Current Status of Sustainable Aquaculture and Resource Enhancement in Cambodia

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Abstract

Cambodia is rich in both freshwater and marine fisheries resources. Aquaculture in Cambodia has been practiced in the Great Lake (Ton Le Sap) for a long time . The culture method involves stocking of wild juvenile fish in pens or cages and feeding with trash fish. In 1994, a new aquaculture technology was introduced in the country through the Asian Institute of Technology (AIT) outreach programme.

Aquaculture development in Cambodia is part of a national policy under the National Rectangular Strategy Policies of the Government. To support the national policy, the Fisheries Administration has introduced the updated Strategic Planning Framework for Fisheries (SPFF) for 2015. Meanwhile, the National Strategic Plan for Aquaculture Development in Cambodia (NSPAD) 2016-2030 aims to meet the growing demand for fish for domestic consumption, and future investment requirements in aquaculture development.

The main aquaculture production produced from inland aquaculture accounts for nearly 90% of the total fish production. Aquaculture systems including floating cage/pen culture, earthen pond culture and integrated rice-fish culture, and other fish culture in small scale or aquaculture-based fisheries in Cambodia are practiced in over 20 provinces and cities, with less development on coastal aquaculture

Annual aquaculture production increased by an average of 20 % over the past decade, from 50,000 metric tons in 2009 to 254,048 metric tons in 2018.

Enhancing rice field fisheries productivity continues to be a priority in the Fisheries SPF, especially through Community Fish Refuges (CFRs). Rice field fisheries provides 100,000–150,000 tons per year which contributed 20–30 % of the total inland fish production.

However, knowledge about the current status of the sector is lacking. Anecdotal field observations and the few existing studies depict a sector with unsophisticated technology, low efficiency and low competitiveness against imports from neighboring countries. Limited availability of quality inputs and services is a major constraint to the growth of the aquaculture sector. Fingerling production, in particular, is insufficient and the poor quality of fingerlings produced results in very low levels of production to support the industry leading to the importation of fingerlings from neighboring countries.

Introduction

Cambodia is rich and has high diversity of freshwater fish, with more than 400 species (IFReDI, 2019). In general, fish consumption and fish supply for local and international markets mainly depend on inland fisheries; only a small portion comes from marine fisheries. The decline in inland fisheries fish stock drove the aquaculture sector to contribute to rural livelihood.

Cambodia has identified aquaculture as one of the three most important pillars of the country's fisheries development. The government's Strategic Planning Framework (SPF) for Fisheries for 2010 to 2019 considers expanding the farming of fish and other aquatic animals as "essential" given the limited capacity of natural resources to sustain the country's growing population. To support the growth of small, medium and large-scale freshwater aquaculture, government spending on aquaculture has been budgeted at more than $16 million under the 10-year framework. Recently, aquaculture extension is one of the national policies under the SPF for fisheries sector. To achieve the sectorial goal, several 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 in Cambodia have been practiced in over 20 provinces and cities, with less development focused on coastal aquaculture.

The aim is to boost production from both freshwater and marine aquaculture from 360,000 tonnes in 2020, to 740,000 tonnes in 2024 (SPF, 2016). In this decade, the aquaculture sub-sector has remarkably grown while production from capture fisheries in the country decreased. Promotion of aquaculture is an important contribution to national food security as well as to the country's revenue generation.

Aquaculture systems

The average annual growth of the aquaculture sector in Cambodia is 10 % over the last 20 years and has consistently been above 18 % over the last 10 years. In 2014, nationwide production is 112,000 tonnes which includes both marine and freshwater production. Aquaculture production is projected to increase from 76,000 tonnes in 2012 to 202,000 tonnes in 2019 (Strategic Planning Framework (FiA), 2011).

Aquaculture production is localized to specific provinces within the country. The Tonle Sap and the Mekong River have cage culture. In 2014, Siem Reap, Pursat and Phnom Penh were home to 61 % of the volume of cage culture nationwide. The lower floodplains have pond culture (79 % of the total pond area). A growing aquaculture sector is based around the outskirts of Phnom Penh. Recent aquaculture development projects have increased the number of ponds in targeted provinces, although nationwide, the overall number of ponds decreased by 9 % from 2009 to 2014.

