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Economic analysis of small-scale freshwater aquaculture production and its product marketing channels in agro-aquaculture system in Hai Duong province, Vietnam

NGUYEN Van Huong, 2020

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ECONOMIC ANALYSIS OF SMALL-SCALE FRESHWATER AQUACULTURE PRODUCTION AND ITS PRODUCT MARKETING CHANNELS IN AGRO-AQUACULTURE SYSTEM IN HAIDUONG PROVINCE, VIETNAM

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Abstract

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Abstract

VAC stands for the first three letters of three words: Garden (V), pond (A), cage (C), referring to a small-intensive farming ecosystem model to solve the shortages of food and develop the rural economy in Vietnam. It has been shaped and developed for nearly four decades since the Vietnam War ended and the country got reunited in 1975. At first, the VAC economy might have seemed to be small, and just an "informal economy". However, it has gradually become an important model for rural farm households to produce their self-sufficient food and income as a strategic tool of livelihood which was recommended for the poor to overcome the shortfall of food with limited resources of agricultural production during the past period of transition time. Since Vietnam approved the autonomous role of the household economy after the revolution of “Doi Moi " in 1986, the VAC model has been widely promoted and exploited by many local provincial authorities and farmers in the country. Hai Duong province is one of the provinces, which has encouraged farm households to develop the VAC model since the beginning of the 1980s when it first was introduced in the Red River Delta in Vietnam.

Impacted by the introduction of the VAC model with small scale aquaculture, many farm households in Hai Duong province have practised freshwater fish production converted from rice fields which have recently turned into zones of concentrated freshwater aquaculture production. The study was carried out to investigate the households' current situations of fish production, focusing on the net returns and marketing channels of fish products. The study results have described four freshwater SSA models operating freshwater fish farming which have played an important role to the contribution of rural households' on-farm income, home consumption, and employment in the local province. These freshwater SSA models are named under their typical characteristics as (FS) single commercially-intensive fish production system, (AF) Animal Fish system, (New VAC) the hybrid system of the original VAC model and the traditional VAC system.

The New VAC model has the best net returns of fish among four identified SSA models. While the traditional VAC model can produce the highest yield of fish outputs, the fish yield of the FS model is recorded as the poorest number. However, the fish income of the FS model occupies for an approximate 90% of the total on-farm income due to the largest scale of fish production. The AF model can generate the highest amount of the total on-farm income including a large contribution of 70% of the fish income. Therefore, study results have reflected the highly profitable level of fish production in the agro-aquaculture system.

The marketing channels of freshwater SSA models' products have comprised the direct and intermediated marketing channels which market the fish outputs available at both local and suburban markets. Fish farmer-collector takes a farm gate wholesale of fish products from fish farmers. Commission wholesalers, merchant wholesalers and retailers play an important role in the marketing chain of fish products from the production to the end consumer at urban and suburban areas in northern Vietnam.

Keywords: economic analysis, freshwater, aquaculture, VAC, fish production, marketing channels, Hai Duong, Vietnam

Résumé

Van Huong NGUYEN. (2020) Analyse économique de la production aquacole en eau douce à petite échelle et des circuits de commercialisation de ses produits dans l'agro système de la province de Hai Duong, au Vietnam (thèse de doctorat en anglais). Gembloux, Belgique, Gembloux Agro-Bio Tech, Université de Liège, 202 pages, 44 tableaux, 24 figures, 03 images.

Résumé

L'acronyme vietnamien VAC correspond aux trois premières lettres de trois mots : Jardin (V), étang (A), cage (C), faisant référence à un modèle d'écosystème agricole intensif à petite échelle pour résoudre les pénuries de nourriture et développer l'économie rurale au Vietnam. Il a été façonné et développé pendant près de quatre décennies depuis la fin de la Guerre du Vietnam et la réunification du pays en 1975. Au début, l'économie du VAC pouvait sembler petite, et n'être qu'une "économie informelle", mais il est progressivement devenu un modèle important pour les ménages agricoles ruraux, leur permettant de produire leur nourriture et leurs revenus de manière autonome, en tant qu'outil stratégique de subsistance recommandé aux pauvres pour surmonter la pénurie de nourriture avec des ressources limitées de production agricole au cours de la dernière période de transition. Depuis que le Vietnam a approuvé le rôle autonome de l'économie des ménages après la révolution du "Doi Moi" en 1986, le modèle VAC a été largement promu et exploité par de nombreuses autorités provinciales locales et par les agriculteurs dans tout le pays. La province de Hai Duong est l'une des provinces qui a encouragé les ménages agricoles à développer le modèle VAC depuis le début des années 1980, lorsqu'il a été introduit pour la première fois dans le Delta du fleuve Rouge au Vietnam.

L'introduction du modèle VAC pour l'aquaculture à petite échelle a eu un impact sur de nombreux ménages agricoles de la province de Hai Duong, qui ont pratiqué la production de poisson d'eau douce à partir de rizières récemment transformées en zones de production aquacole concentrée en eau douce. Les résultats de l'étude ont décrit quatre modèles d'ASS d'eau douce exploitant la pisciculture en eau douce qui ont joué un rôle important dans la contribution des ménages ruraux "aux revenus des fermes, à la consommation domestique et à l'emploi dans la province locale". Ces modèles de pisciculture en eau douce sont typiquement caractérisés en tant que système de production piscicole commercialement intensif (FS), système de pisciculture animale (AF), système hybride du modèle original (New VAC) et système traditionnel de VAC.

Le modèle New VAC a le meilleur revenu net de poissons parmi les quatre modèles SSA identifiés. Alors que le modèle VAC traditionnel peut produire le rendement le plus élevé de poissons, le rendement de poissons du modèle FS est le plus faible. Cependant, le revenu de poissons du modèle FS occupe environ 90 % du revenu total de l'exploitation en raison de la plus grande échelle de production de poissons. Le modèle AF peut générer le montant le plus élevé du revenu total de l'exploitation, y compris une contribution importante de 70 % du revenu de poisson. Par conséquent, les résultats de l'étude ont reflété le niveau hautement rentable de la production de poisson dans le système d'agro-aquaculture.

Les canaux de commercialisation des produits issus des modèles d'SSA d'eau douce comprennent les canaux de commercialisation directe et intermédiaire qui commercialisent les produits de la pêche disponibles sur les marchés locaux et suburbains. Un pisciculteur-collecteur achète en gros les produits de la pêche aux pisciculteurs. Les grossistes de la Commission, les grossistes marchands et les détaillants jouent un rôle important dans la chaîne de commercialisation des produits de la pêche, de la production au consommateur final, dans les zones urbaines et suburbaines du nord du Vietnam.

Mots-clés : analyse économique, eau douce, aquaculture, VAC, production de poisson, circuits de commercialisation, Hai Duong, Vietnam.

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Contents

List of Figures

List of Tables

List of Pictures

List of Abbreviations

ADB	Asian Development Bank
AF	Animal Fish model
DARD	Department of Agriculture and Rural Development
EU	European Union
FAO	Food and Agriculture Organization
FFPS	Freshwater Fish Production Systems
FS	Fish System model
FGD	Focus Group Discussion
IAAS	Integrated Agriculture Aquaculture System
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
GSO	General Statistics Office
HH	Household
MARD	Ministry of Agriculture and Rural Development
OECD	Organization for Economic Cooperation and Development
SSA	Small-Scale Aquaculture
SRD	Sustainable Rural Development
USD	United States Dollar (Currency unit)
VASEP	Vietnam Association of Seafood Exporters and Producers
VND	Vietnam Dong (Currency unit)
VAC	Garden – Pond – Cage
WB	World Bank

1

INTRODUCTION

1.1. General context and problem statement

1.1.1. The importance of aquaculture to improve the nutritional status in developing countries

1.1.1.1 The pattern of fish consumption

Fish demand has been rising over the world at more than 2.5 percent per year (Peterson & Fronc, 2007). According to (FAO, 2018), Asia accounts for almost two third of global fish consumption and 24 kg per capita in 2015 – a level similar to Europe (22.5 kg/cap/yr) and North America (21.6 kg/cap/yr), and close to the levels of Oceania (25.0 kg/cap/yr). Africa, Latin America, and low-income food-deficit countries have the lowest per capita consumption (9.9, 9.8 and 7.7 kg/cap/yr in 2015, respectively). At the sub-regional level, within Asia, consumption levels are particularly high and increasing in Southeast Asia (Table 1.1).

Table 1. 1 Total and per capita apparent fish consumption by region and economic grouping 2015

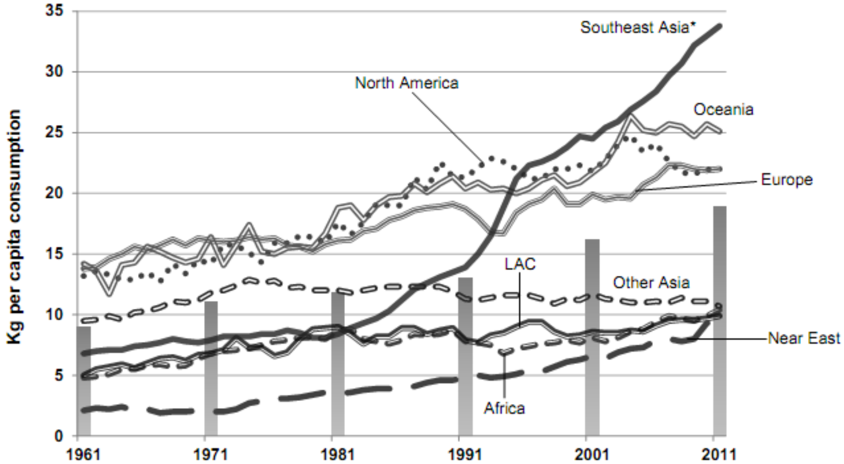
Region/economic grouping	Total food fish consumption (million tonnes live weight equivalent)	Per capita food fish consumption (kg/year)
World	148.8	20.2
World (excluding China)	92.9	15.5
Africa	11.7	9.9
North America	7.7	21.6
Latin America and the Caribbean	6.2	9.8
Asia	105.6	24.0
Europe	16.6	22.5
Oceania	1.0	25.0
Developed countries	31.4	24.9
Least developed countries	12.0	12.6
Other developing countries	105.4	20.5
Low-income food-deficit countries	20.8	7.7

Source: (FAO, 2018)

Although the apparent annual consumption per capita of fish products has grown gradually in developing regions (from 5.2 kg in 1961 to 17.9 kg in 2011) and in low-income food-deficit countries (LIFDCs) (4.4 kg in 1961 to 8.6 kg in 2011), it is still significantly lower than in developed regions (from 17.1 kg in 1961 to 23.0 kg in 2011) (see figure 1.1).

Simultaneously, however, fish is the main source of animal protein in many LIFDCs (Béné *et al.*, 2007; FAO, 2014; Reynolds, 1993). (Nozomi Kawarazuka & Béné, 2011) has used the FAO food balance sheets to examine fish consumption among the 30 countries in the world. The research showed that fish represented more than one-third of the total available animal protein in the world and fish is an important part of animal protein sources for Vietnam as well as 22 countries classified as LIFDCs in 2010.Particularly, fish plays a key role of contributing to animal protein in the wealthier and highly populated countries such as China and India, the demand for fish products is likely to increase rapidly (Garcia & Rosenberg, 2010).

In developing countries, the rapid urbanisation process that goes along with higher income or living standards probably created a higher demand for aquaculture products, including fish and seafood (Speedy, 2003). In fact, according to Speedy, there is a high demand for fish in the wealthier groups of society and this demand for fish will increase at a higher rate in developing countries where the growth of the economic level of development and living standards is taking place.



Source: (HLPE, 2014)

Figure 1.1 Regional evolution of fish consumption per capita

The urbanization process was reported to cause the changes in the preference of food consumption with an extra 5.7–9.3 kg per capita concerning fish annually. The fish consumption per capita was considered to be the most rapid growth in the wealthy regions where the progress of the urbanization process took place and in the countries that had more fish products for domestic markets(Delgado *et al.*, 1997). The rapid increase in demand for fish in new-industrial countries in Asia would be a good example of this pattern of fish consumption. In the future, the emerging economies with more wealthy classes and urban inhabitants are likely to grow fish demand. For example, in the case of China, the prediction of the fish demand was reported to increase from 24.4 kg per capita in 2000 to 41 kg per capita by 2030 (Msangi *et al.*, 2013).

The fish proteins may represent a significant proportion of the people's daily meals in the developing countries due to poor sources of animal protein. Fish, particularly, would provide the main calorie/protein for the communities who have been living on subsistence crop farming with the staple foods of cereals or grain. In addition, the culture of consumption has required fish as the main ingredient of the local recipes since fish could be cheap and provides more nutrients. For instance, fish providesabout50 percent of the total animal protein intake for local people in some developing countries such as Bangladesh, Cambodia, Ghana, Indonesia, Sierra Leone, and Sri Lanka. In 2013, FAO reported that fish contained about 17 percent of animal protein and6.7 percent of all other sources of protein consumed by the global population. Moreover, fish provided an intake as animal protein for more than3.1 billion people and accounted for approximately 20 percent of animal protein intake on average (FAO, 2016).

1.1.1.2 Important source of protein from fish for the poor

Poor households are generally characterized with limited income and food availability therefore some basic food items for consumption are prioritized to purchase. The purchased items might be stapled foods such as cereals or grains. The cheap non-staple foods, vegetables – for example, would be only purchased when the income and staple foods were secure(Brinkman *et al.*, 2009; Von Braun *et al.*, 2008). Previous studies in Asia suggested that low-income households would consume less fish than the wealthy, however, the low-income households still much depended on fish as a major source of animal protein (Bose & Dey, 2007; Hossain *et al.*, 2005; F.-U.-A. Islam, 2007; Mohan Dey *et al.*, 2005). (Mazumder, 1998) has shown that the consumption gap between rich and poor in meat, eggs, milk and milk products is much widened in comparison to the case of fish. This is because animal foods are often expensive for the poor to purchase and they refer to fish for the cheap price. Most studies have come to a conclusion that fish provided an important source of protein for low-income households. In contrast, food sources related to animal protein has been preferred and much consumed by the wealthier households

Farmers operating small-scale aquaculture would improve their nutritional status because they consumed more fish from their fishpond. Income from the sale of fish also provided the farmers to afford better nutritional foods. Besides, providing the availability of fish with cheap price, SSA farmers would increase the status of nutrition in the local communities (Aiga *et al.*, 2009; Dey *et al.*, 2007; E-Jahan *et al.*, 2010; Roos *et al.*, 2007a).

The small-scale aquaculture also took impacts on dietary intake according to recent studies. The extensive and semi-intensive methods are commonly applied in small-scale aquaculture. The small-scale aquaculture uses mainly the traditional fish species, such as catfish, carps, and tilapia. Therefore, polyculture is feasible to utilize local nutrient availability. The small indigenous species would be stocked for household consumption to overcome micronutrient deficiencies. The large fish species and prawns generated an important source of cash income for the households through the sale(Alim *et al.*, 2004; Kadir *et al.*, 2006; Roos *et al.*, 2007; Thilsted *et al.*, 1997). Aquaculture would improve nutritional status through exploring all types of interventions and achievement of agriculture-aquaculture integrated interventions, such as rice-fish culture, and vegetables-gardening on the dykes of fish ponds. Figure 1.2 demonstrates the interactions and achievements of aquaculture contribution to nutritional improvements.

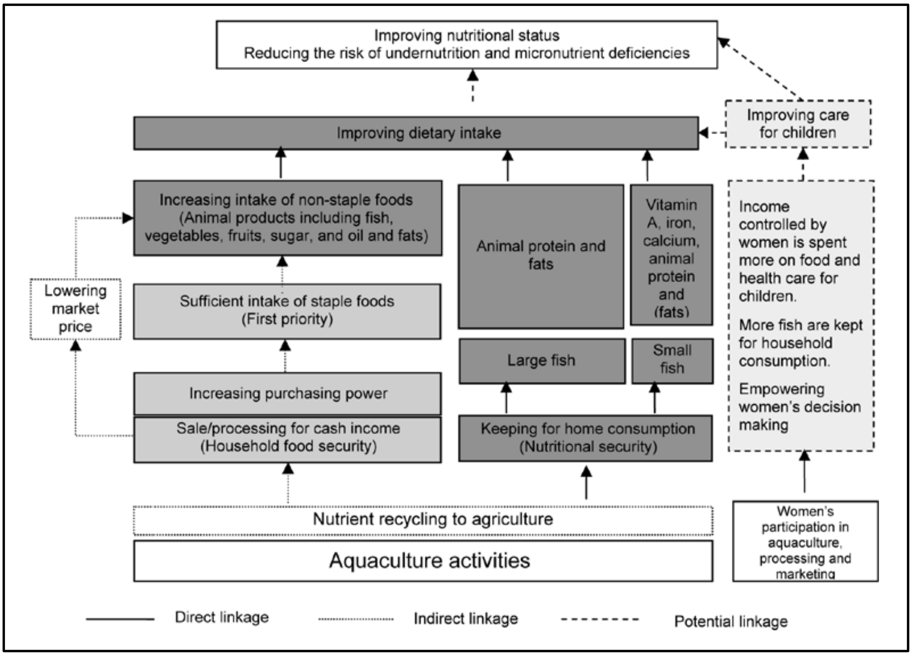


Figure 1. 2 The pathways through which aquaculture can improve the nutritional status adapted to (N Kawarazuka, 2010)

For aquaculture households, farmed fish becomes relatively significant because it is normally either kept for household consumption or sold for cash income. Regarding the fish for household consumption, aquaculture has also been traditionally practiced from a human nutrition perspective to improve dietary intake directly. In the context of Vietnam, there is a variation in nutritional content which depends on fish species that are selected to produce for contributing to the dietary intake. Currently, large freshwater fish is predominant in aquaculture and therefore the figure below shows the greater share of aquaculture production as large fish or high market value species. The surplus of fish sold for cash income has provided certain cash resources for purchasing appropriate staple foods, and could also be used for purchasing non-staple foods which directly improve nutritional diet beyond energy intake.

In many developing countries, fish from small-scale aquaculture represents one, if not the principal, animal-source food for the populations, supplying both high-quality protein and essential micronutrients (Goswami & Sathiadhas, 2000). The contribution of small-scale aquaculture to rural communities' consumption is often underestimated, as the partial harvest from subsistence farming are rarely included in national statistics and their importance is often overlooked (Gale, 1996; Roos *et al.*, 2007a).

The fish produced for home consumption varies from country to country and is documented in some studies. For example (Garaway, 2005) indicated the fish for home consumption in the Lao People's Democratic Republic representing 75 percent of the fish in the production. In contrast, it only accounted for 10–20 percent of the total finfish in Papua New Guinea (Friedman *et al.*, 2008). The low market-value fish species are mainly reserved for the household consumption, sometimes it covers the indigenous aquatic animals such as frogs, freshwater molluscs and snails (Chamnan *et al.*, 2009).

1.1.1.3. Nutritional improvement with food from fish

The improvement of fish to human nutrition and its outcome to health has been examined from different regions in over the world. Many researchers and scientists have been interested in the health benefits of polyunsaturated fatty acids (PUFAs), which prevents the blood from increasing, reduces the risk of heart disease, and contribute to infant growth and cognitive development (Wang *et al.*, 2006). In developing countries, the contribution of fish to nutritional needs has been highlighted in public health related to undernutrition, micronutrient deficiencies. Most of the previous studies have revealed the potential of fish to improve the nutritional conditions and combating health problems. A healthy diet needs to provide adequate protein, different types of essential amino acids and fatty acids (EPA/DHA) as well as vitamins and minerals. Fish can provide a rich source of these nutrients for a man to reduce the risks of both malnutrition and non-communicable diseases, which may co-occur when the man consumes a too high intake of energy and a lack of balanced nutrition protein (Allison *et al.*, 2013; Larsen *et al.*, 2011; Rangel-Huerta *et al.*, 2012)

Fish and fishery products represent a very important source of protein and essential micronutrients for balanced nutrition and good health. In 2009, global fish production provided approximately 20 percent of the animal protein for nearly 3 billion people as an intake of protein on average, and 15 percent of the protein per capita for an additional 1.3 billion people (FAO, 2012). The protein contribution may be more for some countries such as the West African coastal countries, where the protein from fish represents 47 percent in Senegal, 62 percent in Gambia and 63 percent in Sierra Leone and Ghana. It is also significant for Asian countries where the fish protein accounts for 59 percent in Cambodia, 57 percent in Bangladesh, and 54 percent in Indonesia (Briones *et al.*, 2004).

The fish protein is more important for humans because it is approximately 5–15 more digestible than proteins from plant sources. According to(A. G. Tacon & Metian, 2013),animal-related foods, including fish, contain several of the essential amino acids that are good for health. The lysine and methionine of these food contents could facilitate the digestibility of the essential amino acids from the intake. The diet containing fish can generate more protein in total intake since fish can compensate for the shortage of these amino acids than other ingredients of the diet do not cover. This is really meaningful for many low-income food-deficit countries where the meals are mainly plant-based diets.

1.1.2. Impacts of aquaculture on economic development and food security

1.1.2.1. Aquaculture for rural development

The aquaculture production, the fastest-growing subsector of the food industry has surpassed terrestrial animal meat production and natural capture fisheries (A. Tacon, 2001). For centuries, aquaculture has been introduced to culture in many parts of developing countries, such as Africa and Asia, to create opportunities for local rural communities to improve their living standards and the pathways to escape poverty (Peter Edwards, 2000). The development of aquaculture is considered to be one of the shortest ways for the poor to make a living for their own, meanwhile, it is also a tool of foreign exchange for national development. First of all, aquaculture has gradually been integrated as an important part of rural livelihoods as it has become a solution for the problems of increasing population pressure, environmental degradation or inaccessibility, and decline of catch production from wild fisheries (Carleton *et al.*, 2013). While global wild catches have decreased at an annual rate of more than 0.5 million tons, aquaculture has grown by about 2.5 million tons per year from 2004 to 2011 (Cleasby *et al.*, 2014).

A majority (75%) of the poor, who may rely directly or indirectly on agriculture for a living, belong to the rural areas of developing countries. Agriculture development is believed to be important to stimulate growth in other areas and reduce poverty (World Bank, 2007b). Agriculture contributes to growth and poverty reduction varies from country to country. For agriculture-based economies, agriculture is an important source of growth (responsible for an average of 32% of GDP growth) due to a large percentage of GDP (average of 29%) and high generation employment levels (using an average of 65% of the labour force). It is estimated that GDP growth from agriculture is at least two times more effective at reducing poverty than growth from any other sector, making agriculture an important strategy for reducing poverty in developing countries (World Bank, 2007b)

Agriculture contributes to development as an economic activity, promotes local and national economic growth and stimulates growth in agriculture-related industries and non-agricultural economy. Agricultural production is very important for food security, stability and increased domestic food production and providing income for the majority of the rural poor. Also, the rural poor depend on a range of livelihood options including diversification of activities in agriculture and non-farm employment, with those in resource-poor environments that have a range of broader livelihood strategies. A study of farming systems in the world carried by (Dixon *et al.*, 2001) identified five household strategies for escaping poverty: intensification; diversification; increased farm size; increased off-farm income; and exit from agriculture.

Diversification, including aquaculture, is considered an important poverty reduction strategy in all types of farming systems and is the most important strategy in developing countries for agricultural poverty reduction (Kassam, 2013). However, the level of aquaculture that will lead to poverty reduction depends on several factors including the level of participation of the poor, the scale of application, the importance of livelihoods and production efficiency compared to consumption efficiency benefits poor consumers and the importance of indirect effects such as increasing labour demand from larger enterprises and the linkages of economic growth arising from systems. Aquaculture production varies and thus, its associated economic impacts vary, too. Therefore, although aquaculture may have the potential to contribute to the development of agriculture and agriculture systems and rural development and poverty reduction, the extent to which this potential will be realized depends on multiple extra elements.

According to Edwards and Demaine (Peter Edwards & Demaine, 1997), rural aquaculture is often explained as extensive to semi-intensive aquaculture activities with relatively low production and technology costs. With targeting to low-income consumer groups, this small-scale aquaculture operation has applied agricultural inputs and non-agricultural organic fertilizers, without relying on any formulated feed based on the production of low-value fish species. Aquaculture development is often a part of rural development programs because most aquaculture is widely promoted in rural areas. This mentioned development, however, is ambiguous and highly controversial, whether it follows the traditional dichotomy between rural or agricultural and urban or industrial areas (W. G. Yap, 1999).

Establishing a successful aquaculture production is not an easy task, particularly in a rural condition where working resources are poor and limited to access to. So far, many practical cases have been taken mostly in Africa and some other undeveloped countries, where aquaculture has failed. A typical example of this would be the cage culture of carp in Bangladesh where cage culture was officially introduced in the 1980s at Kaptai Lake (K. Ahmed & Saha, 1996; Peter Edwards *et al.*, 2002). The carp aquaculture soon collapsed because local people were unable to have the affordability of capital and input costs to buy cages (Bulcock *et al.*, 2000). The reasons behind the failure in aquaculture may be the lack of access to capital and resources, vulnerability and aversion to farmers to take risks (Asian Development Bank, 2005). The lack of skills and technical knowledge in the fish farm operation of local villagers is also an important hindrance to overcome. Insufficient financial support from the government and the local village has made rural aquaculture more difficult to remain (Peter Edwards *et al.*, 2002).

Although most aquaculture farms run by rural communities are responsible for improving living standards towards poverty reduction and ensuring food availability, successful aquaculture does not guarantee for all mentioned benefits (Rajee & Mun, 2017). If not properly managed, rural aquaculture can also be a threat to the poor because each coin has two sides. In other words, aquaculture carried out by rural communities also has negative consequences and positive benefits for the villagers.

1.1.2.2. Aquaculture with the rural livelihood

Aquaculture contributes to the livelihoods of the poor through employment and improved incomes. Due to the small-scale operation of households and the deficiency of high-tech equipment, rural aquaculture is labour-intensive. Taking this into account, landless local people or villagers do not have access to the land at least to make a living by providing their manpower for other aquaculture farms (M. Ahmed & Lorica, 2002). Rural aquaculture creates a self-employed enterprise that make the whole family members dedicated to the business (Peter Edwards, 2000). Sometimes, during the harvest season, casual or irregular labour is required for the operation (Nesar Ahmed & Garnett, 2010). The number of people related to the global aquaculture value chain varies from country to country; however, most data reported by FAO are likely to be underestimated. The estimated data indicated that total global aquaculture employment lies somewhere between 27.7 and 56.7 million full- and part-time jobs (Phillips *et al.*, 2016).

A recent follow-up study conducted by Ahmed & Garnett (Nesar Ahmed & Garnett, 2011) has found that after the development of integrated shrimp farming in Bangladesh for decades, some closely linked industries have developed. These include the seed industry, feed industry, fertilizer business, and shrimp marketing. By establishing networks related to this fish farming, it has opened up more employment opportunities in the limited aquaculture sector.

According to (Nesar Ahmed & Garnett, 2011), Bangladeshi farmers have received approximately, an increase of US $ 125 in average annual net income after integrating aquaculture in their rice farms. In Bangladesh farmers, involvement with rice production is often considered the poorest of the poor. The integrated rice-fish or shrimp has become a win-win solution for farmers because they can have additional income besides rice production with few other resources invested. Taking the advantages of natural resources, Bangladesh farmers can develop their aquaculture from the availability of wild post-larvae, low rice fields, warm climates, fertile soil and abundant labour (Nesar Ahmed & Garnett, 2010). (Nesar Ahmed & Garnett, 2011) reported that after farmers' incomes have increased, they reflect stronger purchasing power than before and better access to resources, including sanitation, transportation, housing, health services, and communication technology, all of which are recorded in integrated farming. Bangladesh’s aquaculture achievement has significantly improved the living standards of local people.

In addition to Bangladesh, outstanding examples of sustainable aquaculture in improving the rural communities’ livelihoods can also be seen in the Pacific Islands (PICT). In Fiji, sandfish, also known as Beche-de-Mer, was cultivated by the locals after being trained by experts. The sandfish aquaculture in remote rural areas like Fiji will not only benefit local people but also contribute to environmental and biological conservation. The success of sandfish farming led to a huge export volume and economic profit for the Pacific Island. The quantity and value of exports from countries have increased nearly tenfold after the sustainable farming of sandfish was introduced in the 1990s (Carleton *et al.*, 2013).

It is similar to the case of pearl culture developed in Tanzania for the sustainable rural community development under the initiatives of the Worldwide Fund for Nature (WWF). Native participants were able to have an increase in average income growth by 6 times through the culturing of valuable ornamental products (Troell *et al.*, 2011). Whereas in Cook Island, pearl farming industry has contributed US$18 million, which was corresponding to 20% of the country's gross domestic product (Southgate & Southgate, 2007)

The rural aquaculture took effect remarkably to villagers in Assam, India where marketable freshwater species, such as *Labeorohita, Catla Catla* and *Hypophthalmichthys molitrix*, were introduced to local rural communities for farming. This project of the fish farming program has increased returns quadrupled from RS15,591 (USD 230) to RS62,500 (USD 923) (Jana & Jana, 2003; Rajee & Mun, 2017). It is undeniable that the improvement in local infrastructure in rural communities is remarkable. Thereby, schools, libraries, and herbal medicine gardens have been established to upgrade the local living standard. Workshop and public activities were increased to conduct for better aquaculture practices and increasing qualification of labour (Goswami & Sathiadhas, 2000).

In China, aquaculture is often limited to small-scale operations conducted by the community or state-owned enterprises. Overtime under the expansion, the Chinese aquaculture has created tremendous job opportunities for the local rural people who participated in the aquaculture sector in 1997 reaching 3.29 million jobs, an increase of nearly three times compared to 1989, 1.53 million jobs (Qian, 1994). About 64% of income is spent on living, communication, health care and sanitation purposes that are associated with rural aquaculture (Song, 1999). This showed that rural aquaculture has a great contribution of benefits to rural communities as the sustainable livelihoods.

However, scholars and researchers have been highly controversial about aquaculture in rural communities that are showing pro-poor growth. (Kakwani *et al.*, 2003) explained pro-poor as a means of economic growth that benefits the poor rationally more than the non-poor. Whereas, some scholars might explain it in another way: 'a growth episode that gives every rich person $1 million but 1 cent to a single poor person'(Grinspun, 2004). The latter was believed because in Bangladesh, for example, the landless people dominated the community and hindered the poorest people from aquaculture (Toufique & Belton, 2014). As a result, poor and middle-income communities in Bangladesh could only benefit indirectly from the job created by commercial aquaculture, while most of the profits still went to wealthy landowners (Toufique & Gregory, 2008). Similar findings were reported in the Philippines, where aquaculture accounted for the poor's income a half as much as the income of the non-poor. Land ownership in the Visay region was very imbalanced and the average wage of workers was low (Irz *et al.*, 2007). The survey farmers in the study of Irz et al. (2007) also described their fish farming as a gamble in which a large number of intermediated inputs have been invested for the high uncertainty of its returns. Therefore, this game could only be provided for rich people who had strong financial situations and were willing to take risks; that made the rich much richer. Although aquaculture offered fewer advantages to the rural poor in absolute terms, it certainly provided more benefits in relative terms of poverty reduction and relative inequality (Irz *et al.*, 2007). Therefore, aquaculture growth has had a strong influence on income distribution in developing countries and effectively narrows the gap in income inequality.

1.1.2.3. Aquaculture with the food security

Aquaculture in a small rural farmer system provides high-quality animal protein and essential nutrients, especially to nutritionally vulnerable groups, such as pregnant women and breastfeeding, infants, and preschool children. Nearly half of all deaths worldwide have been related to malnutrition (Rajee & Mun, 2017). It has been shown that after getting the necessary nutrition which could be found mainly in fish, such as vitamin B12, calcium, and potassium, unfortunate cases such as blindness in children and death in infants. There has been a significant reduction (Nesar Ahmed & Garnett, 2011). In the situation of rural aquaculture, most household farmers have tended to consume small fish which fails to meet the market size. The bigger fish would be spent on sale which can obtain higher prices (Nesar Ahmed & Garnett, 2011) [4]. Sometimes, fish was used to be a gift or barter as a form of payment for laborers working on farms (Irz *et al.*, 2007). The consumption of the small fish as a whole including heads and bones would supplement more micronutrients, vitamins, and minerals than that of the larger one(Nesar Ahmed & Garnett, 2011). Indirectly, the “free fish” collected from fishponds has provided a major source of nutrition for poor rural families and helped to reduce infant malnutrition.

The contribution of aquaculture to food security to promote public health has been clearly illustrated in the case of the VAC system in Vietnam where the self-production food system in the field for family consumption could increase food availability of the household and thereby bring about an increase in food provided for the family meal. Besides, aquaculture by rural communities helped increase the availability of fish in both rural and local markets. Regarding the laws of supply and demand in economics, when the supply of an item increases, its price automatically decreases, provided there are no external constraints (Gale, 1996). It is similar to ideology, the supply of fish production increases, the unit price of the fish will then surely fall to a lower price which more households can afford to pay.

However, it is a critic that the introduction of large commercial fish into polyculture farms has negative consequences for the food security of rural communities. Before starting any aquaculture activities in the rural communities, fish could only be accessed through the wild catches of small native fish. The case of mola (*Amblypharyngodon mola*), would be an example in Bangladesh. While the small fish species contain rich nutrients which have played an important role in meeting the nutritional needs of the rural poor, the large fish species have not provided the same amount of nutrients as small fish. The rural poor have been forced to shift to fish species with larger size which they reared in their rice farms because of the environmental degradation, overfishing and declining in the catches

(Mazumder, 1998). (Bouis, 2000)has claimed that the nutrient content of small fish has been better than that of large species. Following this, research on the nutrients between mola (*Amblypharyngodon mola*) and other major introduced species, such as tilapia and some common carp species was conducted. It was found that 100 g of edible mola contains more than 1,500 retinol (RE), which is equivalent to vitamin A content, while large introduced species carry less than 100 RE (Roos *et al.*, 2003). Therefore, aquaculture development in rural areas does not always guarantee food security in terms of fair and equal distribution of good quality nutrition. However, the problem can be mitigated through appropriate governmental legislation, elimination of market monopolies and appropriate allocation of resources.

1.1.3. Problem statement

The importance and impacts of aquaculture on economic development and food security in developing countries have been widely discussed in the above sections. Similarly, the Vietnamese government has paid much attention to aquaculture in order to develop for such goals. It has been promoted to produce for export markets and domestic consumption. The former is normally referred to as the commercial production of shrimp and catfish (Thi Thanh Vinh, 2006). The latter is characterized by small-scale aquaculture (SSA) operated by smallholder farmers (FAO, 2005). The small scale aquaculture is strongly involved with the VAC model of which development has been promoted during the period of economic reforms in Vietnam in the 1980s. This VAC model has been considered as a means to solve the food problem thanks to sustainable development and environmental protection in the Red River Delta(Tii Giay & Dat, 1986; Nam, 1994). Although it has been highly appreciated for its application and potential to improve the rural farmer until now, there are no or little studies on its contribution to rural development in terms of household income and livelihoods.

Despite small scale aquaculture in the Red River Delta of Vietnam has been projected to develop with the goal of providing fish products for domestic markets, the role of aquaculture remains less described (Nghia & Jepsen, 2017). This leads to a lack of scientific information and data for applying appropriate policies to promote farmers developing aquaculture in a proper manner. However, the essence of each form of fish culture encompasses the generally understood influences upon the production environment and the object of production. The varying extent of this influence defines the position of the given form of fish culture with respect to other branches of material production; with particular respect to the production of other food products. The most primitive forms of inland aquaculture closely resemble earthen ponds. The small scale aquaculture is very diverse in forms of fish culture. This is because fish culture is generally complex and complicated production resulting from different possibilities for intensifying various forms of fish culture, as determined by natural, historic and economic conditions(Leopold, 1981). Moreover, the characteristics of fish culture point to the enormous difficulties in an unequivocal assessment of its economic efficiency under comparable conditions or situations(Berge, 1976).

It can be assumed that the dominant role of pond-based fish production in the Red River Delta will increase in the years to come since changes in food consumption patterns are being shifted to greater consumption of fish, meat, fruits and other products due to a rising income and urbanization (Le, 2008; Regmi & Dyck, 2001). Taking into account the growing role of fish culture and forecasts of its further development, the small-scale fish culture, characterized by integration with the ecological environment, attempts to use as much as possible the natural resources of this environment and can operate and be economically effective in different types of production.

Hai Duong province, which belongs to the Red River Delta of Vietnam, has great potential for the development of inland freshwater aquaculture due to appropriate socio-economic and agro-ecological characteristics(Tran & Demaine, 1996). This region would continue to be characterized by small-scale fish culture as the VAC model has been created and strongly promoted to develop so far(Luu, 2001). Given the development potential of freshwater aquaculture production, and increasing demand on freshwater aquaculture products in the markets, the local farm households are expected to take advantages to develop the freshwater fish production in order to improve their farm income as the main farm alternative livelihood in the region.

Besides, given the increasing demand for fresh fish products in urban and peri-urban areas, the marketing of the freshwater fish outputs in Hai Duong province has been an important issue for both local authorities and freshwater fish households. Particularly, fish farmers and market participants have been confronted to market volatility, selling fish price fluctuations in recent years. Moreover, the market access to main inputs and outputs of freshwater aquaculture production has not been described in the province. Therefore, the investigation on marketing channels of fish outputs as well as inputs will provide scientific evidence for government officials, producers and other agents related to understanding and to support the local farmers to develop the freshwater fish products in a sustainable manner in the region. The main characteristics of market access to the freshwater fish household's involvement with the inputs and the harvested fish outputs are investigated and analyzed. While the market access to major inputs of freshwater fish production might be consisted of fingerlings, feeds, technical knowledge, the market access to the finished products could be referred to the market actors, marketing costs, margins along marketing channels of freshwater aquaculture products(Burden, 2012; SECTOR, 2010).

1.2. Research questions

From the literature review on the important role and contribution, great development potential, increasing market demand and emerging issues of the marketing the freshwater aquaculture products in the Red River Delta, more specifically in Hai Duong province, freshwater small scale aquaculture can be a profitable venture which provides farmers for large share of farm income and becomes an alternative livelihood for the rural people. Given the favorable conditions in the production, fish producers might be faced with many challenges and constraints in their marketing of fish outputs when they further intensify their fish production. These challenges and constraints could be considered as the general difficulties in marketing activities such as seeking for the appropriate market outlets, fish product quality, low bargain power of the sold fish outputs during the harvested season. Besides, lack of technical knowledge, increasing input prices, poor fingerling and feed quality due to lack of government control may have narrowed the profit of fish households. Thus, the study will be designed to investigate the small scale freshwater aquaculture production in the study areas to answer the following research questions:

(1) How freshwater fish farming practices are operated by farm households in Hai Duong province?

(2) How efficient and effective are the freshwater fish farming practices contributing to farm households on-farm income in total as well as livelihoods in Hai Duong province?

(3) How are the marketing channels of the freshwater fish products used by farm households in Hai Duong province?

1.3. Research objectives

The study is designed to shed light on the important role of developing the small-scale freshwater fish production in the rural households' livelihoods in northern Vietnam or the Red River Delta, specifically in Hai Duong province. The study will also provide some valuable insights into the marketing channels of the agricultural commodities used by smallholder farmers supplying fish food to the domestic markets in Vietnam. Thus, the economic efficiency and effectiveness of the freshwater fish production operating in the rural households' agricultural farming system will be investigated to understand the role of small-scale aquaculture to the farm households' livelihoods. Moreover, the actual situation of marketing channels will be surveyed to find and address problems and challenges in the marketing of the freshwater fish products along the marketing chain of the finished fish products that are specific to the region. The study results will be a good document recording some scientific facts and evidence for the different levels of government agencies, policymakers, researchers involved with the development of the small-scale freshwater aquaculture sector in general. Specifically, the study addresses to focus on the following:

(1) Understand the actual freshwater fish farming practices in agro-aquaculture systems in Hai Duong province;

(2) Analyze economic efficiency and effectiveness of the freshwater SSA production models in Hai Duong province;

(3) Explore the marketing channels of the freshwater fish products used by fish farmers in Hai Duong province; and

(4) Develop several recommendations to enhance the economic efficiency and effectiveness of the freshwater fish production and marketing based on the study findings in Hai Duong province;

1.4.Scale and Scope of the Research

The scope of the research: This study focuses on the economic efficiency of small scale freshwater fish farming in the agro-aquaculture system. The marketing of the aquaculture outputs are also taken into account. Due to limitations on time and financial resources, the study selects one province of the Red River Delta – northern Vietnam as the study area. Moreover small scale freshwater aquaculture in the region has been relatively diversified and dynamic in forms of fish practices. The main targeted samples are concentrated on farm households operating the earthen fishpond in Hai Duong province. The sampling design is specific to understand the contribution of the small-scale fish production to rural farmers' livelihoods in the local province.

