year 2019 suggested that aquaculture production will increase by 15% per year to 185,000 tons by the end of 2019.

The main objectives of this study aims to review the existing literature and combine this with primary data to understand the evolution, current situation and potential of freshwater and marine aquaculture development, and to identify problems/constraints, issues, gaps and opportunities in aquaculture development in Cambodia.

Methodology

The methodology used by the authors for this study combined a review of secondary data with primary research data with focus on interviews with key stakeholders.

Results and Discussion

Implementing the SPF for the Aquaculture Sub-sector

Aquaculture offers enormous long-term potential for Cambodia. However, the starting level is fairly low (only 50,000 tons was produced in 2009, mostly from small-scale operations). In order to achieve immediate growth whilst also maintaining a pro-poor focus, the main interventions will be to support small and family-scale development, primarily through training, the provision of fingerlings, and establishing risk management systems. Targets include:

- At least 85,000 trained fish farmers actively engaged in aquaculture by the end of 2019
- Fish seed production is increased to 250,000,000 per year by the end of 2019
- A surveillance, monitoring and control system for fish disease outbreaks is developed and implemented by the end of 2014
- Research and development to identify commercially viable production of indigenous species in cooperation with regional organizations, i.e. Mekong River Commission (MRC)

In order to facilitate the general growth of aquaculture, the FiA will also develop comprehensive regulations and technical standards under the Law on Fisheries that are specifically designed to support the ability of the aquaculture sector to reach the targets set out for it.

Current Status of Aquaculture Technology

Aquaculture activities have been categorized at different types, especially in terms of scale and intensity. In practice these various "types" are continually evolving, and individual farmers and the sector as a whole operate on a continuous spectrum of scale and intensity depending on resources, skills and market/economic

incentives. Farmers may also shift species depending on input costs and market conditions. We have therefore found it more useful to recognize certain basic technologies, all of which may be applied at different scales and levels of intensity, and for different species (Table 1).

Freshwater Cage Culture

Freshwater aquaculture, especially of snakehead, has been undertaken in Cambodia since the 10th century – partly as a means of storing and fattening fish to reduce the seasonal surplus noted above, and partly as a means of converting low-value fish into high-value fish. Historically, both Chinese and Vietnamese have taken a significant role in this activity. In the 1960s production of fish in cage already stood at around 4,000-6,000 tons/year and during the 1980s comprised 80-90% of total aquaculture production and 70-80% during the 1990s. Since 2005, however, cage culture of snakehead has been banned because of concerns about over-exploitation of wild fingerlings – for both stocking and feeding – and the overall level of cage culture has declined, though it is still thought to comprise more than 50% of all aquaculture production.

Most cage culture takes place in the Tonle Sap, Mekong and Brassac rivers, and in the Great Lake. Apart from illegal rearing of snakehead (mainly *Channa micropeltes*), the main species stocked are *Pangasionodon hypopthalmus*, *Hemibagrus wyckioides* (redtail catfish) and *Oreochromis niloticus* (tilapia). *Clarias* (catfish), *Puntius* (silver barb), *Oxyeleotris* (sand goby), and *Leptobarbus hoevennii* (Hovens carp) may also be fattened or stored over a few months to exploit seasonal price variations. Cage culture probably remains the most important type of aquaculture, at least in terms of the number of enterprises.

Cage sizes vary from 48 to 540 m^3 for Pangas catfish culture, and 18-180 m^3 for snakehead culture, and are usually made from bamboo or wood, though net cages are becoming more common. Sometimes these are large boat-shaped structures with accommodation and sometimes pig sties on board. For Pangas, the average yield is between 28 and 90 kg/m^3; and for snakehead 75-150 kg/ m^3.

Overall trends are unclear other than the decline in snakehead farming. However, it seems likely there has been a shift in favor of Pangas (perhaps related to seed availability) and redtail catfish.

