Technical report of aquaculture activities 2012-2014

Final version

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ANNADYA project:

Its objective is to promote appropriate technology for smallholders to increase food security among peoples in Cambodia and Lao PDR. It is funded by the European Union (Europaid) under its Technology Transfer for Food Security in Asia (TTFSA) Programme, and implemented by the Université Libre de Bruxelles (ULB) in partnership with the Cambodian Center for Study and Development in Agriculture (CEDAC); Gembloux Agro-Bio Tech/ULg (GxABT/ULg) and Hanoi University of Agriculture (HUA) in the provinces of Attapeu (Lao PDR) and Ratanakiri (Cambodia).

« Promoting appropriate technology for smallholders to increase food security among peoples in Cambodia and Lao PDR » DCI-FOOD/2011/277-743

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1 Introduction

1.1 Objective of the aquaculture activities

The objective of the ANNADYA action in Lao PDR aims to increase the sustainable improvement of food security by building the capacity of target beneficiaries to increase food production and diversify income-generating activities. One of the specific objectives is to improve the nutrition of ethnic minorities in Attapeu province by diversifying and increasing the quantity and quality of animal and agricultural production. The logical chain of the ANNADYA project is based on food security dimensions: food availability, food accessibility, and nutrition. The general and specific objectives are explained in the Annex 1 of the amendment of February 2014.

The main objective of aquaculture activities is the nutritional improvement and the integration of the best practices. The best practices are based on new knowledge (disease, medicine, aquafeed, water supply, weather conditions). The monitoring and the following are very useful to learn about the households. The protein diet is very low at Attapeu and the objective of this activity is to increase fish consumption.

1.2 Description of the aquaculture species

In Lao PDR, the fresh fish market is characterized by a big diversity of species. Kottelat (2001) has listed 481 species including 22 exotic species. The project has chosen to work with three exotic species: Tilapia (*Oreochromis nicolata*), Rohu (*Labeo Rohita*), and Catfish (*Clarias gariepinus*). The reasons of this choice are the productivity and the fingerling production. The production of local species in ponds does not have a good output and has not been well studied (Phonvisay S., 2013). Furthermore, fingerling production of indigenous species is not possible because fingerling production is based on exotic fish. This low production is not sufficient for supplying fish producers.

1.2.1 Characteristics of catfish *(Clarias gariepinus)*

The main catfish characteristics include: Body elongate; large head; depressed and bony with small eyes; mouth terminal; four pairs of barbells; long dorsal and anal fins; without dorsal

fin spine and adipose; Anterior edge of pectoral spine serrated; Caudal fin rounded; Color varies from sandy-yellow through gray to olive with dark greenish-brown markings, belly white.

Stomach contents of *Clarias* species typically include insects (adults and larvae), worms, gastropods, crustaceans, small fish, aquatic plants and debris, but terrestrial seeds and berries, and even birds and small mammals, have also been observed. Most species of *Clarias* are slow foraging predators, with very small eyes, using their four pairs of barbels to feel their way around in the dark and find food detected by the array of sensitive taste buds covering the barbels and head. Approximately 70 percent of feeding activity takes place at night.

Figure 1: Picture of Catfish

1.2.2 Characteristics of Rohu (*Labeo rohita*)

Body bilaterally symmetrical, moderately elongate, its dorsal profile more arched than the ventral profile; mouth small and inferior; lips thick and fringed with a distinct inner fold to each lip, colour bluish on back, silvery on flanks and belly.

In its early life stages rohu prefer zooplankton, mainly composed of rotifers and cladocerans, with phytoplankton forming the emergency food. In the fingerling stage, there is a strong positive selection for all the zooplanktonic organisms and for some smaller phytoplankters like desmids, phytoflagellates and algal spores. On the other hand, adults show a strong positive selection for most of the phytoplankton. In the juvenile and adult stages rohu is essentially an herbivorous column feeder, preferring algae and submerged vegetation; decayed organic matter and sand and mud.

Rohu is a eurythermal species and does not thrive at temperatures below 14 °C. It is a fast growing species and attains about 35-45 cm total length and 700-800 g in one year under normal culture conditions.

Figure 2: Picture of Rohu

1.2.3 Characteristics of Tilapia (Nile tilapia, *Oreochromis niloticus*)

Body shape generally laterally compressed to oval and deep, though variable depending on the environment. Caudal fin has 7-12 distinct vertical stripes. The regular and definitive stripes on the caudal fin, the red flush of the breeding male and the dark margin of the dorsal fin. Color in spawning season, pectoral, dorsal and caudal fins becoming reddish; caudal fin with numerous black bars.

Nile tilapia is a tropical species that prefers to live in shallow water. The lower and upper lethal temperatures for Nile tilapia are 11-12 °C and 42 °C, respectively, while the preferred temperature ranges from 31 to 36 °C. It is an omnivorous grazer that feeds on phytoplankton, periphyton, aquatic plants, small invertebrates, benthic fauna, detritus and bacterial films associated with detritus.

Figure 3: Picture of Tilapia

1.3 Fish Consumption in Attapeu province

This chapter describes fish consumption in Attapeu. The results are based on the expenditure and consumption surveys (LECS) of households in 2002 and 2007/2008. A study of

Phonvisay Singkham (2013) is also used to present the consumption of Laotian fish. The consumption is estimated by the expenditure and the price of fish in the Attapeu market. The fish consumption is often calculated for Lao PDR and three regions (North, Center and South) but the data per district are very complicated to obtain or do not exist. Moreover, there are few studies of fish consumption and fish market in Attapeu and Southeast of Lao PDR. The LECS surveys integrate fish expense for aquaculture and capturing fish. After the rice and meat, fish expenditure represents 15.5% of the total food consumption. This consumption is estimated at 8.3% of the total food expenditure. For the results of the aquaculture activities, We analyze the difference between the number of kilos of fish consumed by the beneficiary households per capita per year and the number of kilos of fish consumed per capita per year in the South region of Lao PDR. In 2002/2003 and 2007/2008, the consumption was, respectively, 28 and 27 kg per capita per year.

In 2002, fish consumption in the South was estimated at 535 g per capita per week (g/capita/week). The LECS 4 carried out in 2007/2008 estimated that fish consumption was 522 g/capita/week. This fish consumption in the South region was higher than the national average (477 g/capita/week). Road accessibility and village location (rural and urban) determine the quantity of fish consumed. In fact, according to the LECS 4, fish consumption in urban areas, rural areas with road access, and rural areas without road access is, respectively, 526, 463, and 466 g/capita/week (Table 1).

Table 1: Fish consumption Estimation
Source: Andres L., 2014 according to the agricultural and forestry ministry database

Location	2002/2003	2007/2008
South[1] of Lao PDR	535 g/capita/week	522 g/capita/week
Urban areas in Lao PDR	460 g/capita/week	526 g/capita/week
Rural areas with road access in Lao PDR	530 g/capita/week	463 g/capita/week
Rural areas without road access in Lao PDR	377 g/capita/week	466 g/capita/week

Food availability is calculated with food expenditure expense, but also with the food balance sheet. Both data from the agricultural and forestry ministry during 2009-2012 and the population of Attapeu during the same period allowed for calculating the fish balance sheet. Food availability per capita is estimated with the quotient of the production (ton) and the population. These data concern only the aquaculture fish production and exclude the data of capture fisheries.

[1] In the Survey of Lao PDR, the South represents four districts: Champasak, Sekong, Saravan, Attapeu

Figure 4 shows the annual variation between 2011 and the other years. The aquaculture fish consumption in 2012 was 17 kg/capita/year (Figure 4).

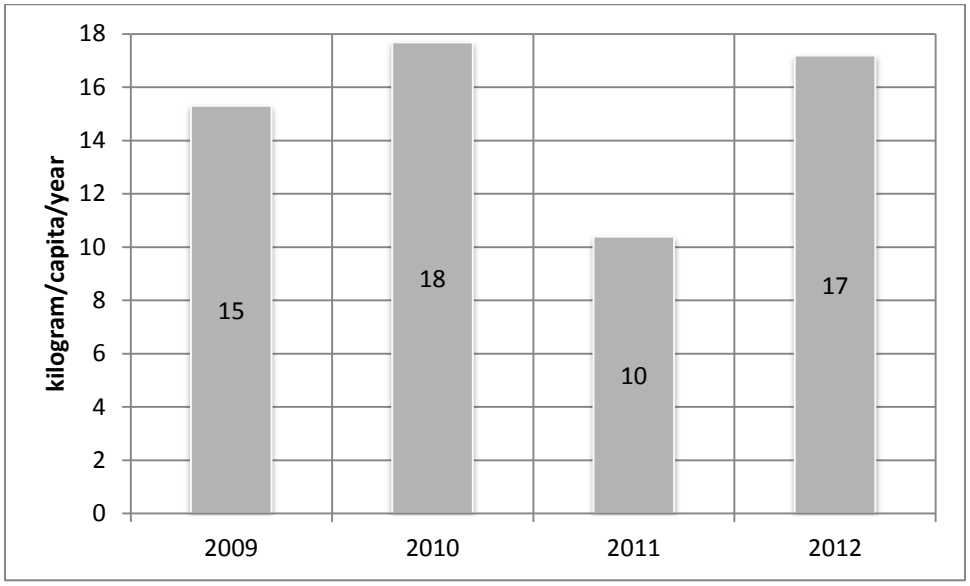

Figure 4: Fish balance sheet
Source: Andres L., 2014 according to the agricultural and forestry ministry database

1.4 Fingerling supply in Attapeu province

The team has found two hatcheries in Attapeu that could provide fingerlings for the project. Furthermore, the team has found some hatcheries in Pakse but the technical team has rejected this option because the trip from Pakse to Attapeu could cause a high mortality of fingerlings. In addition, the project does not have the capacity to store fingerlings. The two hatcheries in Attapeu are located in:

- Naphoc village, Sanamkkhixay district, Attapeu. The owner's name is Mr. Phouthone.
- Hom village, Sanamkkhixay district, Attapeu. Farm model for aquaculture and fingerling production.