The scale of the research: The research takes an economic analysis of the SSA production models at the household level. The marketing of fish products corresponding to the identified SSA models is investigated to understand the main market participants along marketing channels of the live fish commodities from the producers to the retailers at the main regional markets.

1.5. Structure of the Thesis

This thesis comprises an introduction, five discussion chapters, and a conclusion and recommendation section. Chapter 1 (the introduction) provides general information on the importance and impacts of aquaculture on economic development and food security around the world and Vietnam. It includes information on small-scale aquaculture production models operated by smallholder farmers in Hai Duong province, the Red River Delta of northern Vietnam. The SSA production has been put in the context of producing fish products for domestic markets to increase food security, improving nutritional status and generating an alternative livelihood for the rural farmer, providing a background for the problem statement of research problems. The research questions are developed and followed by the objectives of the study.

Chapter 2 reviews some relevant concepts and theoretical background from previous studies and theories of peasant economics and farm production regarding the development of freshwater SSA production models related to the agricultural context in Vietnam and some developing countries. Besides, the chapter contains a developed analytical framework applied to the study of understanding the economic contribution of SSA production models to the fish households under the condition of trade and exchange of fish produced by them.

Chapter 3 provides an overview of the VAC model related to the process of agricultural and rural development in Vietnam since 1975. This part offers readers further insights on the evolution of Vietnamese agriculture as well as the VAC model. Besides, this chapter also provides a descriptive part of the aquaculture role as the positive impacts on the contribution to the national economy.

Chapter 4 contains two parts. The first part provides general information about the Hai Duong province and the performance of the aquaculture subsector. The second part introduces the research methodology.

Chapter 5 analyzes the economic efficiency and effectiveness of different freshwater SSA production models in Hai Duong province.

Chapter 6 describes the strategies of direct marketing of the traditional VAC households and market participants along the marketing channels of fish commodities produced by fish farmers operating the New VAC, AF and FS models in Hai Duong province. Some marketing information and data related to marketing situation and market access affecting the prices of inputs, and outputs are illustrated and discussed.

Chapter 7 discusses the economic efficiency of the freshwater SSA production models and the impacts of marketing practices on the development of freshwater aquaculture production in the study area. It also summarizes the main findings for the study questions and proposes several recommendations and policy implications for supporting the development of the freshwater aquaculture production systems in Hai Duong province.

2

LITERATURE REVIEW

The first part of this chapter presents an overview and general concepts of small-scale aquaculture and its beneficiaries, typical characteristics, and a discussion of the advantages and prominent practices of small-scale aquaculture in Vietnam and Asia. The first part and third part accompanying with the chapter 3 of this dissertation will draw the context of freshwater aquaculture cultured practices of which characteristics will be presented in chapter 5. Several empirical studies on the marketing of agricultural and fish products in the second part of the chapter. This part addresses the description of the approach used to understand marketing of the fish products as well as challenges and constraints encountered by small-scale fish farmers, which will be presented in Chapter 6. The third part is mainly reviewing the theoretical background concerning peasant behaviors and selection of farm enterprise in agricultural production in the actual context in Vietnam. The self-sufficient food strategy involvement with agricultural policies of the land designation for rice production in Vietnam with specifically in Hai Duong approached to develop the analytical framework of this study.

2.1. General concepts of small-scale aquaculture

2.1.1. Beneficiaries and characteristics of small-scale aquaculture

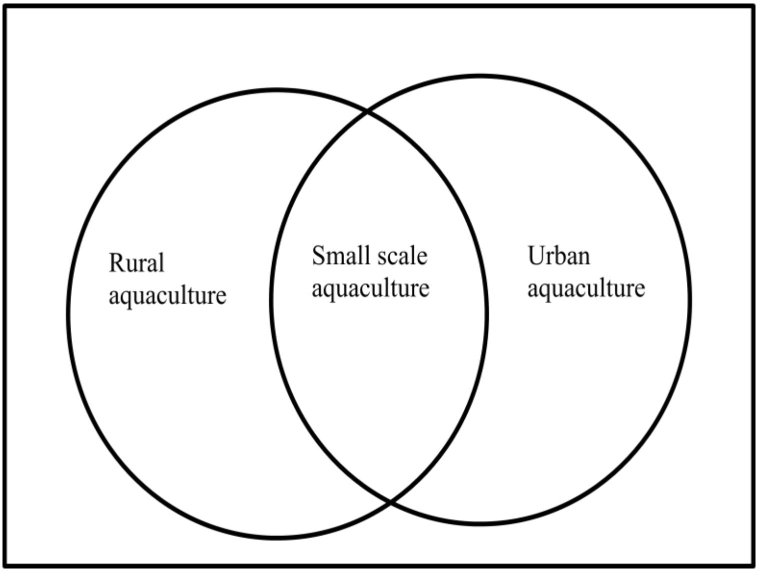
2.2.1.1. Beneficiaries of small-scale aquaculture

The rapid growth and expansion of aquaculture for both finfish and shellfish have taken place throughout the world. Aquaculture is regarded as having the potential to provide a valuable source of high-quality food in developing countries and to be integrated into the farming systems and livelihoods of the smallholder farmers in the rural areas (Peter Edwards & Demaine, 1997; Peter Edwards *et al.*, 2002; Harrison, 1997). The beneficiaries of small-scale aquaculture might be defined as an overlap in rural aquaculture and urban aquaculture literature (Fig.2.1). It is important to understand the difference between the two targeted beneficiaries in the general literature. *Rural Aquaculture* refers to benefit the poor or/and the poorest in the conventional agriculture systems. Whereas the former operates the aquaculture with very low cost and very low output which was mainly consumed by aquaculture producers, the latter of *Rural Aquaculture* was characterized by low/medium cost, and low/medium output whereby a large share of output was sold for economic profit (Ridler & Hishamunda, 2001). *Urban aquaculture* has proposed or attempted for entrepreneurs or the wealthier smallholders in urban or peri-urban areas. It is dedicated to producing commercially more sources of aquatic protein to meet the increasing demand on fish food required by millions of the migrated people moving from rural, inland areas to coastal cities (Bunting & Little, 2003; Lutz, 2005). *Small scale aquaculture,* as defined, might increase the resilience of the rural livelihoods in developing countries in Asia (Belton, 2013; Bhujel, 2012b; Shrestha & Pant, 2012; Townsley, 2013).

Regarding the contribution of aquaculture development, there has been lack of literature regarding a consistent theoretical framework and empirical evidence to evaluate the contribution of small-scale aquaculture to a rural economy. The small scale aquaculture has been introduced to become an alternative livelihood for economic improvements in the local economy in the Red River Delta of Vietnam(Van Huong et al., 2017). There are two strands of the literature linking small scale aquaculture with poverty reduction through the market-oriented production of aquaculture. The first strand has referred to the subsistent and/or semi-subsistence aquaculture. This strand has emphasized direct benefits that small scale aquaculture households might gain the benefits by cultivating aquaculture for home consumption and the sale of fish surplus to earn supplemental income through the application of low input technologies. This narrative has primarily presented in the work in relation to rural aquaculture and poverty reduction(M. Ahmed & Lorica, 2002; Peter Edwards, 1999; P Edwards et al., 2002). It has become a dominant argument in the literature since then; for example (M. Bondad-Reantaso & Subasinghe, 2013) and until so far e.g (Golden et al., 2016).

The second strand has belonged to the narrative of the aquaculture literature in relation to commercial production of small-scale aquaculture. This has stemmed from the semi-subsistence aquaculture through observing the empirical studies on aquaculture in developing countries. The rapid growth of aquaculture production in Asia and more recently in Africa has been prompted vigorously by the investment of the commercially produced farmers and the supports of the off-farm enterprises, the application of a mix of capital intensive, productive production with an acceleration of the advanced and sophisticated technologies (Belton et al., 2018; Belton & Little, 2011b; Hernandez et al., 2018). According to (Belton et al., 2012), in spite of the poor and insufficient resources to engage in aquaculture as the direct producers, the poorest farmers have enabled them to obtain benefits from the aquaculture sector through employment linkages.

While the literature on subsistent and/or semi-subsistent small scale aquaculture focuses on direct benefits derived from aquaculture farming by produces, the narrative of small scale commercial aquaculture production derives that impacts of aquaculture to poverty reduction is mainly indirect. These indirect benefits are effects from business opportunities and employment created both on- and off-farm. Such terminologies are not really convinced, however, this narrative reflects the logical arguments that have been referred to the growth linkages of rural nonfarm activity to establish a successful mechanism by which poverty is reduced (Haggblade & Hazell, 1989; Mellor, 1995).



Source: own elaboration

Figure 2. 1 The boundaries of small-scale aquaculture: rural aquaculture and urban aquaculture

In Asia, empirical studies on the contribution of small-scale aquaculture to rural developments in China, Philippines, Thailand and Vietnam were analyzed to identify two types (Type I and Type II) of small-scale aquaculture (SSA)(Pongthanapanich, 2013). In general, research results indicated a relative contribution to social capitals to improve fish producers' livelihood assets. Type I was referred to the traditional fish farming systems applying polyculture practices such as the integrated fish-mulberry tree in China, small plastic-lined pond based catfish in Thailand, and the Vuon-Ao-Chuong (VAC) in Vietnam (Luu, 2001; Qing, 2013; Vartak *et al.*). This traditional type provided a more balanced contribution to all livelihood assets for fish households. While Type II is defined as the modern commercial aquaculture production systems (e.g. current farming practices of tilapias and seaweed in the Philippines, shrimp finfish, lobster, and catfish farming in Vietnam) (Espaldon, 2009; Phan *et al.*, 2009) that contributed significantly higher to financial and physical assets for the rural producers. In particular, the rural households have been operating the freshwater aquaculture in the populated regions in Southeast Asia such as the Red River Delta of Vietnam.

The beneficiaries operating freshwater aquaculture in the empirical studies conducted in Asian countries is not well defined as the term 'rural aquaculture' and small scale aquaculture are used interchangeably. Initially(De Silva & Davy, 2010) defined small-scale aquaculture as the family-owned, managed and operated'. Later, the lexicon "leased" is added by De Silva, this definition is more developed into: 'family-owned or leased, managed and operated'. Although the ownership terminology of aquaculture operations has usually been not applicable in the (NACA) FAO document in 2005, it has been an important character of freshwater aquaculture operation when a study is carried out to evaluate economic benefits of fish farming in the agro—aquaculture system (Krishnan *et al.*, 2012; W. Yap *et al.*, 2006). In the perspective of the agro-aquaculture system, the economic contribution of small-scale aquaculture to rural households is required to clearly understand the aquaculture producers' aspirations, development options and developmental strategies as the characterizations of small-scale aquaculture which will be discussed in the following section.

2.2.1.2. Characterizations of small-scale aquaculture

Small-scale aquaculture (SSA) can serve as an entry to commercial aquaculture production. As considered to be small and less risky, small-scale aquaculture can be adopted easily by resource-poor farmers (Bhujel, 2012a). According to (Peter Edwards, 2013), it is necessary to consider the farmer hopes and aspirations, developmental options as well as aquaculture technology for systematizing the various characterizations of small-scale aquaculture.

Hopes and Aspirations

There has been a remaining fact that farmers and their families always seek to improve their living standards and have increasing hopes and aspirations. Their main concerns are that aquaculture would earn money and be profitable(Management & Reconstruction, 2001). The attractiveness of aquaculture is preferred to alternative livelihood options both on farms and off the farm. Aquaculture is likely to be only one of several income-generating activities for farmers at the smaller end of the SSA spectrum(Van Huong *et al.*, 2017). Small-scale farmers are increasingly electing to earn from non-farm livelihoods, either part- or full-time, as they are driven by rising aspirations and needs. They are also inhibited in agriculture by a default contracting as well as resource-poor base, unfavorable terms of trade, and a strong belief that farming is a low-status occupation (Rigg, 2004).

Many studies have shed light on the problem that the age of farmers is on the rise as more and more young people, in particular, leave the farm for alternative employment. It is reported that farmers do not want their children to turn into farmers due to the relatively low standard of living, based on resource-poor and small-scale farms. In particular, their children also wish to migrate to the city.

In the book of 'Raising and sustaining the productivity of smallholder farming systems in the tropics' decades ago (Beets, 1990) has described and predicted the "state of flux" and "the isolated subsistent farm"...hardly exists anymore. Regarding the shift from farmers' agricultural practices based on their resources, a range of agricultural products from diversified farming for home consumption to specialized production, of which only a few crops supplied to the market, may be the most noticeable phenomenon in tropical agriculture in the twentieth century. This prediction could be understood that millions of dispersed and independent smallholding farmers have become a large share of the regional or national economies. In a certain context, aquaculture nowadays may be incorporated with international economies or markets.

Home consumption of farmed fish through aquaculture by poor fish households is possible to be small due to the reason that their resource base is limited. However, such small amounts of high-quality food may be extremely significant to the relatively small economy of households overall. Also, the objective of fish production is to provide household food security or income becoming simplistic. Fish households tend to consume more fish, however, they can achieve food security through more complex strategies in which they may purchase cheaper fish for consumption by selling their farmed fish with higher value to meet their needs for cash, using fishes as a gift for social benefits and consuming fish products for their food security (D. C. Little *et al.*, 2007).

Development options

Oriented history

Aquaculture has unquestionably made a contribution to poverty alleviation in those countries in the world in which traditional practices have been being applied although it would be hard to provide proofs recorded in documents. However, the role of aquaculture in poor rural communities is documented in the past e.g. China (Hoffmann, 1934), Vietnam, Indonesia (Ilan & Sarig, 1952).

The initial attention to developing aquaculture through institutions, NGOs reacted to the growing awareness about the rapid growth of populations which placed increasing pressure on the existing systems of food supply production in developing countries. The shortages of animal protein and mineral sources in the food intakes of the British Empire's people was indicated and recommended that these deficiencies could be supplemented from fish(WORTHINGTON, 1943). A bright future for fish culture was predicted based on an ambitious vision to bring it to reality, more intensive research for developing appropriate technology was required. This initiative was delayed for more than a decade because of World War II, then a Fish Culture Research Station in Malacca was opened as the first research centre in the tropical region for the principal study of fish culture (Hickling, 1959).

The FAO report in 1949 had mentioned the "special mission" to the Thai fishing industry. The report claimed that "fish is of dietetic importance second only to rice". It also indicated that there was potential for increased production in both inland and marine waters through aquaculture even though at that time Thai fisheries were still in a 'primitive and unorganized condition' (FAO, 1949).

The first international symposium on the cultured fish in the warm-water pond held by FAO in 1966, the first in the history of the fish culture for more than 3000 years gathering workers in this field for discussion on a global basis, was the most urgent need in the developing countries to increase the alternative supply of animal protein(FAO, 1966). The recognition followed up for FAO projects to reiterate that "fish culture can form a valuable and integral part of farm homesteads and land and water development projects"(FAO, 1976). There was a hope that this symposium would offer the path to develop a more complete science of the warm-water pond fish culture which could do much to improve the economies of any countries and to alleviate the hunger and malnutrition status in many developing countries. The report also pointed out that the subsistent fish farming, actually serving its limited purpose, was still being extended to commercial fish production. One problem, however, was that while remarkable results have been achieved in fish farming in smallholdings, this progress has not kept pace with the incredible increase in population growth. The role of aquaculture in integrated rural development is now better understood in many countries and has been willingly accepted by planners, administrators and policymakers as a part of the integrated rural development. However, in the achievement of small-scale aquaculture, there is a need for available support services such as technical assistance, input and credit packages under reasonable provisions. Moreover, the introduction of aquaculture into the programs of integrated rural development will help to increase small-scale aquaculture enterprises in regions that benefit the maximum number of poor people.

Developmental Strategies

There is some literature on diversification as a livelihood strategy of rural households in developing countries. The diversification strategies are defined as the process by which rural families establish a diverse portfolio of activities and social support capabilities to survive and to improve their living conditions (Dixon *et al.*, 2001). These major farm household strategies to improve livelihoods are listed:

- Intensification of existing production systems
- Diversification of production and processing activities
- Expansion the size of farm or herd
- Increasing off-farm income, both agricultural and non-agricultural
- Off-farm jobs or complete exit from agriculture.

A mixed set of strategies is normally recognized to pursue by small-scale farmers because these strategies are not mutually exclusive. In other views, development has been conceptualized in different types and scales of structural change in entirely national economic conditions, and in people's evolving livelihoods for smallholding farmers (Dorward, 2009) as:

- “hanging in “as the importance of survival and coping strategy, which is hardly a sustainable option
- “stepping up” engaging in investments in assets to expand the scale or productivity of existing assets and activities – improve the farm productivity
- “stepping out” with an accumulation of assets to allow investments or switches into new activities and assets – exist the farm for alternative employment.

To reduce poverty successfully, only option two and option three are feasible for the development. The option two may engage in aquaculture and households may not always choose to culture fish instead of intensifying crops and/or livestock.

The option of ‘Stepping up’ that involves aquaculture can increase the productivity and/or profitability on-farm resource facilities for SSA are often poor; or small-scale farmers with limited access to the public, government or public water sources. The major constraints facing many poor farmers are the knowledge transfer “the knowing how to fish" that should specify the skill to organize, bargain collectively, expose misappropriation and get corrupt officials off their heads (Black, 2007).

'Stepping out' is the strategy which has been increasingly followed by small-scale farming households, especially in developing countries where the off-farm employment opportunities domestically or abroad are available either part-time or permanently. Therefore, agricultural production has declined compared to other sectors of the economy as the development process of countries would move a large part of the farming population into other livelihoods (Hazell & Wood, 2007).

It is noticeable that aquaculture needs to be considered in a broad developmental perspective. It should not only promote the poor's livelihoods of farming systems via small-scale aquaculture and be also recognized by the World Bank report (World Bank, 2007a).

Although the small-scale aquaculture in the IAAS provides small contributions of food security to the whole economy, those small contributions are very important and significant towards the nutrition and income of the relatively poor households living on farm livelihoods; they also provide an almost risk-free safety mechanism through which farmers might gain aquaculture experience before deciding if they wish to continue developing the production more intensively and profitably through use of off-farm inputs i.e. the initial stage of intensification for farmers interested in expanding the aquaculture as a main livelihood.

The IAAS has described with the greatest potential since the land-based culture systems in the inland areas could be integrated with existing farming activities of smallholder farmers (P Edwards *et al.*, 2000).Currently, the success stories of aquaculture development in Asian countries have posed this statement into qualified context to refer to indirect integration with pond-based aquaculture integrating with agricultural by-products such as bran and oil cakes and manure available generated from intensive livestock feedlots at the locality. The indirect integration has appeared because small-scale farms are normally limited or shortage of the on-farm resources which hamper maintaining the direct "integration" of IAAS. Regarding the potential for indirect IAAS, there was clear evidence that millions of smallholders in Asian developing countries and Africa have adopted the semi-intensive, primitive production-based aquaculture and culture-based fisheries. And small-scale farmers need to purchase off-farm inputs as their farms usually do not have much available resource base to operate a relative scale of fish production.

The SSA is acknowledged to be appropriate to fish species with the low food chain as these species use commonly natural feeds available in the pond environment, which is an environmentally sustainable farming and has potential for organic aquaculture. However, most of the subsistent SSA has a low production which has reduced the importance of aquaculture contribution to farm livelihoods. Therefore aquaculture would be a socially and economically sustainable farming.

2.1.2. Definition of small-scale aquaculture

In 2010, at the Nha Trang workshop, FAO experts have raised a definition of the small-scale aquaculture as:

a) Systems involving limited investments in assets, some small investments in operational costs, including large family labor and in which aquaculture has just one of several enterprises (referred to Type 1 as mentioned above in the "section 2.1.1.1"); and

b) Systems in which aquaculture is the principal source of livelihood, in which the operator has invested substantial livelihood assets in terms of time, labor, infrastructure and capital (as attributed to Type II of SSA system)"

Follow this definition, both Type I and Type II are characterized by three common components: (1) ownership of or rights to use an aquatic resource; (2) family ownership or communal properties; and (3) the relatively small size of landholding (M. Bondad-Reantaso & Subasinghe, 2013). The definition also identifies some characteristics which are attributed to the two types representing in table 2.1. Thereby, the type I of the SSA which is to determine the aquaculture produces of which fish production mainly for home consumption with small income generated from fish. The SSA of the type II is more invested and intensified the aquaculture production for better returns to improve the on-farm income of fish producers.

Table 2. 1 The typical characteristics/attributes of small-scale aquaculture

Characteristics	Small Scale System	
	Type I	**Type II**
Mostly based on family labor	X	X
Informal management structures	X	X
A certain degree of vulnerability	X	X
Often limited access to physical and technical resources	X	X
Limited technical expertise	X	X
Limited investment	X	
Usually limited value of sales	X	
Low household income	X	
Mayor may not contribute a significant proportion of total household income	X	X
Contributes to the family food supply	X	not necessarily directly

Source: Adapted from (M. G. Bondad-Reantaso, 2007)

However, the definition of SSA is applied to this study which is necessary to develop to cover and take into account different characteristics and scale of the SSA in the study areas. Although the above-mentioned definition of the SSA has addressed five key points to identify and classify the aquaculture producers in the previously empirical studies (Peter Edwards, 2013), it is not really appropriate to apply to this study. First, it does not address the boundary between small and large-scale aquaculture. Regarding the term of SSA as identified from rural aquaculture and urban aquaculture as discussed in the section 2.1.1 above. In addition, it should be clearly defined and separate the SSA from medium to large-scale aquaculture. Second, the definition in the workshop has mentioned the term ‘operator’ which has not distinguished between an ‘owner operator’ and a ‘hired operator’. While the ‘owner operator’ is normally characterized by a small-scale farm, a ‘hired operator’ is for an off-farm or metropolitan investor or entrepreneur who generally operates a medium or even large-scale farm (Peter Edwards, 2013). Third, the list of typical characteristics accompanying the definition of SSA such as “limited investment”, ”usually limited value of sales” and “low household income” does not necessarily apply to Type 2 of the SSA. These features also do not apply to medium- and large-scale aquaculture farms or enterprises. Fourth, the Type 2 of SSA mentioned in the definition was referred to the term of “mostly based on family labor”, it does not specify the upper limit of hired labor for this Type. Fifth, there is no reckoning of prominent concepts in the terminology of development concerning small and medium enterprises (SMEs). SMEs’ small-scale aquaculture could cross over the conceptual gap between the larger with more commercialized small-scale farmers and medium, large-scale aquaculture (Peter Edwards, 2013).

Moreover, the location (inside and outside within villages - residential areas) of small-scale aquaculture and degree of integration to other farming enterprises/components such as livestock and horticulture are noticeable features to be taken into account when the study is carried out in some regions such as Vietnam. This is because the aquaculture has been very diverse, complex and dynamic since it was introduced and developed in the Red River Delta of Vietnam. Particularly, the culture practices of fish in the agro-aquaculture system have been commonly known as the so-called small scale VAC integrated farming system in the region (Ngoc & Demaine, 1996; Pant, 2002). This VAC model has also been well acknowledged to be very diverse and dynamic in the aquaculture subsector in Vietnam (Peter Edwards, 2010).

Thus, the definition of the small-scale freshwater aquaculture applied to this study should be much more paid attention to farm categories such as location, integrated levels between farm components, scale of fish production, economic contribution and other practices related to fish cultivation. Those characteristics of small-scale freshwater in the study areas will be investigated and drawn some main characteristics. The economic efficiency of fish production should be evaluated to understand the economic contribution to the fish households’ total on farm income. Thereby, farm categories from the integrated level of very low input with available farm by-products utilization in fish culture to the integrated level of high input used off farm materials in aquaculture production, covering both inside and outside village and other characteristics are added (table 2.2).

Table 2. 2 Classification of small-scale aquaculture by farm categories

Small scale aquaculture	Very low input aquaculture - intensive orchard (Traditional VAC model)	Low input aquaculture-intensive orchard (New VAC model)	Medium input aquaculture-semi-intensive orchard (Animal + Fish production—AF model)	High input aquaculture-extensive orchard (Commercially intensive fish production—FS model)
Scale	Relatively small	Small	Small/medium	Medium/large
Market orientation	Subsistence and/or local	Local/district	District/urban	Urban/national
Investment	Low	Low/moderate	Moderate	Moderate/high
Ownership	Family-owned & operated	Family-owned & operated	Family-owned & operated	Family-owned & operated or absentee owner
Labour	Family	Family & possible occasional hired	Family & occasional hired	Permanent labour
Organisation	Minor activity in a portfolio of livelihood options	One of a portfolio of livelihood options	Primary livelihood activity	Primary livelihood activity or entrepreneurial investment activity
Location	Inside village	Outside village	Outside village	Outside village
Integrated Levels between SubSystems	High with closed available nutrient flow of food	High with closed nutrient flow of food	Medium	Low with more external supplement of food flow
Farm Household Situations	Experience in aquaculture production, prevalence of rice production	Less experience in aquaculture production	Experience in aquaculture and animal production	Experience in aquaculture
Animal Husbandry	Small or medium livestock production	Medium livestock production	Large livestock production	Very small livestock production
Horticulture	Medium gardening	Medium/large gardening	Small/medium gardening	Very small/small gardening

Source: adapted from (Peter Edwards, 2013)

The table 2.2 is presented the characteristics of the small-scale aquaculture producers in the study which can be defined into four main types based on the main components (gardening, aquaculture, and livestock) of a VAC ecosystem in which fish production will be focused to examine the economic contribution to the rural farm households operating small scale aquaculture. This classification can be incorporated with the type I and type II defined by(Pongthanapanich, 2013). The small scale aquaculture producers are likely to be attributed to four types as follows:

• Relative small-scale aquaculture (excluding the better-off running SSA for hobby or entertainment) or traditional VAC model is usually referred to as the type I.

• Small scale aquaculture or New VAC model is attributed to type II.

• Small/medium small scale aquaculture or AF model is considered as Type II.

• And medium/large aquaculture or FS models are involved with the type II.

2.1.3. Advantages of small-scale aquaculture

There is no doubt that small-scale aquaculture has several advantages over its large-scale counterpart in contributing to local food and nutritional security and the livelihood of rural populations. The major ones will be presented in the following sections.

2.2.3.1. Utilization of locally available resources

Small-scale aquaculture is more efficient in using locally available resources, such as small water bodies, homestead land, family labor, and cheap household feedstuff than large-scale operation (Emokaro & Ekunwe, 2009). This type of aquaculture usually does not create many adverse impacts on the environment and is more sustainable, though its economic sustainability may not always be sound. Adoption of simple technology and easy management scheme small-scale aquaculture usually employs simple technology and hence is easy to manage. Therefore, it is relatively easy to get started with and operated by small rural households/communities with poor knowledge and skill.

Small-scale aquaculture can prominently be recognized in the Integrated Agriculture Aquaculture System (IAAS) in which the utilization of locally available resources is effectively applied. The operation of aquaculture could improve the nutrient-poor environments of the current farming systems although it requires a supply of nutrients to support significant yields (Hambrey & Moehl, 2006). On smallholder farms, these inputs are available mostly in the form of wastes from crops or animals. As a component of an integrated farming system, aquaculture also plays a role as a provisioning source of inputs to other farm components. By-products of aquaculture such as enriched wastewater and sediments can be used as inputs for other agricultural activities (Peter Edwards, 1998).

The interactions among farm components were analyzed in different methods (Mark Prein, 2007). These methods take into account every single interaction as a flow of nutrients, energy or mass, and thus, budget analysis is usually performed (Dashu & Jianguo, 1995; Ruddle *et al.*, 1986). In the 1990s, the flow diagrams of bio-resources were commonly used as a tool for the study of interactions (C

Lightfoot *et al.*, 1994). However, they did not consider the external flows that enter or leave the farm, such as commercial feed, inorganic fertilizers or products for sale. Consequently, all flows are taken into account in the later developed approaches. Generally, these approaches explained the technical effectiveness and efficiency of the flows through a set of indicators by using ECOPATH software (Dalsgaard *et al.*, 1995; Dalsgaard & Oficial, 1997; Phong *et al.*, 2010).

In IAAS, the on-farm crop and animal wastes are used to fertilize the pond. The aim of the pond fertilization in aquaculture is to stimulate pond primary productivity, in this way, to supply natural foods for cultured organisms. Pond fertilization is to increase the production of bacteria, phytoplankton, zooplankton, and benthos which help to enrich a source of protein for fish, especially in their early stages of development in the pond environment (C. Lin *et al.*, 1997). The IAAS is mostly crop-dominated, but it also includes livestock husbandry and non-cultivated areas such as pasture, woodlands. For instance, a typical farming system in South East Asia comprises rice as the main crop, with other enterprises occurring on the farm such as annual and perennial crops; a mixed garden around the homestead for fruits and vegetables, grass-fed cattle, and scavenging pigs or poultry (Devendra & Thomas, 2002; Peter Edwards *et al.*, 1988). The farming diversification in these farms are usually a strategy of risk spreading, which leads to many decisions in family agricultural systems (Altieri, 2002). These strategies would more discuss in the following paragraph

2.1.3.2. Integration with other agricultural practices

Small-scale aquaculture can easily be integrated with other farming activities, such as crop cultivation, poultry livestock, and horticulture, which not only minimize the production costs and create more efficient utilization of the resources but also enhance the resilience of rural livelihoods through diversification.

The introduction of aquaculture into current agricultural systems is being proposed to develop as a sustainable alternative strategy for the future production system of food (Choo *et al.*, 2005; Kiers *et al.*, 2008; Pretty, 2007). The amalgamation of aquaculture and agriculture helps to create the synergies between farm components. According to (Peter Edwards, 1998)), synergies take place when “an output from one subsystem in an integrated farming system which may otherwise have been wasted turns to input to another subsystem bring on greater efficiency of the output of desired products from the land/water area under the farmer’s control”. The definition of Integrated Agriculture Aquaculture Systems (IAAS) is common to identify as the concurrent or sequential linkage between two or more farming activities, of which at least one is aquaculture (D. Little & Muir, 2003). In general, IAAS has been called base based on their components combination, i.e. rice/fish, pig/fish, poultry/fish, vegetable/chicken/fish or multi-component farms with three or more linked elements. The typical characteristic of the interaction of the components is that animal manure and crop wastes are used as compost and feed, respectively, for fish ponds (M Prein, 2002). The application of these synergies in an appropriate technology would diminish the necessity of externally supplemental inputs, thus, total farm productivity and profitability would be increased in an ecologically sound manner thanks to raising in resource-use efficiency (Management & Reconstruction, 2001).

2.1.3.3. Low initial investment and operational cost

Simple culture infrastructure and production inputs are characterized by small-scale aquaculture. These characteristics enable the small-scale aquaculture to reduce the initial investment and operational cost to be considerably low in comparison with large-scale counterparts. This enables the smallholding farmers to start aquaculture production with a very small investment and also minimizes the potential economic risk of the enterprise.

In many developing countries, most smallholder farmers’ operations take place under conditions of low external input agriculture (Smaling, 2002). This condition leads to on-farm diversification and integration becoming a common strategy towards the survival of farming households (Alayón-Gamboa & Gurri-García, 2008; Rufino *et al.*, 2009; Tipraqsa *et al.*, 2007). There are more than 60 percent of aquaculture products produced from Asia and about 90 percent are from small-scale aquaculture (SSA) based on fish farms size of less than 1.0ha. The fish farms are generally operated integrated farming systems (FAO, 2006). As the key role of the integrated farming systems, the aquaculture component is interested in the concern for natural resource management by recycling nutrients in form of wastes and by-products to reduce the dependence on the purchased inputs such as inorganic fertilizers or pellet feeds. This enables the resource-poor farmers to participate in small-scale aquaculture (Dalsgaard & Prein, 1999; CLIVE Lightfoot, 1990; Clive Lightfoot *et al.*, 1995).

There are some studies in Bangladesh supporting the evidence that the very small scale forms of aquaculture were adopted by the poorest farmers. For instance, tilapia seed production in rice fields, the sale of fish could provide the poor farmers ‘source of cash income to purchase more necessary items (Haque, 2009). Furthermore, the homestead carp pond is very common in rural areas of Bangladesh where rice cultivation is their principal livelihood activity. For these households, the introduction of aquaculture as a new enterprise offers a pathway of agricultural diversification. It is a fact that the semi-subsistence homestead pond based aquaculture is not possible to become more commercially large scale forms due both to constraints (most importantly limited land and capital) and disincentives to intensification (the limited opportunity costs)(Belton *et al.*, 2012).

2.1.4. Prominent practices of small-scale aquaculture in Vietnam and Asia

Small-scale aquaculture has been practiced for a long history in Asia. There has been considerable progress in its development in the region during the last decades. Many appropriate farming systems and practices have been developed for different natural and socio-economic conditions. Although there are not many studies on these systems that are considered to view as the concept and goal of small-scale aquaculture, the small-scale aquaculture, however, can be seen from the following systems:

2.1.4.1. Integrated paddy-fish culture

The paddy-cum-fish culture can be practiced at paddy fields in which remain waterlogged for about 3 to 8 months throughout the year around (Haobijam *et al.*, 2016). It is likely to increase farmers' income through providing more focus on low-cost technology and appropriate management practices of more effective extension to the poor people and properly providing the right of access to land resources, rather than technical research (Peter Edwards, 2002). (Okoye, 2004)pointed out that fishery resources play a major role in maintaining the livelihood of the rural poor in Asia. Fish-rice farming has been for a long time in Asia (Rabbani *et al.*, 2004; Tasnoova *et al.*, 2008). The integration of fish into the current agricultural system would create an extremely important protein for the subsistence farmers, especially for the rain-fed agriculture system. Fish provided more than 50% of the animal protein available in many Asian countries. The rice-fish system creates a typical agro-landscape in many countries across the world, especially in Asian countries such as China, Thailand, Philippines, India, Bangladesh and Indonesia (Lu & Li, 2006). (IDRC, 1998) indicated that the rice-fish system cultivation provides not only more protein available for people but it also increases the actual rice yield (up to 10% in some cases) which created additional income for the farmers.

The actual practice of fish-rice culture is relatively inexpensive and low-risk. (Saikia & Das, 2008) reported that rice-fish farming under either capture systems or culture systems in low-cost are sustainable farming practices. By utilizing locally available resources, traditional rice-fish farming can be turned into a low input close recycle system if the appropriate location-specific modification of packages of practices is achieved. (N Ahmed & Luong-Van, 2009)reported the resource optimal is achieved in the integrated production of rice-fish culture through the complementary utilization of land and irrigation water, especially in the rural tropical areas of less developed countries. It contributed the benefit to provide rice for the source of the carbohydrates and fish as a source of high-nutrient protein (Frei & Becker, 2005). It can reduce the lower costs of the farmer's economic conditions and increases in their additional income from the fish sale as the achievement at the farm level since rice-fish integration reduces the use of fertilizers, pesticides, and herbicides in the farming activities(Nesar Ahmed & Garnett, 2011; Niyaki & Radjabi, 2010; Noorhosseini, 2010).

Integrated rice-fish farming also provides higher rice yields and gains a higher gross margin than a single rice cropping system (Das *et al.*, 2002). There is a lack of various new modern farming techniques of the rice-fish system in the most practical area of rural sectors of the world where these techniques are very necessary to be spread. Many reports proved and suggested that integrated rice-fish farming is ecologically sound as fish improves soil fertility by increasing the availability of nitrogen and phosphorus (Nesar Ahmed & Garnett, 2011; Nesar Ahmed *et al.*, 2011; M. A. Rahman *et al.*, 2002). Developing the fish in the paddy field is an ancient traditional farming practice which was found in numerous rice-growing areas of the world and as well as in the northeastern states of India. However, the higher uses of organic fertilizer and chemicals in the paddy field for the recent period make the survival and practice of fish in the paddy field become almost devastated. In a densely populated country like Vietnam, where the per capita availability of land and water resources is declining day by day, there is an essential need to have a vertical growth in food grain production without endangering ecological assets. Therefore, an integrated farming system along with fish can provide both food security and generate rural income to farmers and livelihood security to the rural workforce on an economically sustainable basis.

Paddy culture is one of the most important traditional rural livelihood activities in Vietnam and Asia. There are vast areas of paddy fields that are suitable for integrated paddy-fish practices. Fish and other aquatic animals can synchronously or alternately be integrated with rice cultivation. Such integration can significantly reduce the production costs in both rice production and fish farming through a symbiosis which minimizes the feed requirement for fish, and fertilizers, herbicides, and pesticides for paddy. There are varieties of aquatic animals that can be integrated with paddy cultivation. They are different herbivorous and omnivorous fish and freshwater prawns and crabs. Major requirements for successful paddy-fish production include limited investment (basically labor) for modification of paddy fields, the supply of good quality fish seed, limited supplementary feed, good water, and pest management schemes.

2.1.4.2. Cage culture in rivers, lakes, and reservoirs

Cage culture is an aquaculture production system where fish are held in a floating mesh enclosure. Cage culture of fish utilizes existing water resources but encloses the fish in a cage or basket which permits water to pass freely between the fish and the pond allowing water exchange and waste removal into the surrounding water. Cages in freshwaters are used for growing fish farming and for fry to fingerling growing. The origins and history of cage culture are a little vague. It can be assumed that at the beginning fishermen may have employed the cages as maintaining structures to store the captured fish until they are sent to the market. The first cages which were used for producing fish were developed in Southeast Asia around the end of the 19th century. People used wood or bamboo to construct these ancient cages and the fish were fed by trash fish and food scraps. In the 1950s, modern cage culture began with the beginning of production that made synthetic materials for cage construction. The cage culture has become highly popular among small or limited resource farmers who are seeking alternatives to traditional agricultural activities.

Fish production in cages along rivers, lakes, and reservoirs is another suitable system for small-scale aquaculture in remote and mountainous areas. This system does not require land resources and just uses the additional service of open water bodies. It is very flexible to have an operation scale according to the capital affordability of the households. Construction of cages usually costs less than land-based culture infrastructure. The fish species are also diversified; however, filtering and herbivorous fish species are among the best choices. At the preliminary time, production was normally solely dependent on the plankton of the water body. Over time, it has been enhanced by the application of locally available supplementary feed, such as aquatic weeds, terrestrial grass, and byproducts from grain processing and pellet feed. In many areas, the cage fish production is very successful to provide a large volume of fish, especially a supply of large-sized fish seed. Cage is also designed and manufactured well.

2.1.4.3. Pond fish culture integrated with other agricultural livelihood activities

The history of pond-based integrated fish farming began about 2,000 years ago in China. Such traditional farming practices still completely fit into the present models and applied for small-scale aquaculture development. Those models really are considered as small-scale aquaculture systems such as poultry-fish, crop-fish, sericulture-fish, horticulture-fish and green fodder fish, etc. Although a majority of the models are not similar in the practical, they all develop based on the crucial principles such as minimization the production cost; highly utilization of resources and inputs; more social and economic efficiency and maintaining the ecological concerns through reducing and recycling the agricultural wastes and by-products in the production cycle.

In Vietnam and Asian countries, smallholder farmers generally depend on subsistence farming that produces a balance of food and cash for their basic requirements. The single crop production systems normally associated with different types of risks, vulnerabilities, and uncertainties which are mainly the concerns to the variations in income and employment. Therefore, appropriately integrated aqua-farming systems need to be explored and performed(Al Mamun *et al.*, 2011). Aquaculture plays the most important role in integrated aquaculture farming. It is well combined with other agricultural livelihoods such as livestock, vegetable cultivation. The high-quality organic food and renewable energy can be easily found in the integrated aquaculture farming system. The basic principles of the operation such systems are the optimum of wastes recycles and diversification of on-farm income (Al Mamun *et al.*, 2011; Becker *et al.*, 2012; Gill *et al.*, 2009; Morris & Winter, 1999; Rana & Chopra, 2013). The terminology of Integrated means synergistic cultivation that covers different types of plants and animals to grow in the same production base maximizing the natural nutrients and energy. In the aquaculture production system, the combined types of fish species are applied to maximize the yield and income. The farming diversification not only provides more profit for producers but also creates more employment at the household level (Chopin, 2010; Troell, 2009; Troell *et al.*, 2009). The fundamental principles of the integrated farming system include the utilization of interrelated farm resources such as farm wastes. In integrated aquaculture farming, nothing is considered as waste because the so-called waste of any trophic level is used as a valuable resource for another production system (Crissman & Antle, 2013; Doorenbos & Pruitt, 1977; Habib, 2008; Nabi, 2008). Integrated aquaculture farming system highlights the mutual benefits from different farming without causing damages or threats to the environment (Al Mamun *et al.*, 2011; Becker *et al.*, 2012; Gill *et al.*, 2009; Morris & Winter, 1999). In Vietnam and Asia, conventional farming has been long practiced, however, the integrated farming systems have been recognized to be more sustainable and profitable systems of food production(Nesar Ahmed & Garnett, 2011). The integrated agricultural aquaculture system could be the measures for the issues of the agricultural projection such as incomes, nutritional improvement and environmental protection (Nesar Ahmed & Garnett, 2011; M. Islam *et al.*, 2013).