Freshwater Pond Culture - Smallholder

Pond aquaculture has not been a traditional activity in Cambodia, probably because of the abundance of wild fish. However, since the 1990s there have been substantial efforts by donors and NGOs to promote pond based fish culture – on individual farms, in community ponds and in rice fields. These initiatives have been accompanied by introduction of a range of Chinese and Indian carps, tilapia, and hybrid catfish for which breeding technology is well developed. While initially, care was taken to keep these exotic introductions away from the Great Lake and Mekong river system, they have since been introduced widely across the country, and there is some evidence that some species, such as common carp (*Cyprinus carpio*), are breeding in the wild. Native species, including silver barb (*B. gonionotus*), walking catfish (*Clarias batrachus*), river catfish (*Pangasianodon gigas*) and occasionally L*eptobarbus hoeveni*,

Table 1: Fish species cultured in Cambodia

No.	Scientific name	Common name / Khmer name	Culture method	Source of seed	Culture area
Indigenous species					
1	*Pangasianodon hypophthalmus*	Striped catfish/ Trey Pra Thom	FC, P	HS, WS	Great Lake, Tonle Sap, Mekong
2	*Pangasianodon bocourti*	Basa catfish/ Trey PraKe	FC	WS	Great Lake, Tonle Sap
3	*Pangasianodon larnaudii*	Spotted-ear catfish/ Trey Po	FC	WS	Great Lake, Tonle Sap, Mekong
4	*Pangasianodon conchophilus*	Snail eating catfish/ Trey PraKchao	FC	WS	Great Lake, Tonle Sap, Mekong
5	*Channa micropeltes*	Giant snakehead/ Trey Chhdor	FC	WS	Great Lake, Mekong, Tonle Sap rivers
6	*Channa striata*	Snakehead/ Trey Ros	FC	WS	Great Lake, Mekong, Tonle Sap rivers
7	*Barbodes gonionotus*	Silver barb/ Trey chhpenprak	FC, P, RF	HS, WS	Whole country
8	*Leptobarbus hoeveni*	Saltan fish/ Trey praloung	FC, P	HS, WS	Mekong, Tonle Sap, Great Lake, Takeo, SvayRieng, Prey Veng
9	*Hemibagrus wyckiode*	Redtail catfish/ Trey kyakrahom	FC	WS	Mekong river, Tonle Sap, Great Lake
10	*Oxyeleotris marmorata*	Marble goby/ Trey Domrey	FC, P	WS	Mekong, Tonle Sap,
11	*Anabas testudineus*	Climbing perch/ Trey kranh	P	HS	Whole country
12	*Barbodes altus*	Red tailed tinfoil/ Trey kahekrahom	P, RF	HS, WS	Whole country
13	*Epinephelus* spp.	Grouper	FC	WS, Imported	Coastal, Koh Kong, Sihanoukville
14	*Lates calcarifer*	Seabass	FC	WS, Imported	Coastal, Koh Kong, Sihanoukville
15	*Lutjanus malabaricus*	Snapper	FC	WS, Imported	Coastal, Koh Kong, Sihanoukville
16	*Penaeus monodon*	Tiger Shrimp	P	WS, Imported	Coastal, Koh Kong, Kampot
17	*Eucheuma cottonii*	Seaweed	Open water	Imported	Coastal, Kampot
Exotic species					
1	*Oreochromis niloticus*	Nile tilapia	P, RF, FC	HS	Whole country
2	*Hypophthalmichthys molitrix*	Silver carp	P	HS	Whole country
3	*Cyprinus carpio*	Common carp	P, RF	HS	Whole country
4	*Aristichtys nobilis*	Bighead carp	P	HS	Whole country
5	*Ctenopharyngodon idella*	Grass carp	P	HS	Whole country
6	*Cirrhina mrigal*	Mrigal	P, RF	HS	Whole country
7	*Clarias* spp.	Hybrid catfish	P	HS	Whole country
Note: P: pond; FC: floating cage; RF: rice field; WS: wild seed; HS: hatchery seed					

Barbichthys altus and climbing perch (*Anabas testudineus*) are also grown.