Six main production systems represent more than 99 % of the total aquaculture production in Cambodia. Freshwater cage culture dominates the sector (more than 50 % of total production), followed by small and medium-sized enterprises (22 %) and smallholder high-input ponds (18 %). Other systems such as smallholder low-input ponds, marine cage culture and rice-fish systems are of minor importance. Marine low-value fish account for 3 % of the total feed used in aquaculture, while manufactured pellets represent less than 1 %. The rest of the fish feed used in aquaculture is provided by Cambodia's inland capture fisheries.

Aquaculture in Cambodia is dependent on capture fisheries which supplies the

sector with feed and seed for most of the semi-intensive ponds and cage systems. The total value of aquaculture production in 2011 is estimated at $114 million, freshwater cage farming reached 37,000 tonnes during that year (WorldFish, 2011). In terms of production and gross revenue, pangasius and snakehead dominate, with more than $30 million generated for both species. Though marginal, marine cage production is estimated at $7 million.

Freshwater

Cambodia has many water resources, such as the Great Lake Tonle Sap, the Mekong River, the Tonle Sap River, the Bassac River and many of their tributaries. A number of these lakes are potential sites for aquaculture. Freshwater aquaculture includes culture in cages, ponds and pens in areas with abundant water resources or are irrigated. Recently, fish culture have spread throughout the country, including the upland areas. Freshwater pond culture covers a total area of 1,350 ha of earthen ponds, comprised of 39,955 ponds. Floating net-cage culture is also important and covers 12 ha, comprised of 4,224 cages (FiA, 2014). These cages are used primarily for snake head (*Channa striatus*), giant snake head (*Channa micropeltes*), silver barb (*Barbonymus gonionotus*), *Pangasius* spp. and *Mystus spp.*

Cultured species and potential species for culture

Freshwater aquaculture is more developed than marine aquaculture. Cultured fishes include both indigenous and exotic species. The major cultured species are *Pangasius* spp. (73 %) followed by giant snake head (*Channa micropeltes*) (21 %). Other species produced include *Puntius sp.*, Thai catfish (*Clarias batrachus*), marble goby (*Oxyeleotris marmorata*), *Cirrhinus* sp., red tailed tinfoil (*Barbonymus altus*) and Hoven's carp (*Leptobarbus hoeveni*).

Culture systems, techniques, feeds and feeding management

Small-scale

A number of projects that dealt with small-scale aquaculture development are implemented in collaboration with the Fisheries Administration such as the following:

1. Agriculture Productivity Improvement Project (APIP);
2. Aquaculture of Indigenous Mekong Fish Species (AIMS/MRC);
3. Asian Institute of Technology-(AIT–ARRM); and
4. NGO. Native fish species are commonly used for pond culture with *Pangasius hypophthalmus* as the major cultured species. Please see **Table 1** for the other cultured species.

Pond fertilization techniques are well understood by farmers through aquaculture extension workers in project sites in some provinces. Green water is commonly used to rear fish by applying organic fertilizers. Small-scale farmers also apply inorganic fertilizer in order to improve pond productivity. Rice bran, broken rice and waste vegetables are the most common feed ingredients used in Cambodia. These ingredients are sometimes fed directly without processing; although, a few farmers do so, depending on the availability of labour and firewood. Other feeds used by most small-scale aquaculture farmers are duckweed, termites, cassava leaves, kitchen wastes and rice wine waste. Integrated fish-farming is also practiced in some areas, such as pig-fish, duck-fish, chicken-fish, rice-fish and garden-fish etc. These

Table 1. Most common fish species in Cambodia and their respective culture method and seed source