2.2. Empirical studies on the marketing of agricultural and aquaculture products

2.2.1. Marketing channels of agricultural products

2.4.1.1. Marketing of agricultural and fish products

According to (Gebremedhin *et al.*, 2012), agricultural marketing refers to the performance of all business activities which convey the flow of food products and services from producers to consumers. Therefore, marketing ensures that products are available for consumption viz.

- in the right place
- in the right form
- at the time needed by consumers and users
- whenever possible, at the needed quantity and quality.

Agricultural marketing may cover some sequential activities which include drying, cleaning, sorting, grading, processing, packaging, labelling, transporting, storing, advertising, and selling. The products can be added values from those activities via the performance of the producer and/or middlemen in the marketing chain.

When agricultural marketing is defined as the identification of customer needs and satisfying those needs at profit, agricultural marketing is more than just trying to sell what is produced(Crawford, 1997; Eskola, 2005). It is important that what should be produced and sold for a remunerative price. The customers' needs, wants and preferences should determine for the sake of production. The questions of "how", "where" and "when "should be addressed for farmers and other participants in agricultural marketing. This definition is particularly important in the context of the transformation of subsistence agriculture into market orientation. When farmers participate to produce market-oriented products, it means that they have to analyse the market demand to find out exact products and services that can satisfy the identified needs and demand. They also have to market and promote such products and services in an appropriate manner to make a profit. Thereby, the importance of agricultural marketing includes:

- creating new demand
- activating existing demand (e.g. through a promotion)
- transforming farm products (to meet consumer preferences)
- encouraging farmers to use new production opportunities
- promoting innovation in response to market signals (demands and prices)

(M. J. Alam *et al.*, 2010; Ali *et al.*, 2014; Piumsombun, 2001)defined an effective marketing system is to make fish available to consumers concerning market demand with the right time and the right place. Fish farmers in Bangladesh normally do not sell their fish in retail markets. Several intermediaries may approach to buy the fish from fish farmers. The authors also described that fifty-five percent of fish sellers trade the fresh fish in rural primary markets, 17% deal in live fish, and sale of dry fish accounting for 7%. Some small, fresh fish vendors may be the fishermen themselves, who sell directly to the consumers or the collector traders. To sell the fish in the market or open places near the fish market, these vendors had to pay very high tolls to extortionists. As a consequence, transaction costs for selling fish in the market were very high. The competition in retail markets was reported to be higher than in any other kinds of market. Price settings were shaped by the direct interplay and interactions of demand for and supply of fish in retail markets.

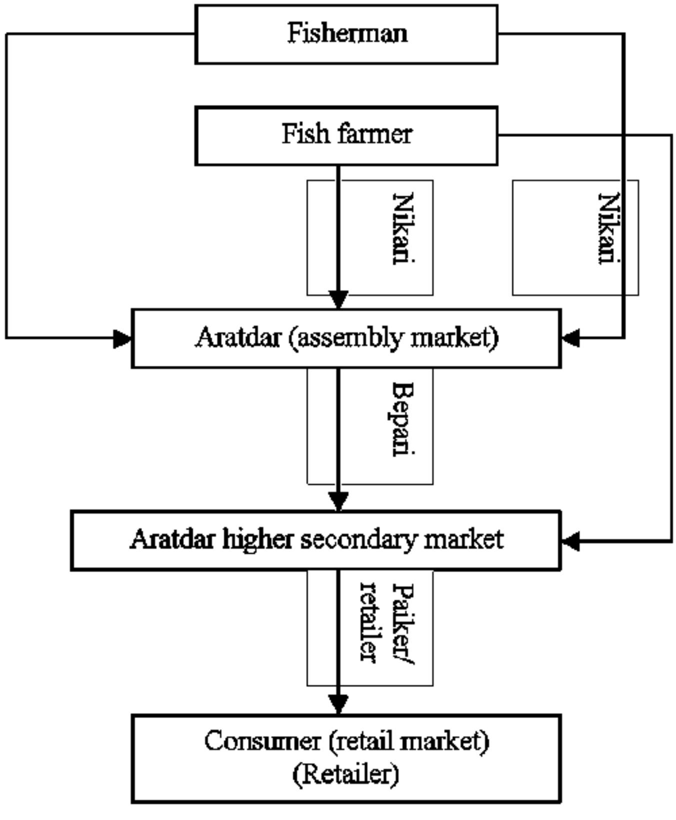


Figure 2. 2 Domestic marketing channel in Bangladesh adapted to (Piumsombun, 2001)

The market at all levels has a retail arrangement based on a group of retailers who sell fish directly to consumers. In major cities such as Dhaka, Chittagong, Khulna, and Rajshahi and district towns, city authorities or municipalities manage the retail market. In general, the conditions of markets in urban and rural retail are inadequate in terms of stalls, parking lots, distance, sanitation, drainage, and management. Bargaining, in terms of eye estimation, is still a popular way of setting price fish. Strict sorting, grading, and price tagging are ignored in retail. The product quality and standardization for complete weighing are not obligatory. In such situations, fraud and exploitation are inevitable. Reasonable prices based on the level, size, origin, and freshness of fish may not have been possible without the standards of marketing practices and the lack of enforcement of legal authorities. As a result, access to the market is restricted to a weaker part of the consumer's economy, the marketing channel as figure 2.3.

In India, the marketing system of fresh fish involves some intermediaries with different functions such as an auctioneer, commission agent, wholesaler, retailer, and fish vendor. The length of intermediaries involved and distribution channels vary from region to region, part to part in the country. Setting prices for fresh fish depends upon the quality and harvesting season. A positive correlation between prices, demand, and imbalanced supply were observed (Trondsen, 1997). The major problems and challenges in fish marketing in India include high perishability and bulkiness of materials, high cost of storage and transportation, no guarantee of quality and quantity of commodities and high price spread (Ravindranath, 2008). Fish marketing in India, which has received little attention from public sectors, is mainly handled by the private sector. As a result, the marketing channels were involved with a wide range of intermediaries, especially in the freshwater fish subsector; hence the share of fishermen/fish producers in consumer price (retail price)reduced significantly and caused retail prices higher(Ravindranath, 2008). Although fish production was obtained a considerable achievement, the fish marketing system was very poor and highly inefficient in India (Kumar *et al.*, 2008)

2.2.1.2. Participants in the marketing channels of agricultural and fish products

Market participants in the marketing system are described as all the people involved in the production (farmers), distribution (intermediaries), processing (processors) and consumption (consumers) of the commodities(M. F. Alam *et al.*, 2012). These market intermediaries are involved in the process of the transformation of the agricultural product from the point of production to consumption. Market intermediaries or ‘traders’ are the people who involve conveying a product from the producers to final consumers. Farmers do not usually sell directly to consumers. Most often, farm products go through several intermediaries before they reach consumers. The market intermediaries (traders)—play important roles in the flow of the products from producers to consumers because(Gebremedhin *et al.*, 2012):

• Consumers and markets are normally far away from production areas and products need to be transported, even long distances.

• Agricultural/aquaculture production is usually seasonal while consumption is year-round. Thereby, many agricultural/aquaculture products need to be stored.

• The farm products are not always in the form that is acceptable to consumers. It required extra activities after post-harvest such as handling and/or processing (cleaning, sorting, grading), which help to provide the produce for consumers in acceptable forms and right quantities.

The market intermediaries can be classified into some categories. Each would perform one to several different functions in the marketing system. Below is a characterization of some of the most important market intermediaries in a typical agricultural and/or aquaculture market.

• Mobile collectors

These are small and very mobile traders who visit villages and rural markets. Their sellers are village bulking agents or scattered farmers. The mobile traders then bring their goods back to higher markets to sell to assemblers, wholesalers or retailers. These travelling traders rarely make storage for more than a few days. They are opportunistic and diversified traders who, in many cases, deal with a wide range of agricultural products. Their involvement in agricultural marketing is often seasonal and they can also engage in agriculture and other activities. They operate with limited capital, trade small volumes at a time and use very simple means of transportation, such as bicycles and motorbikes. In more remote regions, there may be more local people involved in collecting products as the local bulking agents. These are common in areas where farmers and markets are poorly organized.

• Assembly traders

These are sometimes referred to as primary wholesalers. Their suppliers are farmers and mobile collectors and their buyers are wholesalers. They conduct the main function of the marketing system in terms of gathering produce for sale to large traders who do not have the time and capacity to carry out small purchases from dispersed producers and collectors. However, in some cases, they may also supply local retailers and distant retailers as well. Assembly traders are normally based in rural markets or towns. They may own or rent small storage facilities and means of transportation such as motorized transport vehicles, trucks...

• Commission agents

These are individuals or organizations that undertake the responsibility of marketing on behalf of the traders. They get their income or profit from the charging based on weight or value of products which are managed to market on behalf of the trading owner.

• Wholesalers

Wholesalers are very flexible and vary in the size of their operation. The typical characterization is that they normally deal with larger volumes than collectors and assemblers. The storage function is more important for them. Generally, they possess or rent medium to large modes of transporting for agricultural products such as vehicles, trucks... They also own or rent medium to large-size storage facilities, which allows them to maintain their sales at certain times. The supply of these traders enhances markets with a significant concentration of retail outlets and consumers, i.e. large towns and cities. Sometimes, they may buy products from farmers and collectors, but tend to rely on assembly traders and other wholesalers as the main source of supplies. The main buyers of the wholesalers are other wholesalers and retailers.

• Retailers

The retailers keep a main role in the dissemination of the products to consumers. They undertake the function of offering products supplies in requested forms and at the right times and the most convenient to consumers. Retailers are very diverse in size and operation from small kiosks and hawkers or roadside vendors who sell small volumes of a limited number of goods as compared to modern retailers such as hypermarkets, supermarkets that deal with a wide range of agricultural products. In between these two extremes of retailers, there are many village stalls and small town or city shops that sell various goods. However, these retailers generally do not keep sizable stocks of goods and products. Some retailers specialize in specific product categories, whereas others have a more diversified product portfolio of fresh, dried, processed and frozen products.

2.2.2. Marketing channels of fish products

In northern Vietnam, agriculture in general, aquaculture, in particular, was practised mainly on a subsistence basis; the villages were self-sufficient, people exchanged their commodities, and services within the village (IKEGUCHI, 2007). With the development of means of transport and storage facilities, agriculture has become commercial; the farmer produces diversified commodities that get a better price. One of which, marketing of aquaculture products is considered as an integral part of agricultural marketing since the rural farmer is encouraged to make more investment and to increase production. Consequently, there is an increasing awareness that it is not enough to produce an agricultural commodity; it must be marketed as well as agricultural marketing involves in its simplest form as the buying and selling of agricultural products (van Anrooy, 2003b). This definition of agricultural marketing may be accepted in a preliminary time, when the village economy was somehow self-sufficient, when the marketing of agricultural products presented no difficulty, as the farmer sold his surplus directly to the consumer on cash or barter basis. Currently, the marketing of agricultural produce is different from that of ancient days. In modem marketing, the agricultural product has to undergo a series of transfers or exchanges from one hand to another before it finally reaches the consumer (Rajendran & KARTHIKESAN, 2014).

The agricultural marketing system of any commodity is determined by factors such as the scale of market participants, product characteristics, grade and standardization, and market information. In the case of a fish marketing system in developing countries with a growing aquaculture development, it is characterized by a large number of producers (small-scale aquaculture) and small traders or middlemen. In these regards, the fish marketing system in Bangladesh is a clear example to underpin how systems are implemented and developed in developing countries (Qatan, 2010).

The fish marketing in Bangladesh is almost entirely managed, financed and controlled by a group of powerful intermediate market operators. The marketing channels from fish farmers to consumers encompass mainly primary, secondary and retail markets, involving sales agents, suppliers, wholesalers, and retailers. Fish farmers are the primary producers in the fish marketing chain. With a few exceptions, fishermen never communicate directly with wholesalers, retailers, and consumers. Only around 1% of the fish is sold directly from fishermen or fish farmers to retailers and consumers (M. Rahman *et al.*, 2009).

Farmers tend to sell their fish at the landing centres (primary or local markets) to suppliers with the help of commission agents. The commission agents play a major role in the fish marketing system at primary markets (Nesar Ahmed & Sturrock, 2006). The price of fish is affected by the seasonality of production, and weather conditions, and which influences the quantity of the product available on the market. Price varies from market to market due to a larger concentration of consumers and better family incomes (Nesar Ahmed & Sturrock, 2006; Briones *et al.*, 2004)

In African countries, fish marketing channels are paid much attention to developing for smallholder farmers such as Nigeria. A large amount of literature and studies are focused to reveal the effects and importance of fish marketing channels which are described as the path of a commodity from its primary form to the finished product or the path of a product as it moves from the producers to the final consumers. In other words, it refers to a set of individuals, participants, players or organizations which facilitate the transferred fish as they pass from the fishermen to the final consumers (Ezihe *et al.*, 2014). These participants are also known as intermediaries. The intermediaries of marketing channels are involved in providing various functions that may or may not change the form of fish before it gets to the final consumer such functions include providing services of processing, preservation, packing, transporting.

In the distribution channel, it is noteworthy of importance for a group of powerful intermediaries who participate in the transferring flow of commodity and property rights from the producer to the final consumers. Each intermediary participates in the chain to form a level in the distribution channel and decides the channel length (Szopa & Pękała, 2012). (Olowa, 2015b), depicted the classes of middlemen include farm-gate middlemen, the commission agents, cooperative marketing agency, the wholesaler and retailer. In developing countries, marketing and distribution channels play an important role in the process of transfering produce from production to ultimate consumers due to multiple urban centres. The role of middlemen is sometimes perceived as the cause of increasing the prices of food in the market. This has led to the concerns that middlemen should be removed from the marketing channels (Olowa, 2015b). Generally, two major types of distribution channels are identified in the marketing of aquaculture including the direct and indirect marketing channel. The commodities are sold directly by producers to the consumers in the direct marketing channel, whereas in the indirect marketing channels more participants are involved in the chain between the producers and the final consumers. Marketing channels for a particular commodity vary from one region of the country to another, so it is always difficult to define a typical marketing channel for a particular commodity (Olowa, 2015a).

The choice of a distribution channel depends not only on how to bring a product or service to the market at a lower cost but also upon the quantity and quality of fish, distance of the market, demand of the consumers and the different restrictions of each market and each channel operating in the market. It is also following the specific constraints faced by each channel member. The types of fish may be affected by the structure of marketing channels (Imam *et al.*, 2014; M. M. Rahman *et al.*, 2012).

In terms of marketing efficiency, an efficient marketing system stimulates production. Producers likely produce more if they can sell at reasonable prices. Similarly, an efficient marketing system stimulates consumption as consumers are likely to buy more if they can purchase their requirements in the right form, place, time and at a minimum cost for maximum satisfaction (Nwabunike, 2015).

2.2.3. Problems of fish marketing

The major problem associated with the preservation of the live freshwater fish and its marketing includes harvested quantity uncertainty, high perishability, bulk quantity, high heterogeneity, high storage, and transportation cost (Parvathy *et al.*, 2019). In this circumstance, more focus is required for the development of modern supply chain models with an effective management strategy. Different methods of processing and preservation of fish guarantee quality and safety to a different extent. Thereby, one of the most noticeable methods that can be adopted is keeping them alive until it reaches the table. The marketing of fish in the live form not only attracts customers for its natural quality but also provides an important path for farmers to obtain high-profit margins.

However, the survival rate of fish is a major concern to live fish transportation. Live fish are transported for several purposes such as restocking, live marketing, or delivered to processing factories/plants for slaughter. This transportation stage mostly depends on labour and associated costs and therefore, most care needs to be taken to prevent loss of commodities due to mortality or injury as it affects profit margins. Some internal, as well as external factors, need to be seriously considered to improve fish life during transportation throughout the delivery chain. Stress-related to live fish is one of the biggest concerns affecting its health status as well as its survival during transportation and storage (G. J. Carmichael & Tomasso, 1988). Addressing this problem can effectively improve the survival rate and change the allied biochemical quality. Stress in these aquatic creatures includes obvious symptoms like colour changes, rapid respiration, behavioural changes like anxiety, etc. On the other hand, intangible effects including many changes in the blood of fish significantly reduce their ability to withstand changes in water quality. Careful handling practices along with thorough knowledge of fish tolerance conditions are required for effective transport and storage practices (Parvathy *et al.*, 2019).

Customer's quality criteria must be met in the target species to successfully deliver live fish (Van Anrooy, 2003a). Therefore, entire procedures from harvest to the after transportation play an important role in addressing the success of live-fish transports. Right from harvest, measures should be taken to properly handle the fish to avoid or minimize stress.

Harvesting and keeping fish alive: Fish are harvested from the cultured farm for direct transport. Harvesting fish early in the morning or at night is recommended because of lower ambient temperatures to avoid high-temperature changes (Thong & Olsen, 2012). The harvesting techniques that are less damaged and do not cause stress for the fish are recommended (Quang, 2005). Therefore, nets without knots are always recommended for harvesting live fish because they minimize the damage caused to the skin and scales in consideration to a smooth surface. Moreover, the period they have left on the net should be minimized to avoid damage. Fish should be carefully removed from equipment to reduce damage or stress caused to the organism. Physical damage to the skin, scales, etc. may not be attractive and can lead to an infection that affects the value of the fish. When harvested, exposure to air should be kept to a minimum as it may lead to dryness. Moreover, fish should be treated gently while moving from a net to a captive tank. Practices like dropping or throwing fish will kill or injure them. Hand-picking or grabbing the body or tail is usually not recommended because the force exerted to handle them can often seriously damage the fish.

When harvested, fish must be kept in proper conditions to minimize stress and maximize survivability (Harmon, 2009). In this regard, a basic prerequisite for captive fish is the supply of clean oxygenated water. This is essential because the fish caught will be under high stress affecting its breathing rate and can cause discharge such as mucus as well as excretion affecting the water quality of the tank. Lowering the temperature helps lower the metabolic rate and brings about a state of lethargy that makes handling easier and reduces stress for the species (B. A. Barton & Iwama, 1991). Therefore transferring the species into a good aeration tank with lower temperatures is desirable. Following this, the temperature is slowly lowered to the maximum ambient temperature below 10 ° C, over about 30 minutes. This is usually done by adding ice directly to freshwater.

Fish is usually kept and starved for a certain period, usually 24 to 48 hours before harvesting and transporting, a procedure known as' purge. The goal of starvation is to reduce the deterioration of water quality due to faecal excretion by fish leading to bacterial decomposition and associated ammonia accumulation (G. Carmichael *et al.*, 2001).

To transport live fish effectively, an in-depth understanding of optimal environmental conditions is required to minimize stress and minimize survival. When a fish leaves its natural environment, it must be in a self-sustaining environment, providing necessities such as optimal temperature, oxygen, etc. However, modifications under the current environmental conditions during transportation may require additional care and adaptation procedures such as better aeration and lowering temperature.

The transportation of live fish in closed water systems where fish are transported in an airtight bag or tank methods in which tanks filled with water of different types with the requirements for survival provided continuously from outside sources are used. The choice of this transportation system depends on the quality and quantity of the transported species, the means of transport available, the transit time, the size of the market, etc (Fries *et al.*, 1993).

Appropriate handling of live fish would keep quality and the shelf life of fish significantly improved. One such good handling practice are to ensure that live fish are in good environments of no struggling and suffocation or lack of oxygen.

Struggling after harvest will accelerate spoilage post-mortem by speeding up chemical reactions in the flesh of the fish. This reduces the time that the fish is in a state of rigidity or stiffness, thus speeding up the attack and damaging bacteria (Quang, 2005). Fish should be handled with care to reduce the rate of spoilage as well as prevent contamination with undesirable microorganisms and foreign objects and also avoid physical damage of edible parts. (Nwabunike, 2015).

Therefore, good handling of fish from the point of harvest to consumption is essential and the quality of the fish can only be maintained if only suitable containers are used in transporting, distributing and marketing (Quang, 2005). Fish handling procedures include all processes that maintain food quality and safety characteristics from the time the fish is harvested until it is consumed. The facilities that handle fish in the transportation process would be designed in such a way to avoid damage from all conditions. Such facilities should include electrical power supply, freezing facilities, freshwater and smooth roads that wheels place. Poor handling of harvesting fish at the pond accompanied with the distant location of markets poses failures to fish marketing techniques.

2.2.4. Challenges and constraints of fish marketing

Marketing of fish involves a variety of issues that often hinder the producers' goals to satisfy consumers' wishes and ensure farmer profits. Profitable marketing of fish is an ongoing challenge for the fisheries sector (Nwabunike, 2015; Panigrahy & Vahoniya, 2016; Ravindranath, 2008). It is observed that the problem of agricultural products is not the instability of marketable surplus concerning the impact of the loss in the distribution system. After that, without adequate transportation (roads, vehicles, rails, etc.) also hinders the efficient delivery of goods from one point to another. Lack of capital also constitutes a problem in the marketing process. Therefore, marketing issues to a great extent hinder effective product marketing(Nwabunike, 2015). For example, in Nigeria, the major limitations of fish marketing are pronounced in the different pre-harvest methods of fishery products. This method involves manual use and, to a degree, commercial (trawling systems). These systems are not well developed and easily wasted. The subsequent harvest, mainly related to processing, and storage, is at its lowest level (Agbebi, 2010). It was noteworthy for identifying the extremely perishable fishery products and the type of physical and chemical techniques used in processing and conservation to contribute a large proportion to the selling prices in the targeted markets.

However, another major limitation of fish marketing in low-income areas of the population is the price. It was the fact that prices are likely to be high in suburban areas and urban markets with good transportation access. The need for fresh fish is increasingly demanding in both urban and rural areas and all fish products are easily sold in rural areas. Rural producers think that premium price could be paid to fish in urban or suburban markets but are faced with transport problems (Akinneye *et al.*, 2007). Fish normally load on the back of the pick-up car which often carries heavy cargo and transport passengers. Smoked fish is usually packed in large woven baskets or trays that do not protect against insects' dust and rain, and the weight is so large that their contents must be crushed and fragmented. The conditions under which fish are kept and sold at the final market points for most parts often extend the treatment model indicating starting at the terminal at that early stage that is difficult to overcome at a later stage. Large market centres largely lack facilities for receiving and storing large quantities of their fresh and smoked fish, a situation that hinders the development of the real wholesale industry in the marketing system, (Ayodele & Fregene, 2003).

All this has harmful effects on a rapidly growing industry. The situation has improved steadily over the past few years, but a large amount of restoration work still has to be done. At all times, poor road conditions and traffic links generally contribute to waste and limit the distribution of new increases in the marketing margin when the transporters/ wholesalers recover their expenses. High vehicle maintenance costs from consumers. Also, supply and demand combined with marketing transaction costs affect the prices that fish farmers can charge for their products.

2.3. Theoretical background

2.3.1. Theory on agricultural economics and production model

To conduct an empirical study of SSA production models related to agricultural systems, it is necessary to begin the study with existing concepts and theories related to peasant and agricultural economics. The complexity of the agricultural production models and its multitudes of relationships, the study will be investigated and made a clarification of the key concepts and actual context. Agricultural production systems may be conceived as transformation on the socio-economic context or changes on specialization, intensification of the cultivation methods and/or agricultural diversification which enables or disables farmer participation in the new market environment. A thorough study of the agricultural production system must take into account these changes by looking after the impacts of the agricultural production system on the rural communities according to units of social and economic organizations, of which the farm household is the central importance.

2.3.1.1. The peasant economics

Peasant households are understood as the farm households which function as relatively corporate units of production, consumption, and reproduction (Castree *et al.*, 2013). They are characterized by access to land as the basis of their livelihood, using “family labour”, a mix of subsistence and commercial agriculture. However, they are only partially integrated into incomplete markets due to their partial integration and the degree of imperfection of the markets.

(Ellis, 1993) depicts the farm households’ making investment decisions in an economic environment which is limited by a number of constraints in comparison with farm enterprises in developed countries. These constraints include the uncertainties occurring in both agricultural production and markets. First, the production of farm households is confronted with natural hazards (droughts, floods, volcanic eruptions, animals and plant diseases) which may destroy the farm households' agricultural management. Second, market fluctuations are another form of agricultural uncertainty. These market fluctuations, on the one hand, come from the fact that the unavoidable time lag between the decision to produce a fish and fish output under imperfect market in the formation may result in loss of income. On the other hand, government policies must be considered as an element of uncertainty to the economic environment. Policy settings on farm input subsidies, pricing regulations, credit supports and market development influence farm households' ability to invest in new agricultural production models and farming technologies. The government also creates an important stimulus to develop agricultural production through the provision of extension work, infrastructural investment, and social services.

The principle of safety first as a key character of peasant behaviour is highlighted in the literature on agricultural development. This principle comes from the risk-aversion behaviour of farmers to cope with the uncertainties of agricultural production when they decide new investments in farming activities. (Scott, 1977) argued that peasants mainly target to minimize the opportunities of producing below the crisis level of subsistence rather than maximize the average return. What could be taken for irrational behaviour (such as not adopting new high-value cash crops/animals or paying exorbitant interest rates on loans from lenders) can be explained by understanding the moral economy of the peasant? That is, any behaviour that reduces risk and prevents a peasant from falling below the subsistence level is more likely to be followed. Farmers enable the subsistence through a wide array of choices: an inclination to mix crops and to employ several seed varieties for the same crop; a preference for stable crops with modest yields; a justification for crops to be consumed rather than sold. The cash animals/crops will be grown when they do not compete with the subsistence animals/crops in the farmers' production resources of land, labour, and capitals.

2.3.1.2. The neoclassical theory of farm production

To achieve food self-sufficiency is usually framed under a measurable goal in many development interventions, particularly in Vietnam (Bach & Saeed, 1992). A study on agricultural production models normally employs the input/output models or some enterprise budgets to explain the farmers' choices on typical farms, farming activities. This study generally is considered to put many efforts that can demonstrate the cost effectiveness of the production model providing a given amount of outputs (e.g. fish and rice). It is supposed that farm activities are eliminated from or maintained within the agriculture production models based on these accounting procedures. Surprisingly, it is often observed that farmers behave contrary to extension officials' expectations about resource allocation and enterprise selection.

A food-cost minimization or net income maximization based method of evaluating farm enterprises does not really make sense. Surely with single analysis, the effects of trade of farm products on a household's welfare are usually overlooked. This is because of the fact that a barter or cash sale of local products is a common farm activity which is employed by subsistence farmers to improve their total farm welfare. When a household is integrated with a market, his or her decisions on resource allocation will differ from the neighbouring'. A household may choose the degree of farm activities covering one or several enterprises. This choice objectively maximizes the household's total welfare. It may not necessarily only be based on the cost-effectiveness in producing food, nor net returns to resources used (Debertin, 2012). It can be seen from an illustration below (Figure 2.3).

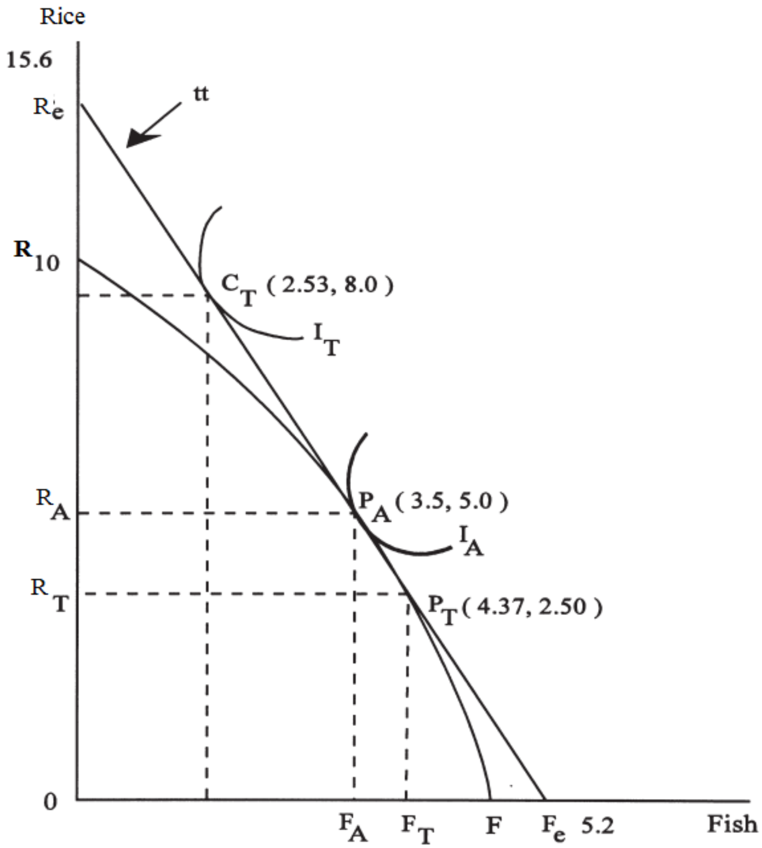


Figure 2. 3Fish±Rice production possibility frontier and patterns of production in autarky and trade

Let's consider a small, rural household that produces rice and fish on a given plot of land to satisfy its requirements of edible protein. It is assumed that the household is able to produce twice as much rice as fish with the same pattern of resources used. Substitution of rice for fish exhibits a decreasing opportunity cost. The household's model of agricultural production encompasses the rice and fish enterprises which create a corresponding household's production possibility frontier (PPF) depicted by the curve BF in *Fig. 2.1*. This PPF, which illustrates the trade-offs between rice and fish, represents the supply side in agricultural economics. The demand side in the absence of market transactions is described by the isolation curve IA, which portrays the household members' requirements for rice and fish. The interaction between demand and supply determines the optimal rice and fish production combination along the household's PPF, the ratio between the selling price of rice and selling price of fish (the relative price), and the household's income. As assumed in the PPF in a closed economy, when the relative price of fish (RA/FA) is 1.42, for instance, the household produces and consumes at point PA (3.5 units of fish and 5 units of rice) on its PPF. Given available resources and a set of technological applications, the household decides to allocate resources to rice and fish and produces at point PA. This point is dictated by the comparative advantage of rice and fish in providing protein to the household, and tastes and preferences as perceived by the household members.

The opportunity for trade creates changes in the household's agricultural production. As partially integrated to incomplete markets, farmers are usually unaware of managing their resources to produce the competitive (the least cost) products with high-quality standards required by markets. Alternatively, they manage to maximize their total welfare from the given resource constraints, available technology, and a set of priorities.

The farmer's decisions on agricultural products may be changed when the market is available. The market opportunities result in more consumers who may purchase one of the household's agricultural products with a higher value. It is supposed that there are some local consumers who would like to exchange 1 unit of fish for 3 units of rice. Now, the relative market price of fish is represented by the terms of trade (tt) line ReFe in Fig. 1. The slope of this line (Re /Fe = - 15.6/5.2 = - 3) indicates that 1 unit of fish can exchange for 3 units of rice. This creates the high relative market price of fish which is likely to motivate the household to allocate all or most of its productive resources to fish production, ceteris paribus.

The optimum of the rice±fish production (PT) is determined by the tangent bundle between the PPF and the terms of trade line. The consumption takes place along the term of trade line (tt). Follow this; the fish-specialized household can produce 4.37 units of fish and 2.5 units of rice representing at the point PT on the PPF. The tangent of the terms of trade line and the household's indifference curve (IT) shows the utility-maximizing quantities of fish and rice in consumption. It is assumed that the household takes a choice to consume2.53 units of fish, and the fish surplus (1.84 units) can be exchanged for 5.52 units of rice. This strategy can provide the household with a utility-maximizing consumption bundle which corresponds to 2.53 units of fish and 8.0 units of rice (at the point CT tangent between the term of the trade line (tt) and the IT curve).

In addition, fish production can increase real gain through trade. It can be easily recognized in the case of taking fish as the basis for comparison. Consumption in autarky consists of 3.53 units of fish plus 5 units of rice (1.42 units of rice/1 unit of fish). The conversion of 5 units of rice equals to 3.52 units of fish plus 3.53 units of fish to sum a total of 7.07 units of fish. Consumption with trade includes 2.533 units of fish plus 8 units of rice (with the same relative price of fish and rice 1.42). The calculation of 8 units of rice is equivalent to 5.64 units of fish plus 2.533 units of fish to obtain a total of 8.16 units of fish. The value of consumption in the autarky now is 7.07 units of fish and consumption with trade corresponds to 8.17 units of fish. In the condition of market availability, the household may increase the consumption beyond its PPF, moving to a higher level of the indifference curve IT. As a result, the welfare of the household is increased. The total welfare of the household has increased by 1.1 units of the fish equivalent of 15.5%.

It is obvious that fish may not be the most cost-effective farm enterprise of producing protein. The graph technique of input/output analysis is able to show that the household's agricultural production may be changed through the availability of market and trade. The introduction of fish culture into the existing farming systems could increase the total household welfare if market access to the farm household’s products is ensured.

2.3.2. Analytical framework

2.3.2.1. The policy of rice land designation and rice field conversion to small scale aquaculture in Vietnam

With the policy approach of rice self-sufficiency, Vietnamese government encourages rice farmers to continue to produce rice. This food security policy has mainly focused on how to increase the supply of rice, especially by keeping paddy land stable and through restrictions on converting to other crops and nonfarm activities since the economic reforms began in 1986 (Vasavakul, 2006).The Vietnamese government has designed public policies to achieve rice self-sufficiency rather than income growth in rural areas (Taylor, 2007). The long-term sustainability of Vietnam agriculture has been threatened due to the intensive rice production which rapidly increased in the use of chemical inputs (C. Barton, 2015). This leads to environmental degradation to become one of the biggest concerns in sustaining rice productivity and quality in the long term (Jaffee & Van Sanh; McPherson, 2012). While environmental degradation is increasingly concerned in the intensive rice production system, the policy of priority producing rice may not be appropriate for the food security strategy in the current situations in Vietnam.

This rice food security strategy is directly referred to the rice land designation policy which has been pursued by different levels of authorities in Vietnam. This sufficient-food policy was shaped when the National Food Security under the Government's Resolution stipulates that a reservation of 3.8 million hectares must be protected and allocated to rice production(GOV (Vietnamese Government), 2009a). This designated paddy land represents about 90 percent of currently cultivated paddy land in total or 35 percent of agricultural land. Particularly, the land Law 2003 restricts the conversion of rice land to perennial crops, aquaculture, forestry or non-agricultural uses. The use of planning is stipulated by different government levels. These plans explicitly specify areas for rice land, crops, aquaculture and other purposes (National Assembly, 2006). This introduces effective restrictions on rice land conversion to other uses, especially to aquaculture, although the degree of enforcement varies from local to local (Markussen *et al.*, 2011). The restrictions of rice land conversion have become more explicit and strict in recent time. Decree 69/2009/ND-CP (GOV (Vietnamese of Government), 2009)confirms that areas for wet rice production must be clearly identified in the land use plans, and provincial

People's Committees are responsible for the plans to keep a view on protection of land areas allocated to wet rice production. The new decree on the protection of rice land cultivation(GOV (Vietnamese Government), 2015) stipulates strict enforcement of rice land plans down to the commune level. This decree enforces the provincial authorities to control the conversion of rice land to other uses, even to other annual crops. It also means that the conversion of rice land to aquaculture has been constrained under the rice land designation policy in Vietnam. On the other hand, the conversion of rice land cultivation to aquaculture has been proven to be effective impacts on increases in real GDP and consumption, better growth in agriculture, and decline in poverty (Giesecke *et al.*, 2013).This study found that the removal of the rice land designation policy increases an average of 0.35 per cent per annum in real private consumption over the period 2011-2030. It also reduces poverty, improves food security and contributes to more nutritionally balanced diets among farm households in Vietnam. The findings raise the issue of whether the rice land designation policy is still appropriate for the national strategy of food security and rural development in the current situation of Vietnam.

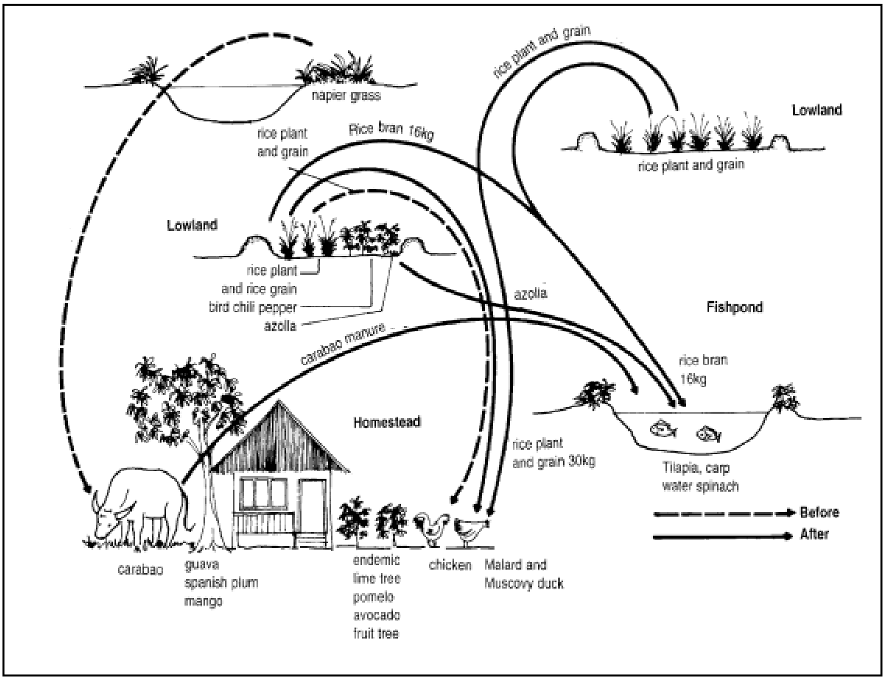
Small scale aquaculture has rapidly changed from traditional VAC (HOMESTEAD FISHPOND, located in the residential village) to the improved VAC (FISHPOND conversed from rice fields) in the Red River Delta of Vietnam (Peter Edwards, 2010; Van Huong *et al.*, 2018). The potential of the models were mentioned in several studies (Peter Edwards, 2015; Luttrell, 2006; Ngoc & Demaine, 1996; Wilder & Phuong, 2002) despite the fact that these are constrained by the restrictions of rice land conversion resulted from the rice land designation policy as discussed above. There is still no empirical evidence to show that the economics of these SSA models can contribute to the household economy and increase the rural livelihoods in the local region. Therefore, this study is designed to understand the economic contribution of small-scale aquaculture to the fish farmers by using the budget technique to examine the profitable degrees of different SSA production models under the context of market availability, specifically, the marketing channels of fish have been shaped and influenced to fish production.

2.3.2.2. The analytical framework of the study

The agro-aquaculture system

The SSA producing fish is generally integrated with other agricultural activities such as crops and animal husbandry in the Red River Delta of Vietnam and several Asia (Luu *et al.*, 2003; Ngoc & Demaine, 1996; M Prein, 2002). The introduction of farming of fish into existing agricultural systems normally creates an integrated aquaculture system on the basis of agricultural diversification towards linkages between subsystems. This system increases the synergies which “an output from one subsystem in the integrated aquaculture system may otherwise have been wasted becomes an input to another subsystem as a result of greater productivity of the desired products as compared to land/water area (Belton & Little, 2011a; Peter Edwards, 1998; Peter Edwards *et al.*, 1988). Therefore, the characteristics of integrated aquaculture farms should be taken into account for analysing in the study. However, aquaculture may or may not integrate with other subsystems in the farming system. Moreover, the degree of integration between subsystems should be considered such as simple integrated systems with two linked components (animal fish; crop fish), multi-component integrated systems with three or more concurrent components (crop-garden-fish-animal). Particularly, all the integrated aquaculture farms use organic fertilizers to supplement or alter to inorganic fertilizers. This is because the availability of by-products, farm wastes are readily utilized to induce natural food production (e.g algae..) in the ponds (Knud-Hansen & Clair, 1998; C. K. Lin & Baker, 1997; Pucher *et al.*, 2014) and provide CO2 if the pond water is of low alkalinity (e.g. lime). These farms have been acknowledged to be cost-efficient as compared to the counterpart with the utilization of wastes on- and off-farm (Peter Edwards, 1998).