A survey shows that the hatchery in Hom village does not have the capacity to meet the demand of the fishery activities. The capacity of this hatchery is estimated to be 20,000 fingerlings per year. Additionally, in 2013 a flood caused a high mortality rate of fingerlings (50%). The hatchery of Mr. Phouthone produces 150,000 fingerlings per year and is the same hatchery that the project used in 2012 and 2013. In conclusion, the technical committee chooses the store of Mister Phouthone in Naphoc village to provide the fingerlings for the fishery activities of the ANNADYA project.

Furthermore, there are two producers located in Somboun (Sanxay) but they stopped the production of fingerlings in 2012 and 2013. In 2013, the ABD project invested 20,000$ to build fingerling ponds in the village of Somboun. The capacity of the station reached 350,000 fingerlings (250,000 catfish and tilapia; 100,000 local fish). The ADB project created 22 ponds and the total area of these ponds reached 2 ha. The project has intended to support poor households but one year later, a private owner acquires the ponds and produces catfishes, chickens and pigs in this area. The producer's name is Mrs. Savannani. She has stopped the fingerling production. This was due to a poor fingerling demand and because the ABD project did not buy part of the fingerling production. In summary, the reasons for stopping the fingerling production are low demand from the fish producers of Sanxay and the non-profitability of the production. The second producer's name in Sanxay is Mrs. Brinhung. She has a capacity to produce 45,000 fingerlings but she stopped the production because she had power cuts and the mortality rate was 90%-100%. Furthermore, she did not have the workforce to produce fingerlings (Figure 5).

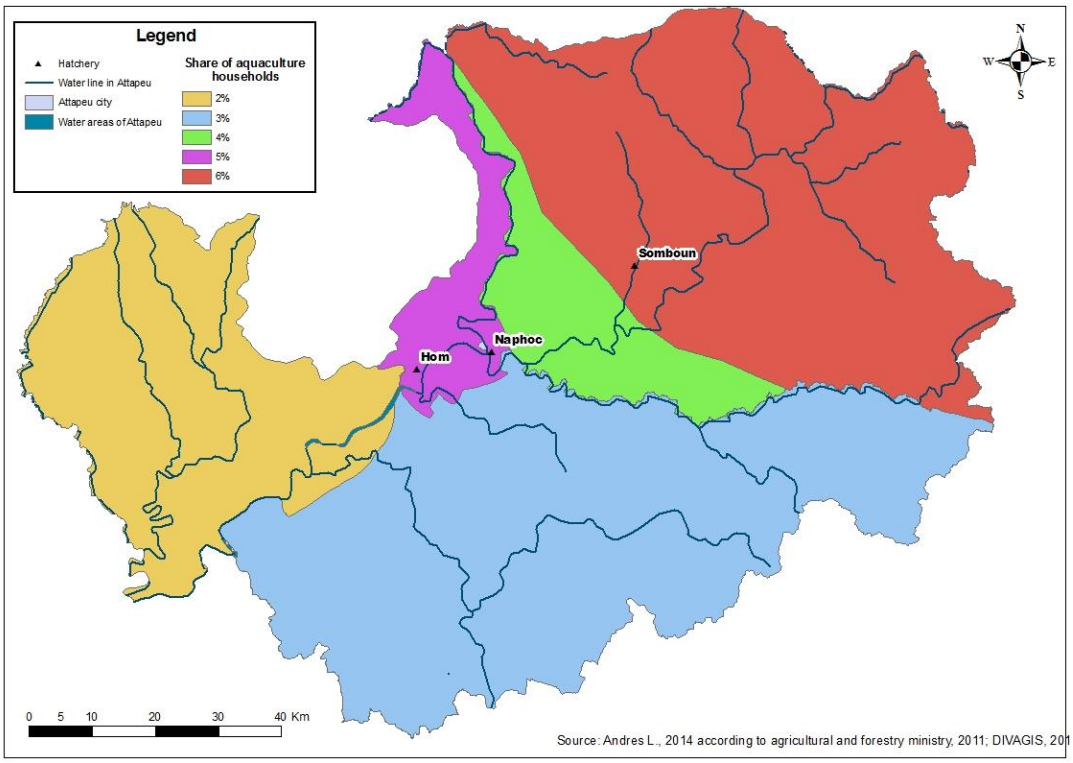

Figure 5: Location of the hatcheries in Attapeu province

2 Description of the aquaculture activities

2.1 Identification of beneficiary households

The ANNADYA project assures the distribution of fingerlings and improves the understanding of diseases, food and protein diet of each household. The activity is divided in five steps:

1. Discussion with the Province for agricultural and forestry Office and the village chief of each target village;
2. Identification and baseline survey of beneficiary households;
3. Training course for farmers to diffuse good practices in feeding, diseases and water supply;
4. Fish distribution in each village;
5. Follow up and monitoring beneficiary households.

In 2012, the choice of beneficiaries was based on a participatory meeting and the factors that determined the choice included three points:

- The capacity to produce fish (tank or pond);
- Some characteristics such as poverty, poor rate of protein diet, etc.;
- The beneficiary households that were chosen in the HPA project.

In 2011, the HPA project provided 85 tanks in four villages: Sakare; Numhieng; Dakekiet; Kamvongsa. The reason of this choice was to link projects and to decrease the cost of tanks construction. In fact, synergies between different development projects were very important to create sustainability and continuity to support households in Attapeu province. Furthermore, the aquaculture activities are carried out to increase the food diet of the minorities in Attapeu province. The choice of the beneficiary households was a participatory process (DAFO authorities, village chiefs, and households). The ANNADYA team in Attapeu was chosen some villages with the District of Agriculture and Forestry Office. The selection criteria are based on the aquaculture production and the technical knowledge of fish production. After that, the village chiefs and the village establish a list of poor aquaculture households and the ANNADYA team checks it. In 2012, ANNADYA project provided two types of activities: fingerling distribution and aquafeed distribution. The household was received 200 fingerlings. This number is based on the volume of the tank pond created by the HPA project in 2011, which is 9 m^3. In 2013, the number of beneficiaries was estimated at 171, with a distribution of 73.100 fingerlings in 7

villages. The last four villages were chosen to strengthen the technical knowledge. The other three villages were chosen to spread good practices in aquaculture and to increase their protein diet. The other activity, during 2012 and 2013, was the implementation of two models of earthworm production, distribution of fingerlings in a school and financial support in a store. The 41 families received 2 buckets, and the village community got 2 trolleys for the transportation of water in the tank.

3 Description of the beneficiary households

3.1.1 Number of beneficiary households

In 2012, the aquaculture activities contributed to improve the nutrition of 85 beneficiary households (HHs). The households are located in four villages: Sakare, Numhieng, Dakekiet, and Kamvongsa. These villages are located in three districts: Saysetha (Sakare, Numhieng); Sanxai (Dakekiet) and Sanamxay (Kamvongsa). Furthermore, a school with 69 peoples was supported with a fish distribution. The Table 2 shows the number of households per village per year. The beneficiary households have a tank created by the HPA project in 2011 (Table 2). The tanks contributed to the development of the ANNADYA activities. In 2013, the number of villages increased to 7 and the number of beneficiary households reached 171. The choice of the beneficiaries is based on their aquaculture capacity and the development of this capacity. In fact, some beneficiary households received fingerlings in 2012 and 2013. This distribution was carried out to enable the sustainable development of aquaculture. The implementations were located Phouvong (Kamvongsa, Somboun) and Saysetha (Sakare, Numhieng, and Khengyai) (Table 2). In 2014, the number of beneficiary households reached 152. This number is comprised in 8 villages: The, Somsock, Donephay, Hinlath, Somboun, Mainakog, Tatkoom, and Khengyai. The high number of beneficiaries in "The" is explained by its structure. In fact, "The" is composed by four hamlets (Table 2).

Table 2: Number of beneficiary HHs
Source: Baseline of the project, 2014

Years	Phouvong		Sanamxay				Sanxay				Saysetha				Total of beneficiary HHs
	Khamvongsa	*Somboun*	*The*	*Somsock*	*Donephay*	*Hinlath*	*Dakekiet*	*Somboun*	*Mainakog*	*Tatkoom*	*Sakare*	*Numhieng*	*Somkhod*	*Khengyay*	
2012	**41**						**16**				**16**	**12**			***85***
2013	**26**	**43**	**50**				**14**				**14**	**10**	**14**		***171***
2014			**46**	**13**	**27**	**12**		**19**	**19**	**7**				**9**	***152***

The Figure 6 shows the location of the 13 target villages. These villages are mainly located near the main rivers of Attapeu. This location will enable the setting up of irrigation systems.

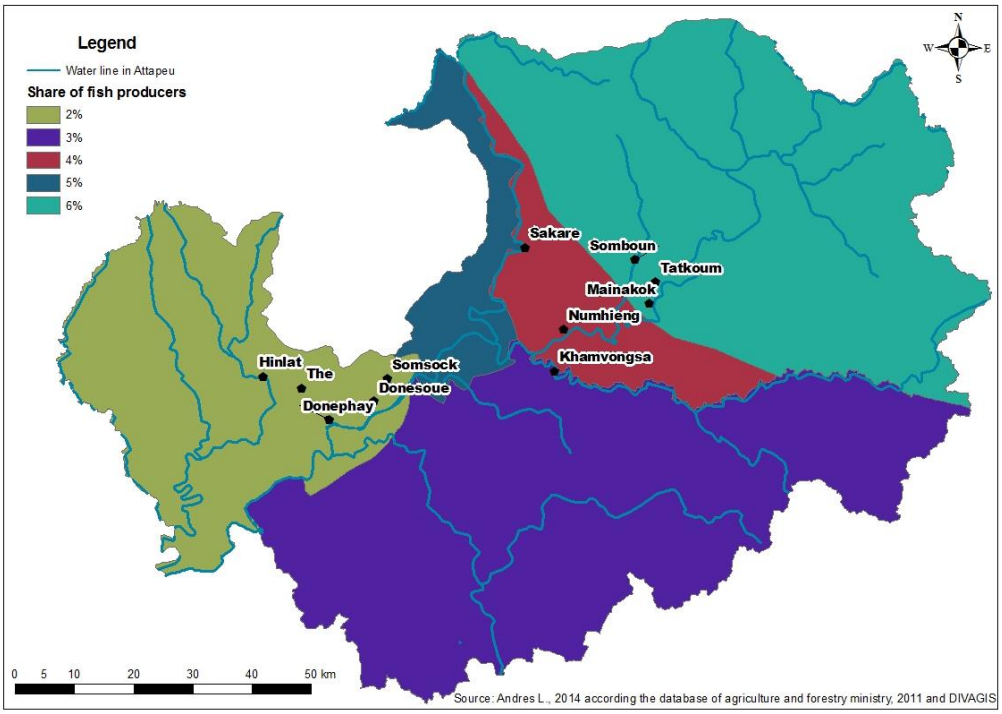

Figure 6: Location of target villages in each district of the project

3.1.2 Ethnic minorities

One of the general goals of the project is to improve the livelihood and the food security of the minorities in the Attapeu province of Lao PDR. Figure 7 shows the percentage of the ethnic minorities per district. The aquaculture activities involve six of ten ethnic minorities.