Species name	Farming system	Source of seed	Production volume
Native			
Striped catfish (*Pangasius hypophthalmus*)	floating cage, pond	hatchery, wild	high
Basa fish (*Pangasius bocourti*)	floating cage	wild	high
Spot pangasius (*Pangasius larnaudii*)	floating cage	wild	low
Trey pra ke (*Pangasius conchophilus*)	floating cage	wild	low
Giant snake head (*Channa micropeltes*)	floating cage	wild	high
Snake head (*Channa striatus*)	floating cage	wild	high
Silver barb (*Barbonymus gonionotus*)	floating cage, pond, rice field	hatchery, wild	high
Hoven's carp (*Leptobarbus hoeveni*)	floating cage, pond	hatchery, wild	medium
Trey khya (*Mystus wyckiode*)	floating cage	wild	low
Marble goby (*Oxyeleotris marmorata*)	floating cage, pond	wild	low
Snakeskin gourami (*Trichogaster pectoralis*)	pond, rice field	hatchery, wild	low
Red tailed tinfoil (*Barbonymus altus*)	pond, rice field	hatchery, wild	low
Exotic			
Nile tilapia (*Oreochromis niloticus*)	floating cage, rice field, pond	hatchery	medium
Silver carp (*Hypothalmichtys molitrix*)	pond	hatchery	medium
Common carp (*Cyprinus carpio*)	rice field, pond	hatchery	medium
Bighead carp (*Hypophthalmichthys nobilis*)	pond	hatchery	low
Grass carp (*Ctenopharyngodon idellus*)	pond	hatchery	low
Mrigal (*Cirrihinus mrigal*)	pond, rice field	hatchery	low
Hybrid catfish	pond	hatchery	high
African catfish (*Clarias gariepinus*)	pond	hatchery	high

Source: FIA, 2014

practices effectively reduce feed cost and increase fish production. Feed represents more than 70 % of the total operational cost and is mainly from small sized or low value fish which is between 60 % to 100 % of the total feed used depending on feeding strategies adopted by different farmers (So *et al*., 2005). During the dry season (October to May), the most important source of feed is freshwater small sized or low value fish, while more marine small sized or trash fish are used during the rainy season (June to September).

Commercial-scale

Cage culture is the most prevalent aquaculture practice in Cambodia and commonly practised in rivers and streams in provinces bordering the Great Lake. The major fish species for cage culture are river catfish (*Pangasius hypophthalmus*, *P.*

bocourti and *P. larnaudii*) and snakehead (*Channa micropeltes*). The river catfish, *P. hypophthalmus* is the dominant species for cage and pond culture. Fish production from cage culture systems is much higher than from pond culture. Commercial-scale cage culture in Cambodia contributed about 70 % of the total aquaculture production.

The main feed for pangasid catfish and snakehead is low-value fish (such as small cyprinids), which are available during peak season of fish catch, particularly from November to January. Small cyprinids are caught by 'dai lot' (bag net fishing) along the Tonle Sap River. Availability of feed ingredients varies both regionally and seasonally. During the peak of the fish catch, cultured fish are overfed, due to an abundance of low-value fish. After the peak period, fish are fed cooked rice bran mixed with 10–20 % of dry fish, depending on availability. Aquaculturists rarely use commercial pellets to feed fish because its use has not yet been widely disseminated in Cambodia. Furthermore, commercial feeds are imported and commands higher price than other feed types. Commercial fish pellets are not produced locally due to its high production cost and low market demand. However, Cambodia produces feed pellets for livestock and poultry which some rich farmers also use to feed fish, but it is not profitable at present.

The estimated feed conversion ratio (FCR) for pangasid catfish around Phnom Penh municipality during 1994–1995 season are as follows:

- fed only rice bran, FCR = 1:4 to 1:4.5
- fed rice bran mixed with low value fish and dried fish, FCR = 1:3 to 1:3.5

Production, consumer demand, cost of production, profitability

FiA statistics show that total aquaculture production reached 39,025 tonnes in 2008, representing 11 % of total inland fishery production. Inland fishery production came from cage culture. There are approx. 4,500 cages that can be found along the Mekong River (33 %), Tonle Sap River (17 %), Bassac River (7 %), and in the Tonle Sap Lake (43 %) which contributes 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 in 1993 to 56,234 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).

