

**Assessing economic and welfare values of fish in the Lower Mekong Basin**  
*Project funded by ACIAR*

**Biology Component**

# **AQUACULTURE PRODUCTION IN CAMBODIA 2012 update**

**JOFFRE Olivier<sup>1</sup>**

WorldFish Center, Phnom Penh, Cambodia.

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## Abstract

Aquaculture in Cambodia is one of the fastest growing sectors of the economy. Average annual growth of the aquaculture sector over the last 20 years exceeds 10% and over the last 10 years, average growth has been consistently above 20% per annum.

Aquaculture production is localised to specific provinces within the country. The Great Lake as well as the Tonle Sap and Mekong rivers have cage culture while lower floodplains have in-ground pond culture, including a growing peri-urban aquaculture sector based around Phnom Penh.

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 & Medium Enterprise* (22% of total production) and *Small holder high input* production system (18% of the production). Other systems such as *Small holder low input*, *Marine cage culture* and *Rice fish system* are of a minor importance in terms of overall production.

Based on the characteristics of these systems and their relative contributions, as detailed in WorldFish (2011), we estimate the actual production of each of those systems for the year 2011, where fresh water cage farming reached 37,000 tons. In terms of both production volume and gross revenue, the Pangasius and Snakehead fish species dominate, with more than 35 and 15 million USD generated respectively.

## Keywords:

Cambodia, pangasius, cage aquaculture, Production systems

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# **1. INTRODUCTION**

## **1.1. BACKGROUND**

Research concerning the proper role of fisheries in economic development has continued in increasingly sophisticated fashion well into the modern era (e.g. The WorldFish Center was founded in 1975 as ICLARM). Beliefs about the nature of small scale fisheries and their role in economic development have continued to evolve. In turn, the types of research questions considered relevant for fishery-related policy development have continued to change. WorldFish Center supporter by ACIAR launched a project in 2012 called “*Valuation of Fisheries in Cambodia*”.

The overall objective of the project is to quantify the multiple values of fish resources and convey information to national decision-makers and development agencies for sustainable and improved rural livelihoods. The objectives of the project are to:

- i. assess the economic value of capture fisheries in Cambodia;
- ii. assess the welfare value of fish for rural populations in Cambodia and identify strategies that maximize this value;
- iii. establish a coordinated monitoring of fish resources through a network of universities;
- iv. improve national statistics about fisheries resources;
- v. inform a large range of stakeholders about the actual role of fisheries in national economy and livelihoods.

## **1.2. PURPOSE OF THE STUDY AND APPROACH**

The purpose of the study is to provide an updated estimate of total aquaculture production in Cambodia, based on national statistics and a literature review. This work will be based on the “Fish Supply and Demand in the Lower Mekong Basin with special reference to Cambodia” research program developed by the WorldFish Center in 2010/2011.

The objective of this review is to provide fish production statistics for each of Cambodia’s 6 main aquaculture production systems. The information found in this report will be used, along with the rest of the data generated in the production component of the project, to estimate the market value of freshwater fish in Cambodia. In addition, it will be possible to estimate the quantity of wild fish used as fish feed in Cambodia’s aquaculture sector.

## **1.3. CONTENT OF THE REPORT**

The report includes a brief review of Cambodia’s aquaculture sector and a description of the 6 main production systems that generate the bulk of the country’s aquaculture production. We then estimate total aquaculture production using updated 2011 statistics and the fish production model found in “Fish Supply and Demand in the Lower Mekong Basin with special reference to Cambodia”

**2. METHODOLOGY**

The approach we use combines updated statistics with a recent study of Cambodia’s aquaculture sector to generate new production data for each of the 6 main aquaculture production systems in Cambodia.