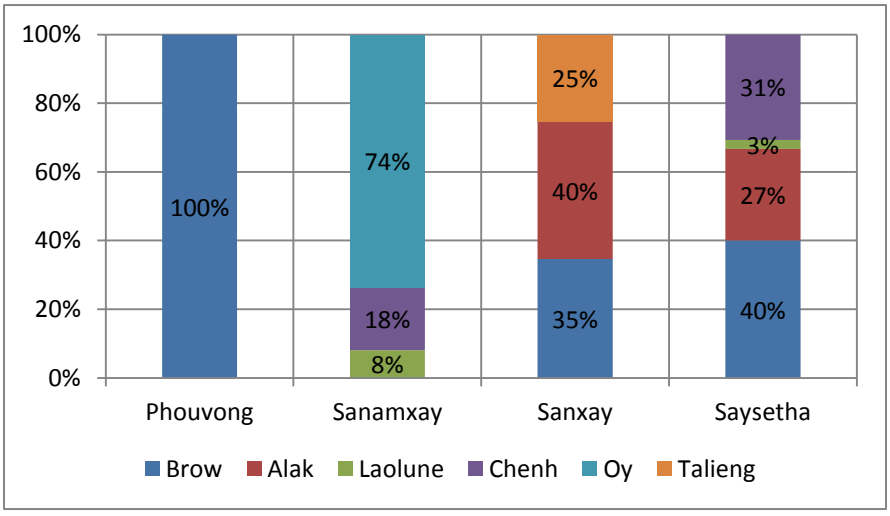

Figure 7: Ethnic minorities in four districts
Source: Baseline of the project, 2014

In 2012, the Brow minority represented 67% of the beneficiary households while the Alak minority represented 32%. In 2013, the higher number of villages increased the activity impact on the ethnic minorities. In fact, five ethnic minorities are represented in the sample of the beneficiaries. The most important ethnic minorities are the Brow and the Alak but the Chenh and Oy ethnic minorities also appear in the sample. In 2014, the aquaculture activities affected a high diversity of minorities (Talieng, Oy, Chenh, Laolune and Brow). The Alak ethnic is not present among the beneficiary households in 2014 and the Brow is less represented in relation to the last two years (Figure 8). The ethnic minorities are not presented according to the villages because, generally, each village is composed of only one ethnic group. One of the beneficiary households is Laolune, in the Numhieng village of Saysetha.

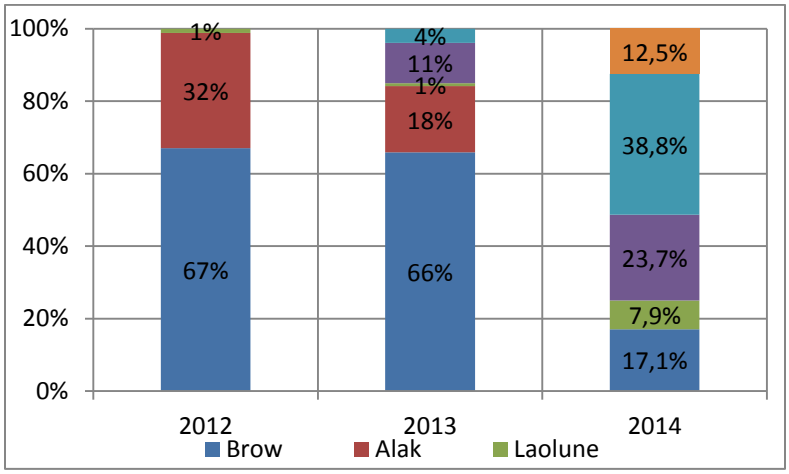

Figure 8: Distribution of ethnic minorities by year
Source: Baseline of the project, 2014

3.1.3 Family size

The family size is important to analyze the distribution of fish consumption (Figure 9). The consumption is estimated by two factors: the first is based on the survey of the household (number of fish consumed per week) and the second is based on the availability of fish per household. In 2012, we observed little difference in the average family size between the four beneficiary villages. The average household size is increasing from 5 to 8 members. But the size variability in each village is very important. For example, the village of Donephay presents a minimum of 2 and a maximum of 15 members per household. The other example is shown in the ANNEX 1. The rurality and the main activities (agriculture and livestock) are a decisive element in the high size of the household. Indeed, the workforce for agriculture and livestock is generally very high if the household is not mechanized (Figure 9).

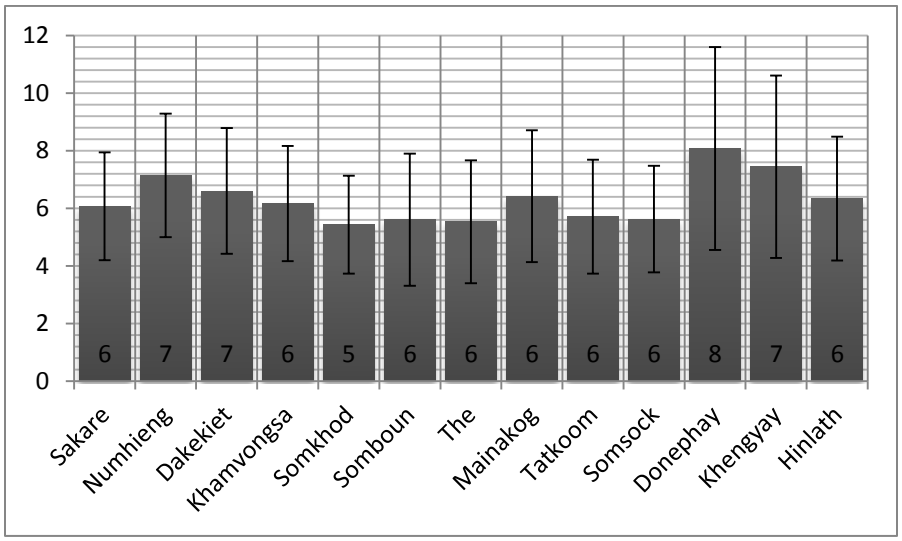

Figure 9: Average family size in each village
Source: Baseline of the project, 2014

Furthermore, gender is characterized by an intra-household analysis. This intra-household analysis is calculated based on the number of man and women in the family size parameters. The average rate of men is lower than 50% in five villages: Numhieng (48%); Dakekiet (47%), Somkhod (49%), Tatkoom (43%), Somsock (45%). It must be highlighted that Donephay presents the highest rate of men with 57% (Figure 10).

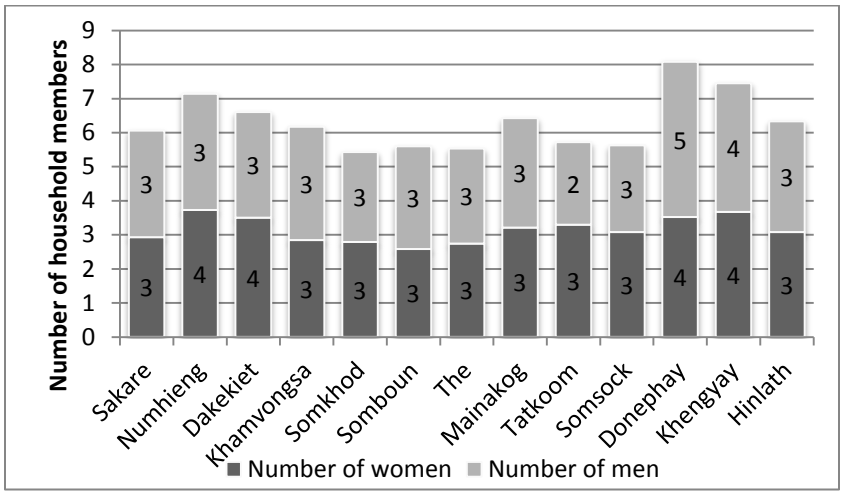

Figure 10: Average number of women and men in the household
Source: Baseline of the project, 2014

3.2 Description of the aquaculture production capacity

3.2.1 Pond and tank capacities

Aquaculture is practiced during the wet season, from May to October, and sometimes November and December. It is implemented with two structures: tanks and ponds. The tank is a

concrete structure, which size is generally between 6 and 8 m^2 whereas the pond has a bigger size (Figure 11).

Figure 11: Pond (left) and tank (right) used for aquaculture in Attapeu

In 2012, the beneficiary households only practiced aquaculture with tanks whereas, in 2013, five villages used tanks to produce fresh fish and two villages used ponds for aquaculture. But in 2014, the target villages use mainly ponds, with the exception of poor households in Somboun (Table 3).

Table 3: Number of ponds and tanks in each village in 2012, 2013 and 2014
Source: Baseline of the project, 2014

Type	Tank						Pond							
Village	Sakare	Numhieng	Dakekiet	Khamvongsa	Somkhod	Somboun	Somboun	The	Mainakog	Tatkoom	Somsock	Donephay	Khengyay	Hinlath
2012	16	12	16	41										
2013	14	1	14	26	14		43	5						
2014						1	18	46	19	7	13	27	9	12

The average size of tanks is 6 m², reaching a maximum of 8 m² in Somboun (Sanxay). The standard deviation of the tank size is equal to zero but, for the size of the pond, it is very different according to the villages. The average size of all the ponds (n = 244) is 111 m² and the minimum and maximum are, respectively, 8 m² and 1100 m². The boxplots show some extreme values in Donephay, Hinlath, Somsock and The. The pond sizes in Hinlath and Khengyai are relatively grouped around the mean and the median (Figure 12).