These systems range from relatively low input systems using on-farm products (rice bran, duckweed, termites, morning glory, pumpkin, etc.) yielding less than 1 kg/m^2 (mostly 0.25-0.5 kg/m^2) for 6 months of culture (May to October), to systems using rice bran mixed with small-sized fish or fish powder and/or commercial pelleted feed, giving yields from 1.5 to 20 kg/m^2 (15-200 t/ha) with high quality feed. Lower input systems tend to be dominated by carps and tilapia; higher input systems are typically carp-dominated polyculture with tilapia, pangasius-dominated polyculture, or pangasius or tilapia monoculture. Ponds may be as small as 100 m^2, although high-input smallholder systems are usually 0.1 to 0.2 hectares.

There are currently two significant projects facilitating development of small-scale freshwater pond aquaculture – the USAID "Harvest" project and the JICA-funded FAIEX project. JICA is promoting small-scale hatchery production as a key element in increasing seed supply, encouraging farmer networks and supporting lead farmers. They do not subsidize inputs. The Harvest project is concentrating on extension and farm business development, encouraging farmers to understand the costs and returns associated with different levels of intensification, as well as offering intensive regular extension advice to focus on farmers. They also assist farmers with input purchase on a declining trajectory over six production cycles. The number of ponds reportedly used for fish culture increased from 3,455 (239 ha) in 1993 to 56,234 (962 ha) in 2009-2010, operated by 40,500 farmers.

Freshwater Pond Culture - Small and Medium-Sized Enterprises

More recently, intensive Pangas (*P. hypophthalmus* and hybrid catfish) farming in ponds has increased significantly, driven in part by expatriate Vietnamese farmers seeking better water quality, biosecurity, lower wages and cheaper feed ingredients (especially "trash" fish). Productivity is very high (several hundred tons/ha/yr) based on intensive feeding with pellets (usually at start and end of production cycle), rice bran, trash fish and a variety of other ingredients. Most farmers mix and prepare their own feed mixture, producing home-made pellets. Low-value fresh fish may be purchased in bulk and stored with rice bran as a semi-fermented product for several months. This type of aquaculture takes place mainly around Phnom Penh and Kandal. In addition, there are now significant areas of nursing ponds – primarily for imported Pangas seed – for example to the north of Phnom Penh.

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 depth of 2 to 3 meters, and permanent access to a water source. The culture period is 8-12 months for Pangasius and 2.5-3 month cycle for hybrid catfish culture with an average of 3 cycles per year. Some of these Pangas farmers are diversifying to *Clarias* catfish, *Anabas* (climbing perch), sand goby, and a variety of other species such as featherback since the price for pangas is low. Most farmers would like to be able to rear snakehead.

Rice-fish Culture

Rice-fish culture is typically based on stocking rice fields and/or small connecting ponds and channels mainly with fish species such as tilapia, or common carp, *Pangasius* catfish, and silver barb (*Barbonymus gonionotus*). Fish are stocked at a density of 0.03-0.45 individual/m^2 in concurrent rice-fish systems with an average area of 0.4 ha, harvesting yield between 100 and 300 kg per hectare. The growth cycle lasts around 4 months.

Development of this type of aquaculture, while highly desirable from a food security perspective, is perhaps the most challenging, since many factors, including intensification of rice production, chemical use, short production cycle, losses to theft, flood and migration may all constrain further growth.

Freshwater Prawn and Shrimp Farming

Traditional extensive shrimp farming is practiced on a small scale in Kampot Province. This relies mainly on natural seed and feed, and productivity is less than 100 kg/ha/year. More intensive shrimp farming began in the 1990s and its production rose to a peak of over 700 tons/year in 1995. Tiger shrimp *Penaeus monodon* and banana shrimp *Penaeus merguensis* were the main cultured species. Unfortunately, shrimp farming suffered from serious disease and collapsed. Production has been less than 100 tons in recent years.

More recently a new medium-scale enterprise has restarted in *Koh Kong* province in ponds previously used for fish culture.

Technology for the production of *Macrobrachium* seed has been developed at two government hatcheries, and there is some limited farming of this species in inland waters, but this has not become a significant activity as yet.