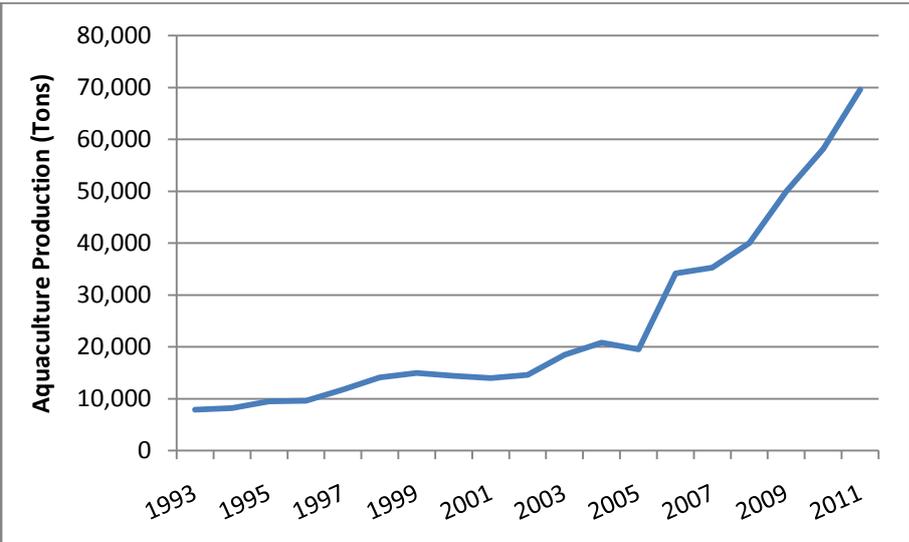
Cambodia’s aquaculture production systems were studied by the WorldFish Center and are detailed in Brooks and Philips (2011) and WorldFish Center (2011); they include descriptions, productivity data and information on wild fish feed inputs for each production system. WorldFish also computed the relative contribution of each of these production systems to total aquaculture production. The results of this project were based on consultations with the different stakeholder in the aquaculture sector and on-farm survey in different provinces of Cambodia.

Using updated statistical data (from 2011) on aquaculture production, provided by FiA, we were able to estimate new production figures for each of the 6 main production systems, based on the hypothesis that since 2010 the relative contribution of each of the production systems to total aquaculture production did not change drastically. The update was done in consultation with FiA’s Aquaculture Division and IFRaDI.

**3. RESULTS**

**3.1. AQUACULTURE IN CAMBODIA – A BRIEF OVERVIEW**

Aquaculture production in Cambodia is one of the fastest growing food sectors in the country. Aquaculture production has been increasing since at least 1993 (Figure 1) but remains marginal compared to capture fisheries, which generate around 10 times the volume of the aquaculture sector (~600,000 tons vs. ~70,000 tons in 2011). In 2011, the total national freshwater (and marine) aquaculture production reached 69,617 tonnes (and 72,000 tons including eel, frog, shrimp and mollusc production).



**Figure 1: Volume of Aquaculture Production (freshwater and marine) in Cambodia from 1993 to 2011 (source FiA)**

Between 1993 and 2011, Cambodia’s aquaculture sector sustained average annual growth of over 12% and sustained an annual average growth rate above 21% between 2002 and 2011. According to the Strategic Planning Framework (FiA. 2011) aquaculture production in 2012 is projected to reach 76,000 tons and by 2019, 202,000 tons. Considering the most recent statistics, the aquaculture sector achieved its production target in 2011. Aquaculture in Cambodia is dependent on capture fisheries. Much of the aquaculture sector’s fast growth may be attributed to the capture fishery, which supplies the sector with feed and seed for most of the semi-intensive ponds and cage systems.

Marine low value fish account for only 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. More than 50% of the aquaculture production comes from intensive cage systems that use small sized fish as fish feed. It was estimated that the demand for wild fish used as feed in the aquaculture sector was about 73,000 tons in 2009 (WorldFish 2011). In addition, 26% of the fingerlings used in aquaculture production are collected in the wild (So and Haing 2007).

Even if hatchery reared fingerling production is increasing in Cambodia (more than 130 million in 2011) and assuming importing fingerlings is common, the sector remains dependent on the wild capture for fingerlings..

Aquaculture production in Cambodia is spatially clustered. Intensive, market oriented pond culture surrounds Phnom Penh. Cage culture is located mainly in Kandal Province (home to 73% of cages nationwide in 2009), in the Tonle Sap Lake and the Mekong and Bassac rivers. Cage culture is also present to a lesser extent in other provinces along the Mekong River (e.g. Kampong Cham and Kandal) and around the Tonle Sap River and Tonle Sap Lake (e.g. Siem Reap, Kampong Chhnang).