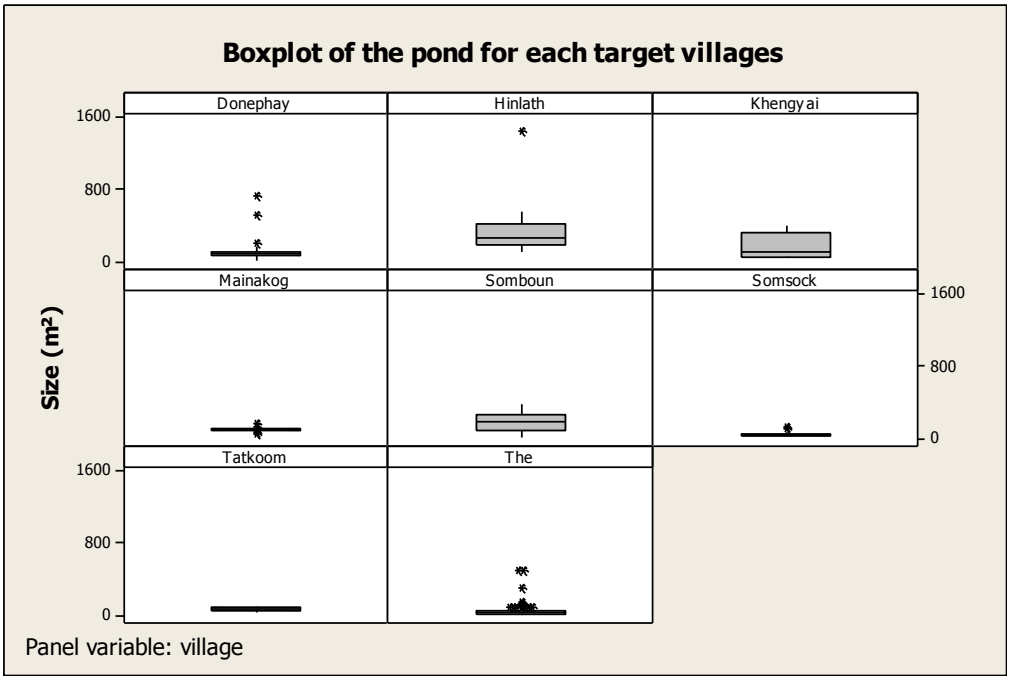

Figure 12: Boxplot of pond sizes in each target village
Source: Baseline of the project, 2014

Figure 13 shows the average size of ponds and the level of standard deviation. Tatkoom is the exception with a low standard deviation (20). Hinlath presents the biggest average with 364 m². The other bigger ponds are located in Somboun (166 m²), Khengyai (165 m²) and Donephay (112 m²). The average size of the Somsock ponds is smaller (38 m²) than in the other villages (Figure 13).

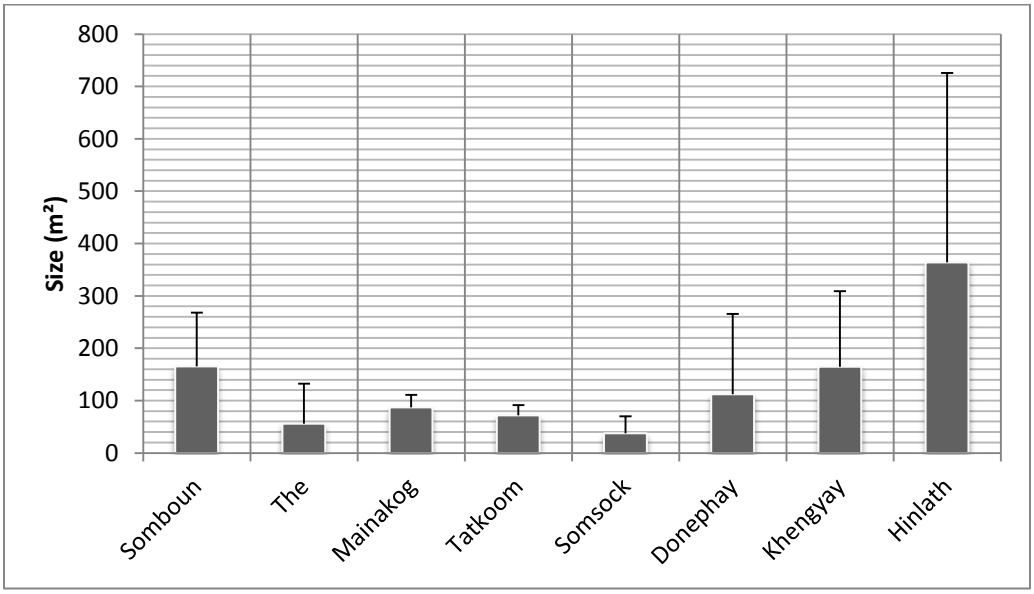

Figure 13: average size of ponds in each target village
Source: Baseline of the project, 2014

The size of the ponds and tanks is present in this chapter because it is used to calculate the yield of fish production (kg/m²). This yield is presented in chapter three: "The main results of fishery activities".

3.2.2 Feed resources for fish

In 2012, each beneficiary household received 200 kg of aquafeed to increase fingerling production. Aquafeed is the main resource to feed the fish in the tank. The other resources are termites, earthworms, rice, and rice bran. Termites and earthworms are given in low quantity as part of the protein diet. Two earthworms' farm models are being installed to increase the capacity of the household to ensure the nutrition, especially the protein diet of fish (Figure 14).

The Annex 2 describes these models and their cost. Unfortunately, these models were not sustainable because the humidity was not enough during the dry season and the farmers did not supply manure into the tank to ensure the development of earthworms. The solution to these problems is the location of the farm model. Therefore, the choice of the household is based on the capacity to produce manure and the water access to keep the manure moist. In addition to, a study of the feed should be realized to improve the practice of the farmers (see Figure 15 and 16).

Figure 14: Earthworm model in Dakekiet village

Figure 15 shows a difference between villages. The Sakare and Numhieng villages are near the river and, therefore, it is easier for the households to get worms and termites. Rice and rice bran are rarely used because Catfish do not like rice. The difference in feed sources (earthworms, termites and rice) is highly significant between the four villages. The Dakekiet village does not use earthworms for fish feeding. This non-utilization of earthworms to feed the fish is perhaps the reason of the non-sustainability of the farm models.

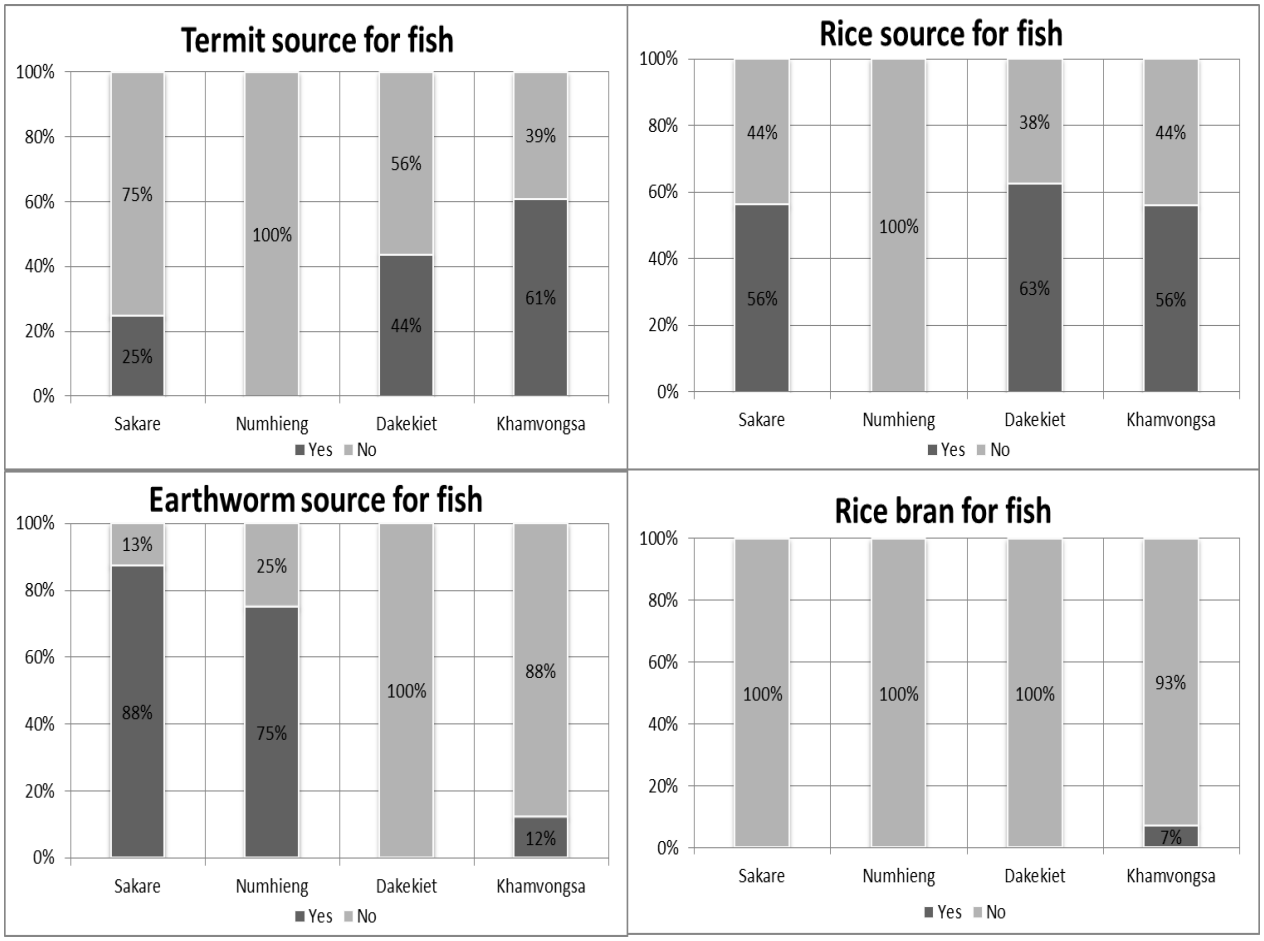

Figure 15: Feed source for fish in relation to the percentage of HHs in 2012
Source: Baseline of the project, 2014

In 2013, the main feed source was aquafeed. The other feed sources (rice bran, rice, worms and termites) were rarely used. After the aquafeed, the products that were mostly used were the by-product of rice (rice bran) and rice. Termites were used to a lesser extent than the other sources, which depended on the proximity of the forest. In addition, the earthworm production and harvest were not very significant in the seven target villages. The villages of Saysetha (Sakare, Numhieng) used more earthworms (Figure 16).