The typical characteristic of integrated aquaculture farms is the nutrients flow between enterprises. For example, pond mud and nutrient-rich water become inputs for vegetable production around the pond. This shows the important role of the pond for farmers to increase the nutrient linkages (see Fig. 2.2) which enable them to provide more nutrient requirements for better production, although it requires additional labours (M Prein, 2002). Fish farmers may be successful with multi-enterprise production when they organize a good production calendar to make residues from one enterprise available at the right time and in the right amounts needed as inputs to other enterprises.



Source: (M Prein, 2002)

Figure 2. 4 Bio-resource flow diagram of an integrated aquaculture farm.

The integrated fish farms are operated over the entire spectrum of scales and may be partially or fully participated in market-oriented production. Farms with limited market access consider their fish production as a minor component of the farm, and part of fish outputs is for subsistence purposes with some level of market involvement or at least local community exchanges. Besides, the aquaculture enterprise can become dominant in the greater farms with more specification and market orientation (e.g rearing specific species and sizes, or expanding hatcheries or nurseries). These greater farms' products may focus on supplying specific targeted markets (e.g. in suburban areas).

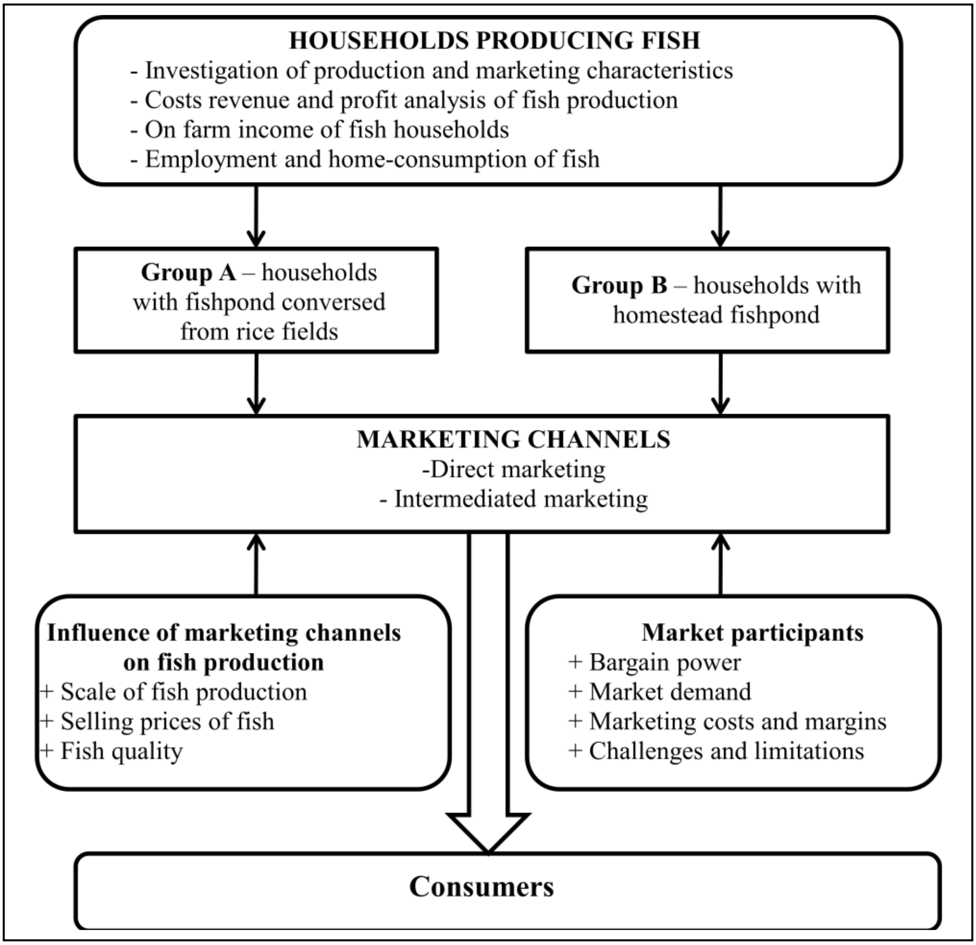


Figure 2. 5 Analytical frameworks for understanding the profitability and marketing fish products of SSA models in Hai Duong province

For the economic viability of fish farming, ponds usually require a greater number of inputs as well as the high degree of input quality. (Phuong *et al.*, 2007) mentioned that different aquaculture production practices and systems co-exist with one another depending on the level of technology that prevails. Moreover, four of the most important resources to aquaculture outside human and technological resources are land, water, seed and feed. The optimum production of aquaculture can be achieved only when these resources are used efficiently. Although the integrated aquaculture farms have still developed so far, there is no or very little studies on the economic efficiency of these production models which can provide empirical evidence for researchers, policymakers and authorities as a basis of developing agriculture and rural economy in the Red River Delta of Vietnam.

As described above, the small-scale aquaculture is really complex and always integrated with other farming components to enhance the total agricultural production of the households in the Red River Delta. However, the documented works revealed two fishpond origins related to the SSA production in the households' agricultural systems in the Red River Delta. The first is the HOMESTEAD FISHPOND which is a component of well-known ecosystem VAC (Chung *et al.*, 1995; Luu, 2001), the latter is the FISHPOND CONVERSED from rice fields. With the objective of the study to understand the economic efficiency and marketing channels of the freshwater SSA production models in the Red River Delta the study is designed to select the households operating the fishponds as the research samples. Hai Duong province was chosen as the study site. The selection of this province can be explained by some reasons. First, Hai Duong province is located centrally in the Red River Delta. This province‘s fishery sector has been quickly developed both in area and output recently. Moreover, thanks to the geographical characteristic of fully located by an inland boundary (without coastal lines surrounding see Fig.4.4 in chapter 4) freshwater SSA production becomes unique and quite pure. Furthermore, freshwater SSA and VAC ecosystems have been long practised in this province. Thus, the analytical framework of the study has been developed according to this province as Fig. 2.3.

3

EVOLUTION OF VAC MODEL IN AGRICULTURE AND RURAL DEVELOPMENT IN VIETNAM

The first part of this chapter presents a brief summary of the evolution of the VAC model in line with agricultural policies mainly during the time of economic reforms in Vietnam after the national reunification in 1975. The VAC was found and promoted as a tool to solve the shortages of food in Vietnam at that time. The evolution of the VAC model was depicted under the period of economic transition from centrally planned production to the market-oriented mechanism. The new vision about the VAC model is referred to in some cases for a specific condition of scarce land and more environmental socio-economic situations. The second part presents the history and role of aquaculture as a strategic tool in developing the country economy in recent years.

3.1. Foundation of VAC model in the process of agricultural and rural development in Vietnam

3.1.1. Foundation of VAC model in Vietnam

The foundation of VAC (three letters of Vietnamese presented for Vuon, Ao, Chuong with English meaning according to garden/pond/livestock pen) economy is inherent in the household economy and the renovation "Doi Moi" in 1986 in Vietnam. After reunification in 1975, Vietnam pursued a centrally planned system to develop the national economy. However, the economy of Vietnam was plagued by enormous difficulties in production, imbalances in supply and demand, inefficiencies in distribution and circulation, soaring inflation rates and rising debt problems(Xuan, 1995). The renovation "Doi Moi" was introduced and disseminated after the decisive Sixth communist party congress in 1986 (Forbes, 1991). In line with the renovation of Doi Moi, the VAC ecosystem was first introduced as a model for sustainable rural development and environmental protection in Vietnam by Professor Tu Giay in the 1980s (T Giay *et al.*, 1980; Tii Giay & Dat, 1986; Nam, 1994). Although the agricultural practices had been followed the principles of this model before (V. Nguyen, 1997), the renovation "Doi Moi" in 1986 has created an encouraging environment to develop the VAC model in over the country (Irvin, 1995). With VAC models, farmers can improve the production and consumption of animal source foods and reduce the malnutrition status (Hop, 2003). This model has been originated from the achievement of the Doi Moi renovation process (Nam, 1994; Phạm, 2000)when the agricultural sector was further liberalized to develop with increased security of tenure on land allocated to individual households, privatization of output markets, decentralization of input supplies, and individual decision-making for household resource allocation, crop choice, and crop management (Pingali & Xuan, 1992).

Through the process of agricultural collectivization and decollectivization, the household economy has gradually been recognized and become as an autonomous economic unit through the household-cultivated garden of the "5 percent" plots in the agricultural production (Vien *et al.*, 1967). This is fundamental to shape the VAC model which was not only a "second economy" but also became an "official economy". With a new role, VAC has been being increasingly and made greater contribution to the growth of agricultural production and rural development in the post-Doi Moi period (Le Du Phong *et al.*, 1996).

In the history of peasants' livelihoods, a new couple started their independent living with the first establishment of a house made of soil through digging some area around the garden where the fishpond was shaped. To raise some animals, they also need to make cages/shelters near the garden where some vegetable and fruit trees were cultivated for subsistence. Such doings shaped the structure of the VAC model in the traditional rural areas of Vietnam (Le Du Phong *et al.*, 1996). This typical VAC model could be found in many parts of the country. However, it has been transformed over time and space by the changes in socio-economic conditions and ecological situations of different regions in Vietnam. No matter how this VAC has been changed, it is characterized by four components which include man or human and three subsystems of V-A-C. In such a structure, many supplemental linkages exist and arise from agricultural activities in order to increase the family farmers' income and nutrients(Nam, 1994). According to (T Giay, 1994), the VAC model can be understood as follows:

"V' has been extended to refer to all kinds of land farming, in which gardening, crop field production, even swiddening (crop rotation commonly in some regions) are included.

'A" stands for all activities related to aquatic resources which are employed and used for food production. Therefore, it includes a pond, lake, canal, spring, watercourse... from which man can get such products as fish, shrimp, crabs, snails, frogs, tortoises... and even water grasses (algae, water spinach) diversified with a wide range of farming practices.

"C" covers all practices in animal husbandry, for example, poultry, ducks, goose, pig, cattle..., rearing and even deer breeding. In some regions such as uplands or high plateaux, "C" may include the rearing of horses, the taming of elephants, and beekeeping(T Giay, 1994).

As defined above, VAC model cannot be regarded as an isolated activity inland farming, it is in fact a subsystem of the household in which various practices are being combined to create a 'harmonized' system wisely managed by MAN. The other farming subsystems are surrounded by the household subsystem, in which the entire system is developed with its close internal relationships, can be illustrated by Fig. 3.1. as below.

In the VAC model, all products from V gardening or cropping (e.g vegetable, bean, roots, tubers, fruits, rice) from C (milk, eggs, meat) and from aquatic culturing A (fish, shrimp, crab, shellfish) are used for the nutrition of household members. The residues from V, A, C and MAN, in their turn, are utilized to foster the VAC system. For example, the residues from V cultivating are used for cattle breeding and fish culturing. Those from C breeding after a certain time of recycling would be utilized for tree planting, vegetable gardening and/or as feed for fish (mainly for the pond fertilization). Particularly, with the addition of A into V-C establishment, water can be used for irrigation, ponds bottom mud for soil dressing, and small fry for animal feeding. In some cases, pig manure could be used as feed for fish, and fish in its turn is used for pig fattening (T Giay, 1994).

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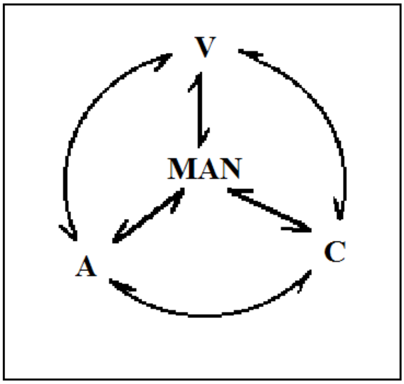


Figure 3. 1The relationships in the VAC ecosystem model

VAC ecosystem model is an intensive farming system (Nam, 1994) in which all the potential and resources available are fully used in a wise manner and residues there from are also recycled for use. Following this, pig raising farms at the communal level should also operate for increased meat production, and fish farming therein should be combined with the capture of fisheries products for sales. Tree nurseries of some households or enterprises should also provide plant or seeding materials for fruit crop gardening and even animal breeds to all farm households in the region. In actuality, when the national economy has been shifting towards a market-oriented system (H. Nguyen & Grote, 2004), it was not advisable to create fish ponds only for fish culture, but to be integrated into more diversified bio-systems, of which VAC with its garden, fish pond and cattle shed seems to be the best ones; following this, "product rates' contracts could be signed to encourage private households to improve their farming land management (Phạm, 2000).

3.1.2. Evolution of VAC model in the process of agricultural and rural development in Vietnam

Overcoming approximately 40 years of wartime, Vietnam had been plagued by a shortage of technical competence to carry out economic activities and rural development (Xuan, 1995). The evolution of the VAC economy has been accompanied by the process of agricultural and rural development in Vietnam. Thus, agricultural policies are always in line with the political system. Clearly, Vietnam started the political system favoured a top-down approach in agricultural development with a centrally planned system in 1975 (Pingali & Xuan, 1992). However, these policies appeared problems which led to the Renovation "Doi Moi" in 1986 that significantly transformed the national economy and rural areas. In line with the changes in agricultural production, the VAC economy can be recognized, established and developed as following in-depth descriptive sections.

3.1.2.1.VAC model in the period of agricultural collectivization (1975-1986)

After the reunification in 1975, Vietnam set a new political system which favoured a centrally planned system in the entire economy including agricultural development; thus farmers were told to produce ordered products from local government officers and managers of cooperatives (Pingali & Xuan, 1992). This period was experienced with a campaign to create and enlarge agricultural production cooperatives (hop tac xa nong nghiep), which obligated farmers to perform collective labour and fulfil procurement quotas imposed by central authorities. In North Vietnam, when authorities established the agricultural production cooperatives they permitted rural households to privately produce some crops on small plots of land. These lands were called “5 percent” plots (dat nam phan tram) allocated from the arable land within each cooperatives boundaries from distribution to individual households (Beresford, 1985). These “5 percent” plots were, at first, viewed as part of a supplementary “family economy” that contributed to the “vital needs” of rice and other staple foods supplied by agricultural cooperatives. They soon became an important means for the farmer to produce food and income at subsistence. During the 1960s-1970s, farmers earned between 60 and 75 percent of their income from the private 5 percent plots. These plots were not officially allocated within the resources controlled by cooperatives, yet households cultivated intensively these family gardens (Vien *et al.*, 1967)which were later a fundamental basis to picture the VAC model. While the autonomous role of the family economy was replaced by a new form of organization, the agricultural cooperative which controlled all agricultural production activities lead to adverse consequences such as land being left fallow, labour remaining underemployed, the domination of rice monoculture featured in the countryside of Vietnam (Van Anh & Huan, 1995).

In 1976, finishing wartime, Vietnamese government’s attempts to consolidate and enlarge the agricultural cooperatives through outlawing the private ownership of farming equipment (pond, natural aquatic resources..), confiscating irrigation pumps, tractors, tillers, and water buffalo from farmers, and preventing families from raising livestock(Beresford, 1985). The land redistribution program was implemented with equal formulas which lead to a smaller means of VAC production– “small individual plots or 5 per cent” for each household (Beresford, 1985).In line with the campaign of agricultural collectivization, a food obligation (nghia vu luong thuc) policy that was implemented in 1978 and 1979, which required farmers to sell a quota of rice to the state at fixed prices in exchange for state provisions of fertilizer, gasoline and necessary commodities a subsidized, below-market price (Raymond, 2008).

Therefore, the VAC economy turned the individual plots to become a labour-intensive farming and the main source of secondary food crops such as vegetables, products of livestock (e.g pigs) (Lai, 1967).With the individual plots, peasants mobilized extra labour to work for three to four hours over and above the normal eight-hour day. This was explained by using individual incentives in an economy which is characterized by drastic shortages and widespread poverty (Dong, 1982). Moreover, the welfare aspects of cooperatives enabled the household economic activity to expand its scope. This welfare with one comes from the use of mechanized ploughing which is done by the cooperative sector, by saving ploughing time, releasing labour for involvement in family plots, the other might result from child care facilities which free the women of the collective to devote to household plots. More interestingly, the nature of family plot cultivation is changed fundamentally under the cooperative system by the truth that it is sustainable for the household due to the impossibility of going bankrupt and losing its land (White, 1988).

During the period 1976-1978, after the agricultural collectivization completed in the North, Vietnam was continuing to implement collectivization in the South, national grain production fell by more than 17 percent. Food became particularly scarce in northern Vietnam, and so the Central Politburo of the Communist Party issued Directive 100 in January 1981. This directive allowed farm households to undertake the planting, tending and harvesting of crops which are intensive stages of cultivation based on the land contracted from the cooperative for one to three years. A specified quantity of rice was also assigned in the contract and delivered to the cooperative at each annual harvest. A similar kind of contract had illegally appeared in the 1960s and 1970s; farmers were still forced to purchase ploughing services, seeds, irrigation, fertilizers, and extension services from cooperatives. Crops produced an excess of the quota could be sold at a fair-high price either to cooperative or on the free market (Raymond, 2008). Directive 100 had a significant impact on rice cultivation which rapidly rose between 1981 and 1987 and then began to toughen down. Total rice production increased annually at a rate of 2.8% during 1982—1987 against 1.9% during the period 1976-1981. The success of Directive 100 (the contract system) could not be sustained over the long term because two reasons were explained. First, the top-down approach on land use and crop choice was made of agricultural planning without consideration of peasant preferences and available market situations (Pingali & Xuan, 1992). In parallel, the VAC economy was introduced to experimental as pilot testing by Professor Tu Giay in some localities such as Thai Nguyen Company of metallurgy from 1977 to 1980. Very encouraging results were gained and praised in the conference coordinated by the Ministry of Agriculture, of Internal Commerce, of Health in May 1980.The success at the Thai Nguyen company of metallurgy had been proof of nutritionists' ability not only raising needs but also in finding ways to satisfying them. A National Institute of nutrition was created by the decision of the Prime Minister one month after the conference on 13/6/1980 (T Giay *et al.*, 1980). This initial establishment of VAC model has much attention paid by farmers and authorities when the previous policy on rice self-sufficient food legalized many environmental deteriorated practices such as forested gardens and land to increase areas for rice-fields, and most ponds, as well as water/aquatic resources, were managed unproductively by cooperatives in Vietnam (Pingali & Xuan, 1992).

3.1.2.2. VAC model under the renovation period of decollectivization 1986-2003

Faced with high deficits of food, the growing threat of famine, the household-based production "VAC economy" had been to a greater or lesser extent recognized and encouraged to produce more food for the national economy. This gradual recognition and changes in economic reforms finally became known as Doi Moi or "renovation" in the whole country. It began to emerge in November of 1986 when the Central Politburo approved Resolution 146, which urged cooperatives to distribute unused land to individual families for household production. It was the first time when the individual family was allowed to privately breed livestock without limits. Nonetheless, households were prohibited some private production such as cultivating in the fields that were listed and planned to produce rice crops by state farms, cooperatives, and production collectives (contracted production) which accounted for a large proportion of farmland at that time (Pingali & Xuan, 1992).

Until April 1988, the Resolution 10 was released by the Central Politburo to abolish the contracted system of rice production. Resolution 10 opened an avenue for farmers to develop their individual production. The autonomous role of the household economy was officially approved. Although cooperatives still existed under Resolution 10, their monopoly on the provision of ploughing, seeds, irrigation and other inputs services was lost and gradually replaced by private suppliers (Wurfel, 1993). The aggregate output of agricultural production increased dramatically right after Resolution 10. It made Vietnam become the third rice exported country in the world in 1992 (Pingali *et al.*, 1997). This achievement mainly resulted from the individual family production in which the VAC model was exploited and improved through initiative and creative practices of individual households.

The explosion of VAC development surely had to mention the stimulus of farming appropriation through governmental interventions and individual farmers' needs to improve the deficit nutrient conditions. Vietnam operated several nutritional intervention programs with objectives to prevent malnutrition protein energy for pregnant and lactating mothers supported by 2 projects PAM 2651 (24 million USD) and PAM 3844 (33 million USD). Through these programs, the nutritional knowledge was disseminated to the whole population, many pilot testings of VAC models were conducted widespread to introduce household food security (English & Badcock, 1998; Hop, 2003). With the appropriation of VAC ecosystems, suggested by Professor Tu Giay, various species of plants, including vegetables, beans, legumes, roots, tubers, and fruits are multilayer-cultivated in mixed cropping and intercropping systems. Different types of fish, shrimp, and crabs were also reared in the ponds. Besides, farmers developed animal husbandry with poultry and much other livestock (e.g. such as deer, bears, snakes, pythons, parrots, ornamental birds..) production which could be linked with garden and fishpond cultivation. Thus, the contribution of VAC to variety in people's diet and fully recognized as means to solve the problem of household food security in Vietnam (N. C. Khan *et al.*, 2002). As considered an emergent solution for self-sufficiency food, an association of VAC (so-called VACVINA) was established in 1986 in order to promote VAC widespread. This VACVINA was responsible for providing technical training and education for its members to transfer knowledge and experience to the farmers (English & Badcock, 1998). The VAC food production soon became implemented at household level all over the country.

After the promulgation of Resolution 10, with the initiative of farmers in individual production, the works of (Van Anh & Huan, 1995) showed that the vast majority of the rural households in Vietnam represented much improvement in their living standards. Almost all the rural families performed various economic activities within their sphere. As an economic unit, the household pursued its objectives of maximizing income generation by making the fullest use of resources (Phạm, 2000). The movement of VAC development was at the peak during the early 2000s when the agricultural land market was emerging in Vietnam (Marsh & MacAulay, 2002). However, it then levelled off since the Land Law 2003 restricted the conversion of rice land to other crops and purposes (Giesecke *et al.*, 2013).

3.1.2.3. A new vision about the VAC model

In the context of the market-oriented economy integrated with the world market, farm households are independent to decide their own agricultural production (Hayami & David, 1994). The new political environment provides farmers for both opportunities and challenges of their livelihoods with the limitations of allocated land and other resources (Ravallion & Walle, 2003). With the accumulation of capital, knowledge and experience from VAC models, many farmers have expanded their agricultural products from one to several components of the agricultural system with high-value products for domestic markets, and even for exported markets such as pig production, shrimp and catfish farming (Phuong & Oanh, 2010; TẾ, 2017). These success stories have proven that the VAC model itself has created a new class of peasants who are knowledgeable, entrepreneurial in their jobs to find a path of becoming wealthier.

However, in many localities of Vietnam, smallholder farmers are facing various difficulties and challenges related to developing the VAC model not only in their production but also in market volatility (Dai & Dien, 2013). For example, pig households in Hai Duong have coped with market price fluctuation (Chau *et al.*; Hanh *et al.*, 2013) or shrimp farmers may become actual gamblers due to the shrimp market volatility. Therefore, the VAC model is really required to have a new approach to development in the current situation in Vietnam.

On the other hand, the VAC model is an integrated farming system in which gardening, animal husbandry, water food culture are combined to yield the best results (Luu, 2001). Therefore, it is best to think of VAC farming in many localities where lands are scarce and limited, such as urban areas. This is because VAC gardening cannot be practised on large stretches under such conditions. The VAC model then can solve various problems related to water supply, fertilizer production, animal feed procurement based upon the actual situations prevailing in the areas. The residues of all activities are processed by appropriate recycling methods to produce the necessary inputs. These practices of VAC models really make sense while people are struggling to improve the living environment of their areas. For fish farming, the same thinking and problem-solving approaches could also be put into practice.

3.2. Aquaculture development in Vietnam

3.2.1. Aquaculture history

Aquaculture is an important and growing part of Vietnam's agricultural economy. As of 2014, fisheries (capture and aquaculture) accounted for approximately 3.5 percent of the whole country's gross domestic product (GDP). With its tropical climate and more than 1 million km2 of inland surface water and approximately 3,260 km of coastline, the country has offered attractive features from the standpoint of aquaculture development (Phuong & Minh, 2005).

In 1960, when the General Fisheries Department of Vietnam was founded, the new stage of aquaculture development took place. During the first 20 years of this stage (1960-1980) marine and brackish aquaculture along with rice- cum-fish farming attracted great attention of farmers and aquaculturists. The marine aquaculture was started experiencing at Kien An commune, Hai Phong province in 1962 and gained the first succeed with artificial fish seed production in 1963 (Chu Viet Luan & Ha, 2003). Meanwhile, several other fish farming practices like rice-cum-fish, lakes, riverine and earthen ponds were also developed in some other parts of Vietnam. Those systems, especially the rice-cum-fish, became increasingly popular at that time with over 100,000 ha. In the next 12 years (1963-1975), when Vietnam in wartime, the aquaculture was considered as an important and emergent in providing food for people and militarists. Therefore, it received higher government's attention for its development.

In 1965, along with the process of agricultural collectivization, Vietnam had established about 15,000 cooperatives of aquaculture and state-run enterprises from all levels of the country (central to localities). Some provinces such as Hai Phong and Thanh Hoa had strong aquaculture development of shrimp farming with production orientation for exportation. Besides, aquaculture was also considered a major career at the district level in these locations (Chu Viet Luan & Ha, 2003). After the war, Vietnam got reunification; the fisheries sector including aquaculture was identified as a key economic sector of the national economy. The total aquaculture production witnessed an increase from 59,000 mt. in 1976 to 160,000 mt. in 1980. The turnover of exported fisheries products (both aquaculture and capture) recorded at USD 11.2 million USD in 1980 (Phuong & Minh, 2005). The driver of the growth of the fisheries sector came from the subsidiary of the Vietnamese state. When the subsidiary was cut in 1977 and 1978, the fisheries production got a sudden drop right afterwards.

In the latter stage since 1981, the export-oriented production of shrimp was dominated by the aquaculture subsector. The aquaculture in freshwater, marine and brackish water got more incentive to develop in many parts of the country. There was a drastic increase in aquaculture production since it was promoted to be export-oriented production decades ago. Exportable species of the aquaculture production were started to develop such as black tiger shrimp (*Penaeus monodon*), catfishes (ca tra – *pangasius hypophthalmus* and ca basa– *pangasius bocouti*), lobster (*Panulirus Spp*), groupers (*Epinephelus Spp*), bivalves (*Meretrix lyrata and Anadara Granosa*), etc. Many aquaculture systems applied high levels of intensification and integration have also been shaped in the whole country, which results in the peak of aquaculture growth in the period (1999-2001). The number of jobs from aquaculture and related activities along the aquaculture supply chain in Viet Nam ranges from 3.2 to 4.2 million people, of whom about 1.6 million people are being employed in shrimp value chains, 240,000 people are participated in catfish value chains and between 1.5 and 2.2 million people are engaged in traditional freshwater aquaculture (VAC) and other aquaculture systems (Phillips *et al.*, 2016). In Vietnam, except for freshwater catfish which has recently become controlled by large-scale production, other species, including those cultured in brackish water and marine, are commonly found in small-scale production. Those producers whose farm size was less than 2 ha accounted for about75 percent of the 2.4 million households, and less than 3 ha was 90 percent (Phillips *et al.*, 2016).

3.2.2. The role of aquaculture in the national economy

The development of aquaculture has been recognized to be one of the key economic sectors of the nation right after Vietnam got the reunification in 1975. According to (MOFI, 2005), it was estimated that the total area of aquaculture in 2004 was 902,900 ha. In 2004, total aquaculture production reached 1,150,100 tons, increased 15.2% compared to that of 2003 (see Fig. 3.2).

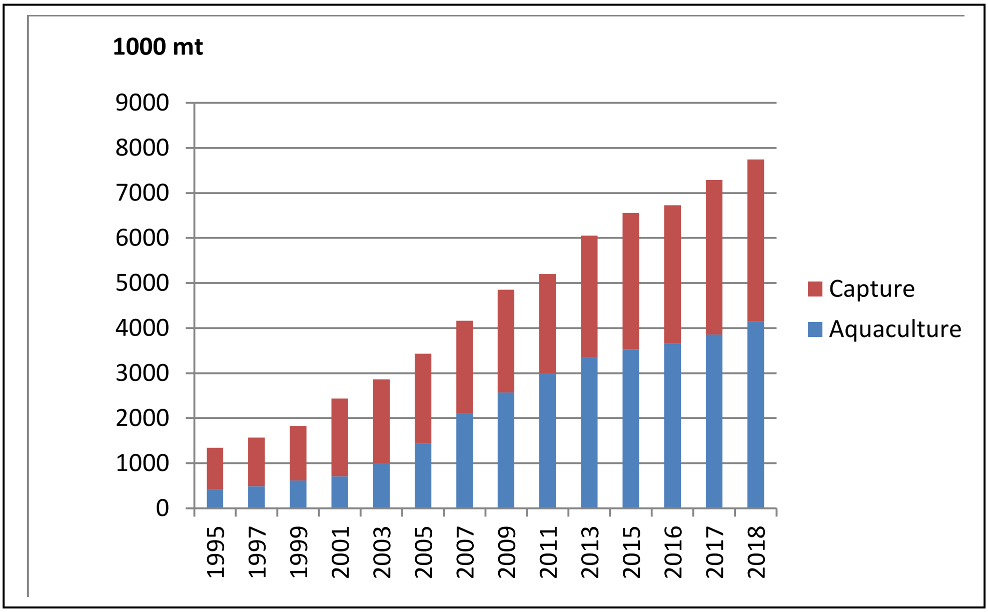


Figure 3. 2 Vietnam fisheries production over the period 1995-2018

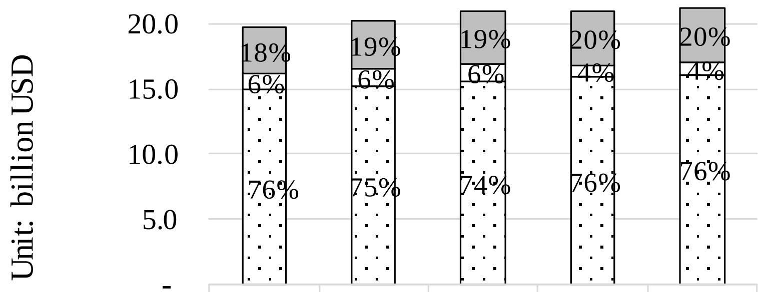
Distributions of aquaculture systems are typically different from the North, Central, and South of Vietnam. The favourable condition assists Vietnam's fisheries production to maintain continuous growth over the past 17 years with an average increase of 9.07% per year(VASEP., 2019). Some policies have been promoted and taken into effect to develop aquaculture; as a result, the aquaculture subsector has made strong progress; the aquaculture output has continuously increased in recent years, an average of 12.77% yearly, making a considerable contribution to the growth of the whole country's fishery output. Meanwhile, due to the depletion of natural resources and the slow improvements of the catching techniques and technologies, the captured output from fishery has increased at a slower pace over the same period, with an average increase of 6.42% per year. According to the General Department of Fisheries report, the value of fishery production in 2018 reached about VND 228,139.8 billion, an increase of 7.7% compared to 2017, the total output reached about 7.74 million tons, an increase of 7.2. %, of which capture output reached 3.59 million tons, increasing 6.0%, aquaculture reached 4.15 million tons, rising 8.3%.

The aquaculture system in the northern part is commonly practised with freshwater fish ponds, rice-cum-fish, and marine cages. Meanwhile, in the central region, it appeared more like a marine cage with finfish or lobster. Ponds, both small and large scale, and rice cum shrimp are also found with shrimp production. Moving further to the Southern part, the aquaculture system is more diversified. It includes a pond, fence, cage, rice-cum-fish, rice-cum-prawn, and mangrove-cum-aquaculture. Moreover, intensive aquaculture production in the southern part is more than that of other parts of Vietnam, especially for catfish and shrimp.

Aquaculture production in Vietnam according to FAO statistics has grown at 12%/year since 1990 with freshwater and marine production showing the highest growth rates (13 and 17% respectively). Total aquaculture production in 2003 is estimated at 966 tons, contributing more than 40% by weight to total fishery production. The freshwater sub sector remains dominant, contributing 65-70% of total production.

Aquaculture is becoming an important engine in the Vietnamese national economy, making significant contributions to rural development and the process of international economic integration. Moreover, this sector has a principal role to restructure the agricultural and rural economy which undertakes the responsibility for alleviating poverty and eliminating hunger through generating more than 4 million jobs(Hang, 2018). According to the (GSO, 2017), the growing pace of the whole economy was 6.21% in 2016 as compared to 2015. The Agro-Forestry-Fishery sector contributed only 1.36% to the GDP growth, this figure is the slowest pace of growth since 2011. The sector of agricultural, forestry and fishery production is estimated to value at VND 870.7 trillion in 2016 (at current prices), representing the growth rate of 1.44% against the year 2015. In 2016, agriculture valued at VND 642.5 trillion, the annual rising to 0.79%; 28.2 trillion VND for the forestry with a growth rate at 6.17%; and aquaculture produced the value of VND 200 trillion, an increase of 2.91%. Out of the Agro-Forestry-Fishery sector in Vietnam, the single fishery subsector has a growth rate of 2.80%.

Aquaculture plays as a tool to restructure the composition of rural areas and the agricultural sector. Reviewing the growth of the agricultural economy during the period 2012 – 2016, there has been a shift in the structure. While the value proportion of fisheries in the sector of Agro-Forestry-Fishery has gradually increased, that of forestry witnessed a decline. The book of (GSO, 2017)also indicated that the fishery subsector, which accounted for 18% of the total agricultural GDP in 2012, has a shift of occupying for 20% of the total value of the agriculture-forestry-fishery GDP in 2016, whereas forestry decreased from 6% in 2012 to 4% in 2016 (figure 3.3).



	2012	2013	2014	2015	2016
Aquaculture	3.65	3.79	4.04	4.14	4.26
Forestry	1.20	1.25	1.34	0.89	0.94
Agriculture (culitvation & livestock)	14.94	15.28	15.64	16.00	16.11

Source : (Hang, 2018)

Figure 3. 3 ***Value and proportion of the Gross Domestic Product of the Agricultural sector by economic activities (2012-2016) at the constant price in 2010***

It is an interesting point that the changes in the structure of the fisheries sector have shifted to positive and effective composition. The fraction of aquaculture and aquatic product processing was increased gradually while the proportion of natural aquatic resource capture was reduced considerably. In other words, this shift is consistent with the trends of decline in the consumption of natural aquatic resources and increases the consumption of the fishery products associated with artisanal aquaculture. This transition is a good signal for aquaculture development because it not only strengthens the value of aquaculture products but also opens up the opportunities in new markets for the export of Vietnamese fishery products, which in turn contributes to the generation of more employment opportunities for the rural people. Therefore, current aquaculture development in Vietnam would help to ensure a sustainable livelihood for farmers in rural areas.

4

RESEARCH SITE AND METHODOLOGY

This chapter provides the first part with an overview and detailed description of the agricultural and aquaculture sector in Hai Duong province – a province selected for the research. This part presents its economic achievement, natural resources, and climate characteristics, especially those related to agricultural production, particularly including freshwater aquaculture development. This chapter spends the second part to explain the methodology including the process of data collection and analysis to achieve the study objectives. Thus, research design, sample selection, the process of data collection, and data analysis methods are elaborated.

4.1. Research site

4.1.1. General information about Hai Duong province

4.1.1.1. Geographical conditions

Hai Duong is one of the provinces which is located centrally in the Red River Delta, with six neighboring provinces: Bac Ninh, Bac Giang and Quang Ninh to the north; Hung Yen to the west; Thai Binh to the south; Hai Phong to the east. The natural land area of Hai Duong province is 1,668 km^2, which is divided into two regions (mountainous region and plains region) based on topography. The mountainous region is in the north of the province, accounting for 11% of the total natural area, comprising 13 villages in Chi Linh district and 18 villages in Kinh Mon district. This is a low mountainous region which is suitable for fruit crops, timber trees, and fast-growing industrial trees. The remaining plains region accounts for 89% of the total natural area built up by alluvial soil from Thai Binh River. There are 12 district-level administrative units, including 2 cities: Hai Duong, Chi Linh, 1 town: Kinh Mon and 9 districts: Binh Giang, Cam Giang, Gia Loc, Kim Thanh and Nam Sach, Ninh Giang, Thanh Ha, Thanh Mien, and Tu Ky (HDSO, 2017).

Natural Resources

Land resources: The natural land of Hai Duong province is mainly covered by the Red River and Thai Binh river systems' alluvium; thus, it is generally good and favorable for the diversified agricultural activities with various plant, animal and inland aquatic products. It was classified into 3 main types of land: agricultural land, non-agricultural land, and unused land.

In 2017, land for agricultural production covered 106,984 ha, accounting for 64.1% of the natural land. The agricultural land is allocated for rice production and annual crops, which account for 39.8 % of the land area; perennial crop covers 19,497 ha, accounting for 11.7%; the forestry land covered by trees made up 9,377 ha, representing up to 5.6 % of agricultural land; aquaculture land makes up 11,270 ha, accounting for 6.8 % of the natural land and the land remaining are for gardening, which is spent for growing perennials (V. T. Nguyen, 2017). Since 1991, the area of agricultural land (especially rice fields) used for high-intensive crops (vegetable, fruits, fish) has increased significantly resulting from agricultural land policies involvement with economic reforms (Doi Moi) in 1986 as discussed in chapter 3 above. Non-agricultural land accounts for 59,559 ha, which are areas for the residential garden, housing, urbanization, and other off-farm activities representing nearly 35.7 % of the province's total natural land. Unused land occupies for 281 ha, accounting for 0.2% of the total natural land which concentrated at the areas of river basins or forestry surroundings (HDSO, 2017).

Water resources: Hai Duong province takes great advantage of freshwater resources which include the underground water and surface water reservation with over 3 million m^3 per day(HDSO, 2017). The favorable resources are results from a high density of canals and irrigated systems which provide water for both people's daily consumption and agricultural production, particularly fish production. With ownership of 32 pumping stations; 1.248km canals, ditches, irrigation water supply, the irrigation system can provide enough water for about 82.3% of crop areas. Particularly, these water resources favored for fishing, aquaculture farming activities which, recently, has developed and accounted for more than 11,000 ha (HDSO, 2017) as the areas of fish ponds. Besides, some cage culture in rivers and reservoirs also practiced in many regions of the province. Recently, as conceived, the local authorities have approved for farmers to converse some areas of low-lying and unproductive rice field into aquaculture purposes (unpublished provincial report annually).This policy, accompanying with the introduction of some technical training and advanced technologies on seeds (fingerlings), feeds, farming practices, leads to a considerable achievement of fish production with the average growth rate over 10% every year during 2005-2015 (unpublished report). This achievement of fish production has brought Hai Duong province becoming a remarkable region for supplying fish into domestic markets in northern Vietnam, especially Hanoi and some neighboring provincial cities.

Climatic characteristics

There are two features of hot (summer) and cold (winter) in the climatic characteristics in Hai Duong province. The cold feature affects significantly the seasonality of fish production due to in-appropriation for fish growth during cold winter time when many chilly-windy fronts penetrate into the region. Every year, there are 3-4 occurrences monthly in the winter season in Hai Duong province. The temperatures sometimes go down from 4 to 5 °C (7 to 9 °F). Particularly, extreme cold may often last for a long time. This characteristic is because of the daily endurance with cloudless or partial cloudless and accompanied with drizzly situations (HDSO, 2017).

In summer, the southeasterly winds generally occur in Hai Duong province. This phenomenon is caused by the predominance of the equatorial and tropical air blocks which originate from high-pressure systems in the southern hemisphere. Besides, ocean-tropical blocks come from the subtropical high-pressure system in the Pacific Ocean (Pacific subtropical high pressure). Every summer, on average, there are about 7-11 storms and typhoons in the region. The weather feature also causes some difficulties for agricultural activities such as rice cops.

Besides, spring and fall are transitional seasons in the climatic characteristics in Hai Duong province. The atmospheric circulation in these seasons represents a transition between winter–summer and summer–winter respectively.

In general, similar to many other parts of northern Vietnam, Hai Duong has four seasons: winter, spring, summer, and fall (autumn) which brings both advantages and disadvantages to develop agricultural production. However, the climatic characteristics are more suitable for aquaculture production in comparison with other farming activities. Promoting fish production to develop Hai Duong province's economy seems to be an appropriate strategy for not only local authorities but also for local farmers.