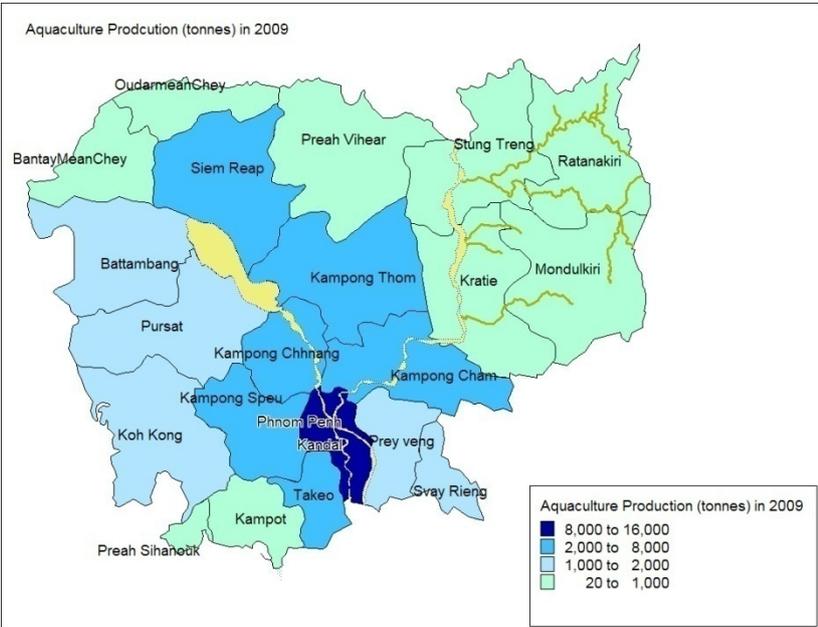
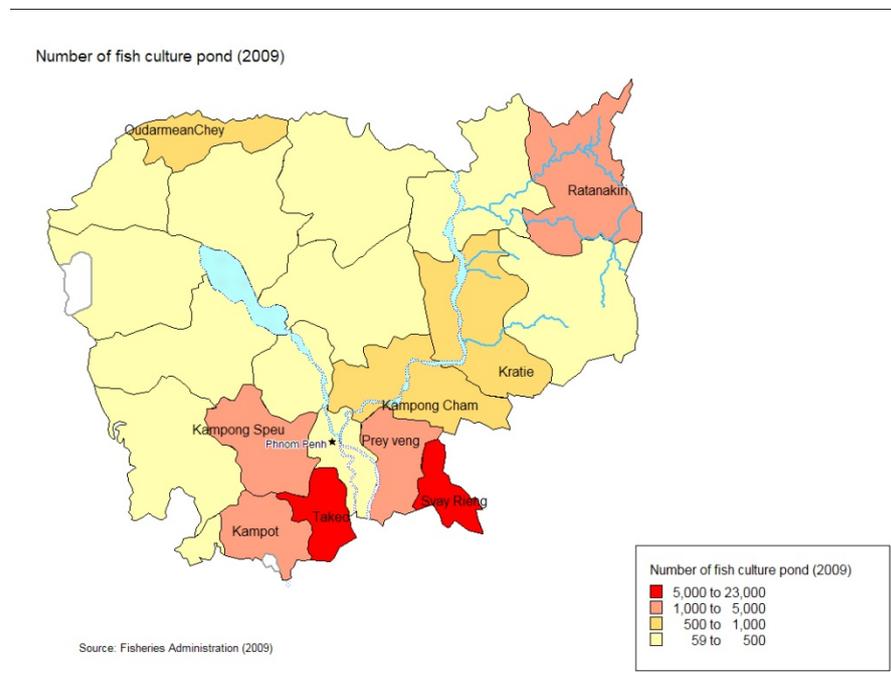


Figure 2: Aquaculture Production (tonnes) per province in 2009 (source FiA 2009)

However, according to 2011 statistics, the number of cages decreased in Kandal Province and now represents only about 20% of the total cages in Cambodia. This recent change was explained by the enforcement of the ban on snakehead cage culture. Pursat, Battambang, Kampong Cham and Kampong Chhnang provinces still have an important number of aquaculture cages, representing between 12 to 20% of the total aquaculture cages in the country.

Low input production systems are more common in the lowland floodplains south Phnom Penh, while aquaculture remains undeveloped in the mountainous areas and the northeast part of the country.