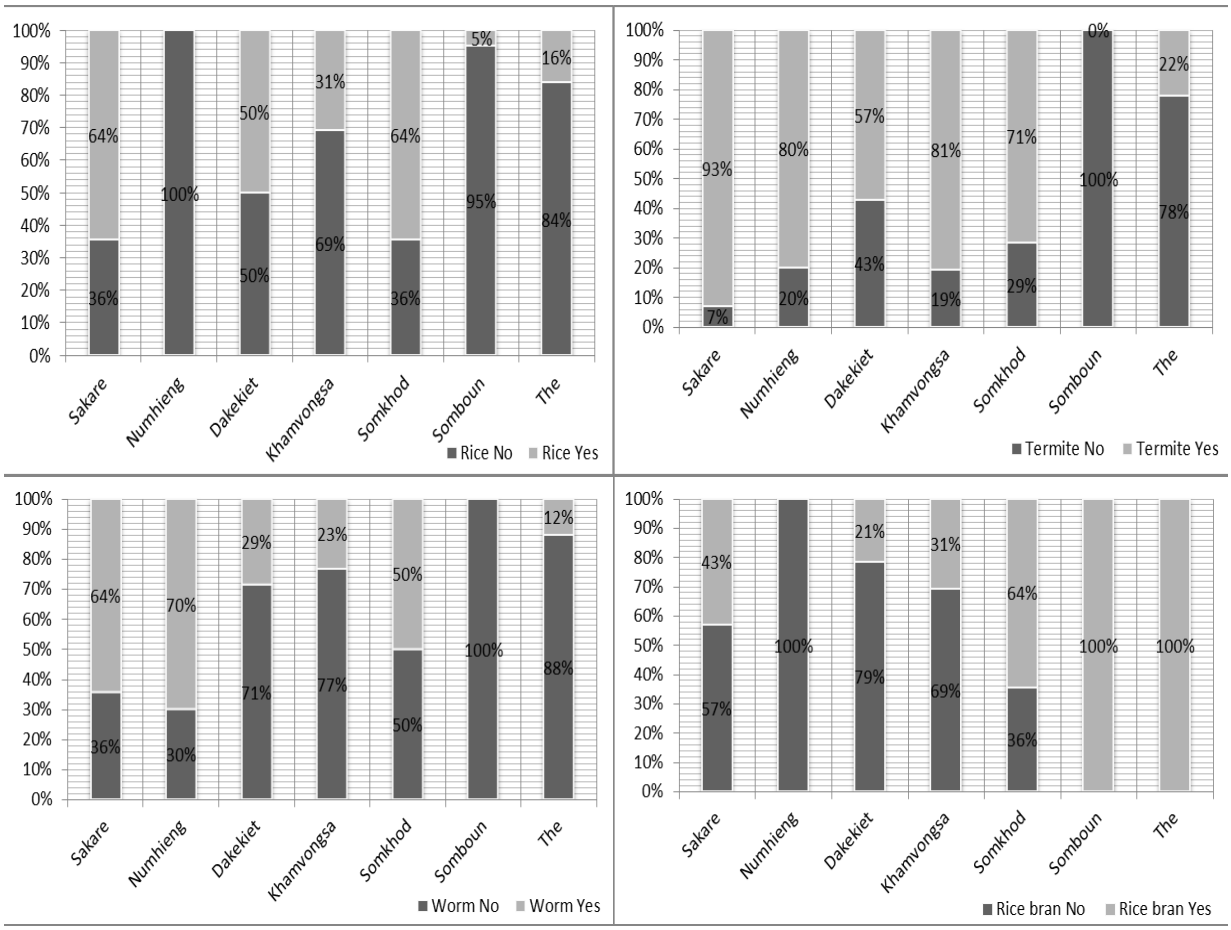

Figure 16: Feed source for fish in relation to the percentage of HHs in 2013
Source: Baseline of the project, 2014

Furthermore, the ANNADYA project supported an aquafeed store in Kamvongsa (Phouvong) during one year. The store received a loan of 1,550,000 LAK and after one year, the store reimbursed it to the project. The survey of farmers during June and July 2014 indicated that the cost to buy aquafeed is higher in Attapeu from 7,750 to 10,000 kip per kilo. The aquafeed store has a capacity to supply the farmers in Attapeu and the aquafeed' price for the store owner is 7,750 LAK per kilo. In Kamvongsa, the aquafeed price is 9,000. The store owner realizes a benefice of 1,250 per kilo and the farmers obtain the aquafeed at 9,000, being a difference of 1,000 LAK per kilo in relation to Attapeu price. The aquafeed supply in the store is 200 kilos. The store's owner buys aquafeed by increments of 5 to 10 kilos. The farmers of Kamvongsa say that they don't buy aquafeed if the store is located in Attapeu because the cost is higher. After the survey (June and July 2014), the Annadya team analyzed the value chain of aquafeed considering its importance in food ration. The network is concentrated among some wholesalers who import aquafeed from Pakse or Vietnam. Some retailers in Attapeu city and the four centers of the district indicated that they go to Pakse to buy aquafeed. The aquafeed production in Pakse

generally comes from Thailand but there are some aquafeed producers in Pakse too. They provide in the region of Champasak, Sekong and Attapeu. The imported quantity is not important and transportation is carried out by cars, buses and sometimes trucks. The most important problem of aquafeed supply is transportation and the network of traders (Figure 17).

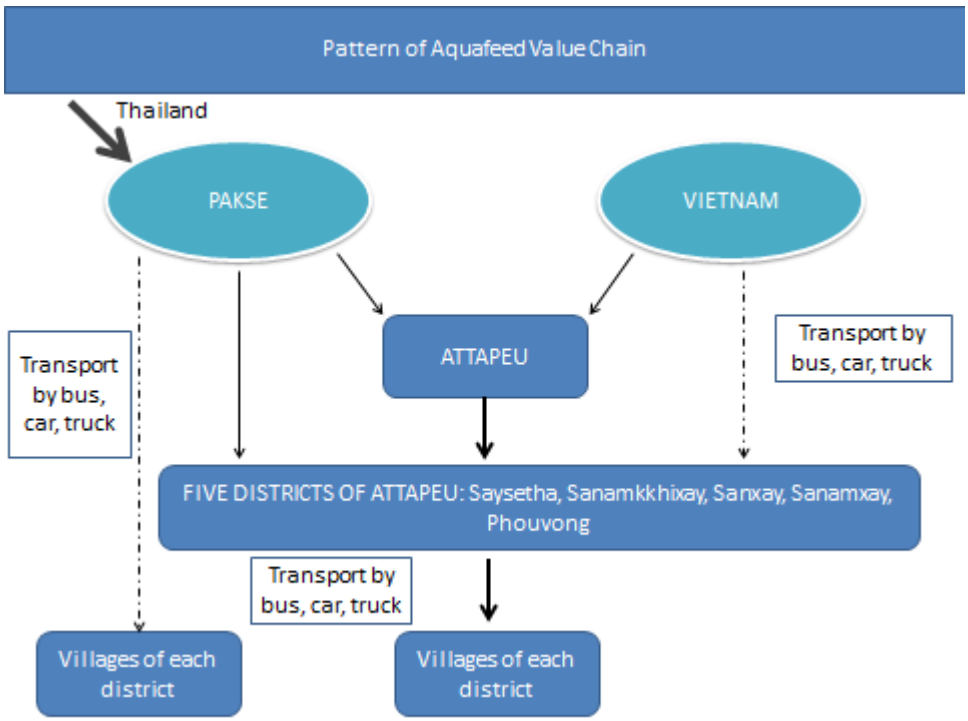

Figure 17: Pattern of aquafeed value chain

4 Results and outputs of the aquaculture activities

4.1 Cost and fingerling distribution

During 2012 and 2013, the only fingerling species used was catfish while in 2014, some farmers preferred species such as tilapia and rohu. In 2012, the distribution of fingerlings reached 17,000 whereas the number of fingerlings in 2013 was estimated at 73,100. In 2014, the project provided 36,000 fingerlings. In three years, the ANNADYA project distributed a total of 126,100 fingerlings (Table 4). The number of fingerlings per household depends on the pond size. In 2012, the aquaculture was based on fish production in tanks and each beneficiary received 200 fingerlings while in 2013, the number of fingerlings per household was variable according to the size of the ponds. In the village of 'The', some beneficiaries did not receive any fingerlings. Indeed, some households were not present during the day of distribution and the supervisor and the village chief decided to distribute the fish between the beneficiaries that were present at the distribution. This distribution among the beneficiaries is carried out because fish do not resist more than one day in the bag and the supply of this fish isn't possible. In 2014, some households

chose species such as Tilapia and Rohu in their ponds and the main factor that determined the number of fingerlings distributed per household was the size of the ponds. 200 fingerlings were distributed for smaller ponds and 300 fingerlings for bigger ponds (table 4).

Table 4: Fingerling distribution in the target villages
Source: Baseline of the project, 2014

Year	Village	Catfish			Tilapia		
		Number per HHs	Total	Number of HHs	Number per HHs	Total	Number of HHs
2012	Dakekiet	200	3200	16			
	Khamvongsa	200	8200	41			
	Numhieng	200	2400	12			
	Sakare	200	3200	16			
2013	Dakekiet	200	2800	14			
	Khamvongsa	200	5200	26			
	Numhieng	200	2000	10			
	Sakare	200	2800	14			
	Somboun	500	21500	43			
	Somkhod	200	2800	14			
	The	720	36000	50			
2014	Donephay	213	1700	8	247	4700	19
	Hinlath				350	4200	12
	Khengyai	256	2300	9			
	Mainakog	216	4100	19			
	Somboun	200	1000	5	257	3600	14
	Somsock	215	2800	13			
	Tatkoom	200	1400	7			
	The	218	9600	44	300	600	2

During the project, the costs of Tilapia and Catfish were respectively 350 and 500 LAK per fingerling. The better results in 2012 are explained by the supply of aquafeed. In fact, the project distributed 10 kilograms of aquafeed per household. Furthermore, the village of Kamvongsa received two trolleys and buckets because the transportation of fingerlings is very complicated (Figure 18). In Dakekiet, the school was provided with 500 fingerlings and 240 kg of aquafeed. This school has three teachers and 67 students. The average weight per fish is 198 g and the total production of the school is 95 kg, with a low mortality rate (4%).