Marine Cage Culture

Marine finfish culture began in the late 80s, early 90s in both Kompot and Koh Kong. Unfortunately this collapsed in 1993 due to freshwater runoff after heavy rain. Marine cage culture restarted in the early 2000s and there is now probably around 1,000 tons production from marine cage culture production in Sihanouk, Kompot and Koh Kong. Species cultured are mainly seabass (60-70%) and grouper. Seeds are sourced from the wild, from Thailand (seabass) or from Indonesia and Taiwan (grouper). Feed is exclusively trash fish sourced locally. This sub-sector is currently suffering from chronic disease problems (up to 50% losses), which seem to be endemic throughout the region.

Crocodile Farming

The farming of the indigenous species, *Crocodylus siamensis* has been undertaken since the early 20th Century. Crocodile farming has increased quite rapidly in recent years, from 4,816 heads in 1993 to 230,000 heads in 2011. This involves mainly production of 30 cm long juveniles that are mainly exported.

Seaweed Culture

Eucheuma cottonii was cultured in Kampot province by a Malaysian company in the mid 2000s, with production reaching 18,500 tons in 2005. However, no production of farmed seaweed has been reported since 2006.

Other Potential Species for Aquaculture

In Cambodia, some intensive production of frog and soft-shelled turtle has been found. There have been some initiatives with oysters and green mussels (*Perna viridis*), though it appears that these activities have now ceased due to financial difficulties.

Fish Seed Supply

There are four primary sources of seed (fry or fingerlings) for aquaculture:

- Imports from Viet Nam and Thailand (freshwater); and from Indonesia, Taiwan (marine)
- Fingerlings caught in the wild
- Private sector hatcheries (small and medium scale)
- Government hatcheries

Fish Feed Supply

Cambodia has significant resources of low-value fish from both marine and freshwater sources that can be used directly as fish feed, or converted into fishmeal and mixed with other ingredients to produce home-made or commercial compound feeds. Indeed, the seasonal excess of low-value freshwater fish underpins the long history of intensive aquaculture in Cambodia. While this is strength in many ways, increasing demand from aquaculture is putting pressure on both freshwater and marine resources.

No recent studies of the species composition of "trash" or low-value fish, and its allocation and value for different uses (fresh for human consumption, fresh for aquaculture, pigs, and ducks, fish paste, fish sauce, dried fish, fish meal, exports in all these forms). This is an important strategic issue for both the aquaculture and fisheries sector.

At present, Cambodia has one fishmeal plant that uses a proportion of this excess, as well as low-value marine species. The country also produces significant quantities of other basic feed ingredients including rice bran, broken rice, corn, cassava, and some soy. Traditionally, various vegetables have been used in the absence of higher quality feeds, including *Lemna*, *Azolla*, morning glory and household waste.

As yet, there is no commercial manufacturer of dedicated fish feeds. As a result a large quantity of fish feeds are imported, mainly from Viet Nam and Thailand. Discussions with suppliers suggest this market is currently around 20,000 t/yr, growing at around 10%/year, and supplied mainly by Proconco (Viet Nam), CP (Thailand) and several other smaller producers from Viet Nam.

The lack of Cambodian production of fish feeds is widely regarded as a constraint, and there is a lot of complaints from farmers about feed cost and quality. However, it should be recognized that Cambodia is fortunate in being able to access reasonably priced and well-formulated fish feeds from both Viet Nam and Thailand. While there may be some quality issues, this is probably partly related to unwillingness to pay the necessary (international) price for high quality feed. There are some interest in investing in a feed plant (both foreign and Cambodian), but demand remains low to justify the significant investment required. However, once demand reaches a sufficient level (probably around 50,000 t/yr) it is highly likely that such an investment will be made.

Limited demand for pelleted feeds relates both to the limited scale of aquaculture production, and to the wide availability of trash fish in Cambodia. Stricter control and management of low-value fish fisheries is desirable from the perspective of biodiversity and fishery sustainability; it would also lead to increased demand for pelleted feed which would ultimately justify investment in feed plant in Cambodia sooner rather than later.

Fish Diseases

Disease is a significant problem in aquaculture globally. Epizootic fish disease has been a periodic problem for freshwater fish culture and indeed wild fish, and spread widely across Southeast Asia in the 1980s. Shrimp farming has suffered from chronic viral and bacterial disease problems throughout the region, and this was the primary cause of collapse of the industry in Cambodia in the 1990s.