In 2009 more than 48% of the total cage and intensive pond aquaculture production was found in Phnom Penh and Kandal province (Figure 2). Those production systems benefit from their proximity to nearby cities and transport facilities for access to markets. Aquaculture in the southern lowland floodplain is characterized by extensive low input aquaculture systems, with the highest number of small holder homestead aquaculture ponds in Takeo, Svay Rieng, Kampong Speu and Prey Veng provinces (Figure 3).



**Figure 3: Number of aquaculture pond per province in 2009. (source FiA 2009)**

In the northeastern part of the country, Ratanakiri Province benefited from recent development projects, which resulted in an increased number of aquaculture ponds and support for hatcheries. But overall provincial production remains low. Other northern provinces have a low number of pond and limited production. Production in the western provinces is intermediate, similar to production in Pursat or Battambang provinces.

Beside cage aquaculture and intensive market oriented ponds, the remaining aquaculture production systems relies essentially on small holder low input ponds located in the central floodplain of Cambodia.

According to 2011 statistics the overall number of active aquaculture ponds in the country decreased by 3% between 2009 and 2011. This decrease can be explained by absence of statistics for Banteay Meanchey, Oddar Meanchey and Pursat provinces. In the meantime, some provinces reported large increases in the number of aquaculture ponds during the same period. For example Pusat (+400%), Battambang (+188%) Kampong Cham (+166%) and Prey Veng (+184%) (Table 1).

For cages culture, statistics for Siem Reap and Preah Sihanouk provinces are missing but the overall number of cages country-wide declined since 2009. The main decline is found in Kandal Province where the number of cages decreased from 12,000 to 733 aquaculture cages.

**Table 1: Number of pond and aquaculture cages in 2009 and 2011**

	No. of ponds	No. of ponds	Difference	No. of cages	No. of cages	Difference
	2009	2011	%	2009	2011	%
Phnom Penh	350	201	-43	169	147	-13
Kandal	370	554	50	12,034	733	-94
Prey Veng	3,200	9,082	184	246	160	-35
Takeo	23,000	19,146	-17	12	12	0
Svay Rieng	14,140	9,418	-33			
Kampong Speu	3,800	1,824	-52			
Kampong Cham	644			600	610	2
Kratie	530	550	4	135	90	-33
Stung Treng	323	380	18	2	3	50
Kampong Thom	384	160	-58	105	137	30
Kampong Chhnang	188	501	166	322	483	50
Pursat	320	1,660	419	532	755	42
Battambang	400	1,150	188	435	560	29
Banteay Meanchey	240			0		
Oudar Meanchey	764			0		
Siem Reap	350	500	43	637		
Ratanakiri	1,800	419	-77	0		
Mondolkiri	62	389	527	0		
Preah Vihea	405	400	-1	2	8	300
Kampot	3,800	7,000	84	10	50	400
Preah Sihanouk	125			919		
Koh Kong	59	118	100	387	135	-65
<b>Total</b>	<b>55,254</b>	<b>53,452</b>		<b>16,547</b>	<b>3,883</b>	<b>-77</b>

(source FiA 2011)

In Kandal this sudden decreased of cage culture was explained b the enforcement of the snakehead culture ban. This decrease seems unrealistic since at the same time national production supposedly increased by 20,000 tons. Therefore, the figures of the number of cages culture in the country should be taken with caution.

### 3.2. PRODUCTION SYSTEMS

The following section present the 6 main aquaculture production systems based on Joffre et al. (2010) and WorldFish (2011). The 6 systems are:

- *Small holder- low input pond culture*
- *Small holder– high input pond culture*
- *Small & Medium Enterprise (SME) intensive pond culture*
- *Freshwater cage culture*
- *Marine cage culture*
- *Rice-fish systems*

### **3.2.1. Small-holder low-input systems**

This system consists in 1 to 2 small ponds (around 200m<sup>2</sup>) within a small holder farm, where rice is the dominant activity and aquaculture is often a secondary livelihood activity in terms of income. The management system is based on on-farm inputs and occasional off-farm inputs (e.g. rice bran) when affordable. Carp poly-culture dominates production, together with tilapia. Production is about 70 kg per pond and 75% of this production is consumed by the household.

This systems represents more than 50% of total aquaculture production systems in Cambodia and more than 90% of the farms in Banteay Menchey; Kampong Speu, Kratie, Stung Treng and Svay Rieng provinces.