Table 4. 1 Some key indicators by economic sector of Hai Duong province (2012-2016)

		Year				
	Unit	2010	2012	2014	2016	2017
Gross Regional Domestic Product (at current price) (GRDP)	Billion USD	1.82	2.06	2.46	2.91	3.17
GRDP from agriculture, forestry and aquaculture	Billion USD	0.31	0.34	0.34	0.36	0.35
GRDP from Industry and construction	Billion USD	0.78	0.92	1.17	1.44	1.62
GRDP from Service	Billion USD	0.61	0.69	0.79	0.91	0.98
GRDP per capita	USD/ capita	1061	1186	1397	1629	1763

(*Source: Hai Duong SO 2017*)

4.1.1.2. Population and labor resources

In 2017, the average population of Hai Duong province was 1,797 thousand people (an increase of 6.4‰ in comparison with 2016), which accounted for 1.9% of the total Vietnamese population. Females account for 50.4% of the population, and males account for 49.6%. The average population density in Hai Duong is 1,077 people/km^2, which is three times higher than that of the whole country (HDSO, 2017).

The population is concentrated mainly in rural areas with 1,346,903 people, accounting for 76%, in urban areas 427,577 people are accounting for 24% (see table 4.2). In 2017, the city of Hai Duong is the most crowded with a population density of 3,207 inhabitants per km2, followed up by Gia Loc, Cam Giang and Kim Thanh districts, with a population density of 1,244; 1,233 and 1,121 inhabitants perkm2, respectively. The labor force in the working-age accounts for 57.6% (1,035,234 people) of the population, of which rural workers make up 75.3% (779,625 people). This leads to a considerable pressure on issues of employment and housing in coming years. The employment has most created by the industrial and construction sectors and reduced by the agricultural sector. The labor-working structure corresponding to the proportion of agriculture, forestry, fishery - industry, construction – services has positively shifted from 47.9% - 31.4% - 20.7% in 2010 to 36.5% - 35.0% - 28.5% in 2015. The average poverty rate decreases by 1.5% annually. During 2010-2015, on average, an annual increase in employment records at 32,942 new jobs that have been recruited by different sectors in the local economy (V. T. Nguyen, 2017).

Table 4. 2 Percentage of the rural population in total population in Hai Duong

Unit: Percentage

	2005	2010	2015
Whole province	84	80	76
City of Hai Duong	14	19[1]	10
Chi Linh	75	68	35
Nam Sach	94	90	90
Kinh Mon	81	80	78
Kim Thanh	96	95	96
Thanh Ha	95	95	96
Cam Giang	88	85	87
Binh Giang	95	95	96
Gia Loc	92	90	90
Tu Ky	96	96	96
Ninh Giang	95	95.	96
Thanh Mien	93	92	93

Source: HDSO (2011) and HDSO (2017)

Overall, Hai Duong province has very favorable labor resources, with relatively high educational backgrounds and hard-working nature. This manpower provides a good opportunity for the socio-economic development of the province in the years to come.

4.1.1.3. Socio-economic situation

Generally, Hai Duong province's economy has been promoted to develop the modern-industrial economy increasing the proportion of industry-construction and services sectors. However, the agriculture-forestry-aquaculture sector remains a large share of contribution to the local economy due to its strengths and favorable conditions of agricultural resources. Currently, Hai Duong has been ranked the fifth among 7 provinces in the Northern Economic Region in terms of total gross regional domestic products (GRDP) and GRDP per capita (after Hanoi, Hai Phong, Quang Ninh, and Vinh Phuc). Hai Duong's total GRDP reaches 1.6% of the whole country's GDP, so the province's GRDP per capita income is lower than that of the national economy, on average. In the master plan of the provincial socio-economic development, Hai Duong is objective to become a modern-industrial province that can provide various commercial products to neighboring provinces and the national market for domestic consumption and export markets for foreign exchange (V. T. Nguyen, 2017).

The current achievement of socio-economic development in Hai Duong is the rapid growth in the industrial sector with increasing employment and economic share of the industrial sector from the total of this province. The province's gross regional domestic product (GRDP) in the period of 2011-2015 increases by 7.2% per year on average, higher than that of the whole country (the targeted goal is an increase 11% annually). In 2017, the province's economic scale (GRDP current price) recorded atUSD3.17 billion, 1.74 times higher than that in 2010; GRDP per capita reached 1763USD. The proportion of value in the industry construction has significantly increased; the percentage of value in the agriculture sector (including forestry, fishery); industry-construction sector; and service sector has shifted from 20.6% - 46.3% - 33.1% in 2010 to 15.6% - 52.3% - 32, 1% in 2015 (V. T. Nguyen, 2017).

Regarding the scale of the local economy in 2015, Hai Duong province achieved 11^{th} ranking among 63 provinces and cities in the national economy; 5^{th} ranking among 11 provinces in the Red River Delta's economy. The total investment capital in the province has reached over 5.8billion USD, of which the investment capital from the state sector increased by 3.8% per year on average, the growth of the non-state sector has increased by 5.4% per year, on average. The average fund direct investment (FDI) has increased by 5.4% per year. The contribution of value in the industry-construction sector, in 2015, has been approximately 2.3 times higher than that in 2010. The provincial plan targeted to set up 18 industrial zones, of which 10 industrial zones have been put into practice and completed infrastructure. These industrial zones have attracted many entrepreneurs and investors coming to implement many factories and projects with a relative amount of investment in this province. The industrial zones have covered the proportion of new job creation about 60% annually in the region. In the future, the province plans to expand more 36 industrial sub-zones with a total area of 1,403ha, forecast to the attraction of 301 invested projects to come leasing 601ha for their operation. The aggregate value of the service sector has risen to 7.1% per year on average (goal targeted at 14% per year). The total contribution of value in agriculture, forestry, and aquaculture have on average grown 2.7% per year, over the goal of the province during this period (V. T. Nguyen, 2017).

4.1.1.4. Agricultural production

Although the agricultural production in Hai Duong province has a downward trend of cultivated land, and suffered continuously from many natural disasters and various epidemics, from 2010 to 2015, the aggregate output of agricultural production has still obtained a significant achievement, with the growth rate2.7% per year on average. The agricultural structure has achieved a positive shifting by reducing the proportion of value in crop cultivation, increasing the percentage of value in livestock and aquaculture (Table 4.3 and see on figures 4.1 and 4.2 for more details).

Table 4. 3 Value of harvested products per 1 ha of agricultural land in Hai Duong

Unit: million VND

Value of harvested products	2005	2010	2015	Comparison between 2005 and 2015
Agricultural land	38,3	82,5	125,3	+ 87,0
Crop cultivation	37,4	80,1	126,1	+ 88,7
Aquaculture	47,6	105,1	202,3	+ 154,7

(Source: Hai Duong DARD, 2015)

The value of agricultural production (including forestry and fisheries) has constantly increased over the past 10 years. In 2015, the value of the aggregate agricultural products (at current prices) reached VND 18,267 billion, an increase of 3.5 times compared to 2005. In general, during 2005-2015, the agricultural sector in total has witnessed an average increase in the growth of 2.7% per year; in which, the single aquaculture value has accounted 5.3% per year, followed up the value of the livestock production represented the growth of 4.5% per year. At the bottom, the growth of crop cultivation has expressed an increase of 2.2% per year on average due to directly impacted by increased growth in industrialization, modernization, and heavily damaged by natural disasters although the provincial authorities have managed to stabilize the area of rice production with over 60,000 ha which follows the self-sufficient security in rice food production imposed by government so far.

With the goal of developing a market-oriented economy, Hai Duong province has promoted high-value products to produce in agriculture. As a result, the product value harvested per 1 ha of area for crop cultivation (including aquaculture in some regions) increased from 94.4 million VND in 2010 to 125.3 million VND in 2015 (see table 4.3).The land use coefficient in terms of crop rotation has risen from 2.56

times in 2005 to 2.35 times in 2010 and 2.67 times in 2015. The rice yield on average constantly has recorded at 59-61 quintals/ha (one of the provinces the Red River Delta obtains the highest yield in rice production); vegetable production in all kinds of crops has gone up from 562 thousand tons to 651 thousand tons; aquatic production has been explosive from 35,659 tons in 2010 to 66,672 tons in 2015, recording an increase of 16.1% on average annually. The figures on agricultural production, particularly on aquaculture have shown that the policy of agricultural diversification has been taking effects to the land-use efficiency contributing a considerable share to Hai Duong economy in recent years and even the years to come.

4.1.1.5. Aquaculture production

In the fisheries sector of Hai Duong province, inland (or freshwater) aquaculture is dominant due to the large proportion of total fisheries sector which accounts for 95.4% - 96.6% in the total value. The fish capture sub-sector makes up for a small proportion of production and value in the total fisheries sector representing from 3.2% to 4.6%on average annually. During2005-2010, the growth of value in total fisheries increased on average by 9.3% per year, of which that of single aquaculture went up by 13.25% per year, while fishery capture recorded at 3.26% per year. The period expressed a peak in the growth of aquaculture production which resulted from the policy of the rice field conversion to fishponds in some regions in the province. However, in 2010-2015, the growth of aquaculture was leveled off, the value of aquaculture production was only slightly increased by 4.24% annually. Several reasons may cause this slow pace in the growth of aquaculture; the most influenced factor is the slow rate in the area increase of aquaculture due to the strict enforcement of local authorities on rice production to stop the movement of aquaculture development in the rice field conversion.

Table 4. 4 Value and production of the fisheries sub-sector in Hai Duong

	2005		**2010**		**2015**	
	Total value of production (millions VND)	Total production (tonnes)	Total value of production (millions VND)	Total production (tonnes)	Total value of production (millions VND)	Total production (tonnes)
Total fisheries sector	472,648	30,594	1,435,719	53,695	2,417,228	66,672
Capture	69,318	2,336	68,834	2,280	78,333	2,102
Aquaculture	403,330	28,258	1,366,885	51,415	2,338,895	64,887

(Source: Hai Duong DARD, 2017)

The statistics on fisheries sector in general and aquaculture in particular in Hai Duong has indicated that the growth in aquaculture production mostly comes from fish production connecting to regions which have converted from rice land with low and unproductive cultivation. It has increased significantly during 2005-2010 and then leveled off in 2010-2015 due to the restrictions of rice field conversion to the fish-pond.

4.1.2. Aquaculture production in Hai Duong province

4.1.2.1. The history of freshwater aquaculture in Hai Duong province

Freshwater aquaculture has a long history in Hai Duong. This freshwater fish aquaculture has evolved from wild fish capture to breeding at the homestead pond for fishermen's home consumption. It, then, gradually became a farmed fish species for many villagers. In the preliminary days, fish farming was mainly developed in small homestead ponds surrounding residential villages. Carp is uniquely selected to culture and become the predominant fish to produce for increased nutritional food in daily consumption. In the 1980s, the Vietnamese government introduced some new fish species into the existing freshwater aquaculture such as tilapia, mud carp (Rohu and Mrigal) and grass carp. Freshwater aquaculture rapidly became an important alternative livelihood for farmers in Hai Duong province where the movement of aquaculture developing strongly took place (MOFI, 1996).

In recent times, these carp species are still cultured commonly in Hai Duong. They can be put in the list of several species such as silver carp, grass carp, common carp, pomfret, (Rohu and Mrigal). Common carp (*Cyprinus capio*) is the most preferred to produce due to easy cultivation and taking advantage of green feed available in the region. Since the 1970s, Hungarian and Indonesian carps have also been brought and introduced to culture in Hai Duong as well as in Vietnam. The introduction of the new carp strains leads to some others by cross-breeding with three local carps. These hybrid carps, created from the cross-breeding, have been cultured and played an important role in the fish production in Hai Duong and northern Vietnam (Pha Anh Tuan & Bui Thi Tuyet, 2002).

In 1958, the grass carp was introduced for the first time to produce in the region through a fish promotion of local authorities. It is a herbivorous species which was very appropriate to develop the natural and climatic conditions, so it quickly became common in most areas of fish production in Hai Duong. The latter species were promoted to produce including silver carp (*Hypophthalmichthys molitrix*), Indian carp, rohu (*Labeo Rohita*) and mrigal (*Cirrhina Mrigala*) during the 1960s and 1980s. The introduction of several freshwater fish species encouraged many local farmers to develop the new farming practice – fishpond farming. The natural advantages and culturing appropriation of freshwater fish were immediately adopted by farm households and paid much attention by local authorities who later put aquaculture to become the strategic tool for developing the local economy.

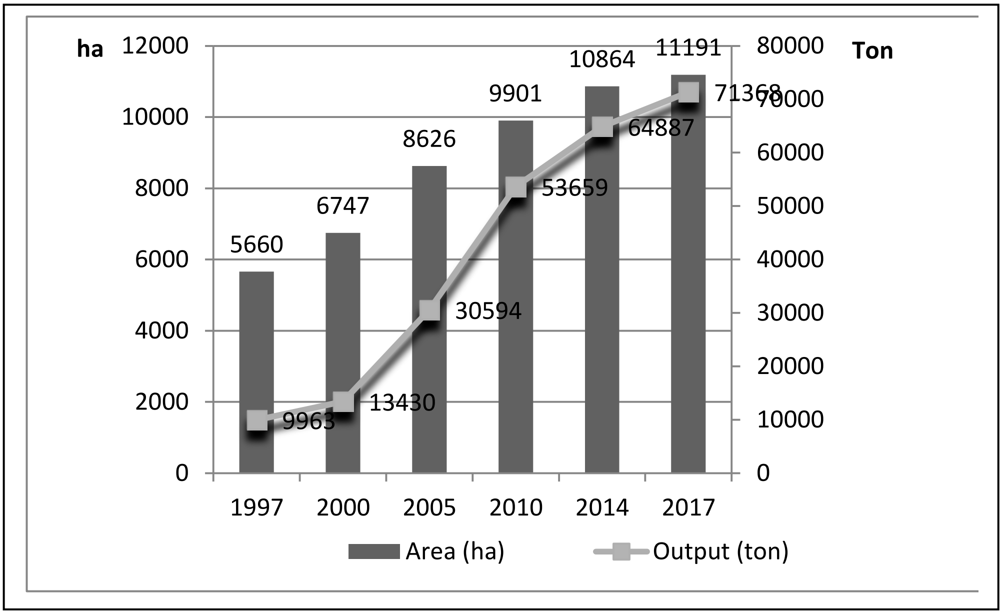


Figure 4. 1 Freshwater aquaculture production in Hai Duong (1997-2017)

According to the annual report of the fisheries department in Hai Duong province, the growth of aquaculture area was about 3.65% annually for 20 years in the past; rising from 5,660 ha in 1997 to 11,191 ha in 2017. The peak of the growth in the area of aquaculture was recorded during 1997-2005 when the Vietnamese government released some unused land and unproductive rice fields (the strict enforcement on protection rice land for converted into aquaculture purposes in regions and provinces set up a program of food security prioritizing a large area of agricultural land to maintain rice production (3 million ha) to ensure the nation producing rice food security imposed by State). Taking this opportunity, Hai Duong authorities approved for local farmers to convert some areas of unproductive rice production into aquaculture. This also explains the incredible increase in fish production in Hai Duong during 1997-2005. The growth of aquaculture production remains rising but at low pace mainly resulting from more intensification of the fish farming practices. The report has summarized the growth of aquaculture in Hai Duong from 9,963 tons in 1997 to 71,368 tons in 2017 with an increase of 10.9% every year during the period 1997-2017.

By 2016, there were 9 stations of hatcheries and the National Center for Northern Freshwater Aquaculture operating in the province. They have produced a total production of 2,122 fries, fingerlings for supplying to the local market and neighboring regions of which fries accounted for 1,871 million units, the fingerlings made up the remaining 249 million fish. The increase in fish yield, on average, has been at 3.52% annually during the period 2012-2016; recording at 6.18 tons per ha per year.

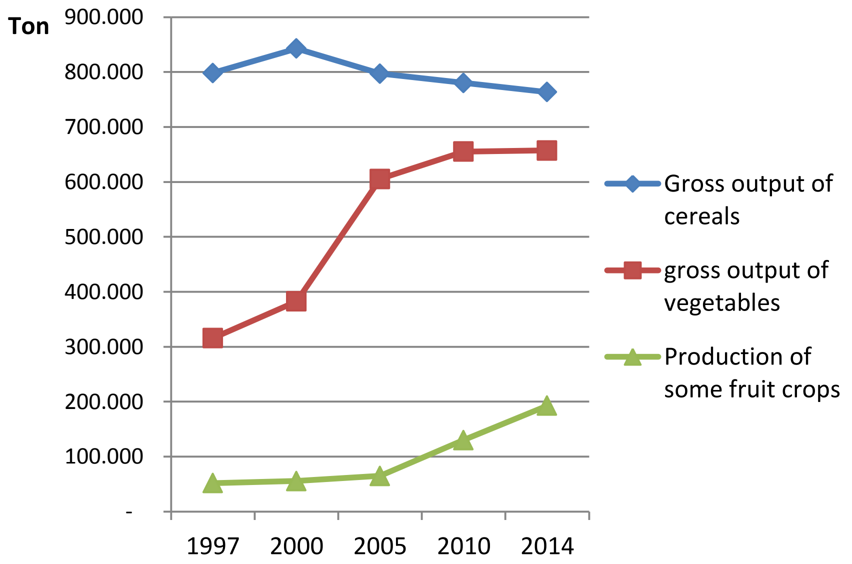
Table 4. 5 Current status of the aquaculture production in Hai Duong

	Unit	2012	2013	2014	2015	2016	Average growth
Aquaculture area	Ha	10,170	10,197	10,044	10,064	10,847	102.12
Average yield of aquaculture	tons/ha	5.4	5.63	5.81	6.01	6.18	103.52
Aquaculture production	Ton	57,757	62,684	63,269	64,887	66,672	103.44
Capture production	Ton	2,203	2,186	2,145	2,102	1,814	95.00
Aquaculture production of special species	Ton	57	58	59	64	66	102.00
Total production of fishery	Ton	60,017	64,928	65,473	67,053	68,552	103.28
Total production of fries	Million fry	2,030	1,972	2,073	2,088	1,873	98.40
Total production of fingerlings	Million fish	265	379	380	285	249	103.73
Gross value of fisheries (constant price: 2010)	Billion VND	1,473	1,620	1,710	1,735	1,762	104.70
Gross value of fisheries (current price)	Billion VND	1,879	2,173	2,284	2,396	2,742	110.02
Gross value of aquaculture products/ ha	Million VND	170,1	179,4	183,4	185,6	187,5	102.46
Aquaculture value proportion from total value of agricultural sector (at current price)	%	9,8	11.6	11.8	12.0	12.5	114.00
Total number of large-scale farms with aquaculture	Farms	78	86	93	102	108	108.54
Number of aquaculture cooperative	Cooperative	22	23	24	25	26	104.50
Total number of aquaculture employment	Person	65,131	69,562	73,039	77,063	80,632	105.368

(Source: Hai Duong DARD, 2017)

The value of gross fisheries products (at constant price 2010) has grown up in the past 5years and recorded at 2,742 billion VND (equivalent to 119 million USD) by 2016; remarked average growth rate at 10.02% per year. The value of aggregate aquaculture products per ha has risen to 2.46% annually during the period 2012-2016. The proportion of aquaculture value occupying from the value of total agriculture value (at current price) rose moderately from 9.8% in 2012 to 12.5% in 2016.This period has also represented an increase in the number of commercial aquaculture farms and cooperatives. Particularly, a considerable number of laborers' involvement with aquaculture increased during the past years reaching to 80,632 people in 2016. All these statistics have drawn a picture which shows the important role of freshwater aquaculture in the agricultural sector as well as the rural economy of Hai Duong province not only in the short-term but also in the long-term.

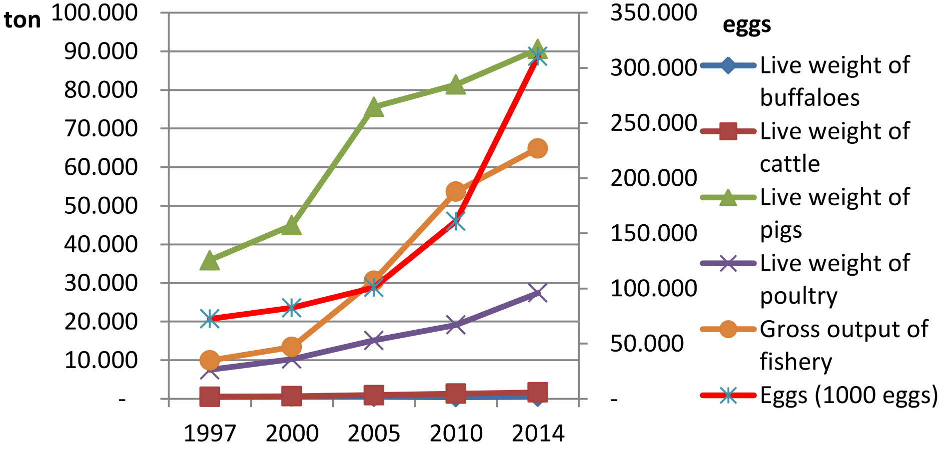
4.1.2.2. Evolution of the diversified outputs in the food production systems of the SSA models



Source: Hai Duong Statistics Office.

Figure 4. 2 The progress of the Gross Output of Different Crop Cultivation in Hai Duong (1997–2014)

`In accordance with the report of the Hai Duong province's department of agriculture and rural development, the food production system in Hai Duong has changed significantly during 1997-2005. In spite of engaging principally in rice production, the output of cereal production showed a downward trend before increasing to 842,826 tons in 2000. In contrast, the production of vegetable and fruit crops, animal husbandry, and fish production grew positively in their annual gross outputs. These outcomes resulted from the strong movement to develop the VAC systems' components in the province (see Figures 4.3 and 4.4). Along with this process, the traditional VAC model has been modified and improved to become the "hybrid" systems of aquaculture in which the components of fish ponds, livestock, and orchards have moved from the residential villages to the rice field areas and developed a more commercial orientation under the impact of urbanization and socio-economic changes.



Source: Hai Duong Statistics Office.

Figure 4. 3 The progress of Livestock and Fish Production in Hai Duong (1997– 2014)

The traditional VAC model was clearly presented and discussed in chapter 3 above in the 1980s, although it was not a far-reaching system with closed nutrient food flows. In just over a decade, the achievements of the system were undeniable; it provided a large quantity of food and foodstuffs to farmers in rural areas. Thus, the statistical data, records, and information prove that the gross output of cultivation such as vegetables and fruit crops also rose to 657 and 192 thousand tons in 2014from 315 and 51 thousand tons in 1997, respectively; this was in addition to strongly developed animal husbandry practices. The availability of eggs greatly increased as well, going from 72.5 million in 1997 to 310 million eggs in 2014 (HDSO, 2005, 1999, 2014). This period also witnessed a sharp increase of 35,895 and 7,524 tons in the output of pig and poultry production in 1997 rising 90,575 tons and 27,421 tons in 2014, respectively.

4.2. Methodology

4.2.1. Data collection

4.2.1.1. Study site

Hai Duong is centrally located in the Red River Delta region of Vietnam where rice production is the main farming practice. It is a traditional livelihood because of providing the principal source of staple food as well as income for rural farmers. Alternative land use and livelihood options such as aquaculture, fruit production, and livestock have performed as integrated components of the IAA systems which created more cash income, food and foodstuffs to meet daily subsistence needs (Lebailly *et al.*, 2015). Recently, freshwater aquaculture has been strongly promoted as the main strategy to develop the province's agricultural economy. Therefore, local authorities have approved farmers to convert unproductive and inefficient low-flooding paddy land into specialized/concentrated zones of freshwater aquaculture (HDSO, 2005, 1999, 2014).

The rapid growth in fish production has resulted from the intensification and expansibility of the aquaculture areas which are forecast to be maintained and encouraged (see Figure4.1). Generic technologies have supported the existing production systems to be more intensively applied, and much of socio-economic and institutional issues will significantly promote greater contributions from aquaculture to rural development. In Hai Duong province, the freshwater aquaculture production system has become complex and diverse, not only at the scale of the ponds, the level of fish intensification, techniques, and technology but also at the levels of integrating to other agricultural livelihoods such as livestock and crop cultivation. The introduction of aquaculture into the current agricultural systems has a great potential for smallholder farms because they can diversify their agricultural practices for generating more foods, income and employment. Therefore, the province has promoted the development of freshwater aquaculture to be the key strategy for food production systems. The boom of fish production has observed from the yearly statistic report of the province's aquaculture production since its re-establishment in 1997[1]. Regarding aquaculture's contribution to food systems and rural economic development, it is, perhaps, not surprising that aquaculture production has been the fastest growing sub-sector of agriculture in Hai Duong, since the 1980s.

Freshwater aquaculture in Hai Duong province has been considered an important economic sector due to its rapid growth. The geographic features such as an inland area (no coastlines), lowlands make the freshwater aquaculture unique and relatively notable in the Red River Delta (see Figure 4.4). Moreover, the VAC model has long

[1]Hai Duong was re-established in 1997 from the before province of Hai Hung – a merged Hung Yen and Hai Duong province.

been practiced and fish farming is also substantially diversified and progressing widespread in the region.

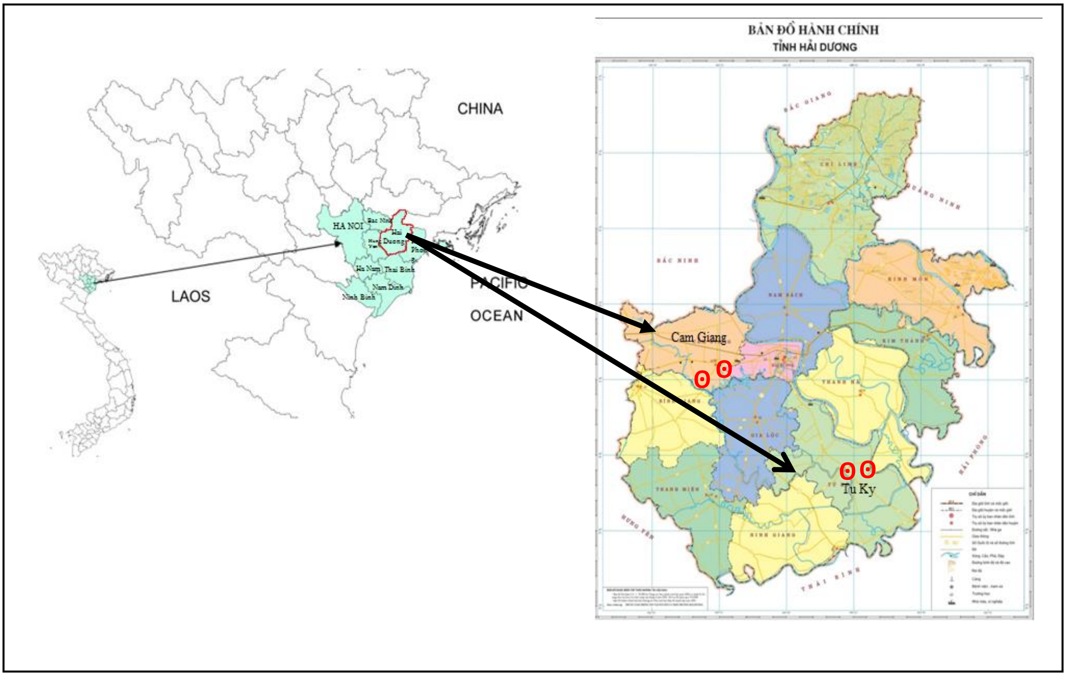


Figure 4. 4 Map of Hai Duong province and selected study sites

The secondary data and records on agricultural activities expressed a great economic contribution of freshwater aquaculture to the agricultural GRDP of Hai Duong. The rapid growth of fish farming is discussed and presented in the above section (**4.1.1.2**). As a result, this province becomes the main supply of fish for consumers in urban and suburban markets in Hai Duong city, Hanoi capital and other surrounding cities. Most aquaculture products are destined to urban wholesale markets namely Gia Loc in Hai Duong and Yen So in Hanoi where the market survey was selected to carry out. The market survey was addressed to identify the marketing channel through which the flow of fish products reaches to end customers from production accordingly. Thereby, the market localities and Hanoi suburban areas were chosen to conduct the market survey for understanding the marketing system and margin efficiency of the freshwater fish produced in Hai Duong province. The marketing investigation would reveal many facets of marketing activities and price settings which are directly associated with the efficiency of the freshwater aquaculture production models in the study sites.

4.2.1.2. Primary and secondary data collection

The survey process and sampling design

Although the agro-aquaculture system is substantially diversified and developed in Hai Duong, there is no or little secondary data (reports or records) on it. However, the secondary data on aquaculture production and area is recorded generally at the provincial department of fisheries and the department of agricultural economics at the district level. The survey samples were designed to conduct at two districts of Cam Giang and Tu Ky which are relatively representative for the diversified pattern of agro-aquaculture systems as these districts are the leading regions of aquaculture farming in terms of production and area in Hai Duong province. Similarly, at the district level, four communes namely Cam Dong, Cam Doai, Hung Dao and Tai Son were identified to carry out the study survey (see table 4.6). The process of data collection and qualification can be illustrated in Fig. 4.5. The data collection carried out 3 surveys in 2015, 2016, and 2017. Each survey will be presented in the following paragraphs.

In 2015, the first survey on aquaculture households was conducted at the selected study sites. The targeted households are not easily verified for the study at the communal level due to no records or lack of available secondary data. However, this difficulty can be solved based on practical situations through which the sampling design can be properly developed. For example, each village with good aquaculture production should be selected from each of the mentioned communes for identifying the targeted samples in the survey. This approach could provide a good protocol for the data collection in the empirical study. Following such approach, aquaculture households were randomly selected for the lists which were provided by the authorized persons who are the head of the village or director of the aquaculture cooperative at the study sites. Since then, the sample size has determined 40 targeted households at each village for the survey. Therefore, the total size of survey samples was 160 households, however, there were 9 inappropriate samples excluded during the process of data analysis. The remaining survey samples of 151 households are illustrated in table 4.6.

The second survey was designed to focus on aquaculture households who are considered to be operating the traditional VAC model in 2016. This type of household is characterized by small-scale aquaculture highly integrated with other farming practices. The most noticeable characteristics of this VAC household are the aquaculture operation at the homestead fishpond located near their home within their residential village. Although this type of household has been reduced significantly in number and changed or hybrid-modified in some characteristics of technological, economical and social aspects as compared against the original model in the past, much effort and time spending with the help of local people could be feasible to find out four expected households at each village which was conducted with the same protocol as the previous survey in 2015. As a result, the additional number of survey households symbolized for the traditional VAC model is depicted with 16 households accordingly. The total number of households was interviewed at 167 samples representing in table 4.6.

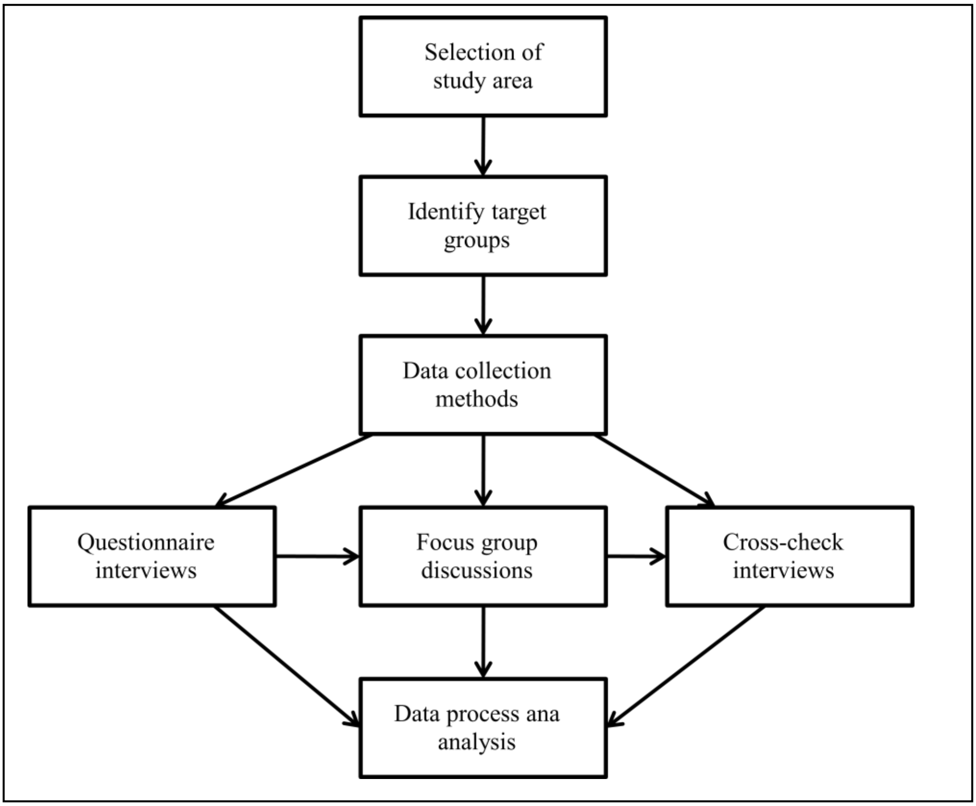


Figure 4. 5 The process of data collection for the study

The third survey was rapid market appraisal that was carried out to understand the marketing channels, market participants and marketing activities associated with fish commodities produced by the aquaculture households in the selected survey sites. The participatory method was conducted in parallel with semi-structured questionnaires to collect the data and information. This survey was mainly combined with previous results of production surveys to examine the marketing activities of the aquaculture households, middlemen and other market operators along the marketing channel of freshwater fish outputs produced in the survey regions. Thus, the participatory method was used to explore the marketing channel, market organized and nature of marketing activities by tracking the flow of the sold fish products. Group discussions with key fish farmers at every village, the actuality of farm gate wholesaling were normally speculated by two frequently contacted fish traders who then were selected for semi-questionnaire interviews at each of the selected survey villages. These fish traders are local villagers engaged in wholesale purchasing fish products at the aquaculture producers' farm gate, therefore, they were named as the farmer collectors in the study. The selection of this farmer collector was taken each two at four villages to incorporate a total number of 8 samples so-called "fish farmer collectors"(table 4.7). Besides trading fish at the farm gate, there were also some small fish traders who often purchased the small quantity from unqualified fishes rejected by large collectors of fish. These small fish traders were understood as local retailers who played an important role of marketing farmed fish products at the production to the consumption, their outlets were generally in local markets. The study selected one local retailer at each village to interview; the representative samples selected 4 local retailers at four selected villages accordingly.

Table 4. 6 Survey samples of the freshwater fish households (HHs) in Hai Duong

Location			Fish HHs	Animal /Fish HHs	New VAC HHs	Traditional VAC HHs	Total
District	***Commune***	***Village***					
Cam Giang	Cam Doai	HoaBinh	13	13	10	5	41
	Cam Dong	An Lai	8	18	9	3	38
	Subtotal		***21***	***31***	***19***	***8***	***79***
Tu Ky	Hung Dao	Lac Duc	19	15	7	4	45
	Tai Son	Thuong Son	11	19	9	4	43
	Subtotal		***30***	***34***	***16***	***8***	***88***
Total			**51**	**65**	**35**	**16**	**167**

Along the marketing chain of fish, the fish products were mainly destined to wholesale markets which are situated in the suburban areas of cities such as Hanoi and Hai Duong. The fish wholesale market in Hai Duong city is named as Gia Loc and another in Hanoi is called as Yen So. While Yen So wholesale market possesses about 100 officially established/registered fish traders every day, Gia Loc wholesale market accounts for the figure less than one half of the total officially established/registered fish traders at the wholesale market in Hanoi. There were two types of freshwater fish wholesalers at the wholesale markets defined in the study. The first fish wholesaler is a commissioned wholesaler. The second one is the merchant fish wholesaler. At each market, the study selected ten wholesalers (including commission wholesalers (5) and merchant wholesalers (5)) as indicated in (table 4.7). Also at each wholesale market, 3 fish retailers were chosen to investigate through the semi-questionnaire in this survey. They were understood as urban retailers as their market outlets were at the surrounding places of the wholesale markets in suburban and urban areas. Thus, the study had 10 fish retailers in total samples including 6 urban retailers at urban areas and 4 local retailers at the areas of fish production (see table 4.7).

Table 4. 7 The sample size of the targeted groups for marketing channels of the freshwater fish products in Hai Duong

Target Group	Sample size
Fish farmer	167
Farmer-collector	8
Commission wholesaler	10
Merchant wholesaler	10
Retailer	10
Total	**205**

The rapid market appraisal method was applied to understand the flow of the fish outputs going into the markets, and then to identify the main marketing channels of the sold fish products at the research region. This method could also help to estimate the fish producers' share in the consumer's price, marketing costs and margins of the marketing concerning market participants along the main marketing channels of the fish commodities in the study areas. Moreover, the marketing strategies, marketing activities and encountered problems of the fish producers and the main marketing actors could be understood and analyzed such as the scale of production, product quality, pricing settings, market demand, bargain power and other concerns that may be affected to the economic efficiency of the small-scale aquaculture operated by fish farmers in Hai Duong province.

4.2.2. Data analysis

4.2.2.1. Farm budget of the freshwater fish enterprise

Economic efficiency is defined by a difference between total revenue and total cost. In order to examine how profitable can earn from small-scale aquaculture to fish farmers in Hai Duong, the farm budget technique introduced by (Engle, 2012) was employed to data analysis. Households' farming enterprises may or not be profitable as the total cost can be higher than the revenue-generating from fish production. A farm budget of fish production is simplified to express in table 4.8.The similar approach was employed for other farming activities to estimate the total whole farm income at each fish household.

In summary, the enterprise budget can present a measure as net farm income at the bottom line. This measure, in the income statements for each farm, may indicate a profit or loss for fish production. The fish revenues in the income statement are normally considered for a particular year. Thus, production expenditure is identified and included in both cash expenses and non-cash expenses such as annual depreciation. Depreciation is really compulsory to add in all measures of profit to examine the fish production/business can generate enough cash to accumulate an amount for replacement of all equipment when it wears out. It also helps to determine the fish is viable to get profitable in the long run (Engle, 2012; Menezes *et al.*, 2017). Total operating expenses are incorporated from all cash and non-cash expenses. The cash interest paid (if available) for the fish for the mentioned year is had to add in total operating expenses to calculate the total expenses for the farm. The net farm income from fish operations is defined by subtracting total expenses from total revenue generating from fish.