Researches done

There are a few researches being carried out at the National Aquaculture Research and Development Institute (NARDI) and Bati Center. Current research is more focused on the breeding of indigenous species, with high economic value such as the giant freshwater prawn, *Himibagrus wickioides* and *Osteichilus melanopleura*; and the domestication of some species such as *Tor tambra*, *Chitala ornata*, *Catlocarpio siamensis* and *Osphronomus goramy.*

A few studies on the cage and pond culture of snakehead in Cambodia were

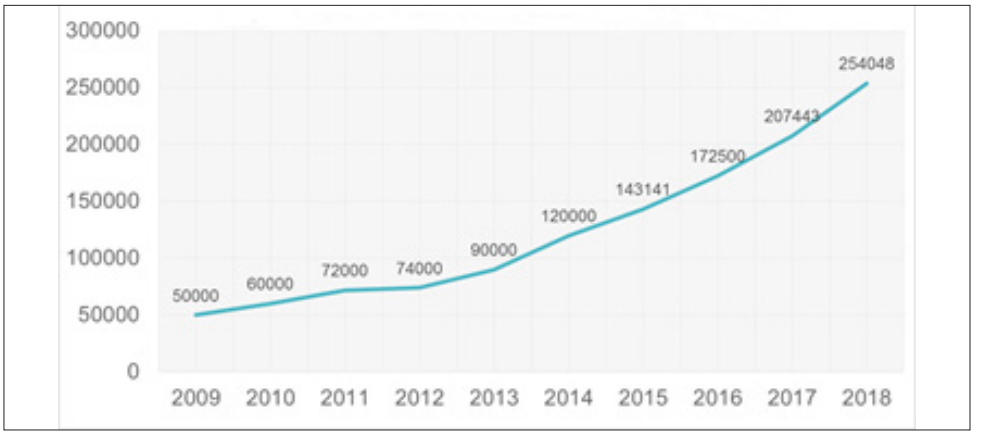

Figure 1. Annual production (in metric tons) from aquaculture sub-sector

done for cost and profitability analysis. Furthermore, factors affecting the success of the business were identified which can be the basis for the promulgation of policies which aim at promoting sustainable development of snakehead aquaculture practices in Cambodia.

Research gaps

The main extension priorities recommended for Cambodia are identified as follows:

- Research on breeding techniques for some other indigenous species, with high economic value;
- Building on the capacity of breeding selection and genetic conservation;
- Research on fish diseases and applied vaccination in aquaculture;
- District and provincial level government capacity building – to enable local staff to carry out breeding, feed and feeding trials and extension;
- Develop better alternatives for small-scale credit schemes – to address the lack of available credit for farming communities;
- Assistance to develop a fish-feed enterprise in Vientiane – to encourage development of a fish-feed center in Vientiane ensuring local ownership and operation; and
- Farmer networks – research into effective ways to develop farmer-to-farmer feed extension networks, similar to other networks developed by AIT and UNDP/FAO.

Problems encountered

Inland aquaculture in Cambodia is still faced with issues and problems regarding breeding and nursery techniques. In addition, the capacity building of fisheries officer is really needed.

Breeding of several indigenous species such as *Barbonymus altus* and *Barbonymus gonionotus* are quite successful but needs to be improved for other species. There are two types of feed, fresh and homemade feed, that farmers use for intensive and semi-intensive culture systems. Fresh feed includes trash fish, fish byproducts, poultry by-products, kitchen waste etc. These

fresh feed materials are dumped directly into the fishpond, causing deterioration of water quality. Moreover, without proper storage, fresh feed spoils easily and its quality can deteriorate. This increases the risks of disease occurrence. This problem is often found in small farms which lack cold storage facilities to keep raw materials.

Management practices

In general, aquaculture is under the management of Cambodian Fisheries Law. Exotic species are banned for culture in natural water bodies. In recent decades, giant snakehead culture is commonly found in areas with high supply of low value fish such as from Tonle Sap Lake, Bassac and Mekong Rivers. The conflict in the use of low value fish as feed to giant snakehead and other cultured species and for human food consumption was recognized; and thus, farm-raised snakehead was banned in 2004. Recently, the Fisheries Administration issued a proclamation on management measures for sustainable snakehead fish farming to the Ministry of Agriculture lifting the ban on farm-raised snakehead.