Figure 18: Picture of the trolleys and buckets in Kamvongsa

In 2012, the mortality rate was very low because the tank was perfect to control the growing conditions of fingerlings, whereas, the mortality rate in 2013 was higher because a flood disrupted the growing conditions and prevented the farmers to supply aquafeed (Table 5).

Table 5: Mortality rate by year and by village
Source: Baseline of the project, 2014

Village	Mortality rate (%)	
	2012	2013
Dakekiet	2 ± 2	12 ± 18
Khamvongsa	3 ± 5	7 ± 2
Numhieng	2 ± 6	9 ± 2
Sakare	4 ± 7	34 ± 29
Somboun		42 ± 23
Somkhod		10 ± 12
The		34 ± 22

Follow-up monitoring and survey were conducted to determine the weight of fingerlings. In 2012, each household was examined to determine the weight of fish, whereas, for the survey in 2013, it was impossible to take weight measures in each of the beneficiary households and in the case of 'The' and 'Somboun', it was impossible to obtain these measures. The fish weight was estimated by a survey nearby the beneficiary households and the yield was calculated with the average weight of fish per household and the mortality rate. The mortality rate was established during the monitoring and survey of the fishery activities. The size of the pond or the tank was established during the identification of the beneficiary households. The yields in 2012 and 2013 were very different. Indeed, in 2013, a flood was decreased the growing capacity. The yields in 2012 and 2013 were, respectively, 6.33 kg/m² and 2.67 kg/m². The 2013 yield was highly

influenced by the mortality rate. The correlation of Pearson determined the link between the mortality rate and the yield. The evolution of the yield is inversely proportional to the mortality rate. The negative correlation is estimated at -0.723. But the tanks presented higher yield than the ponds. In 2013, the yield averages of ponds and tanks were, respectively, 1.6 kg/m² and 3.9 kg/m². Finally, the pond size is correlated with the yield. The correlation is equal to -0.667. This correlation indicates that a larger size of the pond does not benefit the yield because it affects fish growth and growing conditions. Figure 19 shows the yield per village in relation to the year. The villages of Kamvongsa and Numhieng present the best yield. Yields in Sakare, Somboun and The during 2013 illustrate the relation between the mortality rate and the yield.

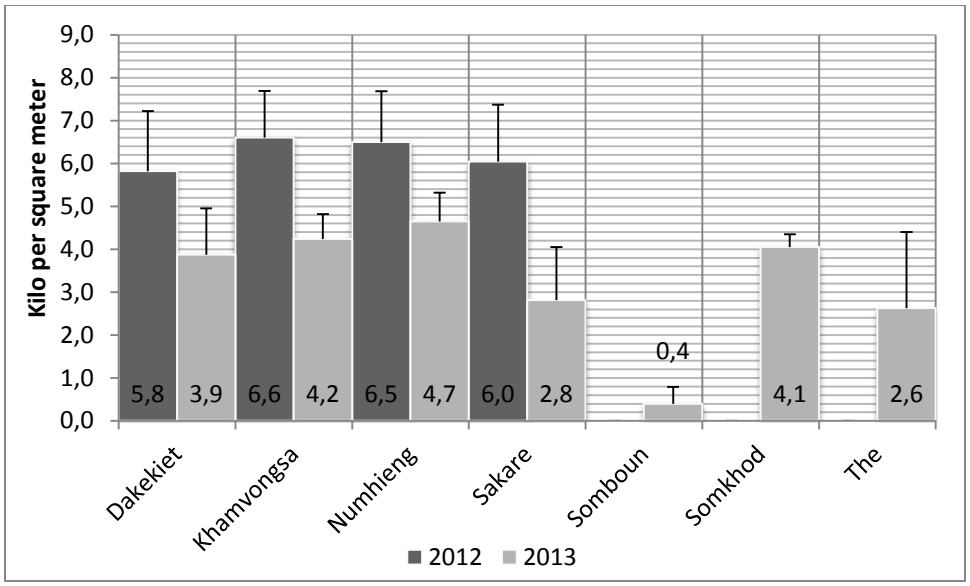

Figure 19: Yield per square meter in each target village in 2012 and 2013
Source: Baseline of the project, 2014

4.2 Fish consumption

The total production of the 256 households in 2012 and 2013 was 12.4 tons and the total amount of fish per household was 48 kg. But this total varied between the target villages and inside the target villages. The villages of 'The' and Somboun present a high consumption per household. In 2013, the fish consumption was reduced due to the low yield. The real fish consumption was two or three times lower than the fish balance sheet. The fish consumption in 2012 (17 kg per capita per year) decreased since a part of the fresh fish went to processing and exportation and due to a high mortality rate in aquaculture. But sometimes, this data is not introduced in the fish production assessment. Finally, rural and urban consumption was different (Table 1), being lower in the rural area of Attapeu and higher in the city of Attapeu (Figure 20).

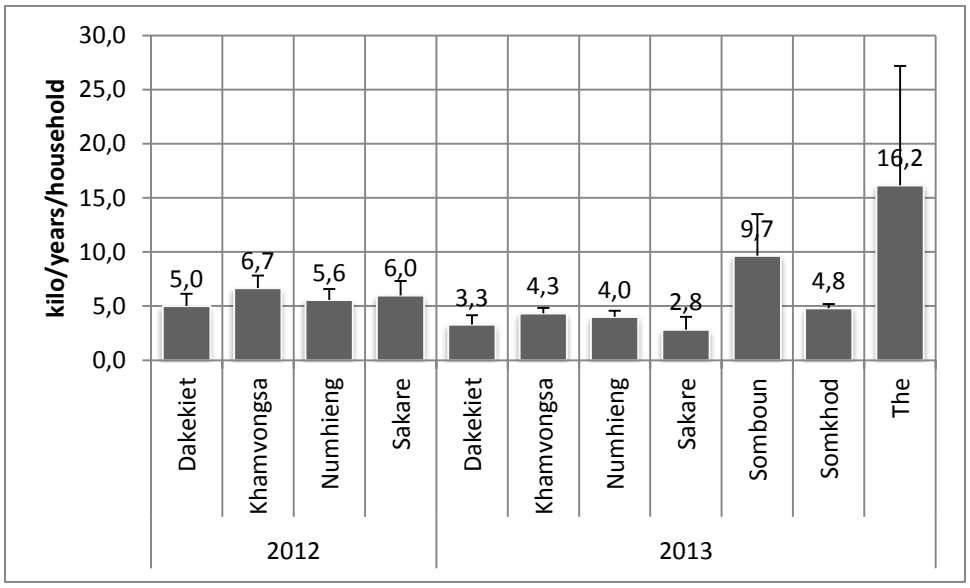

Figure 20: Fish consumption per year per household
Source: Baseline of the project, 2014

The consumption per week per capita is lower than the data from the LECS 2 and 3. But these LECS 2 and 3 consumption were estimated with the capturing and aquaculture expenditure. The beneficiary households in each village were poor households and the capacity of these households to buy fresh fish was much reduced. Furthermore, some regions of the South of Lao PDR are located along the Mekong River and the fish production is considerably higher because they do not have the impact of the dry season and they have two fish harvests per year (Figure 21).

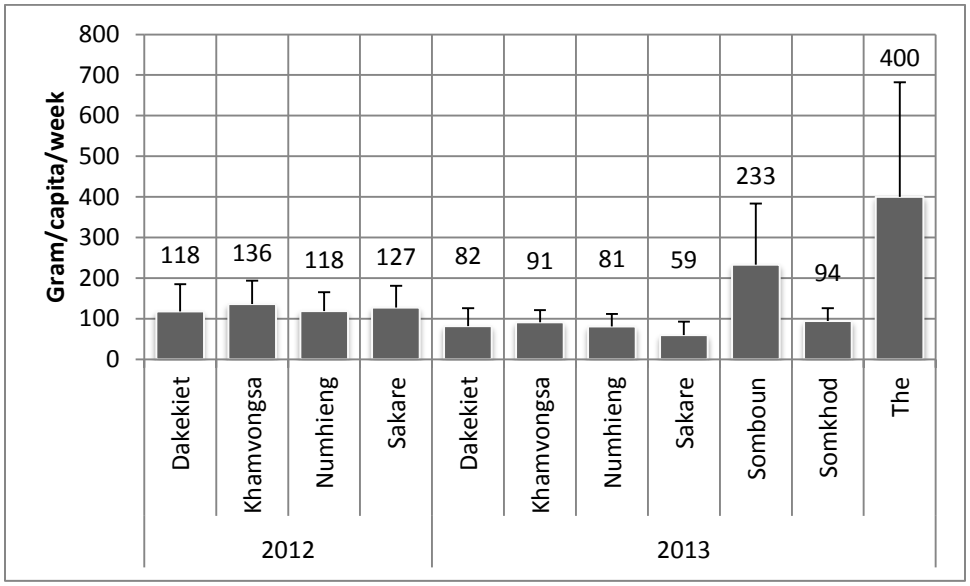

Figure 21: Evolution of the beneficiary households' consumption.

The survey of the beneficiary households showed the number of months that the households consume fresh fish. These fresh fish come from aquaculture. According to the households, they consume fish from capturing fish all year round, whereas, the beneficiary households consume four months aquaculture fish. In Somboun, they consume fish during 5-6 months because the village has an irrigation system that should be stimulated the production all year long. In addition to this system, the main producers of the Sanxai district are located in Somboun[2]. But the villages of Khamvongsa, Dakekiet, Numhieng, Sakare and Somkhod consume fish during the fish production season, just after the rainy season (October, November, December and January). After January, the households reduce their fish consumption. These data show the importance of the irrigation system. Indeed, sustainability is ensured by the creation of irrigation systems in some villages. For example, Somboun and Hinlat have the capacity to improve the water distribution and ensure the production during the whole year (Figure 22).