### **3.2.2. Small-holder high-input systems**

Similar to Small holder low input production systems, this production system is family based, with 1 to 2 ponds ranging from 0.1 to 0.2 hectares in size. Total fish production yields range between 5.5 and 20 tons/ha/year depending upon the type of aquaculture system used. Aquaculture systems range from carp dominated poly-culture with tilapia, polyculture dominated by pangasius or intensive pangasius monoculture with a cultre cycle of 7 to 9 months once a year.

In this system the uses of inputs are more important, with rice bran mixed with small sized fish and in some cases commercial feed pellets. Production tends to be market-oriented, with less than 6% of production consumed on-farm.

This system represents more than 18% of the total number of aquaculture systems in Cambodia; they are found mostly in the lowland floodplain provinces (Takeo, Phnom Penh, Prey Veng and Kandal) and in the Province of Pursat.

### **3.2.3. Small and medium enterprise**

This system is found in the peri-urban areas of Kandal and Phnom Penh where water supply is adequate. This system represents 5% of total aquaculture systems in Cambodia. It includes intensive monoculture of pangasius, giant snakehead and hybrid catfish, with yields ranging from 51 to 300 tons per hectare and per year. Both pangasius and snakehead cultures cycle annually, while hybrid catfish culture is based on a short 2.5-3 month cycle, with an average of 3 cycles per year.

Farms are operated by full time workers, can be larger than 1 hectare and contain more than one pond. This system is input intensive; small sized fish and rice bran account for 77-88% of

the total operational cost. In addition to small sized fish, wild capture provides fingerlings for snakehead production. Less than 2% of total production is consumed on the farm.

#### **3.2.4. Freshwater cages**

Freshwater cages are operated along the Tonle Sap River, and the Mekong River and the Great Lake. Three systems account for more than 90% of the cages: monoculture pangasius, polyculture pangasius (associated with catfish, *leptobarbus*, carp or tilapia) and snakehead monoculture.

Productivity of snakehead cages is averages around 90-100kg/m<sup>3</sup>/yr , much higher than lower Similar to Small holder low input production systems pangasius production of 35-50 kg/m<sup>3</sup>/yr . Snakehead cage production is mainly located on the Great Lake in the provinces of Pursat, Battambang and Siem Reap. Some niche production systems such as wallago (*Wallago micropogon*) and red tail catfish (*Hemibagrus wyckioides*) exist mainly in Kampong Chhnang province along the Tonle Sap River.

In these cage systems the main input is feed, mainly rice bran mixed with small sized fish and in some cases additional commercial pellets. Feed cost account for 68-71% of the total operational cost. All production is destined for market.

Most of the freshwater cages are located in the provinces of Kandal, Kampong Cham, Siem Reap, Pursat, Battambang and Kampong Chhnang. In 2011 each province held between 500 and 700 cages.

#### **3.2.5. Marine cages**

Marine cage farms are composed of 20 to 50 cages, with 2/3<sup>rd</sup>s dedicated to seabass culture and 1/3<sup>rd</sup> to grouper culture. Grouper culture is limited by the availability of the fingerlings (caught from the wild) while hatchery-reared seabass fingerlings are imported from Thailand. In this system the main input is small sized fish used for feed.

These farms are found in Preah Sihanouk and Koh Kong provinces. All production is marketed locally.