Monitoring of aquaculture systems is under the Fisheries Administration, directly under the Department of Aquaculture Development. Recently, Good Aquaculture Practice guideline is introduced and disseminated to all stakeholders. The National Aquaculture Development Strategy (NADS) developed a roadmap for the aquaculture sub-sector

Sustainability

To support the sustainability of aquaculture in Cambodia, policies, strategic plans for the fisheries sector and national aquaculture development strategy (NADS) were developed and amended. The goal of NADS is a commercially viable and environmentally sustainable aquaculture sector contributing to food security and nutrition, socioeconomic development, GDP and export earnings. Seven strategies to guide the sustainable and development of aquaculture in Cambodia:

- To increase access to high quality of seed for a range of species in demand in local, regional and global markets;
- To ensure widespread availability of sustainably sourced, reasonably priced, high quality feed suitable for a range of species;
- To increase access to sufficient and consistent supplies of high quality water, and to reduce flood risk;
- To improve efficiency, profitability and sustainability of aquaculture production through increased knowledge, skill and organization;
- To maintain environmental quality and minimize loss from the disease;
- To increase quality and value of production;
- To facilitate access to credit as appreciate to the need, potential and risk associated with aquaculture development.

Brackishwater

The contribution of brackishwater fishery to socio-economy is not well studied and documented, particularly the aquaculture activities, production, consumer demand, research and problem encountered is not studied and presented in this system.

Mariculture

Cambodia's coastal zone, located on the south-west edge of the country, extends 435 km, and includes 85,100 ha of mangrove forests in three provinces: Koh Kong, Sihanouk Ville and Kompot (Landsat, 1994). Marine aquaculture production (mostly snapper and grouper) is projected to increase by 8 percent per year between 2009 (est. 2,880 tonnes) and 2030 (est. 15,000 tonnes) (WorldFish, 2011).

Cultured species and potential species for culture

The common marine crustaceans cultured are shrimp and mud crab. The common cultured finfish are sea bass, snapper, grouper and cobia. *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 (Lan, 2015). Marine species being cultured in Cambodia including the culture method and source of seeds is presented in **Table 2**.

Culture systems, techniques, feeds and feeding management

Finfish and crustacean farming are mostly semi-intensive usually done in cages, ponds and pens. Extensive culture of bivalve molluscs is done in the coastal areas. Marine aquaculture constitutes 218 ha of earthen ponds (10,232 ponds), 1 571 ha of pens (292 pens) and 14 ha of floating net-cages (1,898 cages) (FiA, 2014). Marine aquaculture practices are as follows:

(1) marine finfish culture in floating net-cages,

(2) marine finfish culture in ponds,

(3) mud crab culture in ponds. Feed is solely locally sourced trash fish.

Production, consumer demand, cost of production, profitability

Aquaculture production increased from 50,000 tons in 2009 and to 70,000 tons in 2012; from 120,000 tons in 2014 to 250,000 tons in 2018 as seen in F**igure 2.** As capture fisheries decline and the local demand for fish is high at 62.5 kg/person/year, aquaculture sector became the most important source of food in Cambodia. Aquaculture production is targeted to be 740,000 tons by 2024

Researches done

Applied aquaculture research is carried out by the National Research and Aquaculture Development Institute (NARDI) of the Fisheries Administration (FiA), Prek Leap

Table 2. Marine fish species cultured in Cambodia

English name	Culture method	Seeds Source
1. Sea bass (*Lates calcarifer*)	Pond and net cage	Hachery and import
2. Snapper (*Lutjanus* spp.)	Net cage	Import and wild
3. Grouper	Net cage	Import and wild
4. Shrimp	Pond	Wild and import
5. Cobia	Net cage	Wild and import
6. Mud Crab (*Scylla serrata*)	Pond	Wild
7. Seaweed (*E. cottonii*)	Raft	Import & local farmer

Agriculture College, National Agriculture College Kampong Cham and the Royal University of Agriculture. The NARDI has two research Divisions. Most of the applied research undertaken is concentrated on breeding techniques, broodstock improvement, seed production, nutrition, fish diseases and production technologies in ponds, cages and rice paddy fields. Most of the researches are on grouper and mud crab.