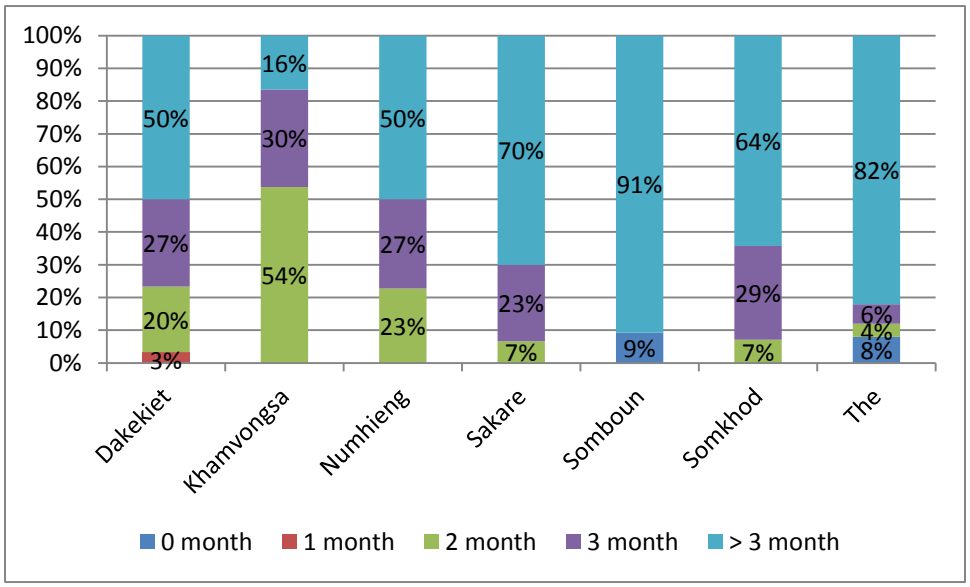

Figure 22: Number of months of fish consumption per household

Taking into account the number of months of fish consumption, the survey calculated the number of days in which the households consume fish. The villages of 'The' and 'Somboun' present the lowest number of days. The households of Kamvongsa consume fish four days per week. The output of the result 1 is realized in 5 target villages but the mortality rate of Somboun and The generate a reduction of consumption (Figure 23).

[2] According with the technical report of hatchery

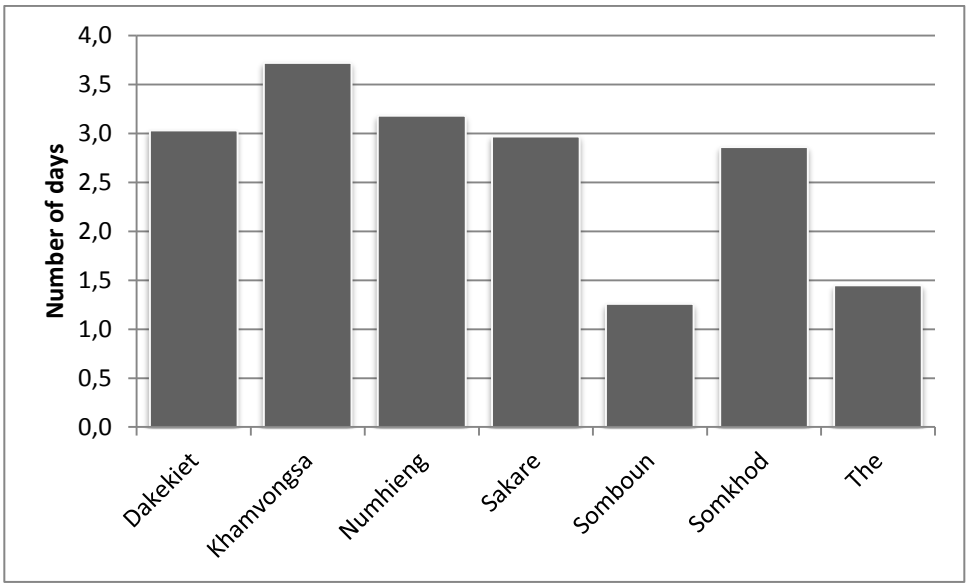

Figure 23: Average number of days in which households consume fish

5 Fresh fish value chain in Attapeu province

The follow-up of fish producers highlights a low number of fingerlings. Each year, the farm households buy between 20 and 100 fingerlings whereas the food security projects (ADB, HPA, ANNADYA) create a high demand of fingerlings in comparison with the farmers' capacity. Furthermore, fingerling production in Naphoc and Homs hatchery is enough for the demand of aquaculture. Indeed, the aquaculture in Attapeu does not exceed 6% of the total farm households (Figure 1). In the Attapeu province, there are few hatcheries. There are two production areas in the districts of Sanamkkhixay (Naphoc), Sanamxay (Hom village) and Sanxay (Somboun). But the larger one is located ten km from the center of Attapeu town. The choice of the latter is due to the amount of fingerlings required (17.500 fingerlings in 2012), the road accessibility and the price. The price is 500 kip per catfish fingerling. Furthermore, the technique required to develop a fish hatchery is not simple (incubation, oxygen demand, feed, water, heat and humidity). The Naphoc hatchery practices the fish hatchery from May to September. The fingerling production is linked to the demand. Indeed, the Laotians of Attapeu province eat fish meat during the dry season and reduce this consumption after September. During a survey carried out in July, a fingerling producer explained that the development and creation of a hatchery is very complicated because the technical knowledge is important and the production is carried out during five months or less.

The market of aquaculture fish enters into competition with fish from capture fisheries and import. The imported fish is transported from the center of Vietnam by bus. Fish capture in the river (all year) and rice cultivation (wet season) are carried out by more than 90% of the farm

households in each district of Attapeu. The competition of the fish from import and capture fisheries prevents the development of the aquaculture. The main constraint for the fresh fish value chain is transportation and the state of roads. The bad state of roads creates a high mortality rate in Attapeu and between Attapeu and Pakse. The sanitary conditions are not generally respected because the transportation is carried out mainly by local buses. The storage during transportation is done with ice (Figure 24).

The fish market is not attractive and the households generally use fish for personal consumption. In fact, 80% of the beneficiary households use their fish production for personal consumption, whereas 20% of households (51 households) eat and sell the fish production from aquaculture. In the rural area of Lao PDR, the proportion of the total production sold at the market reached 19%. In the rural area of Attapeu, the proportion of fish sold at the market was estimated at 21% of the total production. But figure 23 shows a large variability and the standard deviation is 19.48%. One household in Kamvongsa sold 98% of its fish production (Figure 23). The average number of kilos sold is 10 kg per household and the average price is 20,843 LAK.

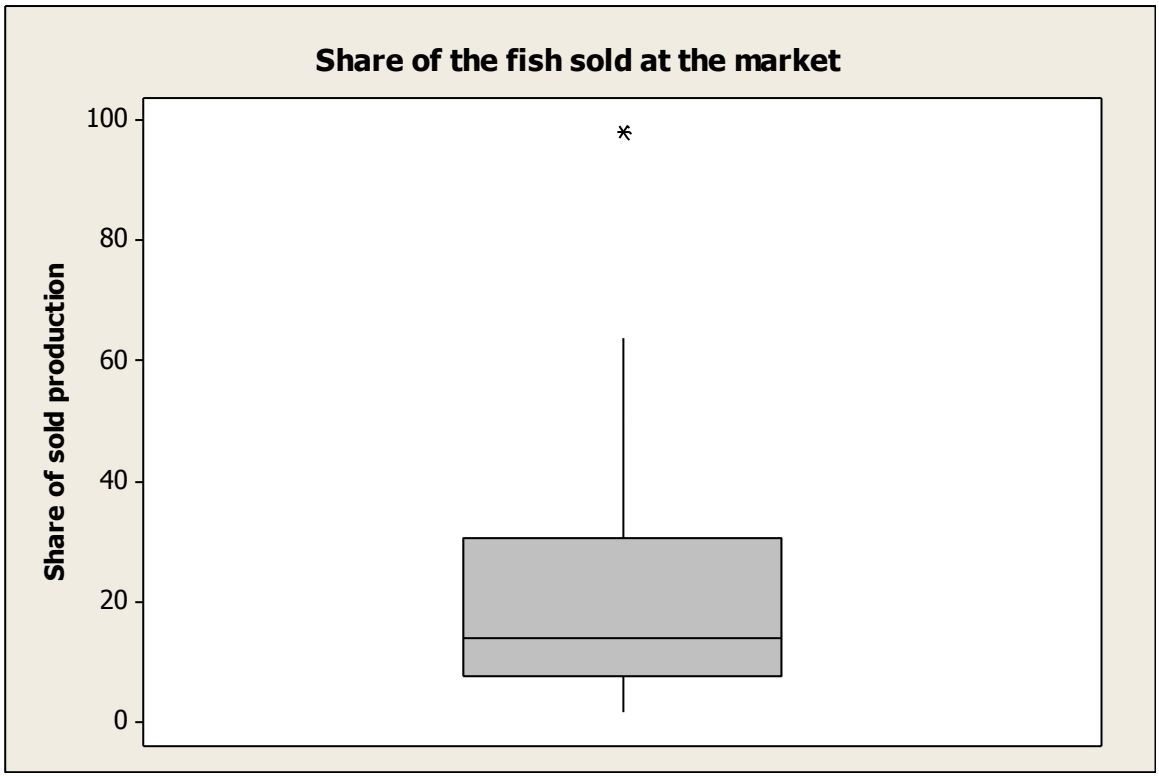

Figure 24: Boxplot of the share of the fish sold per household

The income comes mainly from the agricultural activities. In 2007/2008, the LECS indicated that the fish production for the market represented 4% of the total destination of the aquaculture and the household consumption was 13% for the fish production. The most important

production for both sale and consumption is the grain with, respectively, 43% and 61% of the total production (Figure 25).