Table 4. 8 The enterprise budget of the freshwater fish production

Item	Description	Unit	Quantity	Unit price	Total amount (LC)
Gross receipts (gr)					
Sales of fish species A	Average revenue of marketable size of fish A	Kg	q_A	p_A	$gr_A = q_A \times p_A$ (1)
Sales of fish species B	Average revenue of marketable size of fish A	Kg	q_B	p_B	$gr_B = q_B \times p_B$
Sales of fish species C	Average revenue of marketable size of fish A	Kg	q_C	q_C	$gr_C = q_C \times p_C$
Total gross receipts (TGR)		**LC**			$TGR = gr_A + gr_B + gr_C + \ldots$ (2)
Variable costs (vc)					
Fingerlings	Average expenditure of fish used for stocking	No	q_1	p_1	$vc_1 = q_1 \times p_1$
Feed	Average expenditure of artificial feed	Kg	q_2	p_2	$vc_2 = q_2 \times p_2$
Fertilizers					
Ure	Average expenditure of Nitrogen-based inorganic fertilizer	Kg	q_3	p_3	$vc_3 = q_3 \times p_3$
Diammonium phosphate	Average of expenditure of Phosphorous-based inorganic fertilizer	Kg	q_4	p_4	$vc_4 = q_4 \times p_4$
Lime	Average expenditure of material used to correct water acidity	Kg	q_5	p_5	$vc_5 = q_5 \times p_5$
Organic fertilizer	Average expenditure of	Kg	q_6	P_6	$vc_6 = q_6 \times p_6$

	compost, organic waste, ..				
Veterinary and pharmaceutical products		Kg	q_7	p_7	$vc_7 = q_7 \times p_7$
Formalin	Average expenditure of this disinfectant/ sanitizer	Kg	q_8	P_8	$Vc_8 = q_8 \times p_8$
Potassium permanganate	Average expenditure of this disinfectant	Kg	q_9	p_9	$vc_9 = q_9 \times p_9$
Employees					
Field workers	Average level of remuneration paid to labors in field activities on a full-time basis	No	q_{10}	P_{10}	$Vc_{10} = q_{10} \times p_{10}$
Guards	Average level of remuneration paid to security staff	No	q_{11}	p_{11}	$vc_{11} = q_{11} \times p_{11}$
Annual cost of service providers	Average level of remuneration paid to temporary specialized staff	Kg	q_{12}	p_{12}	$vc_{12} = q_{12} \times p_{12}$
Electricity	Average level of expenditure on electricity consumed on the farm during the year	Kwh	q_{13}	p_{13}	$vc_{13} = q_{13} \times p_{13}$
Other variable costs					
Maintenance and repairs	Average level of expenditure made on various maintenance and repairs on the farm during the year	LC			vc_{14}
Fuel and lubricants	Average level of expenditure made on all kinds of fuel and lubricants needed on the farm during the year	Kg	q_{15}	P_{15}	$vc_{15} = q_{15} \times p_{15}$
Water	Average level of expenditure on water resources consumed on the farm during the year	Kg	q_{16}	p_{16}	$vc_{16} = q_{16} \times p_{16}$
Interest on operating loan	Average level of interest paid to lenders (financial institutions..) of operating funds	kg	q_{17}	p_{17}	$vc_{17} = q_{17} \times p_{17}$

Total variable costs (TVC)		LC			$TVC = vc_1 + \ldots + vc_{17}$
Fixed costs (tc)					
Interest on investment loan	Average level of interest paid to lenders (financial institutions...) of the capital investment	%	q_{18}	p_{18}	$fc_{18} = q_{18} \times p_{18}$
Land taxes	Average level of annual amount of money paid as agricultural land taxes during the year	LC/ sao			fc_{19}
Other fixed costs	Average level of other fixed costs not identified above	LC			fc_{20}
Depreciation					
Infrastructure	Average level of the estimated annual reductions in the value of farm infrastructure	LC			fc_{21}
Equipment and machinery	Average level of the estimated annual reductions in the value of equipment and machinery	LC			fc_{22}
Ponds	Average level of the estimated annual reductions in the value of ponds	LC			fc_{23}
Total fixed costs (TFC)		LC			$TFC = fc_{18} + \ldots + fc_{23}$ (4)
Total costs (TC)		LC			$TC = TVC + TFC$ (5)
Gross margin (GM)		LC			$GM = TGR - TVC$ (6)
Net returns (NR)		LC			$NR = TGR - TC$ (7)

Sao = 360 m^2; kg = kilogram; kWh = kilowatt-hour; LC = local currency; no = number

Source: adapted from (FAO, 2017)

A farm may make a profit for the year when net farm income is positive, on the contrary; it expresses the farm a cash loss. There are some measures which can include in the calculated sheet such as the return to the operator's equity, capital, and unpaid/family labor if they are available in the fish production. These indicators may further be represented by the four principal factors of production like land, labor, and capital productivity to refer to the degree of management. The statements of income can also be illustrated with several criteria such as the proportion of net farm income earned by a unique factor of production. For instance, returns to total assets in the fish operation, and to the equity (total capital investment owned by the fish farmer) could be accessible. Besides, a ratio of operating profit margin (net profit or the remaining from gross revenues after subtracting expenses) can also be identified (Engle, 2012).

4.2.2.2. Mapping the market participants and cost-benefit analysis in the marketing channels of freshwater fish outputs

(Kotler *et al.*, 2014) defines direct marketing channels as a method of marketing the commodities directly to the consumer, used by the manufacturer/ producer with no middle man or intermediary involved. One or more middlemen participated in the marketing chain which attributes to the intermediated marketing chain or channel. On the other hand, the marketing of the live fish outputs practiced by smallholder farmers are complex and diverse activities which might concern to the various intermediated marketing channels including the direct sale considered the direct marketing channel attributed to the direct sales of fish outputs to consumers accomplished by fish farmers (Edoge, 2014).

Therefore, the market survey focusing on the marketing of the freshwater fish outputs from the SSA models employed the market rapid appraisal with the participatory approach. This approach enabled the market participants to indentify their characteristics, marketing costs, marketing margins and other activities involved with the marketing of the freshwater fish outputs generated from the SSA models in Hai Duong province. The market data and information of the marketing activities which directly were associated with the freshwater fish farmers and market participants along with the marketing channels were gathered, analyzed and discussed in the study region. With these data and information collection, the flows and the marketing channels of the fish products marketed by fish farmers including the market participants along the marketing channels were mapped based on the participatory discussions of the involved market participants. In order to under deeply the economic benefits of each market participants in the marketing channels of the live fish commodities, the fish farmers' share in the retail prices and the profitable levels of the business in fish trading which accounted by fish farmers and the market participants along the marketing channels were calculated, analyzed and discussed for the further conclusions and implications in the study. Thus, the cost benefit method was mainly used to calculate the marketing costs and margins of the market participants. These study calculations were examined by the T-test and ANOVA tests which significantly supported for the conclusions and implications such as the direct sales of fish outputs, the differences in farm gate prices of fish products associated with the grading involvement with market demand and requirements and the differences in the fraction of the "premium quality" fish outputs concerning the differences in the net returns of fish products from the SSA models in Hai Duong province.

Besides, the Likert scale method was used to measure and understand the negotiation competences between the fish farmers and fish traders referring to the internal capacity of fish farmers during the marketing of their farmed fish outputs. This method was also employed to examine the satisfactory levels of fish farmers with their current marketing situation of fish outputs referring to the external factor of the marketing constraints and problems encountered in the study areas. Thus, the 3.0 of the decision rule was applied to make the argument and conclusions accordingly. This rule can be considered as the follows:

Decision point: $< 3.0 \Rightarrow$ Rejected

$> 3.0 \Rightarrow$ Accepted

Decision rule : $x = (\Sigma x) / n = (5+4+3+2+1)/5 = 15/5 = 3.0$

Where $\bar{x}$ = mean

Σ = summation

x = value Likert points

n = number of respondents

Calculating marketing cost

The marketing cost of a product/service refers to the expenses incurred by different middlemen in the process of performing various marketing functions to move product/service from producers to the end consumers (A. Khan & Raha, 1999). Different marketing stages of the fish commodities incurred several related costs such as the costs of shop rent/land tax, fuel, materials (ice, salt, water, electricity, etc.), wage (hired labors), repairs and maintenance (motorbikes, trucks...), transportation (hired shipment of fish commodities), transaction (tel. bill, etc.), interests (loans, credits..), tax and fees (transportation tolls, market fee), wastage (loss of dead fish) and miscellaneous expenditure. The total marketing cost can be formulated as follows:

$C = Cp + C1 + C2 + ... + Cn$

Where

C = Total marketing cost

Cp = Cost of the fish sales with farm gate prices paid by the fish farmer collectors

C1, C2, C3 . . . . .Cn = Cost incurred by the number of market participants in the marketing channel.

However, the study was mainly calculated the marketing costs of the market participants at each stage along with the marketing channel to determine their marketing margin based on 100 kg of mixed fish commodities due to the fish commodities purchased by the fish farmer collector were produced in the polyculture with different farmed fish species in the areas of fish production in Hai Duong.

Fish farmer's share in the retail price

The fish farmer's share in the retail price was the cost of the purchased fish commodities paid by fish farmer collectors in the absolute calculation which was expressed as the percentage between the price received by the producer/farmer (Pf) and the price paid by the consumer (retail price - Pr). For example, Pr was the retail price, the fish farmer's share in the retail price (Ps) can be illustrated as follows:

Ps = (Pf/Pr)*100

Where

Ps: The fish farmer's share in the retail price

Pf: The farm gate prices of fish products purchased by farmer collectors.

Pr: The retail price of the farmed fish commodities that the retailers received from fish buyers (the retailers' customers).

The fish farmer's share in the retail price was also calculated from a basis with 100 kg mixed fish products which retained the basic unit of the calculations and comparisons in the entire discussion of this market survey.

Marketing margin

The marketing margin of fish commodities was determined by the difference between the value of 100 kg of mixed fish commodities which was ready for sale from the farm gate of the fish farmers and the cash amount received by the fish retailer from the fish buyers based on the same calculation with 100 kg of fish commodities in the retail markets. The absolute marketing margin of a market participant was the difference between the total payments (the marketing costs + purchasing prices of the fish commodities) and receipts (the selling prices of the fish commodities) of that market participant (i^{th} participant). This marketing margin was also measured as an indicator of the percentage as illustrated below:

The absolute margin of i^{th} market participant (Ami)

Ami = Pri – (Ppi + Cmi)

Percentage margin of i^{th} market participant (Pmi)

$$P_{mi} = \frac{P_{Ri} - (P_{Pi} + C_{mi})}{P_{Ri}} \times 100$$

Percentage make-up of the i^{th} market participant (Mi)

$$M_i = \frac{P_{Ri} - (P_{Pi} + C_{mi})}{P_{Ri}} \times 100$$

Where

Pri= Gross value of receipts per 100 kg of mixed fish commodities

Ppi = Purchasing value of mixed fish commodities per 100 kg

Cmi = Cost incurred during the marketing per 100 kg of mixed fish commodities.

Therefore, the absolute margin consisted of the profit of a market participant and the costs which accrued to his own account for the100 kg of mixed fish commodities accordingly such as the depreciation value of the initial capital investment (including marketing facilities), the interest of the loans and other expenditures in the business of fish trading.

5

ECONOMIC ANALYSIS OF DIFFERENT FRESHWATER SSAMODELS IN HAIDUONG PROVINCE

This chapter discusses the dynamic and diversified changes in the agro-aquaculture systems when freshwater aquaculture has been introduced and developed into the existing farming systems in Hai Duong province. The economic efficiency and effectiveness, and the fish households' diversity on food and income through the different SSA models are also assessed and reviewed. It comprises three parts. The first part introduces the diversification of four identified freshwater SSA production models for producing food and foodstuffs supplying to their family food security and domestic consumption as well as markets in the Red River Delta. The second part discusses the degree of access to main inputs and technological knowledge of farmers in fish production. The third part of this chapter considers the economic analysis of the different SSA production models. It also looks into the contribution of the freshwater SSA production models to the farmers' livelihoods as home consumption and increased on-farm income.

The main study findings of this chapter have been presented in the paper research article in open access: Van Huong *et al*. (2018). Efficiency of different integrated agriculture aquaculture systems in the Red River Delta of Vietnam. Sustainability, 10(2), 493.

5.1. Freshwater SSA production models producing food and foodstuffs in Hai Duong province

5.1.1. Major characteristics of freshwater SSA models in Hai Duong province

To understand the context of aquaculture development, group discussions were used to identify the basic features and characteristics of the existing freshwater aquaculture production systems in the survey sites. The findings showed that fish farms usually have three components: (1) the homestead and perennial trees (fruit orchards created by pond dykes), (2) the pond, and (3) the rice field. The livestock, fruit orchards, and the pond are usually located together. The homestead area consists of livestock, fruit orchards, vegetables, and other trees that are located close to the residence, with an average area of around 433 m2. Besides, the link between the components, the scale of livestock production, area and number of fruit trees, and the household's economic status as well as their experience in fish production were determined (see Table 5.1).

It was reported by the households with animal/fish production (AF systems) and commercially intensive fish production (FS) systems that their fish cultures in the past originated with the traditional homestead VAC model which, to a certain extent, has nearly disappeared in comparison with its initial characteristics. However, the modern VAC and other systems have been progressed due to the number of farmers who have a constant relief that the current VAC model has been being expanded since the increase in income generation obtained from enlarging the scale of this model's components such as fish ponds, orchards, and animal husbandry production. VAC households are, thus, not characterized as aquaculture ventures. On the other hand, most farmers belonging to AF or FS household groups reported that they could obtain the current operation of fish and livestock production that has been a result of a long time to accumulate the knowledge and experience in aquaculture, as well as capital investments which used to be a part of profits and income generating from the traditionally small VAC model at the initial time.

However, many respondents in the discussion also confirmed that there have been some of the households who are operating their fish production near their home within the permanently residential village as before, their fish farming has been symbolized for many similar characteristics of the traditional VAC model as before. These households' freshwater fish production model is characterized by the very low input aquaculture and intensive orchard. It presents a high degree of integration with the available nutrient flow of food in the close system and between subsystems. The subsystems of animal husbandry and horticulture are often small to medium. It can produce several pigs and some chicken which are mainly for farmers' home consumption. In the garden, there are also some perennial fruit trees and annual vegetables which provide farmers' families with a significantly daily nutritional intake.

Interestingly, in Hai Duong province, it is very common with concentrated zones of aquaculture production which has been a result of local governmental efforts on the agricultural land policy that gave farmers the rights of the land conversion to develop the fish production from the low-flooding and unproductive rice fields. This policy was very soon to encourage many farmers who accumulated a certain experience and knowledge in aquaculture to adopt to start aquaculture production from their lowlands of paddy. In the beginning time of fish production, fish farmers reported that they could get some support from local government and authorities such as several technical training on fish farming and/or new species introduction. These supports are really valuable for them to avoid some difficulties in production during the start of fish production. Besides, few farmers also confirmed that they got the fingerlings and some basic input materials for their first beginning of fish production through local authorities' support of agricultural extension services at district levels. These farmers were considered as the pilot testing for introducing fish farming in their communities. In the later years, the local government and authorities set up a support policy to encourage more farmers to involve in fish production through the mechanism of provision of basic infrastructure for fish farming such as water canal supply, roads, and electricity systems. However, it required a consolidated area of fish production reaching 10 ha or more under the planned or projected rice fields as assigned. In line with the stimulus of the support policy ,the appropriation and high economic returns of fish production have to lead to the explosion of aquaculture production converted from the unproductive paddy regions.

Table 5. 1 Classification of freshwater fish production models in Hai Duong

Models	Location	Integrated Levels between SubSystems	Farm Household Situations	Animal Husbandry	Horticulture
Very low input aquaculture - intensive orchard (Traditional VAC model)	Inside village	High with closed available nutrient flow of food	Experience in aquaculture production, prevalence of rice production	With or without medium pig production (5–15 pigs/HH), or small to medium scale poultry production	Small/medium number and area of perennial trees
Low input aquaculture - intensive orchard (New VAC model)	Outside village	High with closed nutrient flow of food	Less experience in aquaculture production	With or without small pig production (1–10 pigs/HH), or small to medium scale poultry production	Large number and area of perennial trees
Medium input aquaculture - semi-intensive orchard (Animal + Fish production—AF model)	Outside village	Medium	Experience in aquaculture and animal production	With or without medium pig production (10–50 pigs/HH) or commercial poultry production	Small number and area of perennial trees
High input aquaculture - extensive orchard (Commercially intensive fish production—FS model)	Outside village	Low with more external supplement of food flow	Experience in aquaculture	Self-subsistence poultry production	Small number of perennial trees

Source: Group discussion of key informants in the research site, 2015–2016.

Therefore, the agricultural system and farming activities have been much changed from the concentrated aquaculture zones since farmers could diversify their fish farming integrated with other farming practices such as perennial tree growing, vegetable production and even livestock raising. The following paragraphs and sections will focus on the discussion about the small scale freshwater fish production models of which fish culture is integrated with other agricultural enterprises to form some new predominant models of integrated aquaculture models. They are likely to be modern fish farming models in Hai Duong such as "hybrid" VAC (New VAC), Animal husbandry cum Fish system (AF model), and the intensively commercialized Fish production (FS model).

While the traditional VAC model has its components with small scale, including garden, fishpond and livestock which are intensively utilized the households' resources and available nutrient flow of food from agricultural wastes and farmed products, the New VAC system has its own components with a larger scale. The fish and other farming enterprises need more inputs from outside of the system. In contrast, it also creates more outputs to provide for households' consumption and a surplus of produce for cash generation. This New VAC model is also characterized by low input aquaculture and intensive orchard. The closed nutrient flow of food in the model is relatively high as compared with the AF and FS models; although farmers operating the New VAC model have less experience in aquaculture production. Besides, this system tends to cultivate a large number and area of perennial trees as this orchard could provide farmers a considerable amount of income from selling the fruits as well as some kinds of vegetables. In the context of no access to off-farm activities, this New VAC could be an appropriate solution for farmers to take advantage of limited land resources and available sources of agricultural by-products for their livelihoods.

With ownership of the AF system, households pay more attention to the culture the fish species due to high economic benefits. However, the fish production is still medium input provision in line with the semi-intensive orchard which mainly utilizes the manure from livestock farming. The integrated levels between subsystems are at the medium as farmers use more commercial feed purchased from markets for their farming practices such as feed for fish, pig, chicken... Farmers have accumulated enough knowledge and experience when they increase the scale of aquaculture and animal production.

While households with FS models enrich their knowledge and experience in fish farming and expand the scale of single aquaculture production with more use of commercial feeds, households operating the traditional VAC model are trying their best with small fish ponds to enhance productivity by increasing the labor use. It is because the farmed species diversified and some species require more natural on-farm available or home-made feeding preparation such as grass carp and common carp. Collecting grasses for grass carp and cooking rice bran for common carp are two activities much time consumed. Furthermore, the collocation of housing and fish ponds makes convenience for every family member engaged in fish production daily.

The study findings of the SSA models are presented in table 5.2 through which the ANOVA test on family size has a statistical significance for the FS model as the smallest among four SSA models. This refers to a fact that agricultural diversification in terms of increasing more farming enterprises normally requires a considerable number of laborers to involve in farming practices during the peak of seasonal time of crop or animal production. Therefore, with a lack of labor, the FS model households usually prefer to intensify single fish production in a manner that more commercial products generate more income for themselves as compared with other model households.

The ANOVA tests on the owned ponds number and production cycle time also show a significant difference between the traditional VAC and three other models. It was the fact that all the traditional VAC model households own only a single pond for their fish production and the fish products are usually harvested partially for home consumption during the production cycle which was only completed at the end of the year before Tet holidays when their fish food and the local market became highly demanded. This really differs from the other SSA models of which fish farming is used to produce more intensified in a shorter cycle and objective for more income.

Table 5. 2Comparable characteristics of different SSA production models in Hai Duong province

	Unit	FS Model (N=51)		AF Model (N=65)		New VAC Model (N=35)		Traditional VAC Model (N=16)	
Age	Year	52.1^{a,b}	(9.79)	52.5^{c,d}	(8.35)	55.8^{a,c}	(8.36)	57.00^{b,d}	(4.35)
Household size	People	3.02^{a,b,c,d}	(1.09)	3.80^{a,b}	(1.12)	3.51^{a,c}	(1.40)	3.63^{a,c,d}	(1.71)
Number of labourers	Labour	2.45^{a,b}	(0.92)	2.86^{a,b}	(1.10)	2.66	(1.45)	2.63	(0.96)
Agriculture land	Sao$^{(\#)}$	18.7^{a,c,d}	(9.10)	18.3^{b,c,d}	(7.76)	11.7^{a,b,c}	(3.82)	10.25^{a,b,d}	(2.29)
Homestead land	m^2	353.0^{a,b,c}	(271)	512.3^{b}	(430)	459.5^{a,c,d}	(228)	320.00^{b,c,d}	(109)
Paddy land	Sao$^{(\#)}$	4.20^{a,c}	(3.48)	6.17^{b}	(3.10)	5.20^{a,c,d}	(3.42)	7.81^{a,d}	(2.14)
Area of fruit trees	m^2	230.0^{a,c}	(371)	317.2^{b,c}	(600)	515.6^{a,b,c,d}	(878)	131.25^{a,c,d}	(76.58)
Number of fruit trees	Tree	36^{a,c}	(56.00)	45^{b,c}	(64.75)	103^{a,b,c,d}	(171.20)	17^{a,c,d}	(7.85)
Number of animals raised	Heads of animals	23^{a,b,d}	(26.36)	188^{a,b,c}	(234.4)	39^{b,c,d}	(36.01)	64.69^{a,c,d}	(17.86)
Area of aquaculture land	Sao$^{(\#)}$	14.49^{a}	(9.58)	12.12 ^{a}	(7.01)	6.51^{a,}	(2.46)	2.44^{a}	(0.63)
Number of owned ponds	Ponds	2.27^{a,b,d}	(1.56)	1.88^{a,b,d}	(0.89)	1.34^{a,b,c}	(0.48)	1.00^{a,b,c,d}	0.00
Experience in aquaculture	Year	16.5^{a,c}	(7.23)	17.6^{b,c}	(7.27)	14.1^{a,b,c}	(4.85)	17.31	(2.02)
Stocking density	Fish/m^2	1.55^{a,}	(1.11)	1.62^{b,}	(1.15)	1.49^{c,}	(0.89)	1.51^{b,c}	(0.35)
Kinds of fish	Fish/stocking	4.31^{a,d}	(1.22)	4.37^{a,d}	(1.18)	4.31^{a,d}	(1.39)	6.13^{a,d}	(0.88)
Production cycle time	Months	9.80^{a,b,c,d}	(2.59)	10.50^{a,b,d}	(1.88)	10.70^{a,c,d}	(2.03)	12.00^{a,b,c,d}	(0.00)

$^{(\#)}$1 Sao = 360 m^2; Different superscripts. (^{a,b,c,d}) denote a significant difference between means within rows (p< 0.10). Parentheses are standard deviations. Source: survey, 2015–2016.

While the AF model seems to be a transitional model between the FS model and New VAC model due to no ownership of any uniqueness of its characteristics in terms of ANOVA test, the New VAC model is characterized by the largest area of fruit trees in parallel with the highest number of fruit trees in the agricultural activities. The farmers operating this model seem to be the most efficient farmer who is nutrient-enriched by the diversification of agricultural food products available at their farms.

5.1.2. Access to the fish production inputs and technology

5.1.2.1. Hatcheries and fingerlings

As the main inputs of aquaculture production, seed (fry/fingerlings) input plays a very important role in improving the productivity and yield in the culture process. In Hai Duong, there are eleven stations of hatcheries in which two are public (owned state) hatcheries and nine are private hatcheries. Most of the fries/fingerlings of these hatcheries are provided into markets through middlemen as “the fingerling traders”. The study result shows that 55.1% of fish households have access to fingerlings from state hatcheries, the remaining (44.9%) are from private providers. Many fish farmers complained about the low quality of fry/fingerlings from these private hatcheries because it did not meet their quality expectations. The limited investment, facilities, and techniques can be explained for the problem of low quality in the private hatcheries. Some private hatcheries have imported fries from neighboring countries such as China, Thailand, the Philippines… to produce fingerlings in their farms to supply to local markets. This business method of private hatcheries is the main cause of the problems of low quality in the fingerlings as they are out of control of the origin of the imported fries.

Fish is the major income source for households operating the commercial fish model (FS) and Animal Fish model (AF). Therefore, fingerlings are an important input for fish production and they paid much attention to the quality of fingerlings. From the study, households of these groups most actively sought the qualified fingerling suppliers; they hoped to reduce the problem of poor quality fingerlings by getting better linkages and commitments based on different types of seed contracts. In spite of that, the majority (75%) of these contracts are only verbal contracts. The evaluation on seed quality of the households also reflected the corresponding results (over 70%) of the households rated the fingerlings in their fish production as good quality. The Chi-square test of variables referring to sources of fry/fingerlings (originated from private or public hatcheries) shows an association of the relationship between the source of hatcheries and the models. The Chi-square test of the self-evaluation of seed quality is presented strong evidence of a relationship between the seed quality and different models (Chi-square = 188.11; df = 6; and $P<0.001$; see table 5.3)

Table 5. 3 Evaluation of access to fingerling sources and seed quality

	Traditional VAC Model (N=16	New VAC Model (N=35)	AF Model (N=65)	FS Model (N=51)	Pearson Chi square	P-value
1. Fry/fingerling providers					**(df = 3)**	
Private hatcheries	16 (100.00)	23 (65.71)	26 (40.00)	10 (19.61)	**41.257 [a]**	**0.0001**
Public hatcheries	0 (0.00)	12 (34.29)	39 (60.00)	41 (80.39)		
2. Having contracts with seed providers					**(df = 3)**	
Yes	1 (6.25)	12 (34.29)	27 (41.53)	38 (74.51)	**28.387**	**0.0001**
No	15 (93.75)	23 (65.71)	38 (58.47)	13 (25.49)		
3. Awareness of seed quality and origin					**(df = 6)**	
Access	2 (12.50)	6 (17.14)	22 (33.85)	17 (33.33)		
Limited access	5 (31.25)	20 (57.14)	30 (46.15)	15 (29.41)	**15.651**	**0.016**
No access	9 (56.25)	9 (25.71)	13 (20.00)	19 (37.25)		
4. The first information provider of seed quality and origin					**(df = 6)**	
Relatives/neighbouring farmers cultured fish	10 (62.50)	26 (74.29)	52 (80.00)	35 (68.63)		
Local government and authorities	4 (25.00)	7 (20.00)	3 (4.62)	6 (11.76)	**10.777**	**0.096**
Other	2 (12.50)	2 (5.71)	10 (15.38)	10 (19.61)		
5. Priority in buying seeds					**(df = 3)**	
Quality	12 (75.00)	28 (80.00)	42 (64.62)	39 (76.47)	**3.464**	**0.325**
Quality and price	4 (25.00)	7 (20.00)	23 (35.38)	12 (23.53)		
6. Self-evaluation of seed quality					**(df = 6)**	
High	2 (12.50)	27 (77.14)	48 (73.85)	37 (72.55)		
Medium	8 (50.00)	4 (11.43)	12 (18.46)	12 (23.53)	**188.11**	**0.001**
Low	6 (37.50)	4 (11.43)	5 (7.69)	2 (3.92)		

Bracket is percentage. (a) 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.28

Source: survey 2017

Overall, more than 72% of the households considered fingerlings' quality as the most priority. Only 28.1% of the households, however, were able to access the awareness of seed quality and origin provided for them by the fingerlings suppliers. This showed that the transparency of information about fish origins was still problematic. The reason was explained by the fact that most of the households did not come directly to the hatcheries to buy their fingerlings. Fingerlings were mostly provided for fish households through "the fingerling traders" who played as middlemen in the input of fingerlings for fish producers. They bought fingerlings from hatcheries and transported them to sell to fish households at the farm gate. The core of this transaction comes mainly from the trust between the seller and buyer because these fingerling traders are local people and they had long experience in fingerling business that made them a certain reputation and prestige. However, the fingerlings' quality was still a very robust problem in fish farming communities because some private hatcheries could not control and manage their fingerings' quality stably. Households could only find a suitable solution for this matter through more actively exchanging and sharing their information about the seed quality and origin among them. And thus, 73.7% of fish households could reach the information about seed quality and origin through their relatives/neighboring farmers cultured fish. The information provider of local government and authorities such as departments of agricultural extension at provincial and district levels, communal cooperatives and other organizations and institutions was able to be accessed by only 12% of the fish producers. The rest (14.4%) of the households were able to access the information of seed quality and origin from the other provider including fingerling middlemen, newspapers, radios and other means of media. This result reflects a recommendation that the supports of local government and authorities on control and management as well as provision the information about the fingerling quality and origin are still limited if the matter can be improved the fish farmers can be better access to good sources of fingerlings which will increase the efficiency and productivity for fish households in the local communities.

There is a trend of getting the linkages and commitments between fish farmers and fingerling providers in households who were more specialized on fish production operating the FS, and AF model. The linkages and commitments are embodied in their contracts of fingerlings committing to quality warranty. This leads to getting a high evaluation of seed quality (73.8%) and (72.5%) for the households operating the AF and FS model, respectively. The Chi-square test of having contracts with seed providers among the SSA models illustrates a high association of a relationship between having and without contracts with seed suppliers (Chi-square = 28.387; df = 3; and $P<0.001$). However, households of the traditional VAC group did not approve with the same pattern of evaluation on seed quality (12.5%) for fingerlings for their fish production, they could still attain a good yield and productivity of fish. It could be explained by the typical characteristics of their farming. With small-scale aquaculture, the traditional VAC households normally owned only one pond that they could not separate the fish culture into two-stage "fingerling nursery" and "grow out". Therefore, the only single stage of "grow out" was applied for their fish production by stocking the larger size of the traditional fish species. This source of juvenile fish came from the larger fish households with the extra production of "fingerling nursery". Sometimes, the tradition VAC also bought their fingerlings from qualified and prestige traders of fingerlings. On the other hand, these households used polyculture with more traditional fish species for their fish culture which was an appropriate method to enhance productivity and utilize nutrients and space in the pond environment.

The Chi-square test of variable referring to awareness of seed quality and origin in terms of the degree of access to seed information has shown statistical evidence of a relationship between the models, while who are the information providers (relatives, neighboring farmers cultured fish, extensional officials and others) and priority in buying good quality seeds are not made sense in terms of Chi-square tested results. These clearly reflect the fact that most households did not have difficulty in accessing fingerlings in their fish farming activities. However, in recent years, many households have the same opinion about the gradual increase in prices of fingerlings, especially at the beginning of the production season. Fish production usually starts in the spring of the year around February and March in Vietnam because of warm weather that provides a favorable condition for fish growth and development. As a high demand for fingerlings at the beginning season, fish farmers face the scarce source and rising prices of fingerlings due to the demand over the supply temporarily.

5.1.2.2. Feeds

Unlike the input of fingerlings, the feed was not paid much attention by fish producers for seeking a contract with feed providers. The investigated results show that approximately 80% of fish farmers did not have a contractual relationship with feed suppliers. Feed was provided by mill companies through villager-resident agents who had their shops and stores surrounding the centre of villages. More than 50% of fish farmers knew and accessed fish feed from at least 5 agents or feed providers. And more than 95% of households often bought the fish feed from 2 and more providers. This availability of feed for fish at the local had been a very favorable opportunity for villagers to develop their fish culture. Particularly, in the case of lack of laborers, the availability of commercial feed enhanced many fish households more relies on the kind of fish feed. The shift of using the home-made feed to commercial feed increased significantly. This phenomenon occurred commonly for the households of the AF model and FS model. However, the Chi-square test has shown strong evidence of a relationship between buying fish feed with or without contracts among the models (Chi-square = 43.139; df = 3; and $P<0.001$; see table 5.4)

Table 5. 4 Evaluation of access to feed supply and feed quality

	Traditional VAC System (N=16	New VAC System (N=35)	AF System (N=65)	FS System (N=51)	Pearson Chi square	P-value
1. Having contracts with feed providers					**(df = 3)**	
- Yes	0	5	15	14		
	(0.00)	(14.29)	(23.08)	(27.45)	**43.139 [a]**	**0.0001**
- No	16	30	50	37		
	(100.00)	(8.71)	(76.92)	73		
2. Awareness of feed quality and manufacturer					**(df = 6)**	
- Access	1	10	23	18		
	(6.25)	(28.57)	(35.38)	(35.29)		
- Limited access	8	15	30	24	**8.79**	**0.186**
	(50.00)	(42.86)	(46.16)	(47.06)		
- No access	7	10	12	9		
	(43.75)	(28.57)	(18.46)	(17.65)		
3. Recognition to evaluate the feed quality and ingredients					**(df = 3)**	
- Yes	7	15	28	27		
	(43.75)	(42.86)	(43.08)	(52.94)	**1.383**	**0.709**
- No	9	20	37	24		
	(56.25)	(57.14)	(56.92)	(47.06)		
4. The payment method of the feed					**(df = 3)**	
- Immediate payment	16	17	30	21		
	(100.00)	(48.57)	(46.15)	(41.18)	**17.996 [b]**	**0.001**
- Delayed payment	0	18	35	30		
	(0.00)	(51.43)	(53.85)	(58.82)		
5. Availability of feed and inputs supply					**(df = 6)**	
- over 5 suppliers	9	15	35	34		
	(56.25)	(42.86)	(53.84)	(66.67)		
- 2-4 suppliers	7	18	28	13	**8.475 [c]**	**0.205**
	(43.75)	(51.43)	(43.08)	(25.49)		
- Only 1 supplier		2	2	4		
	(0.00)	(5.71)	(3.08)	(7.84)		

The bracket is a percentage; (a) 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.79; (b): 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.95; (c) 4 cells (33.3%) have expected count less than 5. The minimum expected count is .77

Source: survey 2017

When buying the feeds for the fish production, households took the most priority on "good quality" instead of the other criterion such as low prices or credit as delayed payment offered by feed suppliers. However, more than 50% of households reported that they were not sure and did not know exactly the quality and ingredients in the feed content. It was difficult for farmers because feed is available with plenty of product types and supplied by a variety of manufacturing companies. Although quality indicators and indexes of feed quality such as protein, vitamins…were clearly labeled on the pack of products, the actual quality might not be the same and guaranteed and committed by manufacturers and providers. Some companies could not provide a good quality of feed due to limited investment, low raw input materials, and poor technology. The Chi-square tests of variables referring to the degrees of access to the identity of fish feed quality and manufacturers and capability to recognize the quality and ingredients content of fish feed do not find any association of them between the SSA models. This clearly leads to an urgent requirement for the local government and authorities to take control and supervise the feed industry in terms of quality to make the organized markets of fish feed with qualified quality, directly contributing to improving the productivity and efficiency of fish production for local communities.

Regarding the payment method of the feed, 50% of fish farmers reported that they selected the method of cash payment immediately to the feed suppliers. The Chi-square test of the payment method in buying for feed production is presented strong evidence of a relationship between the immediate payment and delayed payment among the SSA models (Chi-square = 17.996; df = 3; and $P<0.001$).While households of FS and AF model tended to get the payment method in delay for the fish they bought from suppliers, those of the traditional VAC model usually preferred the payment method of the feed as immediate payment. This could be explained by the fact that households of the traditional VAC model operated such small-scale fish production that the feed used for their fish farming was much smaller than those of the other counterparts. Moreover, households of the VAC model regularly provided for fish farming with their own home-made feed which reduced significantly the amount of commercial feed buying from suppliers in the markets.

Although the feed and input supply was available with fish households, the increase in prices of feed caused some difficulties to them. Many households reported that the feed prices had been increased by 15% for the recent period of 5 years. The rising price would increase the production cost of fish because the feed normally accounts for the largest proportion (over 60%) in the total cost of fish production. Consequently, fish farmers had to pay more expenditure on their fish farming. To increase their income-generating from fish, farmers should reduce the commercial feed which was replaced by the home-made feed produced from agricultural by-products and other available farm products at the local. Households of the VAC models practiced this strategy much better than their counterparts. For the households of the AF and FS models, this strategy was not applied successfully because their fish farming was heavily dependent on the commercial feed whenever fish markets were problematic. In 2017, the selling prices of fish dropped considerably to the level below the production cost and many fish households had to prolong their fish farming with the hope of waiting for the selling prices of fish to recover. However, they could not stand for a long time as their fish production required large expenditure on buying the fish feed. As a result, they suffered a huge loss from that decision. This phenomenon sometimes happens in August or September of the year when the fish harvest is at peak time. In contrast, households of the traditional VAC and New VAC model could prolong their fish farming to get good selling prices of fish at that period. Particularly, some households of the traditional VAC model have their fish farming with 100% of the home-made feed which was made of their own farm materials. Therefore, the traditional VAC model might be an appropriate model for poor households to stabilize their income and reduce the risks from the market. The Chi-square tested result is found that there is no statistical association of a relationship between the number of feed suppliers and the degree of access to feed and inputs among the SSA models.

5.1.2.3. Production technology and indigenous knowledge

Fish production was divided into two main stages, including the fingerling nursing and the grow-out. Therefore, most households usually owned at least 2fish ponds in which a small-scale pond (about 1-2 Sao equivalent to 360-720 m2) was often used to raise the small fingerlings until a certain size (juvenile fish). These fish were transferred to larger-scale ponds (about 7 Sao or 2,500 m2) to keep on growing the second stage of grow-out. The usage of a small pond for breeding fingerlings until juveniles could take some advantages for households' fish production. First, the control of water in the pond and fish management would be easily achieved. Second, farmers also monitor better daily fish farming such as treating the pond environment from fish diseases and maintain the mortality rate of fish at the lowest level.

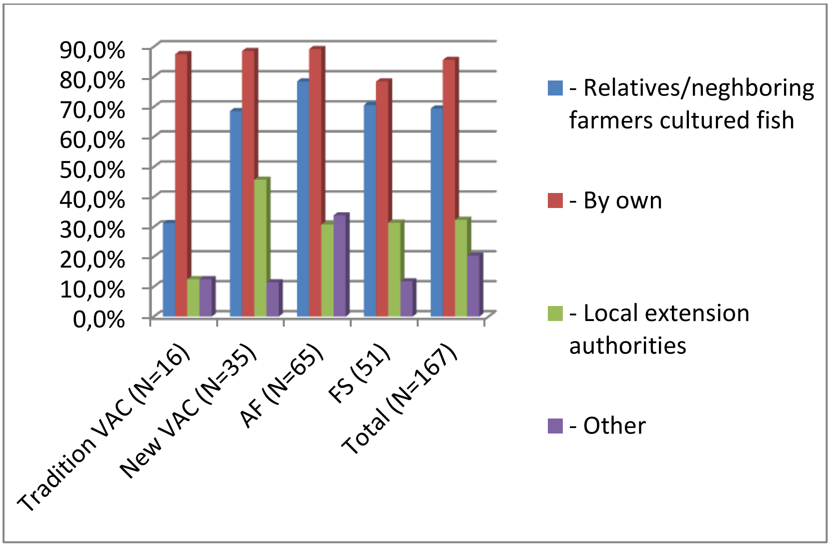


Figure 5. 1 Source of technical information and knowledge on aquaculture

Polyculture was the main method for fish production at the survey households. The farmed fish are mainly traditional fish species such as grass carp, common carp, tilapia, Migral, Indian carp, and silver carp. Many experts and researchers acknowledge the polyculture method as the effective production of fish as the integrated multi-trophic aquaculture is very effective and efficient in the pond environment. Regarding fish surplus for sale, it sometimes helps farmers to reduce and balance the market risks when a fish species has a selling price dropped unpredictably. Although the crowded and more mixed fish species of the polyculture may cause some difficulties in the control and treatment of the fish diseases in the culture process, the advantages of the polyculture method outweigh the disadvantages in the fish production.

According to experts, the polyculture method causes the fish some diseases in the production in the case the fish farmers do not have enough knowledge and experience in fish farming practices. Therefore, they need to get the techniques, technologies, and knowledge of fish farming. To answer the question which is the provider providing for farmers the knowledge, experience, and techniques on fish farming, the investigated results reveal that majority of the farmers (85.6%) received their knowledge about fish raising techniques through their own experience, followed up with the provider of relatives/neighboring farmers cultured fish. The local extension government and authorities provided those information accounts for only more than 30% of the total survey farmers. That of information is also provided by "other" providers such as commercial feed manufacturers, chemical factories, and veterinary companies who take some technical training to provide for farmers as the marketing strategies for selling their products. Some fewer farmers can get the technical information access to the "other" provider, about 20% of the survey households. The study has found that households of the FS model and AF model are more interested in many information providers for upgrading their fish farming techniques and technologies. The households of the traditional VAC model whose fish farming knowledge and technique are mostly from their own experience accumulation (87.5%), those come from relatives/neighboring farmers cultured fish, local extension government and authorities, and "other" providers only account for 31.3%, 12.5%, and 12.5%, respectively (see table 5.3).Whereas households operating the remaining models (New VAC, AF and FS model)could get the farming knowledge and techniques more equally from different information providers.

In Hai Duong, the species of farmed fish were observed from different households 'farming practices. The fish species consists of 9 different fish species including Grass carp, Black carp, Nile tilapia, Rohu, Vietnamese mud carp, Common carp, Vietnamese silver carp, Silver carp, and Freshwater silver pomfret. These fishes can be seen as the traditional species as they have Vietnamese origins or were introduced into Vietnam for a long time, except the Nile Tilapia. From the study, grass carp and common carp are the most common fish species reared in the production. The majority of grass carp and common carp are observed in the fish production of the households operating the traditional VAC and FS models. In the market, grass carp and common carp are high-value fish that bring fish farmers a higher return from the sales. They are familiar with not only their daily meals but also in their farming practices as they have been being introduced to produce for a long time. The average selling price of grass carp and common carp at the farm gate are at about 60 thousand and 45 thousand VND, respectively. These prices are twice as the selling prices of the other farmed fish species. As being omnivorous fish, the food of common carp relies on the natural food available in the pond environment, and grass carp is herbivorous fish that was needed to feed with many kinds of grasses, farmed plants and other by-products in cultivation production. The grass carp species are ideal for many rural households because their food is redundantly available around locally natural locations. For FS model households, fish production plays an important agricultural activity that generates a large proportion of income for their economic conditions. Therefore, grass carp are produced more common in the production of these households due to economic revenue. The FS households often reserve a certain area of land to grow grass to provide the green food for grass carp in their fish farming. The fraction of fish ponds and the land reserved for growing grass is 1: 3.5 for instance if the fish pond of grass carp is about 1 “mau” (3,600 m^2), the land for growing grass is from 2 to 3 Sao (about 700-1000 m^2). The variety of grass is “co voi” elephant grass.