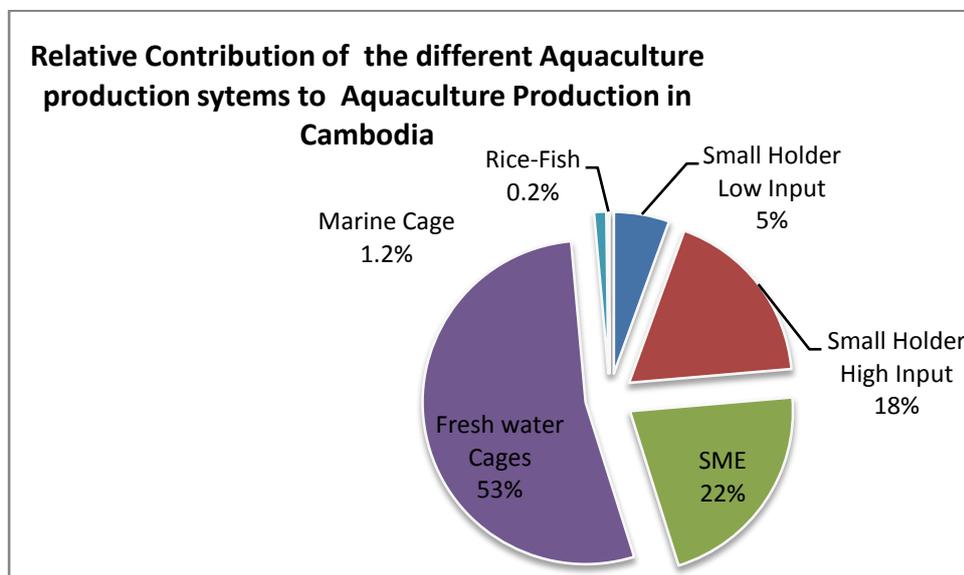
#### **3.2.6. Rice-fish systems**

Concurrent rice–fish systems are operated by small holders, with an average area of 0.4 ha and typically a low stocking density of carp and tilapia poly-culture. The growth cycle lasts around 4 months. Inputs are limited to on-farm feeds (rice bran, duckweed) and the natural productivity of the rice field is enhanced by inorganic and organic fertilizer used for rice culture. The production, around 400 kg/ha/cycle, is partially consumed by the household (30%) during the fish harvest period (1 to 1.5 months) and the excess is sold locally.

Rice-fish systems represent less than 2% of the total fish farms in Cambodia and are mainly located in Takeo province.

### 3.3. CONTRIBUTION TO THE TOTAL AQUACULTURE PRODUCTION

In 2010, WorldFish estimated the relative importance of each production system type in Cambodia, based on a literature review and in consultation with the Fisheries Administration. The relative contribution of the different systems is presented in Figure 4.



**Figure 4: Relative contribution of the Aquaculture production systems in Cambodia in 2011**

Fresh water cages dominate the aquaculture sector with more than 50% of total production, followed by Small Medium Enterprises (SME) and Small holder high input systems. The other production systems combine to represent less than 12% of the total aquaculture production, even if the Small holder low input pond system is Cambodia's most common production system, representing 50% of the total aquaculture farmers in Cambodia.

According to the FiA and IFReDI, the recent increase in aquaculture production is mainly due to Freshwater cage culture, Small and Medium Enterprises and Small holder high input production systems. The contribution of cage culture might be higher in 2011 (between 55 and 65% of the total production) than the estimates from 2009, but without a larger consultation or survey it is difficult to generate a new estimate of the relative contribution of each system. In addition, according to national statistics from 2011, marine cages represent about 1.2% of total aquaculture production, while it was estimated to be 6% by an expert panel in 2009. This difference might be due to a decrease in marine cage culture in 2011 or an overestimate of the contribution of marine cages to total production in 2009.

In order to reflect the recent changes in production estimates for the 6 aquaculture systems in 2011, we use national statistics on marine fishes as the production of Marine Cages and we equally increase the representation of Small holder high input, SME and Fresh water cages.

Considering the total aquaculture production in 2011 (69,617 tons) and the relative contribution of each system, we estimate the production of each of those systems in 2011 (Table 2).

**Table 2: Current production estimates for 6 aquaculture systems in 2011**

	Small Holder Low Input	Small Holder High Input	SME	Fresh water Cage	Marine Cage	Rice- Fish
<b>Relative contribution to total production</b>	5.5	18	21.5	53.3	1.2	0.2
<b>Production in 2011 (tons)</b>	3,829	12,594	14,968	37,106	845	139

(Total production in 2011 is estimated to 69,617 tons.)

Fresh water cages with pangasius, snakehead and catfish have the highest production volume. Similar species are raised in ponds within SME and Small holder high input production systems. Carps and tilapia farming, which are less dependent on small sized fish because they use less feed, comprise less than 10% of total aquaculture production.

According to WorldFish 2011, the wild fish required for aquaculture fish feed for the entire sector was estimated to be around 73,000 tons ( based on 2009 production figures). If we consider that the contribution of the different production system is still similar in 2011 and that farming practices and Feed Conversion Ratio did not change significantly compared to 2009, the wild fish requirement for total Cambodian aquaculture production is estimated to have rises to 101,641 tons in 2011. This figure represents almost 20% of the total volume of Cambodia's inland capture fishery.