Research Gaps

One of the research gap is on selective breeding and genetic conservation in order to ensure that the produced fingerling from government hatchery station are good in quality.

Problems encountered

The problems encountered in Cambodian aquaculture are as follows:

- Deficiency of human resource, both skill and expertise on aquaculture and lack of technical assistant for local fish growth out famer and local hatchery;
- Inadequate and unreliable supply of good quality seed;
- Deficiency of capital, fund or credit for aquaculture investment;
- Adequate knowledge of aquaculture technology; inadequate manpower for aquaculture extension service; and climate and;
- Most aquaculture activities are small scale, lack of infrastructure for aquaculture practice and depend on rain feed;
- Chronic disease problems (up to 50 % losses), which seem to be endemic throughout the region.

Management practices

Cambodian fisheries is governed by the Law on Fisheries and its regulations, issued on 21 May 2006 and is currently being updated. In the updated Law on Fisheries, Aquaculture regulations are included in Chapter 10, under Aquaculture Management; some articles are related to aquaculture activities in both marine and freshwater (Article 53). The Fisheries Administration (FiA) is the principal government agency responsible for managing and developing fisheries and aquaculture. Its mandate and structure are set out in the Sub-decree. The new Law on Fisheries is divided into 17 chapters and 109 articles covering definition, exploitation of freshwater and marine fisheries, aquaculture and the processing of freshwater and marine fishery products, competent authorities for solving fishery violation, penalties and the final order.

Sustainability

Sustainability for mariculture is the same as for freshwater.

Resource enhancement

Stock Enhancement

Stock enhancement programs use seedstock produced for aquaculture purposes and from captive breeding techniques. Techniques to breed fish in captivity are developed for some species and thus the availability of hatchery-produced juveniles for stocking.

Stocking programs have been subjected to substantial criticism due to perceived impact of hatchery-bred fish on genetic

structure and fitness of wild stocks, transfer of disease and their effects on other aquatic species and the environment (no research done on this case).

Country present situation

Annual production of inland and marine capture fisheries

The fisheries sector officially accounts for about 12 % of GDP, and provides most Cambodians with their key source of animal protein, calcium and vitamin A. Cambodian fisheries products are also exported to many other countries, providing much-needed revenue.

Species stocked, scale of stocking

Stocking of indigenous species is usually done during the national fish day together with activities related to stock enhancement and community fish refuge. During the national fish day some indigenous species are stocked in large reservoirs to enhance wild brood-stock as well as increase public awareness on fisheries conservation. Species stocked in reservoir during the national fish day are in **Table 3**.

Source of seeds

Stock enhancement activity for marine species is depended on the supply of fingerlings from government hatcheries and research centers. For the stock enhancement at community fish refuge, stocks are collected wild brood-stock.