While grass carp is a farmed fish that farmers do not need to use a lot of foods with high starch and protein content, the recently introduced fish species in the province’s production is Nile tilapia which requires a variety of food with high protein contents and some other nutrients for developing. Nile tilapias are the omnivores that have good resistance to contaminated and polluted pond environment. The fish is commonly stocked in the ponds of the traditional VAC households (100%) and the AF model households (nearly 60%). Farmers operating the AF model usually provide the pellet feed for this fish, especially in semi-intensive and intensive production methods which are characterized by high stocking density. Because the Nile tilapia can be highly intensified and very productive in fish farming, the supply quantity of this fish to markets from Hai Duong province normally accounts for about 40% of the total fish production. Farmers of the traditional VAC model commonly stocked the Nile tilapia with a low density as it is the fish having relatively fast growth. The production cycle is only 6 months after the stocking, then households can harvest partly for their home consumption. Many households reported that they harvested the fish after 3 months after the stocking mainly for their daily home consumption.

The table5.5 presents the survey results of observation of the stocking fish in the ponds of different freshwater fish production models in Hai Duong. There are a variety of fish species that were farmed in the traditional VAC households’ fish production. The low market value of fish species in the traditional VAC model and New VAC model households appeared more often than in those of the AF and FS model. As explained by farmers, that the strategy of producing the low-value fish to provide them for their daily home consumption and a surplus for sale at the local markets. Although the fish are low market value species, they have a specific content of nutritional value for the daily diet intake and preferences and these fishes are significantly easy to produce in their current farming conditions (see selling price in table 5.5).

Table 5. 5 Frequency of fish species stocked in the SSA models in Hai Duong province

h species	The average selling price* at farm gate (1000 VND)	Traditional VAC System (N=16		New VAC System (N=35)		AF System (N=65)		FS System (N=51)		Total (N=167)	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	Frequency	%
1. Grass carp	59.9	16	100.0	29	82.9	61	93.8	51	100.0	157	94.0
2. Black carp	86.6	2	12.5	13	37.1	19	29.2	27	52.9	61	36.5
3. Nile tilapia	32.9	16	100.0	25	71.4	38	58.5	20	39.2	99	59.3
4. Rohu	25.7	10	62.5	7	20.0	13	20.0	8	15.7	38	22.8
5. Vietnamese mud carp	20.2	13	81.3	10	28.6	16	24.6	10	19.6	49	29.3
6. Common carp	45.9	16	100.0	29	82.9	61	93.8	51	100.0	157	94.0
7.Vietnamese silver carp	16.9	13	81.3	25	71.4	43	66.2	19	37.3	100	59.9
8. Silver carp	15.4	11	68.8	10	28.6	18	27.7	17	33.3	56	33.5
9.Freshwater silver pomfret	22.8	1	6.3	3	8.6	15	23.1	17	33.3	36	21.6

(*) Referring to average selling price of grade 1 "quality" fish at survey time.

Source: survey 2015

5.1.2.4. Harvest

Ponds are drained to a certain extent to facilitate the harvesting fish. There is a group of people (4 – 6 persons) who are specialized in harvesting the fish that could be a service to provide for fish households. These people buy nets, basins and other facilities together. They are experienced and professional in harvesting fish. The harvesting people generally get a sum of wages about 700 thousand VND (30 USD) which is charged based on a pond no matter how large or small this pond is. However, they can get an additional bonus of about 200 - 300 VND thousand (10-15 USD) in cash or in-kind of fish when they harvest a pond which is more productive with a large amount of fish. Fish harvesting is quite hard working and labour-intensive. Therefore, on the date of harvesting fish, households usually ask for help from relatives and neighboring farmers. The harvesting practice is taken place in a very organizational and professional way. While the fishpond owner takes the responsibility for book recording of quantity and quality. Fish are graded based on their weight and appearance. The hired laborers to harvest fish catch the fish in the ponds and the relatives, neighbors are responsible for the fish carrying, sorting and weighing activities along with the buyer. Sometimes, the disputes about the standards of fish quality in the grading between farmers and buyers occurred during the transaction.

Table 5. 6The harvest time and sale of fish

	Traditional VAC Model (N=16	**New VAC Model (N=35)**	**AF Model (N=65)**	**FS Model (N=51)**	**Total (N=167)**
1. Harvest time					
- Morning	5 (31.3)	4 (11.4)	4 (6.2)	7 (12.0)	**20 (12.0)**
- Noon	4 (25.0)	0 (0)	3 (4.6)	4 (6.6)	**11 (6.6)**
- Evening	1 (6.3)	9 (25.7)	17 (26.2)	12 (23.4)	**39 (23.4)**
- Any time	6 (37.5)	22 (62.9)	41 (63.0)	28 (58.1)	**97 (58.1)**
2. Method of fish sale					
- At the farm gate	4 (25.0	26 (74.3)	55 (84.6)	51 (100.0)	**136 (81.4)**
- Both at the farm gate and local market	12 (75.0)	9 (25.7)	10 (15.4)	0 (0)	**31 (18.6)**

(Bracket is a percentage)

Source: survey 2017

According to the survey results, most of the households sell fish at the farm gate, of which 81.4% sell all fish at the farm gate, 18.6% sell fish both at the farm gate and local markets. The traditional VAC farmers have often operated a small fish pond which is not enough productivity for the truck traders to buy at the farm gate. Therefore, the traditional VAC households usually organize to harvest the fish and sell the surplus by themselves. Thus, all the fish were harvested from the pond, and a small part was reserved for their consumption in the following days. The surplus sold at the pond and local markets. While the majority of the households operating the FS, AF, and New VAC models sold their fish directly to the truck traders (farmer collectors) at the farm gate.

The time is relatively flexible for households to harvest their fish. It is up to market requirements and production models. The traditional VAC households preferred to harvest their fish in the morning (31%) since local markets often operate in the morning. They also harvested their fish on holidays, weekends ... when people have a high demand for fish. Only 6.6% of the households said that they usually harvested fish at noon. The FS, AF, and New VAC households reported that the time to harvest fish in the evening is often preferred by traders as fish can be stored and kept better in the low-temperature condition.

5.2. Economic analysis of different freshwater SSA models in Hai Duong province

5.2.1. Production costs of fish production operated in the freshwater SSA models

The total variable costs are the calculations of All Purchased Activity and Direct Inputs of the four models are presented in table5.7. When calculating the variable input costs, economic indicators, only resources that are tradable in the region were taken into account. The operation of the pond was carried out through family labor; thus, the opportunity costs from the labor of collecting leaves and grasses as feed and manure as fertilizer was not included here, as these resources had no monetary value in the research area. Under the traditional VAC and New VAC models, cereals (maize, and rice), rice bran, and some agricultural by-products were resources with a market value and showed a high variation in the amount used as pond input. The variable costs were fingerlings, feed, fertilizer, lime, chemicals, electricity, and other operational costs.

The AF model has the highest total variable cost among the freshwater fish production models outside the residential village. The value amount of feed reaches to approximate VND 6,500 thousand in the model, households operating the AF model characterized by the combination of fish farming with large-scale animal husbandry in comparison to the remaining models. The utilization of livestock wastes as the main source of fertilizer for fish farming reduces significantly fertilizer cost for the producers, some households owned a large scale of livestock production which creates too much fertilizer for fishponds. As a result, more lime and chemicals are used to treat the pond water environment. The pond water of too rich fertilizer requires more electric aeration machines and pumps which also lead to higher costs of energy as more electricity and fuel are consumed for pond water treatment. Many fish farmers have sought a solution to limit the problem of processing animal waste by setting up a biogas model that could reduce and process almost all of the animal waste redundancy. The introduction of the biogas model into the AF model has created a good source of biogas for households' cooking; it could also provide well-processed animal waste without bacteria and safe quality for fish farming both in the short term and long term. For example, Mr. Lan's household in Lac Duc village, Hung Dao commune, Tu Ky district, his family has 2 fish ponds; one small scale pond (2 Sao – 720 m^2)for raising fingerlings, then another larger scale pond (7 Sao ~ 2,500 m^2) for raising grow-out fish. He also develops a livestock production of 4 pig sows and 20 pigs for meat. Initially, the washing water and pig waste cleaning were designed to discharge directly into the pond of grow-out fish. It is very soon the pond water environment will become poor dissolved oxygen due to excess fertilizer which is a result of too large scale livestock production in the integrated levels between subsystems of the AF model. As recognized from the problem, he developed a biogas system to treat this animal waste. By setting up the biogas system, his family has a source of biogas for cooking. The animal wastes could be treated in good condition and available to use or keep in store for other purposes. The manure after treatment would be stored for fish farming, used as fertilizers for some crops. It is sometimes sold to some neighbors cultivating crops for generating income.

While the AF model has the largest financial amount of feed, the New VAC model owns the highest cost of fingerlings since the fish species are high value and the size of fingerlings is larger. The fingerlings are the size of the juvenile that harvested products of the nursing pond. Generally, the fish production is separated into two production stages: "fingerling nursing" and "grow out". The majority of the New VAC households do not have the pond for fingerlings nursing, they have to buy juvenile for their grow-out production. The problem here is that they operate only one fishpond which is spent on the production of grow-out fish. The sources of fingerlings for VAC households often depend on external providers. More than 90% of households operating the New VAC model select grass carp for their fish production, this fish species accounts for a large proportion of total fingerlings stocking in the pond. The expensive fingerlings of grass carp at the larger size (juvenile) leads to a high input cost of fingerlings in the New VAC model.

The fish production in the New VAC model is a household strategy to maximize their demand for home consumption of foodstuffs and income generation. Stocking a large number of grass carps could satisfy the strategy because of several reasons. Firstly, the New VAC model owns an intensive orchard which normally produces some perennial fruit trees and vegetables for the farmer family‘s daily diet intake, which creates an amount of green food such as grass waste, by-products in gardening activities for grass carp fish. Secondly, grass carp is easily cultured and made a part harvest for farmers' home consumption. Third, the high market value fish species of grass carp could provide farmers with a high income. The similarity to the AF model, energy costs are high since the technology of fish production uses a large amount of green food, which leads to the poor quality of the pond water environment such as low level of dissolved oxygen. This poor water condition required an intensive usage of the aeration system to improve the pond environment. This increases the costs of energy for the New VAC households.

The fingerling input of the traditional VAC preferred and selected to stock the larger size of fingerlings (as the juvenile of fishes) for the beginning of the fish production cycle. However, there is a difference in the species stocking in the traditional VAC model and New VAC. While the New VAC model households prefer to stock the high market value species, the traditional VAC model households grow inexpensive and traditional species that are more eligible for the farmers' daily intake and farming practices. In addition, according to experts, they are very suitable for the fish farming management of polyculture in terms of multi-trophic pond management. The species structure of fish ponds in the traditional VAC model also aimed to the strategy of maximizing the demand for household consumption. Although grass carp, a high market value fish, is observed all households operated the traditional VAC model, the grass carp only accounts for a minor proportion of the total fingerlings. More diversification in number kinds of fish is a strategy to intensify the aquaculture production in the traditional VAC households who are marginalized for the land capital, inputs and the economic scale of the production. The interesting point of study results is that the feed cost of traditional VAC households is the lowest among all existing fish production models. This is strong evidence that has supported for the integrated multi-trophic aquaculture as it maximizes the utilization of the different trophic levels in the pond environment that allows one species' uneaten feed and wastes, nutrients, and by-products to be recaptured and converted into fertilizers, feed, and energy for other crops, the traditional VAC households have reduced a remarkable cost of feed in their fish farming in comparison with other models of fish farming.

Table 5. 7 The variable cost structure of fish production per Sao by freshwater SSA models in Hai Duong province

Unit: 1000 VND[1].

	FS Model (N=51)		AF Model (N=65)		New VAC Model (N=35)		Traditional VAC Model (N=16)	
	Mean	%	Mean	%	Mean	%	Mean	%
All variable costs[2]	**8,349.9 [a,d]**		**9,797.2 [b,d]**		**9,305.8 [c,d]**		**5,263.4 [a,b,c,d]**	
Fingerlings	2,202.9[a,c]	24.0	2,577.5[b,d]	23.7	2,995.2[a,c,d]	29.0	1,523.5[b,c,d]	24.6
Feed	5,622.3[a,d]	61.3	6,441.1[b.d]	59.2	5,641.2[c,d]	54.6	2,823.7[a,b,c,d]	45.6
Fertilizer	3.6	0.0	1.0[b,c]	0.0	9.4[b,c,d]	0.1	0.0[c,d]	
Lime	92.8	1.0	109.7	1.0	84.5	0.8	107.7	1.7
Chemicals	242.5	2.6	283.6	2.6	208.2	2.0	323.9	5.2
Energy	187.6 [a,b,c]	2.0	335.7[a,b]	3.1	338.7[a,c]	3.3	253.1	4.1
Other	48.6	0.5	48.7	0.4	28.5	0.3	231.6	3.7
Fixed Costs (Except Depreciation)	172.5 [a]	1.9	193.2 [b]	1.8	272.9	2.6	231.3[a,b]	3.7
All Capital Depreciation[3]	601.2	6.6	885.3	8.1	755.1	7.3	700.4	11.3
Total production cost	**9,175.3**	**100.0**	**10,877.2**	**100.0**	**10,333.5**	**100.0**	**6,196.3**	**100.0**

[1] Exchange rate: 1 USD = 22.500 VND. [2] The cost does not include the family labor ((All Purchased Activity Direct Inputs).[3] The fixed cost is calculated based on depreciation for 10 years.Different superscripts. (a,b,c,d) denote a significant difference between means within rows (p< 0.10)

Source: survey, 2015–2016.

The typologies of the traditional VAC household make a considerable cost of chemical use in their fish farming. Regard to the scale of economics, the households normally own a small fishpond (2.44 Sao or 878 m^2). In the market, the chemical products are supplied under the packing of bags or bottles with a large quantity, while the levels of chemical utilization in the traditional VAC households for fish production do not require much quantity. Therefore, the excess packing products of chemicals was used for another purpose of agricultural farming such as animal husbandry, crop cultivation; this expenditure was still in the name of chemical cost for aquaculture production in the traditional VAC households. During the survey, a majority of the farmers reported that the chemical products were used for a variety of agricultural activities such as animal husbandry, crop cultivation. On the other hand, plenty of chemical products in the markets could cause a difference in the chemical cost of aquaculture. Fish households could select the low price products to reduce the production cost or prefer functional products with a high price to satisfy their farming expectations. The application of the high price chemical products leads to a larger amount of chemical cost in fish farming. Although the biochemical represented high price products, most of the traditional VAC households had priorities to buy and consume for aquaculture production. The environment-friendly management and safety products are important for these households since a large amount of fish would be for their direct consumption and the wish to maintain and increase farming efficiency related to the multifunctional pond (Popp *et al.*, 2019) which is a part of the rural economy. The operation of well-managed pond fish farms contribute to preserving and enriching ecosystem quality, play an important part in water management and forming the landscape, provide services for different recreational activities and contribute to preserving cultural values, all this in addition to producing fish. The Vietnamese experience of operating multifunctional fish farms clearly shows that the diversification of fish farming activities offers good opportunities for the development of sustainable pond farming.

It is very interesting that the feed cost accounts for a smaller proportion of the total production cost (from 53% to 67% see table 6.24) as compared to that of the catfish production in southern Vietnam (from 74% to 92) (Phuong *et al.*, 2007). The freshwater aquaculture in the study is likely to be more sustainable than the catfish industry in the southern provinces of Vietnam since the home-made feeds in the fish production have been commonly used to reduce the significant amount of the manufactured pellet feeds purchased from markets. Particularly, the raw materials to make the pellet feeds have been mainly imported from other countries.

5.2.2. Revenue and net returns of fish production in the freshwater SSA models

The economic efficiency of fish production contributes to household income as shown in table 5.8. Although the total cash revenue from the fish production of the AF model and the New VAC model is equivalent, the fish income from the New VAC model is higher because the total variable cost of the New VAC model is lower. This is a very interesting point of the research which shows that in the model of fish production, the increase of production components in the system will contribute to increasing economic efficiency. In the AF model, there are only two main components of animal husbandry and fish farming combined leading to economic efficiency and production results are similar to the production results in the New VAC model. This again proves that the previous research results of some scholars who have pointed out that the higher the combination of components of the IAAS system, the more efficient the system is.

If the scale effect is not taken into account, the results and economic efficiency between FS and AF models can also be explained as argued in the preceding paragraph. However, when considering the different production scale among the three models, the comparison results between the three models show that the marginal productivity law is decreasing. As the area factor increases, the above economic efficiency per unit area is decreasing. In which the FS value and productivity are the lowest, the New VAC model has higher productivity and value than the remaining models. In addition, the fixed costs also clearly show the scale production efficiency when the equipment will be used more efficiently and have a lower cost when the scale and area of fish farming increase at 3 models excluding the traditional VAC model.

Investigating the production of fish for household consumption is difficult because most households do not remember the exact amount and number of partly captured fish for their consumption during their fish production. However, the calculated results show that the revenue from selling fish of all models, except the traditional VAC model, accounts for about 90% of the total revenue from fish production. This is because the households operating the traditional VAC model do not care much about the cash-generating from fish sales, (80%) of the traditional VAC households agreed with this argument. This is completely consistent with the fish production goal of the traditional VAC households when they think that fish production is mainly for home consumption. Therefore, the income from fish of this group can be reduced to over 7 million VND / Sao. The ANOVA test of the total value of sold fish in the traditional VAC model shows a significant statistical difference from three other SSA models at P-value < 0.10. The similar results of ANOVA tests are found in this traditional VAC model with the total value of fish and the total value of variable costs as compared to the counterparts.

It is also found that the chemical used in the traditional VAC model is higher than that of the others. This is because of the scale of economics, in which the traditional VAC households predominantly own a small fishpond. A full bottle of chemicals for fishpond treatment is not entirely used for a small fishpond. Moreover, chemicals are not only used for fishpond but also for animal husbandry, rice, vegetable production. Additionally, the preference of using the types of bio-chemicals by households in the traditional VAC model would generate higher input costs.

Table 5. 8 Annual profitability of fish production per Sao by freshwater SSA models in Hai Duong province

Unit: 1000 VND[1]

	FS Model (N=51)		**AF Model (N=65)**		**New VAC Model (N=35)**		**Traditional VAC Model (N=16)**	
	Mean	**Std**	**Mean**	**Std**	**Mean**	**Std**	**Mean**	**Std**
Total value of sold fish	17168.6 [a,d]	9669.2	19943.0 [b,d]	10115.0	18946.7 [c,d]	9469.9	11860.1 [a,b,c,d]	3081.0
Total value of fish	17670.7 [a]	9764.5	20537.0 [b,d]	10141.4	20140.8 [c,d]	9301.7	13312.8 [a,b,c,d]	3730.1
All variable costs	8349.9 [a,d]	4115.1	9797.2 [b,d]	5587.6	9305.8 [c,d]	4682.0	5263.4 [a,b,c,d]	1432.3
Gross Margin of Fish	9270.7	6953.3	10739.7	6350.3	10835.2	5515.3	8049.4	2539.1
All Farm Fixed Costs (Except Depreciation)	172.5 [a]	278.1	193.2 [b]	122.8	272.9	356.7	231.3 [a,b]	87.2
Farm Net Actual Returns	9098.2	6960.3	10546.5	6300.0	10562.3	5464.8	7818.3	2461.6
All Capital Depreciation [2]	601.2	472.2	885.3	995.3	755.1	610.2	700.4	247.2
Net Returns of Fish	8495.5	6833.0	9660.3	6527.0	9807.2	5353.4	7116.7	2254.3

[1] Exchange rate: 1 USD = 22.500 VND. [2] The fixed cost is calculated based on depreciation for 10 years. Different superscripts (a,b,c,d) denote a significant difference between means within rows (p< 0.10)

Source: survey, 2015–2016.

The study results expose that the New VAC is the most efficient model with Net Returns of Fish (9.8 million VND or 435 USD per 360 m2). This model has currently been most interested and promoted by different agencies, institutions and individuals. The operation of the New VAC model provides the farmers for higher returns, the best utilization of on-farm inputs, reducing their dependence on the purchased inputs and preserving the patterns of farm resource use. It plays an important role in the food supply, job creation and sustainability of the rural economy. It also opens up new opportunities and directions for farmers to diversify the traditional rice-based production patterns into more sustainable farming systems that enable farmers to obtain a better quality of life with less environmental damage and health risk.

5.3. Home consumption, income and employment from the freshwater SSA models in Hai Duong province

5.3.1. Home consumption of harvested fish outputs

There is a large variation in the global household production of fish between the four freshwater fish production models in Hai Duong province. Research has found that the FS model has the largest amount of the global household fish production reaching 4,727 kg per household; follow up is the AF model with 4,254 kg per household. The New VAC model has the global household production of fishless than one half of that amount as a comparison with the two former models (2,143 kg). The traditional VAC has the smallest amount of global household production of fish (885 kg). However, the traditional VAC model has the highest yield of fish (374 kg/Sao). This is an interesting point of the research result because this kind of model nearly disappears in the current situation of the research sites and the view of farmers, this model should not be developed as it cannot provide them much income generation as compared to the economic demand of the family, even though many local government officials and authorities have the same point of view. In many documents related to economic development strategies for many parts of rural areas in Vietnam, they have never mentioned about this efficiency of the traditional VAC model despite the VAC is also referred to some guidance documents of administrative authorities and agencies to develop the agricultural sector, the VAC meaning may normally be understood in the specifications of the current New VAC model. The ANOVA tests have shown that there is a significantly different ($P<0.10$) in the global household production, household home consumption, and working labor of fish production between the traditional VAC models and the other models, but this test is not found to have a statistically significant difference in the yield of fish. This result reflects that the fish yield of the traditional VAC model is not poor as people‘s bias, and fish farming in Hai Duong is really complex and diversified in terms of productivity as well as the scale of production.

Among the three freshwater SSA models with fishponds converted from rice fields outside the village, the AF model has the highest yield of fish (358.6 kg). Although this yield of fish is not statistically significant with the ANOVA test, the harvested fish products were larger sizes representing a larger proportion of the "grade 1" products since the AF households invested more costs on larger fingerlings of black carp, grass carp, and common carpin comparison with those of households in the FS model.

Fish households reported that fish provided them with a great amount of nutrients in their daily cooking. The estimated quantity of fish for home consumption is about 200 kg per household per year. The traditional VAC farmers consumed the largest proportion of fish products from the global household production of fish. The home consumption of fish is calculated based on the area unit representing the greatest volume of fish consumed by the fish households operating the traditional VAC (52.9 kg) while the FS households account for 11.9 kg. This volume of fish used for home consumption shows a statistically significant ANOVA tests at P<0.1 between the VAC models and the counterparts. This implies that fish production plays an important role in the VAC models for household food security in terms of farmed fish used by farmer families as the home food consumption.

Table 5. 9 The fish productivity, home consumption and employment in the SSA models in Hai Duong province

	FS Model (N=51)		AF Model (N=65)		New VAC Model (N=35)		Traditional VAC Model (N=16)	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Global HH production (kg/household)	4,727.0 [a,c,d]	4,176.0	4,254.0 [b,c,d]	2,475.5	2,143.5 [a,b,c]	1,232.6	884.8 [a,b,d]	286.4
Yield (kg/sao)	325.0	166.0	358.6	176.2	338.9	163.7	373.7	84.0
Home consumption (Kg/sao)	11.9 [a,c,d]	6.2	13.5 [b,c,d]	6.8	27.9 [a,b,c,d]	36.4	52.9 [a,b,c,d]	16.1
Working Labour(man-days/sao)	14.0 [a,c,d]	7.7	16.4 [b,c,d]	9.6	32.6 [a,b,c,d]	40.7	49.6 [a,b,c,d]	23.4

Different superscripts (a,b,c,d) denote a significant difference between means within rows (p< 0.10)

Source: survey, 2015–2016.

5.3.2. Income and employment of fish production in the freshwater SSA models

The farmers operating the traditional VAC model could be considered as the subsistence farmers who often consume a large share of their farm output and who are detained back from participating more actively in commercially oriented agriculture by a variety of constraints in terms of the production resources. The potential to turn the fish production in their models into more profitable enterprise is the greatest among the subsistence farmers who are facing soft constraints—such as limited financial and human capital and poor market access—that can be addressed through various support policies focusing on marketing of their farm products. In this study, off-farm income has not been taken into account, so that the average total farm's income consists of values from rice cultivation, animal husbandry, aquaculture, vegetables, orchard garden, and fish. By this approach, households in the AF system gained the largest annual on-farm income (153,67 million VND or 6,827 USD), in which it is nearly 70% of fish, 22.5% of livestock husbandry, only 8.52% of cultivation (Table 5.10). Households in the traditional VAC and New VAC models have similar on-farm income and it is lower than that of AF and FS models due to their limited agricultural land, capital investment, and some related production resources. However, the study results reflect an actual situation that the fish production has contributed a major income to the total on-farm income of the households in the FS, AF and New VAC systems. The study results of the proportion of fish income accounted for about and over 70% of the total on-farm income of these households since they invested in high value and marketable fish products with high levels of commercial fish production to supply fish food for growing demand for these fish products in the markets. This result coincides with the argument of (Hazell, 2013) that significant numbers of commercially oriented small farms, in the circumstances of economic growth and urbanization, are likely to prosper through diversification into high-value agriculture in the areas with good resources of agricultural production and availability of market access. Therefore, the high-value fish products of the fish farming in the FS, AF and New VAC models are a good example for Hazell's argument. It implies that fish production would be a good farm enterprise for agricultural households to develop their livelihoods in Hai Duong province.

Labour is excluded from the price of the total cost. However, labour employment in the study was estimated as the calculated number of man-days in fish farming which showed that fish households in the traditional VAC and New VAC model are the most labor-intensive (49.6 and 32.6.man-day per Sao, respectively (see table 5.9). The income generation from fish production would be estimated at 143 thousand VND per man/day for the traditional VAC model and 300 thousand VND per man/day for the New VAC model. These figures can be compared with VND 200 thousand as the opportunity cost of daily wages from unskilled jobs available in the study areas. The farmers operating the traditional VAC model would lose about 70 thousand VND per day-man, while the New VAC model can provide for farmers a better income of around 100 thousand VND per man-day. This comparison can explain a fact that the traditional VAC model was not commonly operated and recognized by many farmers and local authorities in the region.

Up to now, the traditional VAC model has been being replaced by the New VAC, AF and FS models which obviously are more appropriate for the local farmers to obtain better returns of fish products as well as improve in the total on-farm income. These new SSA models appear to become an alternative livelihood for local farmers. Particularly when the available resources of agricultural production are favorable for fish production in line with active farmers and growing demand for fish foods in the markets due to a rising income and rapid growth in urbanization in Vietnam.

Table 5. 10 Total sources of on-farm income at fish farms annually in Hai Duong province

Unit: 1000 VND[1]

	FS Model		**AF Model**		**New VAC Model**		**Traditional VAC Model**	
	(N = 51)	**%**	**(N = 65)**	**%**	**(N = 35)**	**%**	**(N = 16)**	**%**
Rice crop	*5265.4*[a,b,d]	*64.5*	*8171.3* [a,b,d]	*62.40*	*6818.2*[c,d]	*46.0*	*13,729.1* [a,b,c,d]	*75.6*
Vegetable crop	-[a,b,c,d]	-	*1380.4* [a,b]	*10.54*	*1053.3*[a,c]	*7.1*	*2189.6* [a,d]	*12.1*
Fruit crops	*2901.8*[a,c]	*35.5*	*3544.0* [b,c]	*27.06*	*6958.0* [a,b,c,d]	*46.9*	*2238.3*[c,d]	*12.3*
Total crops	***8167.1*** [a,b,c,d]	***6.91***	***13,095.8*** [a,b,d]	***8.52***	***14,829.5*** [a,c]	***17.56***	***18,157.1*** [a,b,d]	***28.55***
Livestock husbandry	***4904.6***[a,b,d]	***4.15***	***34,162.4***[a,b]	***22.53***	***8077.9*** [b,c,d]	***9.57***	***29,243.0***[a,c,d]	***45.97***
Fish production	***105,124.8*** [a,c,d]	***88.94***	***106,406.7*** [b,c,d]	***69.52***	***61,529.6*** [a,b,c,d]	***72.87***	***16,207.4*** [a,b,c,d]	***25.48***
Total	**118,196.6** [a,b,c,d]	***100.0***	**153,6664.9** [a,b,c,d]	***100.0***	**84,436.9** [a,b,c]	***100.0***	**63,607.4** [a,b,d]	***100.0***

Different superscripts (a,b,c,d) denote a significant difference between means within rows (p< 0.10). [1] *Exchange rate: 1 USD = 22.500 VND*

Source: survey, 2015–2016.

In terms of household vulnerability, the households operating FS model are more vulnerable to fish income compared to those in other systems. The survey showed that the income from fish of the FS model households accounts for 89% (Table 5.10) of total on-farm income (118 million VND or 5,200 USD). Meanwhile, in the traditional VAC model, households are less dependent on the fish income which presents 25% of the total sources of on-farm income. The largest share of income in these households is from on livestock husbandry accounting for 46% of their total on-farm income. The explanation for the lower proportion of fish income in the traditional VAC model compared to the FS model results from the scale of production. The average area of aquaculture in the traditional VAC system is about 2.44 Sao (878 m^2), while that in the FS system is 14.49 Sao (5216 m^2). Moreover, they also undertook a considerable commercial production of animal husbandry in their agricultural activities.

6

MARKETING FISH PRODUCTS OF FRESHWATER SSA MODELS IN HAIDUONG PROVINCE

This chapter depicts the market outlets and marketing channels of the fish products in the freshwater SSA models in Hai Duong province. The marketing participants and their marketing characteristics are well analyzed and discussed. The chapter is divided into four parts. The first part addresses the market outlets related to the direct marketing strategy of the traditional VAC households that sold their fish products at local markets. The second part describes the market participants and their characteristics in the marketing channels of fish products related to fish production of the FS, AF, and New VAC in Hai Duong province. These marketing channels are responsible for supplying the fish commodities to urban markets. Thus, the main role, functions, and characteristics of middlemen in the main marketing channels of fish are described. The third part provides an analysis of marketing practices, marketing costs and margins of market participants in the main channels of fish products. The fourth part reveals several challenges and constraints of market concerns to the economic efficiency of fish production in line with the freshwater SSA models in Hai Duong province.

6.1. Market outlets and marketing channels of fish products from the freshwater SSA models in Hai Duong province

6.1.1. Marketing channels of fish products from the freshwater SSA models

The surveyed freshwater aquaculture households used multiple marketing channels to sell their products. Three marketing channels were identified in this survey: “direct marketing to consumers”, “wholesale to local retailers”, and “wholesale to farmer collectors” at the farm gate of the fish farmers see Figure 6.1.

Direct marketing to consumers and wholesale to local retailers were common marketing activities of fish products used by the traditional VAC households. 43.7% of the households used only direct marketing to consumers and 56.3% of them used both direct marketing to consumers and wholesale to local retailers together (Table 6.1). “Wholesale to fish farmer collectors” almost exclusively used by the FS and AF households while 82.9% of the New VAC households employed this marketing of their fish products. “Wholesale to local retailers” presented about 17.1% and 56.3% used by fish households of the New VAC and traditional VAC households, respectively.

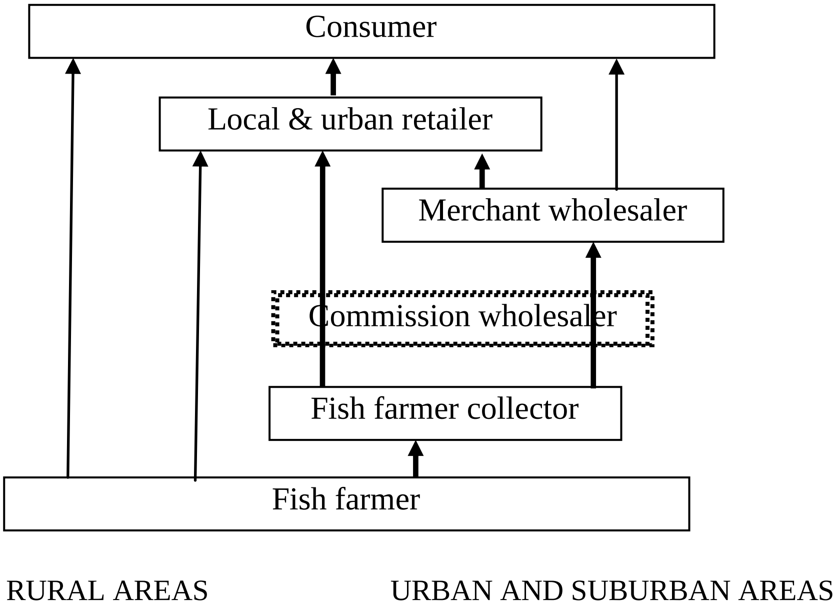


Figure 6. 1Marketing channels of freshwater fish products in Hai Duong province

Why do traditional VAC households prefer direct marketing to consumers? The answer to the question is that the households mostly used the traditional and low-value fish species in their fish production (see table 5.5). These species do not meet the market demand in the urban areas where the "Wholesale to fish farmer collectors" channel supplies to. Also, the small-scale production of fish in the traditional VAC model is another problem for fish farmer collectors who often require a larger amount of harvested fish, because their trucks normally have a loading capacity more than one ton while the fish production of the households reach 885 kg including a part of harvested fish products consumed by their family as the home consumption – table 5.9. The aggregate output of fish products is less than the required quantity from the fish farmer collectors. On the other hand, the low-value species farmed by these households are preferred by local consumers in rural areas. In other words, the local markets are the appropriate market niches for the fish products of fish farming operated by the traditional VAC households. However, how they market their fish products was also investigated in the study. The study results will be described in the next section.

Table 6. 1 Marketing channels of fish outputs used by the survey freshwater aquaculture households

Sales channel	FS Model (N=51)		AF Model (N=65)		New VAC Model (N=35)		Traditional VAC Model (N=16)	
	Number of farms	Percent	Number of farms	Percent	Number of farms	Percent	Number of farms	Percent
Direct to consumer channel only							7	43.7
Direct to consumer and wholesale to local retailers					6	17.1	9	56.3
Wholesale to farmer collectors only	51	100	65	100	29	82.9		
Total	**51**	**100**	**65**	**100**	**35**	**100.0**	**16**	**100.0**

Source: survey 2017

6.1.2. Direct sales and market outlets of fish products from the traditional VAC model

6.1.2.1. Direct Sales by Farm Size and Gross Farm Income

The average value of direct sales to consumers per household was VND 14.16 thousand (640 USD). For all sizes of farms, direct sales accounted for approximately 30 percent of gross farm income, on average. The average percentage of fish sales from direct sales to consumers was about65.83 percent.

The study found that when the scale of fishpond area and gross farm income increased, average direct sales per farm decreased. T-test was used to examine the finding that showed the statistically significant value of fish direct sales and a proportion of fish sales value in the total farm income between the households who owned at most two Sao of the fishpond and those with ownership of a fishpond of over two Sao in the study areas. However, there is no significant difference in direct sales of fish products to consumers between the households who earned below the level of VND 50 million and over VND 50 million concerning the total on-farm income. However, T-tests indicated no statistically significant difference between the farms, in terms of both direct sales per farm and direct marketing share of total fish sales by gross farm income (Table 6.2). These findings consistent with the argument which refers to the goal of fish production in the original VAC model to solve the food shortages and strategic tool for household food security (Tii Giay & Dat, 1986; Nam, 1994)

Table 6. 2 Direct sales of fish products by farm size and gross farm income of the households operating the traditional VAC model

	N	Average direct sales per farm (1000 VND)	T-test (2-tailed P value)	Direct sales as a share of total farm income (%)	T-test (2-tailed P value)	Direct marketing share of total fish sales (%)	T-test (2-tailed P value)
By fish production area							
At most 2 (Sao#)	7	20,871.10	.000*	40.39	.006*	100.00	.000*
more than 2 (Sao)	9	8,944.40		18.87		39.25	
By total farm income							
less than VND 50 million	5	14,565.60	.883	41.68	.051*	63.97	.882
50 million VND and more	11	13,979.10		22.19		66.68	
All farms	**16**	**14.162.4**		**28.28**		**65.83**	

** denotes significance at the 1% and 10%level* *Source: survey 2015-2017*

 # 1 Sao = 360 m^2

6.1.2.2. Market outlets and marketing the fish surplus from the traditional VAC model

The study was found that there are four common forms of the traditional VAC households' market outlets of their fish products in the research areas. They are the sale direct to neighbours and acquaintances, selling at local markets, peddling and roadside stands (Table 6.3). The selling direct to neighbours and acquaintances is the most common form of marketing fish products operated in the traditional VAC model. This is because the fish products were cultured in the homestead fishpond within the villages where they are concentrated with high levels of population density. This form of marketing fish takes advantage of lower transport costs, quick sale with reasonable selling prices of fish products. Through study observation, the selling prices of the traditional VAC model's fish products normally are higher than those of FS, AF and New VAC models. However, most of these fish products are low-value species. Follow up the form of marketing which was used by households operating the traditional VAC model is the selling farmed fish products at the local markets. However, this form caused the traditional VAC farmers some difficulties marketing their fish products due to the lack of time to sell a large volume at the local markets. This is because the local markets often take place periodically (once every two days) and shortly (about 2 hours in the early morning)in the study region. The other forms of marketing fish products seem not to be frequently used by farmers operating the traditional VAC according to the 3.0 of the decisive rule.

Table 6. 3Main forms of marketing the fish surplus used by the traditional VAC farmers

Strategy	$\bar{x}$
Selling directly to neighbours and acquaintances	4.63
Local markets	3.63
Peddling	2.56
Roadside stands	1.38

$\bar{x}$ the mean score of 5-point Likert scale (1 = absolutely not, 2 = preferably not, 3 = neutral, 4 = possibly, or 5 = definitively)

Regarding the encountered problems and future fish production and marketing fish products related to the traditional VAC model, most of these farmers did not have a consistent answer to this question. However, some hope that they wished to expand their current fish production to a larger scale fishpond which may be similar tothe fish-pond of the farmers operating the New VAC model.

6.1.2.3. The difficulties of marketing the fish surplus from the traditional VAC model

Households operating the traditional VAC model faced some difficulties in the marketing of their fish products such as reaching the urban customers, lack of storing facilities to keep fish alive and fresh, shortages of local markets, having a general concern about marketing all their farmed fish products, lower selling prices of fish commodities, inability to meet consumer expectations for high quality and standard products. The research results showed that reaching urban consumers is the most considered issue that most of the traditional VAC farmers were mentioned during the survey. Besides, the lack of storing facilities to keep fish products alive and fresh were the main matters concerning their marketing the fish products from the fish farming. According to the 3.0 of decisive rule, the difficulties of the marketing fish surplus from the traditional VAC model comprise the shortages of storing facilities to keep the good quality of fish commodities; lack of local markets, inadequate sources of market information about the urban customers' preference. The remaining issues are minor and not really difficulties of marketing fish products for the traditional VAC farmers. They are true because the study results show these issues got the average point of $\bar{x}$ with the value below 3.0 (Table 6.4). According to the 3.0 of the decisive rule, they all are not accepted to be the difficulties of marketing fish products from the traditional VAC model in the study areas.

Table 6. 4The difficulties in the marketing of fish outputs encountered by the traditional VAC farmers

Difficulties	$\bar{x}$
Reaching urban consumers	3.94
Lack of local' markets	3.38
Lack of storing facilities to keep fish alive and fresh	3.06
Having a general concern about marketing all of their farmed fish products	2.81
Lower selling prices of fish products	1.94
Inability to meet consumer expectations for high quality and standard products	1.69

$\bar{x}$ The mean score of the 5-point Likert scale (1 = "Not at all effective" and 5 = "Highly effective").

6.2. Marketing channels and market participants of fish products from the FS, AF and New VAC models

6.2.1. Marketing channels of freshwater fish products

The flow of freshwater fish products can go through various channels from the fish farmer to the end consumer and can involve varying numbers of stages. Therefore, the fish market can be separated into four main stages: the production stage, the wholesaling stage, the retailing stage, and the consumption stage.

In the actual situation, fish marketing channels are complicated and diversified as each market operator may perform more than one marketing function. Therefore, the main internal flow of fish products may go through one to several market operators. For example, the case of the wholesaling stage, there are three types of wholesalers participated in marketing channels of fish commodities produced in Hai Duong province which include fish farmer collectors, commission wholesalers, merchant wholesalers, and some cases including provincial traders. Therefore, the fish products from the SSA models, through the marketing agents, were traded and transacted from production to the final consumption.