### **3.4. VALUATION OF TOTAL AQUACULTURE PRODUCTION**

Based on the results presented in WorldFish (2011) relative to the production and selling prices of the different species produced, we estimate the gross revenue of the different production systems for 2011 (Table 3). These results do not take into account any of the operational or investment costs.

Compared to 2009, the proportional representation of each system to total production has changed, based on 2011 statistics. Marine cages are less prominent. Freshwater Cage Culture, SME and Small holder high input all increase in terms of their proportional importance to total aquaculture production. Within each system, the increase in representation is equally spread within the different sub-systems.

**Table 3: Estimate Gross Revenue generated by the different Aquaculture production systems in 2011**

	SH Low	SH High			SME			FW Cages			Marine Cage		Rice fish
	<i>Tilapia carp</i>	<i>Polyculture</i>	<i>Pangas polyculture</i>	<i>Pangas monoculture</i>	<i>Hybrid catfish</i>	<i>Pangas Monoculture</i>	<i>Snakehead</i>	<i>Pangas polyculture</i>	<i>Pangas</i>	<i>Snakehead</i>	<i>Seabass</i>	<i>Grouper</i>	<i>Tilapia &amp; carps</i>
<b>Systems</b>	1	2	3	4	5	6	7	8	9		10	11	12
<b>Relative Contribution<sup>a</sup></b>	5.5	3.81	5.47	8.81	4.54	14.52	2.44	27.53	5.31	20.53	0.3	0.9	0.23
<b>Production in 2011</b>	3,829	2,652	3,808	6,133	3,161	10,108	1,699	19,166	3,697	14,292	209	627	166
<b>Average selling price<sup>b</sup> (USD/kg)</b>	1.5	1.75	1.5	1.2	1.25	1.2	2.06	1.5	1.5	2.1	5	10	1.5
<b>Gross value of the production in Million USD/year</b>	5.7	4.6	5.7	7.3	3.9	12.1	3.4	28.7	5.5	30	1	6.2	0.2

a: the average contribution of each system is based on 2010 data (WFC, 2011)

b: based on 2010 data collection

*Pangasius* production and snakehead dominate the aquaculture sector in terms of gross revenue with more than 30 million USD generated for both species. Surprisingly, *Marine cages* represent more than 7 million USD, while its contribution to the total aquaculture production is about 1.2%. This result is due to the high market prices for marine cage species (seabass and grouper). The overall value of total aquaculture production is over 114 million USD per year, based on this estimate.

WorldFish's (2011) economic analysis of aquaculture systems shows that intensive systems, both in fresh water and marine environments, offer the highest net return for producers. However, this valuation will be updated with fish prices from the "Market Survey" (one of the component of the Fisheries Valuation Project). Recent field observation indicates that fish prices are lower in 2012 compared to 2011 due to increased supply of Capture Fisheries and that producers also face concurrence of imported aquaculture fish from Thailand and Vietnam.

In terms of welfare, it will be interesting to investigate who benefits from which production systems and if aquaculture production that uses large amount of low value fish as fish feed are accessible to the poorest. In addition, it will be interesting to investigate if the poor benefit from aquaculture development directly by consuming the aquaculture production and/or by being involved as labour within the production system of the value chain.

#### **4. CONCLUSIONS**

Aquaculture in Cambodia is a fast growing food sector. Results of previous studies show that the sector is highly dependent on capture fisheries, for seed and feed. The latest production statistics shows are rapid increase over the last 2 years, increasing from to 50,000 tons in 2009 to 72,000 tons in 2011 .

Freshwater cage culture is the main contributor to total production. Dominant species are pangasius and snakehead, while carp polyculture and tilapia represents a lower share of the production and a lower total market value.

Small holder low inputs and rice –fish system represent less than 7,000 tons (less than 6% of total production), while Small holder high input and Small medium enterprise combined represent more than 35% of the production

Based on consultations with national experts, we hypothesized that the relative contributions of the different production system are quite similar to the relative contributions estimated in 2009 and that the sector generates a gross market value greater than 100 million USD per year. We also estimated that the amount of wild fish required as fish feed reached more than 100,000 tons in 2011, illustrating how dependant the aquaculture sector is on capture fisheries.

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