Release strategies, site selection, enclosures, monitoring

The release strategy, site selection and monitoring of fish released during the national fish day is not well established as this is just to raise public awareness, not to enhance wild stock. Stock enhancement during national fish day is done in large reservoir that interests the public. The release strategy, site selection and monitoring process for community fish refuge is more scientific. Through an advocacy campaign called "One Commune, One Community Fish Refuge" and through the legal framework of Community Fisheries (CFi), the government of Cambodia has been promoting Community Fish Refuges (CFRs) (Joffre *et al*., 2012). Joffre *et al*., 2012 describes three steps in establishing a CFR: site selection, institutional arrangements for CFR managements, and local implementation of CFR activities. Identification of appropriate sites is the most important. The CFR site should be selected in consultation with local communities. Specifically, stakeholders such as Commune Chiefs, Commune Councillors, police officers and village heads who are knowledgeable about the local context should be consulted. The site selection should also consider hydrological, socioeconomic and governance factors for CFRs' sustainability. The site should have access to year-round water supply, infrastructures for water management and enough flood level to allow fish migration. CFRs are likely to be successful in areas where there are community-managed ponds and where community members and local authorities are committed to work in harmony. The second step is the formation of CFR Committee and development of rules and regulations for managing the CFR. The third and final step includes the preparation of ponds and filling them with required volume and quality of water, securing fish pathways and plant cover. Then, brood stock and fingerlings are released. Common fish species for the CFR include snakehead (*Channa striata*), catfish (*Clarias batrachus*), climbing perch (*Anabas testudineus*) and the hatchery-raised silver barb fingerlings (*Barboides gonionotus*).

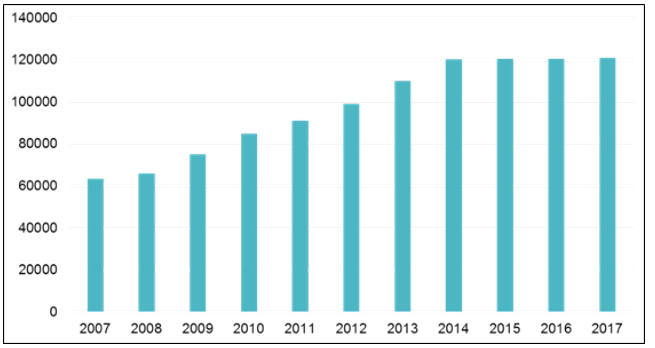

Figure 2. Annual production of aquaculture from 2009 to 2017

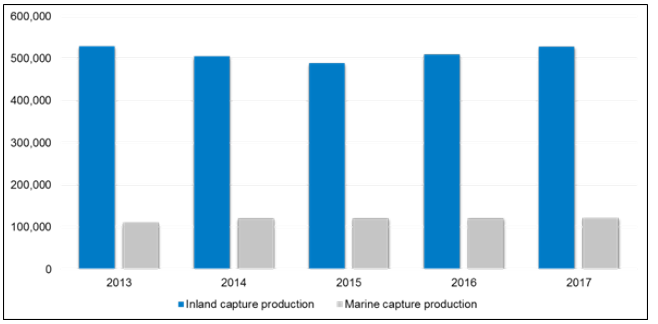

Figure 3. Annual production of inland and marine capture fisheries, Cambodia, 2013-2017

Table 3. Species stocked during the national fish day

Species	Freshwater species	Marine Species
1	*Cirrhinus microlepis*	*Epinephelus* sp.
2	*Trichohodus pectoralis*	*Thalamita crenata*
3	*Macrobrachium rosenbergii*	-
4	*Anabas testudineus*	-
5	*Channa striata*	-
6	*Barbonymus altus*	-
7	*Catlocarpio siamensis*	-
8	*Barbonymus gonionotus*	-

FiA plans to develop one well-functioning CFR in every 1200 communes by 2019 (FIA, 2018). Despite these interventions ongoing for years, there have been no systematic studies on rice field fisheries, particularly about the socioeconomic status of CFR users and their participation in the CFR process.

Management of stocked populations (population, genetics, protection, regulation)

Management of the stock population is under the Cambodian Law on Fisheries. In order to enhance wild stock, the chosen location such as deep pool in the

upper part of the Mekong is converted into a conservatory for broodstock fish protection and for freshwater dolphin. Global significant habitat such as Ramsar site located along the Mekong and Wetland area under UNESCO, at Prek Toal (Tonle Sap Lake) is banned for any fishing activities.

The management of stocked population during the national fish day is limited, whereas, the community fish refuge is more effectively manage by a committee. The protection and regulation of community fish refuge is generally followed and regulated by by-laws, internal regulations and rules implemented by the local community. Stocked fish are mature and from the wild. After stocking, fishing of the wild broodstock in the reservoir is prohibited; broodstocks can be fished during the rainy season when fish swim away from the reservoir.

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