Marine finfish farming is currently suffering chronic disease problems across the region. While these diseases occur naturally, the severity of outbreak tends to be exacerbated by intensive culture conditions and over concentration of development.

Aquaculture system

In general, the aquaculture system in Cambodia is commonly known and categorized into two types: extensive/semi-intensive system and intensive system. The proportion of intensive aquaculture system contributes about 75% to the total aquaculture production, whereas 25% from extensive/semi-intensive system (Figure 2). The main purpose of extensive aquaculture system is additionally to support family fish consumption. The promotion of small fish culture activities was presented in 1986 by the UNICEF's Family Food Programme and then from 1990s by many NGOs/IOs and Projects: AIT Aquaculture and Aquatic Resources Management (AIT-AARM), MRC, FAO, Partnership for Development in Kampuchea (PADEK), etc. Recently, aquaculture activities that have grown rapidly are those that are supported by JICA, DFID/DANIDA, USAID-HARVEST, Ayuda Intercambio y Desarollo (AIDA), FAO/EU, etc.

Aquaculture Production

Aquaculture in Cambodia has undoubtedly grown in recent years – from less than 14,600 tons in 2002 to 74,000 tons in 2012. The production trends for total aquaculture production are shown in Figure 3. In the last ten years, the contribution of aquaculture activities to total fisheries production has been increasing dramatically. Aquaculture development has become a "national moment", as noted in the speech of the Cambodian Prime Minister in 2008.

Economic and social value

Pangasius and snakehead species dominate the aquaculture sector in terms of gross revenue with more than USD 30 million generated for both species. Surprisingly, marine cages represent more than USD 7 million, while its contribution to the total aquaculture production is only about 1.2%. In terms of employment, it has been estimated that there are some 27,000 people involved in aquaculture in Cambodia.

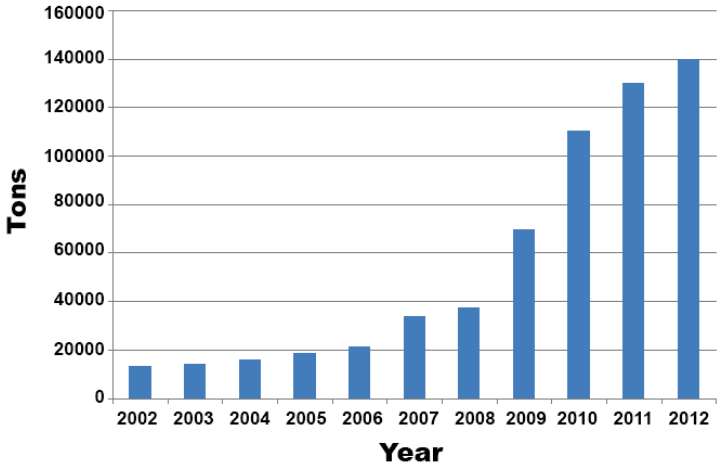

Figure 1. Fish seed production (in thousands) in Cambodia in 2002-2012.

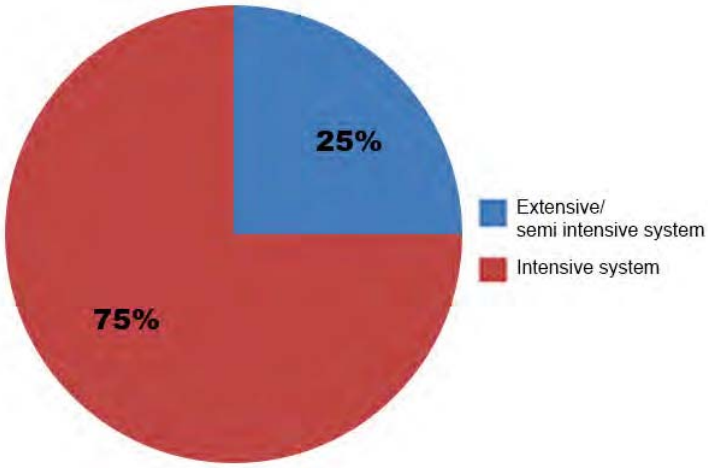

Figure 2. Fish production in pond culture systems (Source: Aquaculture Development Department).