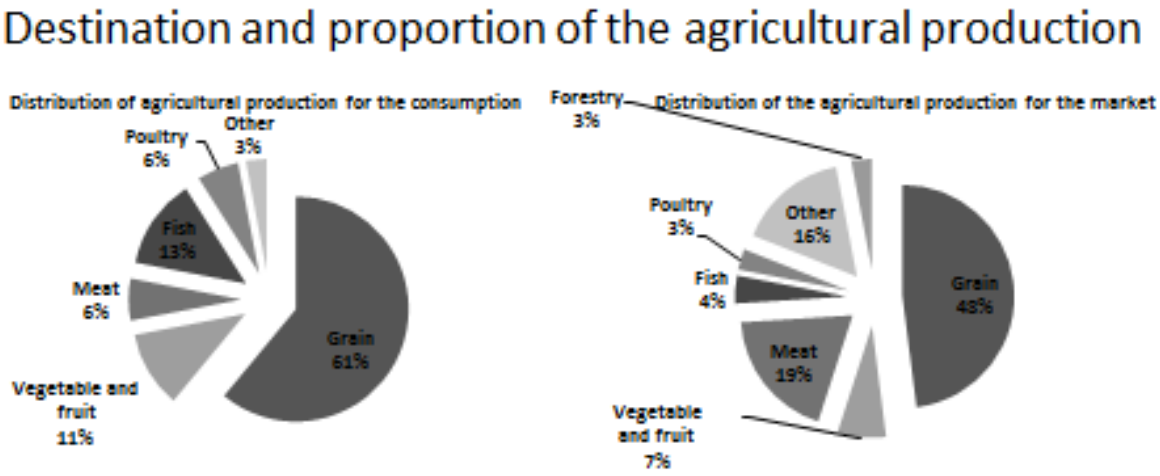

Figure 25: destination and proportion of the agricultural production for sold at the market and consumption

Figure 26 does not integrate the value chain of the fish transformation in fresh fish market. In fact, the Laotian people consume a lot of fermented and dried fish. But, the survey does not describe the fermented and dried fish market in Attapeu.

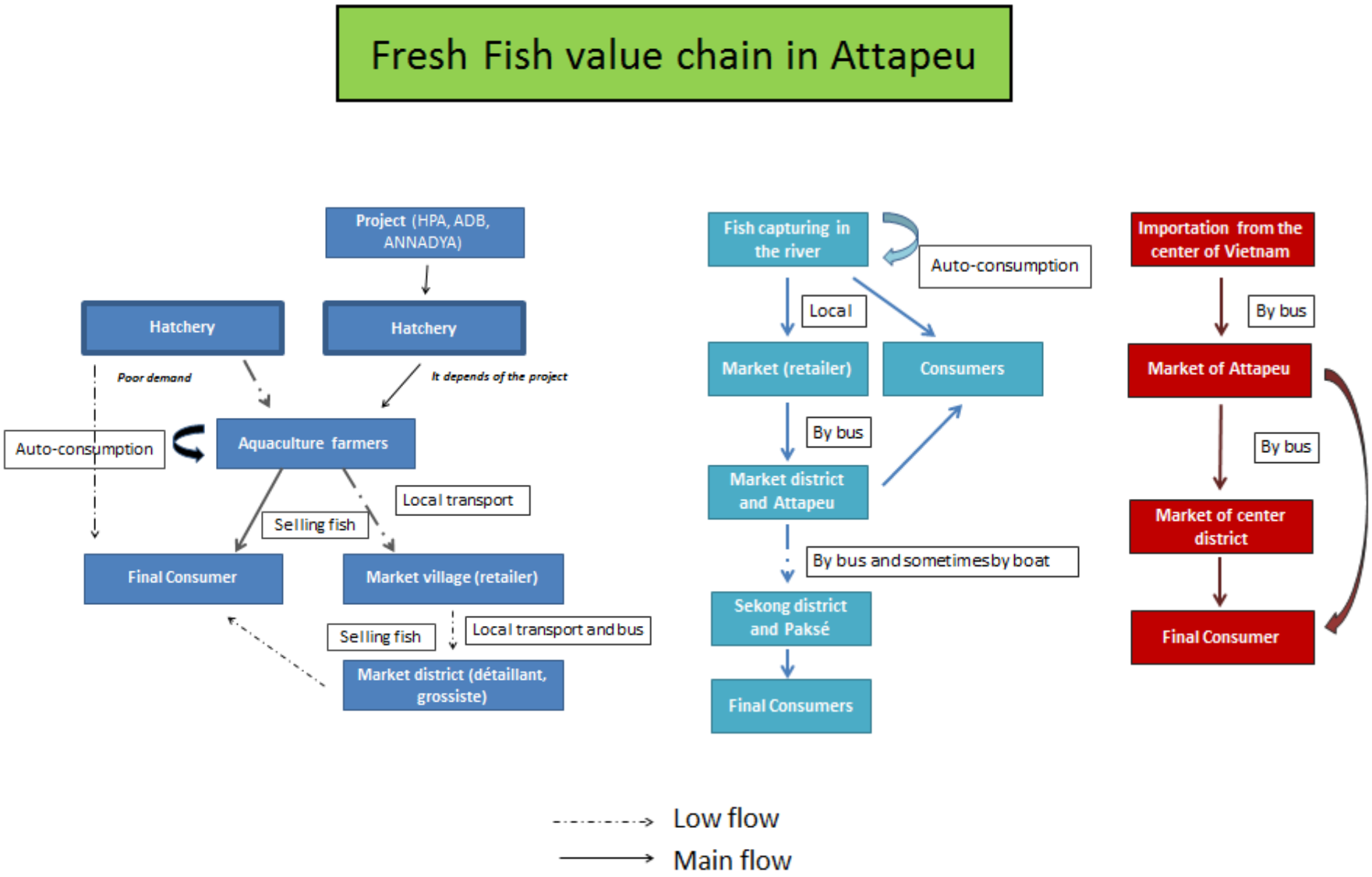

Figure 26: schematic representation of fresh fish value chain
Source: Andres L., Do Huu Q., 2014

6 Conclusion

The output of result 1 is realized with 12 tons and 354 beneficiaries. The fish production is based on 2012 and 2013. But these activities present a sustainability problem. In fact, the fish production is only possible during the raining season. The Dry season disrupts the aquaculture. The hydrology of Attapeu is rich on rivers. The mobilisable water resource could be used to create an irrigation system and/or individual pomp and provide the water for aquaculture the year round. In addition to the hydrology and irrigation potential, 80-90% of the farmers practice the capture fish and this production is very important, any study or any project integrate this parameter. Yet, environment and local fish diversity demonstrate the importance to integrate capture fish in a food security project. Each year, in July, the DAFO of each district organize a fish day. During this festivity, the authority distributes fish in the rivers to supply and increase local fish.

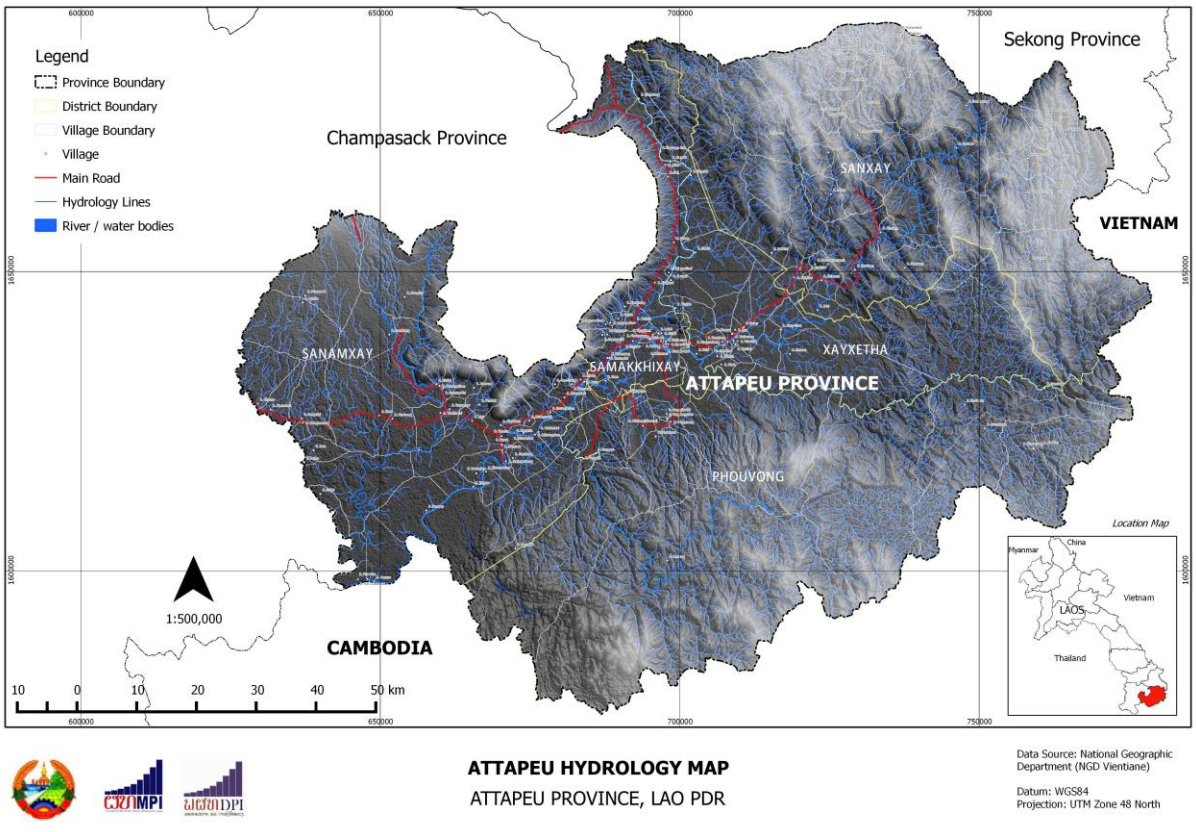

Figure 27: Attapeu Hydrology map

Whereas, the fish distribution in some schools should be expanded and improved to support the protein diet of the children.

The fish commercialization is mainly located inside the village between farmers and in a market if the village has it. The fresh fish value chain study demonstrated the lack of market structuration. The aquaculture sustainability will be obtained to support and improve the market actors. Furthermore, the fish collect will be developed between the aquaculture area and the permanent market with trolleys. Finally, the fermented transformation will be developed with a small unit. This transformation is realized by the women and will be integrated of a new security project. In addition, aquaculture is not integrated in the fresh fish market because the imported fish (Vientam and Paksé) supply the fish demand. The aquafeed network will be improved to facilitate the farmer access.

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