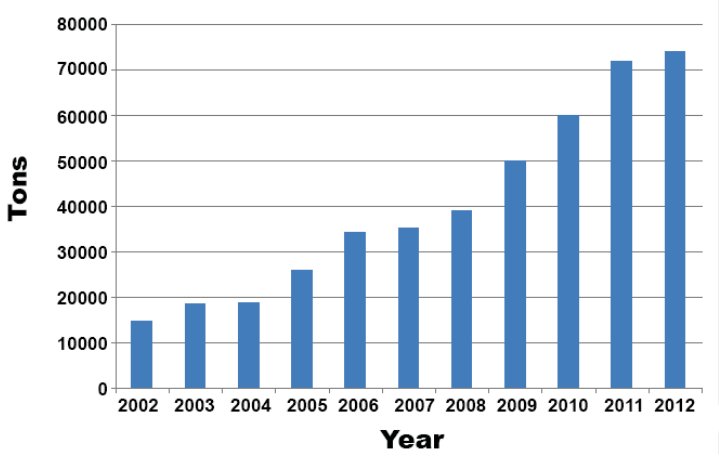

Figure 3. Aquaculture production in Cambodia in 2002-2012.

Constraints in Aquaculture Development

In general, aquaculture activities in Cambodia are mainly on small-scale operations targeting the improvement of nutrition of local people. During the process of fish culture, some constraints were usually reported such as lack of technical assistance, lack of water supply, lack of seed and feed supply, and limited awareness of fish culture technologies among fish farmers. The following key issues are commonly noted in Cambodian aquaculture:

- Problems in cage culture
  - High mortality rates of fishes during summer months, particularly from March-May when the water temperature is high and the water flow is reduced
  - Large amount of waste being discharged, causing deterioration of water quality
  - The seed used for cage culture are collected from the wild and may have significant impact on wild stock
  - For Pangasids and other species, the sharp decline of wild seed supply led to shortage of seed for stocking, while hatchery-produced seed have not been available
  - There is heavy reliance on catching or buying low-value fish/trash fish for feed

- Problems in shrimp culture
  - Unavailability of hatchery-produced shrimp post-larvae
  - Reliance on imported post-larvae from neighboring countries
  - Diseases
  - Lack of special extension programs focusing on shrimp farming

- Problems in pond culture
  - Inadequate water supply is a serious constraint
  - Since most pond water is stagnant, fish kills occur during the summer season
  - Unavailable hatchery-produced seed of high-value culture species.
  - Poor knowledge of farmers about feeds and feeding technology
  - Imported commercial feeds (pellet feed) are expensive
  - There is a heavy reliance on catching or buying trash fish for feed
  - Aquaculture cooperative or society does not function well resulting in a lack of communication to exchange ideas or techniques

- Marine Aquaculture
  - Mariculture is less developed as compared to the neighboring countries
  - Common cultured species: groupers and snappers (wild seed and imported)
  - In 2011, there were about 800 cages.
  - Reliance on wild seed and imports.
  - Unavailability of hatchery-produced seed
  - Unavailability of commercial feeds.
  - Lack of training and extension programs focusing on marine aquaculture
  - Investment for marine aquaculture is quite high (i.e. cage construction, feed cost)

Opportunity for Aquaculture Development

The main points of opportunities for aquaculture development in Cambodia are as follows:

- Remarkable genetic resource in the form of more than 500 freshwater species and a similar number in marine species in the MRC research/breeding programme
- Many potential aquaculture species have high nutritional value
- Many indigenous species have higher price than mainstream aquaculture species
- Region-wide there is an excellent range of high-quality breeds of exotic species in public and private sector
- A wide range of species is suitable for marine and brackishwater aquaculture: filter-feeding shellfish; marine finfish, seaweed. There are also opportunities for the production of tilapia and catfish in brackishwater
- At least 10 species grow well in rice fields and are easy to sell
- Production and consumption of even a small quantity of fish can generate significant benefits and income to the rural poor people in society
- Small-scale fish farmer can reduce costs of inputs, increase price of product, exchange knowledge and experience, and reduce share risk by forming cooperatives, associations and networks
- Small-scale hatchery or nursery production can generate substantial revenue from modest land/water resources – far higher than from rice production
- Successful small-scale fish farmer can expand to medium-scale and large-scale, and land can also be rented
- Aquaculture enterprises at all scales can generate employment for both men and women
- Efficient industrial scale production of easily grown species typically results in widely available low-cost fish, which will benefit the poor, especially in urban areas, etc.

Conclusions and Recommendations

Aquaculture in Cambodia plays an important role in contributing to the improvement of the daily livelihood of the rural poor farmer community. Fish is the most important source of animal protein in Cambodian people's daily diet. There is enormous potential in fish culture production from floating cage culture, earthen pond culture and rice-fish culture and other fish culture activities in small water bodies or aquaculture-based fisheries in Cambodia. Moreover, fish does not only play a major role in the daily diet, but also in the employment, economy of the rural poor farmer and improvement of women's role in aquaculture.

Recognizing the potential role of aquaculture in subsistence farming, NGOs and other IOs have been contributing a significant role towards the development of aquaculture and in the management of aquatic resources in Cambodia. The FiA has been taking a number of steps to promote aquaculture in all potential areas in partnership with various NGOs, IOs and other agencies involved with rural development projects. The FiA, in collaboration with diverse NGOs and IOs, have established public sector hatcheries in different provinces and also assisted in establishing private sector hatcheries

in many rural areas to produce seed to supply seeds to family-scale fish farming operations, as there is a need for good quality seed available all year round. Aside from the establishment of hatcheries and due to shortage of trained human resource to carry out extension activities, all collaborating NGOs/IOs have assisted in capacity building for the fisheries staff and farmers through short-term training course, supported in producing aquaculture extension materials for distribution to farmers and in some cases research activities were conducted in the fish seed production stations and in the fields. However, there are some constraints facing the development of aquaculture such as lack of capital for pond/cage construction, lack of credit system or access to credit is poor as no subsidy exists, unavailability of good quality seed, seasonal nature of pond, competition for the farm resources from other agricultural operation, and lack of aquaculture extension systems and aquaculture research center. The following recommendations are therefore proposed. The Royal Government of Cambodia through the MAFF, particularly the FiA and other development partners such as the NGOs, IOs and other institutions concerned in aquaculture development should address and support the following activities towards aquaculture development:

- To produce good-quality broodstock in government hatcheries or Center for Aquaculture Research and Development to be distributed to farmer-managed hatcheries or private hatcheries in order to produce good-quality fish seed for aquaculture farming;
- To establish sub-research center for aquaculture development and extension service in all regions that have a good potential for aquaculture development in Cambodia;
- To strengthen capacity of existing fish seed producer farmer networks and establish more farmer hatcheries in all provinces or so-called fish seed production decentralization in Cambodia; and
- To strengthen the existing guideline for good aquaculture practice (GAP) and law/ regulation performance in aquaculture farming and fish marketing.

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Suggested Readings

Ministry of Environment. 2002. Cambodia Initial National Communication Under the United Nations Framework Convention on Climate Change, Phnom Penh, Cambodia.

Navy H and Kong H. 2008. Value chains for promoting sustainable fisheries development in the Mekong delta.

Rab MA, Navy H, Ahmed M, Seng K and Viner K. 2005. Socioeconomics and Values of Resources in Great Lake-Tonle Sap and Mekong-Bassac Area: Results from a Sample Survey in Kampong Chhnang, Siem Reap and Kandal Provinces.

Thuok N and Viseth H. 2004. The role of NGOs in aquaculture development in Cambodia, lessons learned. Department of Fisheries, MAFF, Phnom Penh, Cambodia.

Viseth H and Pengbun N. 2005. An Overview of Aquaculture in Cambodia. Department of Fisheries, Phnom Penh, Cambodia.