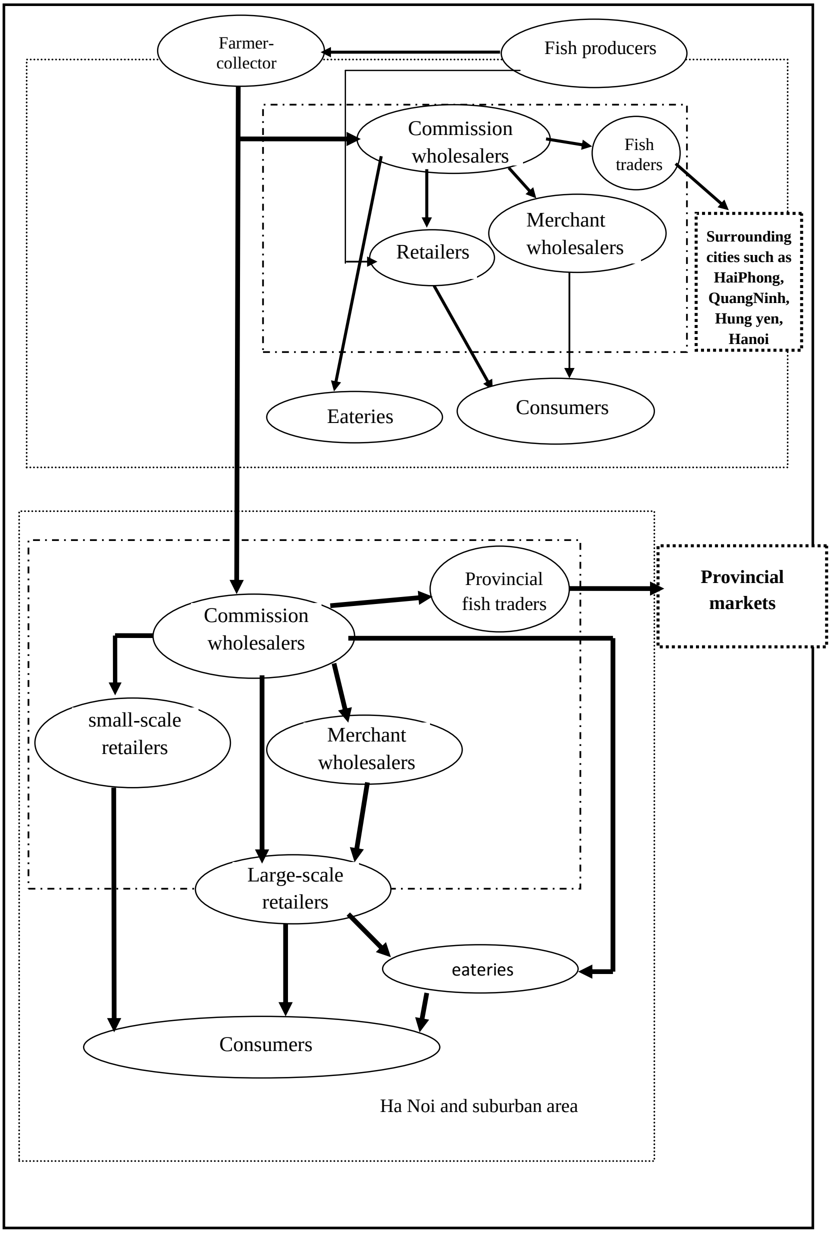


Figure 6. 2 ***Flow of the freshwater fish products in Hai Duong***

Fish farmers operating the FS, AF and New VAC models would commonly love to have direct sale of their fish products to many marketing agents as much as possible. However, only fish farmer-collectors can buy a bulk of fish products from fish households in the region of the study. Therefore, the main flow of freshwater fish products goes through from fish farmers, farmer collectors, commission wholesalers, merchant wholesalers, retailers, and consumers. At the lower level of the channel, the fish commodities supplied from wholesalers are the most preferred because of: (i) diversified types and forms of fish products, (ii) large quantity of products available, (iii) stable supplies over time, and (iv) flexibility of market prices of fish commodities.

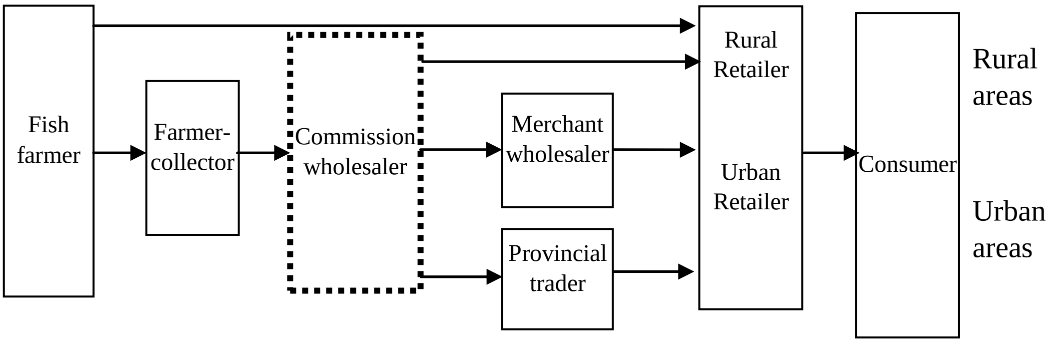


Figure 6. 3 Marketing channels of the freshwater fish products from FS, AF and New VAC models in Hai Duong province

The FS, AF, and New VAC households in Hai Duong province are the primary providers who supplied a large proportion of fish commodities to the fish wholesale markets (at the suburban areas both in Hai Duong and Hanoi cities) through the marketing channels as illustrated in Figure 6.3. They can be defined with some main marketing channels as follows:

i) Fish farmers -> local retailers -> consumers

ii) Fish farmers -> Farmer-collectors -> commission Wholesalers -> retailers -> consumers

iii) Fish farmers -> Farmer-collectors -> commission Wholesalers -> merchant wholesalers -> retailers -> consumers

iv) Fish farmers -> Farmer-collectors -> commission Wholesalers -> provincial traders -> Retailers -> consumers

However, the study only focuses on two main marketing channels (ii) and (iii) due to these channels are the main flow of fish products from producers to retail stage and account for the major proportion of fish sale from farm households operating FS, AF and New VAC models. Then, the main marketing stakeholders are defined including fish farmer collector, commission wholesaler, merchant wholesaler, and the retailer will be depicted and analyzed in the following sections.

6.2.2. Market participants of the freshwater fish products

6.2.2.1. Fish farmer collector

In the preliminary period of aquaculture development, fish products are produced in small-scale production from subsistence fish farming models like the traditional VAC model. Direct marketing to consumers was a main form of selling farmed fish products. This practice enriched some fish farmers with the knowledge and experience in trading fish. With a certain time of participation in trading fish, they have also accumulated some money capital to become professional traders of fish commodities as presently. Therefore, all fish traders in the study originated from farmers who will be named as the fish farmer collectors or farmer collector. Moreover, their function in the business of fish trading was exactly as a collector along with the marketing chain. They are characterized by stakeholders with very experienced in trading fish as most of them have been involved in fish farming as well as trading fish as local retailers since the beginning period of the fish farming development in the region of the study. The average experience in trading fish of the farmer collectors is more than 9 years (table 6.5).This experience in the business of trading fish of the farmer collectors is normally a result of their participation in fish farming and directly retailing fish at their local markets. The average age of fish farmer collectors is over 40 years old. The youngest farmer collector experienced 5 years participating in the business of trading fish. Initially, they started their business of fish trading with a small truck and poor electric aeration system, and facilities, the farmer collectors have improved their trucks with larger loading capacity and better design of the electric aeration system as well as other storing facilities with good conditions to keep the fish products alive for a longer time of far distance transportation. They generally purchased the fish products from fish farmers and sold them to the retailers, merchant wholesalers and other marketing agents through the commission wholesalers at the wholesale markets located in suburban areas in Hai Duong and Hanoi cities.

The typical enterprise of a farmer collector was operated by a man, his wife or his son or a hired labor. The hired labor might be his relative or his friend or his neighbor. The truck is a main means of transportation for fish commodities. The loading capacity of a truck was 1.25 to 3.25 tons, however, the actual quantities of fish commodities might be carried ranging from 0.8 to 3 tons. The truck is redesigned based on the legally registered truck with loading capacity from 1.25 to 8.25 tons. Moreover, the volume of fish products was subject to the size and number of containers in the truck; the small truck was designed to carry about 4 containers of fish, and the larger one could load 8 containers of fish commodities. The average container could store about 250kg of fish. Although fish products are reared in polyculture with different kinds of fish species, the farmer collectors have to grade, sort out and separately pack into different containers. In the case of a small carriage of fish commodities, the prior segregation is not performed, and several different fish are mixed in a container.

The capacity of the loading truck and the number of trucks were indicators to determine the scale of business in trading fish products of the fish farmer collector. The largest farmer collector with ownership of three trucks was observed in the survey. The smallest farmer collector possessed only one truck. On average, these farmer collectors normally traded an amount of 1.7 tons of fish products every day. However, the largest one could trade an average volume with 5 tons of fish commodities. Fish farmer collectors' purchasing areas were normally observed in the areas of fish production within 10 km from their residence, but a maximum distance also observed about50 km a far distance from their home. They usually made oral contracts with fish farmers, negotiated farm gate prices of different fish products before the harvesting date was confirmed. On a usual day, farmer collectors took a visit to areas of fish production to find their sellers who owned fishponds that were ready to harvest the farmed fish. The harvested fish products were checked for quality and volume before the fish farmer-collector negotiated prices of fish commodities with fish farmers. If the negotiation was arranged, the fish farmer collector often made a small amount of cash as the deposit for the confirmation for the purchasing of the harvest. On the confirmed date, the harvested fishpond was draining water to facilitate the catching of fish products. The drainage of fishpond might take a longer time in case it rained. Rain was also a problem for fish loading, as it prevented the truck from getting close to the fish pond due to the muddy ridge. The containers were filled full of water to carry live fish. Fish products were often harvested in the evening to take advantage of low temperature to maintain a good condition for the live fish commodities. The transportation of fish commodities took about 2 hours from areas of fish production to the wholesale market at the suburban wholesale market in Ha Noi, and approximately one hour to the suburban wholesale market in Hai Duong province.

Table 6. 5 The main characteristics of survey fish farmer collectors

	Mean	Min	Max	Std
Age (years)	**40.4**	30	50	6.16
Household size (person)	**4.4**	3	6	0.92
Experience in fish trading (years)	**9.3**	5	15	3.50
Hired labour (person)	**1.5**	1	3	0.76
Number of trucks	**1.5**	1	3	0.76
Volume of trading fish (kg per day)	**2,750**	1,700	5,000	1,250.14
Number of business days per month	25.5	23	28	1.60

Source: survey, 2017.

The larger farmer collectors often took advantage of better loading capacity from their means of transportation and financial ability in the business of trading fish. They could purchase the fish products from any fish farmers whatever the volume of harvested fish commodities (because some fishpond might reach productivity up to several tons which were over the loading capacity of the small farmer collectors' truck). However, in this case, the small farmer collectors usually made a shared business in order to purchase all the fish products from such productivity fishponds. They might also rent the truck from other farmer collectors for increasing the loading capacity in such cases.

Photo 1 Fish harvesting and selling to the farmer collector at the farm gate

A farmer collector needed to mobilize an initial capital investment of about VND 1 billion to start his business of trading fish. This initial capital investment included the expenditure on purchasing a truck about 625 million VND, and some supplemental costs paying for the redesigning the truck, equipping the aeration system in line with some storing facilities. Fish farmer collectors claimed that they had to pay in cash immediately for their purchasing fish products from fish farmers at the farm gate. This cash was recorded at an amount about VND 100 million as considered as the daily operational cost. Besides, a large farmer collector with ownership of 3 trucks could mobilize a total capital investment reaching approximate VND 2 billion (see table 6.6). They often had to hire one to several laborers who were responsible for the job of truck drivers. The hired laborers were also in charge of fish sorting, loading, and unloading during the fish transaction at both farm gate and wholesale markets. They got a daily wage from this hiring at VND 300 – 350 thousand per day. Although their tasks were very labor-intensive, their monthly income was better than that of the local people working at local factories. Trading fish products (specifically the live fish) required a certain knowledge and experience. It included the skills of storing fish, price negotiation, and especially important thing was the establishment of networking with commission wholesalers and other marketing agents (merchant wholesalers, provincial traders) at the wholesale markets. Besides, the good relationship with a group of people who specialized in harvesting farmed fish with professional skills was very important for farmer collectors because their business of fish trading consisted in live fish products. They were susceptible during the harvesting, handling and transportation. Good harvesting and careful handling the farmed fish products could reduce the mortality rate of fish commodities which might increase the profit for the farmer collector.

Table 6. 6 The Initial investment capital, facilities, monthly and daily operational costs of survey fish farmer collectors

Particulars	Mean	Minimum	Maximum	Std. Deviation
The Initial investment capital and facilities				
Initial value of trucks	958,250.0	625,000.0	1,881,000.0	465,678.2
Metal basket	8,302.5	5,400.0	16,000.0	3,741.9
Canvas bags	4,097.5	2,880.0	7,200.0	1,630.1
Large electric aeration	4,453.8	2,900.0	8,850.0	2,235.1
Small electric aeration	4,010.0	2,880.0	7,200.0	1,647.2
Cash capital	171,250.0	100,000.0	250,000.0	46,732.5
Monthly operational costs				
Repairs and maintenance	1,837.5	1,000.0	3,000.0	724.9
Transaction costs	1,250.0	900.0	2,000.0	381.7
Interest payment for a loan	831.3	400.0	1,500.0	352.5
The daily operational costs				
Cost of Fish	102,500.0	65,000.0	180,000.0	43,094.6
Ice	102.5	80.0	150.0	30.1
Fuel	481.3	200.0	800.0	241.9
Labour	381.3	200.0	800.0	226.7
Transportation toll	131.3	75.0	300.0	73.8
Market Fee	75.0	50.0	150.0	37.8
Other	71.3	50.0	100.0	17.3

Source: survey, 2017.

In the business of trading live fish, a daily operation cost required for a farmer collector, on average, at an amount about VND 100 million which comprised the expenditure on cash to purchase the fish commodities and some materials such as ice, fuel. It also included transportation toll, market fee and other expenditures such as food and drink. The cash amount for the daily costs of the farmer collectors might be a larger amount which was subject to the actual volume of fish commodities from the harvested fishpond operated by fish farmers in the study region. The farmer collectors normally took one trip for their business of fish trading every day. Therefore, it was not really difficult to have a good data collection and calculations of marketing costs, marketing margins and some other concerns to their daily business.

6.2.2.2. Commission wholesaler

There were two types of wholesalers at the freshwater wholesale markets in suburban areas in both Hanoi and Hai Duong cities. They were defined as the commission wholesaler and merchant wholesaler due to their marketing functions in the marketing of freshwater fish commodities. The merchant wholesaler is described in the following section. This section is assigned for the description of the commission wholesaler.

The commission wholesalers were exclusively local residents of the wholesale market locations, for instance, the commission wholesalers at the Yen So wholesale market (Hanoi) were all So Thuong villagers and at the Gia Loc wholesale market (in Hai Duong)were Thach Khoi dwellers. Their business of trading freshwater fish commodities was normally operated by a couple and one to several hired laborers. The commission wholesalers often visited each other, exchanged information about the market, and lent money to each other for occasional large scale transactions. Several commission wholesalers reported that they used to share the expenses and profits when they started wholesaling fish at the wholesale market. The commission wholesalers at the wholesale markets were often called by a name of “Cai” in Vietnamese which clearly distinguished them from other traders in this market. The meaning of “Cai” stands for a sense of greatness such as "Boss". The commission wholesalers sold the fish commodities to which the fish farmer collector basically retained their title and responsibility. They took a commission from the sales price as a fee for the sale.

Table 6. 7 The main characteristics of the survey commission wholesaler of fish products

Particulars	Mean	Minimum	Maximum	Std. Deviation
Age (years)	41.4	35.0	51.0	6.0
Household size (person)	4.7	4.0	7.0	0.9
Experience in fish retailing (years)	11.0	6.0	15.0	2.3
Experience in fish wholesaling (years)	16.3	7.0	26.0	5.9
Hired labour	1.4	1.0	3.0	0.7
Business space (m2)	28.3	20.0	50.0	11.5
Number of motorbikes	1.4	1.0	2.0	0.5
Volume of trading fish (kg per day)	2,710.0	1,700.0	5,000.0	1,040.8
Number of business (days per month)	27.7	25.0	30.0	1.9

Source: survey, 2017

Photo 2 Commission wholesaler at the wholesale market

The commission wholesalers had a fixed establishment at the wholesale market and ran the business of trading fish commodities between the suppliers (farmer collectors) on the one hand with other marketing agents, on the other hand, at the wholesale markets. They helped the farmer collectors to sell their fish to urban retailers, neighboring provincial traders, and sometimes merchant wholesalers at the wholesale markets. They usually took a fixed charge as the commission based on weight and fish species ranging from 800 to 1000 VND per kg, for example, black carp VND 1000 per kg and tilapia VND 800 per kg. They provided storage facilities for a short period and made some marketing tasks such grading and sorting of the fish commodities according with market requirements. Normally, they paid cash to the farmer collectors right after the fish sales were finished, but provided fish commodities to the retailers and merchant wholesalers on credit. They usually hired laborers to carry out loading, unloading, weighing, grading … and handled a large volume of fish (2.7 approximate tons per day, on average). Table 6.8 shows the initial investment capital and facilities for business of fish trading, the monthly and daily operational costs of the commission wholesalers. The study results show that they did not spend much on the initial investment capital and facilities except the cost of the rent for the business place (kios) with more than VND 200 million at the beginning of the business. This cash amount was a rent contract with the duration in 5 years. However, they mobilized a large amount of cash capital for daily operational cost at an amount of VND 500 million which was referred from the monthly interest payment for a loan over VND 5 million (interest rate 1% per month). This figure was reported by the commission wholesalers in the interviews, the actual number might be much larger based on the observation of their daily business during the survey.

Table 6. 8 The initial investment capital, facilities, monthly and daily operational costs of survey commission wholesalers of freshwater fish products

(Unit: 1000 VND)

Particulars	Mean	Minimum	Maximum	Std. Deviation
The Initial investment capital and facilities				
Motorbike	26,350.0	14,000.0	52,000.0	12,565.5
Plastic Basin	4,885.0	3,000.0	9,000.0	2,097.6
Rent of business space	208,000.0	185,000.0	300,000.0	34,817.0
Cement tanks	2,820.0	1,920.0	3,760.0	662.2
Aeration system	4,425.0	2,900.0	8,850.0	1,948.7
System of electric light	3,825.0	3,000.0	5,000.0	707.6
Facilities	7,500.0	5,000.0	10,000.0	1,581.1
Monthly operational costs				
Water Supply	305.0	250.0	350.0	28.4
Market fee and tax	1,360.0	1,200.0	1,500.0	84.3
Electricity	710.0	500.0	900.0	117.4
Repairs and maintenance	120.0	100.0	150.0	25.8
Transaction costs	800.0	800.0	800.0	-
Interest payment for a loan	5,320.0	3,000.0	10,000.0	2,350.3
The daily operational costs				
Ice	123.0	80.0	250.0	51.4
Fuel	70.0	50.0	120.0	27.5
Labour	530.0	300.0	1,000.0	249.7
Other	95.0	60.0	150.0	28.8

Source: survey, 2017.

6.2.2.3. Merchant wholesaler

The merchant wholesaler was mentioned above. Similar to commission wholesalers, their business of fish trading at the wholesale markets was commonly operated by a couple and one to several employees as well. Compared with the commission wholesalers, some merchant wholesalers were not local people of the wholesale market locations. They came from other places and rented a stall or shop at the wholesale markets for their enterprise of trading fish commodities. These merchant wholesalers normally purchased fish commodities at their own risk from both fish farmer collectors through the commission wholesalers and other merchant wholesalers. They were professional fish traders both in wholesaling and retailing fish commodities. Their main buyer customers were large scale retailers (canteens, kitchens of school, factories...) and small retailers at retail markets in the surrounding suburban areas. Most of them inherited the fish trading from their parent's generations or initially participated in retailing of freshwater fish products for such a certain time of 5.5 years, on average (see table 6.9).

Table 6. 9 Main characteristics of merchant wholesaler of fish products

Particulars	Mean	Minimum	Maximum	Std. Deviation
Age (years)	37.0	27.0	51.0	8.7
Household size (person)	4.6	3.0	6.0	1.0
Experience in fish retailing (years)	5.5	3.0	8.0	1.8
Experience in fish wholesaling (years)	12.8	7.0	20.0	4.8
Hired labour (person)	1.6	1.0	3.0	0.8
Business space (m2)	48.0	40.0	70.0	13.2
Number of motorbikes	1.3	1.0	2.0	0.5
Volume of trading fish (kg per day)	945.0	800.0	1,100.0	103.9
Number of business (days per month)	27.5	25.0	30.0	2.0

Source: survey, 2017.

With ownership of fixed stalls or shops at the wholesale market, the merchant wholesalers perform marketing functions as the purchasers and sellers within the wholesale markets and selling the fish commodities to the retailers located at the other places which referred to the supplies of fish commodities to the distance buyer customers of meal or food providers and some retailers who were quite far from the location of the wholesale markets. These buyers were close clients of the merchant wholesalers. Thank the good and long-term relationships of the merchant wholesalers with these clients, the merchant wholesalers sometimes could sell a considerable quantity of fish surplus, particularly in some cases when their fish commodities purchased were over the market demand considered as bad market days due to the poorer demand for fish commodities as compared with the level of the normal day. The initial investment capital and facilities seem to be not much difference as compared with those of the commission wholesalers. However, the accounting skills, knowledge and cash investment considered as the operational cost of their business in fish trading was different from the commission wholesalers' ones. This argument has come from the response of many merchant wholesalers who were not willing to shift their current business to become the enterprise of the commission wholesalers because they were not good at calculations and accounting skills as well as knowledge. Besides, they also reported that their financial condition could not mobilize a cash amount more than VND 200 million considered as the operational costs. This cash amount was calculated from VND 1.9 million concerning the average interest payment of the merchant wholesalers for a loan based on the interest rate 1% every month. As compared with the operational costs of the commission wholesalers, the calculation of the merchant wholesalers was a considerably small number. This figure seems to be reasonable with the scale of the merchant wholesalers' business through observing their daily volume of fish commodities and other concerning activities during the interviews with them.

Table 6. 10 Initial investment capital, facilities, the monthly and daily operational cost of merchant wholesalers of freshwater fish

(Unit: 1000 VND)

Particulars	Mean	Minimum	Maximum	Std. Deviation
The Initial investment capital and facilities				
Motorbike	18,500.0	12,000.0	32,000.0	8,527.7
Plastic Basin	5,050.0	3,000.0	9,000.0	2,362.3
Rent of business space	231,000.0	190,000.0	260,000.0	22,827.9
Cement tanks	3,018.0	1,920.0	3,760.0	622.8
Aeration system	4,525.0	2,900.0	8,850.0	2,385.8
System of electric light	3,900.0	3,000.0	5,000.0	809.7
Facilities	7,900.0	5,000.0	10,000.0	1,663.3
Monthly operational costs				
Water Supply	315.0	250.0	350.0	33.7
Market fee and tax	1,370.0	1,200.0	1,500.0	94.9
Electricity	730.0	500.0	900.0	131.7
Repairs and maintenance	115.0	100.0	150.0	24.2
Transaction costs	800.0	800.0	800.0	-
Interest payment for a loan	1,900.0	1,500.0	2,500.0	394.4
The daily operational costs				
Ice	96.0	80.0	150.0	20.7
Fuel	85.0	50.0	120.0	26.8
Labour	305.0	250.0	350.0	28.4
Dead Fish	190.0	150.0	250.0	39.4
Other	82.0	50.0	150.0	33.6

Source: survey, 2017

6.2.2.4. Retailer

A retailer is the marketing agent who stands at the last stage of the marketing channel to sell the fish commodities to consumers. The efficiency of the retailing network ensures that consumers' demand for fish products was satisfied. In the study, most retailers were dependent on the income from their business in trading fish. Their participation in the business of fish retailing could be considered as a vital factor to establish an effective retailing network of fish products because they directly benefited both ultimate consumers and the upper agents of marketing in the chain such as the fish farmer collectors. More importantly, they are responsible for disseminating the live fish commodities to communities as the retailing function when making fish products available to end consumers and maintaining the stability of fish demand at the wholesale markets.

Photo 3A retailer and retail market

The study was found that most fish retailers were female whose age ranged from 30 to 51 years old (table 6.11). They rented a business space with an area about 4 m^2, on average, at the open or wet markets. These open markets are quite common in Vietnam. The study selected 4 local retailers who bought fish at the farm gate and sold to local consumers at their rented shop in the district markets in the areas of the study. The study also selected six urban retailers who were selected at Yen So wholesale in Hanoi for interviewing. The findings about the retail markets of freshwater (live) fish products were very varied in kinds of operations ranging from temporary/roadside markets to the periodly operating retail markets and daily urban retail markets. On average, a retailer could trade a volume of fish commodities about 80 kg of mixed fish per day.

Fish retailers often complained about working hard in poor conditions since their business of fish trading concerns the preparation or pre-processing to make fish commodities ready to cook as extra services given to end consumers. Therefore, they were almost poor people who normally participated in the business of fish trading for more than 27 days per month because income generated from this business was very important for them and, in some cases, it was the main source of income for their family.

Table 6. 11 Main characteristics of the survey fish retailer

Particulars	Mean	Minimum	Maximum	Std. Deviation
Age (years)	38.3	31.0	51.0	7.0
Household size (person)	4.6	3.0	6.0	1.0
Experience in fish retailing (years)	9.1	4.0	15.0	3.2
Business space (m2)	4.0	3.0	5.0	0.5
Number of motorbikes	1.0	1.0	1.0	-
Volume of trading fish (kg per day)	78.0	55.0	100.0	14.1
Number of business (days per month)	27.3	25.0	29.0	1.7

Source: survey, 2017.

Table 6. 12 Initial investment capital, facilities and monthly and daily operational costs of survey fish retailers

(Unit: 1000 VND)

Particulars	Mean	Minimum	Maximum	Std. Deviation
The Initial investment capital and facilities				
Motorbike	14,000.0	12,000.0	17,000.0	1,699.7
Plastic Basin	530.0	450.0	600.0	53.7
Rent of business space	690.0	600.0	800.0	56.8
Battery	286.0	270.0	300.0	10.7
Electric aeration	350.0	300.0	400.0	40.8
Other facilities	435.0	350.0	500.0	47.4
Cash capital	4,050.0	3,000.0	5,000.0	761.9
Monthly operational costs				
Repairs and maintenance	100.0	100.0	100.0	-
Transaction costs	116.0	100.0	150.0	20.1
Interest payment for a loan	-	-	-	-
The daily operational costs				
Ice	24.0	20.0	30.0	3.9
Fuel	27.0	20.0	40.0	7.9
Dead Fish	2.3	2.0	3.0	0.5
Tax and fees	3.9	2.0	7.0	1.3
Other	7.1	5.0	10.0	1.7

Source: survey, 2017.

The retailers' initial investment capital and facilities required an amount about VND 20 million (table 6.11) in which, on average, expenditure on motorbikes accounted for VND 14 million which occupies for over 70 percent of the value of the total initial capital investment and facilities. Motorbike was the main means of transportation for freshwater fish commodities from purchasing place to their retail markets. The retailers started their fish trading with a cash capital amount of about VND 4 million which mainly was the expenditure on purchasing fish commodities from sellers at the wholesale markets or areas of fish production. The urban retailers could easily purchase fish at the wholesale markets; while the local retailers had to look for the sellers (mainly fish farmers) in case they were new markets participated in fish trading when they did not have good relationships and contacts with fish farmer collectors who could provide a lot of information about fish farmers in the region.

6.2.3. Main functions of the freshwater fish market participants

In the study areas, market intermediaries were responsible for various tasks of marketing activities such as assembling, sorting, grading, handling, transporting, price setting, risk taking, and distribution. The farmer collectors were the main actors who performed these functions while the commission wholesalers undertook as the facilitating agents. In general, the merchant wholesalers were involved in all functions performed by intermediaries in the study (Table 6.13).

Table 6. 13 Main functions of market participants in the marketing channels of fish products in Hai Duong province

Functions performed	**% of respondents**			
	Farmer-collector	**Commission wholesaler**	**merchant wholesaler**	**retailer (*)**
Assist buyers and sellers		100.0	70.0	
Buy and sell in the same market			40.0	40.0
Buying from one place and selling in another market	100.0		90.0	60.0
Finance sellers and buyers		100.0	50.0	
Provide business premises and temporary storage facilities		100.0	30.0	

(*) estimation from the volume of fish sales

Source: survey, 2017.

+ Farmer-collector: The various functions performed by farmer collectors are purchasing fish from fish farmers at the areas of fish production and selling fish to other agents at the wholesale markets. All farmer collectors were the villagers at areas of fish production in Hai Duong province. They were responsible for collecting and purchasing a bulk volume of fish to supply to a lower tier in the marketing chain. Transporting was the most important marketing activity that they performed.

+ Commission wholesalers: The main task of the commission wholesaler was to help the farmer collector to sell the fish to the buyers including merchant wholesalers at the wholesale markets. As compared with other marketing agents, there were fewer commission wholesalers who participated in trading fish at wholesale markets. The commission wholesalers provided the financing for the buyers (small retailers) on credit and the sellers (farmer collectors) by paying cash immediately at the wholesale markets.

+ Merchant wholesalers: They acted as the purchasers and sellers in the wholesale markets at the suburban and urban markets. Sometimes, they also helped other buyers and sellers' operations through financial support as a loan. They usually bought freshwater fish commodities from the farmer collectors through the commission wholesaler and sold them to the urban retailers.

+ The retailer: in this study, the urban retailers performed their functions as they buy live freshwater fish commodities from farmer collectors through the commission wholesale and merchant wholesalers at the wholesale markets and sold them to the suburban consumers. The local retailers purchased fish products from fish farmers at the areas of the fish production and sold them at their retail market to end consumers at district areas. These retailers acted as purchasers and sellers at one place and other places.

6.3. Market demand and marketing of the freshwater fish products from the FS, AF and New VAC models

6.3.1. Market demand and grading of the freshwater fish products

In northern Vietnam, all religious and social groups prefer the live fish to the iced or preserved fish. From the survey, a daily supply of fish at wholesale markets varied depending on the supply of farmed fish from the production of Hai Duong province where about 60% of the total fish production was supplied to the wholesale market in Hanoi and the remaining (40%) was marketed at the wholesale market in Hai Duong city. The wholesale market in Hai Duong was a trading place from which fish commodities were delivered to surrounding cities such as Hai Phong and Quang Ninh. Trucks and motorbikes were the main modes of transportation to carry fish products to these wholesale markets, while trucks were unique means of fish transportation to the wholesale market in Hanoi.

According to respondents, the market demand for fish was growing in both urban and rural areas due to the urbanization process and rapidly rising income in the communities. The rich people had a high demand for large fish commodities. The finding from the market survey shows that the farmed fish products trading through markets had increased a triple volume for over 5 years up to the year of the survey in 2017. Particularly, during the peak harvest season (June-December), fish products from Hai Duong region accounted for more than 30% of total farmed fish commodities at the Hanoi markets. As fish farmers increased their production of fish products, the volume of trading fish commodities might be higher than 5 times in comparison with the recorded volume in the previously 5 years.

Table 6. 14 Farm gate prices by grading of fish products

Fish species	Size of fish	Weight (kg)	Average farm gate prices (1000 VND)	Demand
Grass carp	Small	< 2.5	58.0±1.98	Medium
	Large	≥ 2.5	59.9±1.99	High
Black carp	Small	< 3	84.6±2.46	Medium
	Large	≥ 3	86.6±2.46	High
Common carp	Small	< 0.7	43.2±1.14	Medium
	Large	≥ 0.7	45.9±1.26	High
Tilapia	Small	< 0.5	30.7±1.32	Low
	Large	≥ 0.5	32.9±1.61	Medium-High

Sources: survey 2017

In the areas of fish production, the investigation found that a major share(90%) of farmed fish outputs from the FS, AF, and New VAC models in Hai Duong destined at the wholesale markets in the cities in Hai Duong and Hanoi. Fish demand in the markets was categorized in two forms considered as “small” and “large” fish commodities. For example, grass carps were classified into two grades; grade 2 for small grass carp with body weighing of less than 2.5 kg and grade 1 granted for the larger ones. Based on this category, the fish traders set up the farm gate prices of grass carp at VND 59.9±1.99 thousand for the grade 1 and VND 58.0 ±1.98thousand for the grade 2 accordingly. Similar to other fish species, the farm gate prices of four main fish commodities were gathered and presented in table 6.14.

In agricultural marketing, grading and standardization is an important marketing function, which facilitates the moving of the flow of finished products. Without standardization, there is confusion and unfairness as well. Standardization is understood in a broader sense. Grade standards for commodities are established first and then the commodities are sorted out according to the realizable accepted standards. Generally, agricultural products are graded according to certain quality specifications. However, these quality specifications are sometimes confused to grade the agricultural commodities since they vary from seller to seller. The top grade of one seller may be inferior to the second grade of another. This happens when buyers lose confidence in their buying the fish commodities in the markets during the market survey. To avoid this eventuality, it was necessary to have fixed grade standards, which are universally accepted and followed by all in the trade of fish commodities. It was a prerequisite for mass marketing and widening the market for the freshwater fish products in Hai Duong province. The adoption of standards may be either mandatory or voluntary. However, the grading fish products referred to a process of assessing the intrinsic value of commodities. It also ensured that fish products with the higher quality should clearly be defined in terms of freshness, size, color, and other specific features which could bring a premium price in the market back to the fish farmers.

Table 6. 15Percentage of "grade 1" fish products by different SSAmodels

(Unit: percent)

Fish species	FS model	AF model	New VAC model
Grass carp	59.39 [a]	83.89 [b]	68.21 [c]
	(7.47)	(7.75)	(9.48)
Black carp	56.78 [a]	85.06 [b]	69.08 [c]
	(2.10)	(6.45)	(16.56)
Common carp	58.88 [a]	79.34 [b]	70.86 [c]
	(6.25)	(5.99)	(11.87)
Nile tilapia	60.80 [a]	80.16 [b]	63.68 [a]
	(8.84)	(6.18)	(10.01)

Different superscripts. ([a,b,c]) denote a significant difference between means within rows ($p< 0.05$). Bracket denotes the standard deviation

Sources: survey 2017

In general, the grading of fish products assisted the end customers of fish food in exercising their choice and also provided them with the quality assurance. Particularly, the grading and standardization of fish products increased quality consciousness in the wholesale markets in both Hai Duong and Hanoi This argument was made since in the wholesale markets many sellers and buyers referred to "Hai Duong" fish when they would like to introduce some intrinsic features of the fish products that they looked for a good price from them..However, the standardization of fish products was difficult because fish production in Hai Duong reared in polyculture and by small-scale farmers. Moreover, the standardization of fish products sometimes required several concerns in some production methods such as VietGAP fish producing requirements, handling techniques and services in retailing fish products.

On the other hand, fish farmer collectors often downgraded the fish products of the farmers in the study areas. While fish farmers were in the habit of selling the whole fishpond produce to refer the fact that they preferred to sell their farmed fish products without grading, this divergence generally makes a certain time for fish farmer collectors to negotiate in their purchasing fish commodities from fish farmers in the region. Despite that the requirements and classification of grading fish products could benefit the fish farmers for a long term of fish production because it might stimulate the farmers making more efforts for quality improvement of fish products through which increased the demand for fish products from their production. In this case, the AF farmers had taken advantage of their financial condition to invest more on fingerlings to achieve the largest “premium quality” proportion of the total harvested fishes among three compared models; follow up the New VAC model households and the FS model households. The difference in the proportion of “the grade 1” harvested fish products between AF model and FS, New VAC models are significantly at $P<0.05$ (see table 6.15).

6.3.2. Wholesale and farm gate prices of the freshwater fish products

Selling prices of fish commodities produced in Hai Duong were influenced by two major factors; the prices at which the fish farmer collectors bought harvested fish products from fish farmers for the stake to earn some profits as their expectation; it was determined by the rule of supply and demand. Similar to other agricultural commodities such as vegetables and fruits products, selling prices of fish commodities had fluctuated in the markets over time. The selling prices of fish commodities depended on fish species, size of fish, appearance quality and seasonality since fish production from the SSA models were diversified and quite seasonal in the study region. The selling fish prices varied irregularly and more widely than other agricultural commodities such as rice and meat. The variation in selling prices of fish commodities also affected the farm gate prices of fish products which were generally set up by negotiation between fish farmers and farmer collectors because fish farmers sold their fish products to farmer collectors at the farm gate. However, the farm gate prices of fish products also differed for each other in terms of the different SSA models which were categorized in the previous chapter (chapter 5).

The farm gate prices of grade 1 “premium quality” products by different fish species and by SSA models are presented in the table 6.16. The AF model households have the highest selling prices of fishes; follow up on the New VAC model households, and FS model households. The study results refer to the fact that the AF households had more investment in fingerlings and feed of their fish production than those of the other groups. In practice, the harvested fishes of the AF households represented the larger proportion (84% see in table 6.15) of harvested fish products with more premium quality in terms of fish products' appearance, bodyweight. Therefore, these fish products were often purchased by fish farmer collectors with higher farm gate prices compared to those of the New VAC and FS households in the region. The study results show that all harvested fishes (including grass carp, black carp, common carp and tilapia) of the AF households were sold at higher levels of farm gate prices (statistically significant at $P<0.05$). For example, the farm gate price of grass carp in the AF model was VND 61 thousand, while those in the New VAC and FS models were VND 60 thousand and VND 58.5 thousand, respectively.

Table 6. 16 Farm gate prices of "grade 1" fish products by different SSA models

	FS model	AF model	New VAC model
Grass carp	58.49^{a}	61.08^{b}	60.07^{c}
	(2.10)	(1.35)	(1.22)
Black carp	84.81^{a}	88.33^{b}	87.92^{b}
	(2.04)	(1.24)	(2.46)
Common carp	45.37^{a}	46.51^{b}	45.41^{a}
	(1.08)	(1.13)	(1.24)
Nile tilapia	32.00^{a}	33.76^{b}	32.44^{a}
	(1.41)	(1.62)	(1.04)

Different superscripts. (^{a,b,c}) denote a significant difference between means within rows ($p< 0.05$). Bracket denotes the standard deviation

Sources: survey 2017

6.3.3 Bargain power of the fish farmers

The bargain power of fish farmers can be examined through the negotiation competencies and the levels of satisfaction with the current situation of marketing the fish products of fish farmers in the research areas. While the negotiation competencies indicate the internal capacity of fish farmers in the marketing of their fish products, the levels of satisfaction with the current marketing situation reflect the external factors to impact on the capacity of fish farmers in the marketing activities of fish production. The market survey found the differences in these concerns between the FS, AF and New VAC models in the study region. The findings are presented and discussed in the following paragraphs.

The domestic markets of freshwater fish in northern Vietnam are complex and comprise many types of markets and involve a large number of parties. Freshwater fish products are quite perishable commodities due to they were sold alive and fresh. Live fish products were transported by trucks or motorbikes and were kept in water-filled containers. Poor conditions of transportation might cause fish to die and reduces their selling price by as much as 50-60%. Freshwater fish products were moved from fish farmers to consumers along the marketing chain with involvement of several market participants as described in the previous sections where the fish farmer collectors were depicted to be responsible for gathering fish from fish farmers. They had direct contacts with fish farmers for negotiation in the purchasing the harvested fish products from fishponds. It was really useful to understand the situation of the fish farmers' bargain power when they sold their fish products to the fish farmer collectors at their farm gate. This was because the size of some fish species varied significantly (section 6.31) and thus, selling prices of fish were generally based on the some fish specifications through the grading at the wholesale markets and the farm gate as well. It was assumed that fish farmer-collectors might take advantage of fewer participants in trading fish products in the areas of fish production; they would get a good bargain power in purchasing fish products from fish farmers in Hai Duong province. Therefore, the study examined the negotiation competencies of FS, AF and New VAC households in terms of some concerns which referred to the coping strategies in the marketing the harvested fish products of fish farmers such as the number of fish traders that households have had business relationships (traders); negotiating time to accept of selling harvested fish to farmer collectors (days); the production days that fish farmers can extend or prolong in fish farming to look for better farm gate prices of fish sale (days)which were gathered and compared the differences between fish farmer from the SSA models in the region. The study findings are presented in table 6.17.

In Hai Duong province, fish farmers operating the FS, AF and New VAC models typically sold their fish products to farmer collectors who travelled between villages and wholesale markets at suburban areas in both Hanoi and Hai Duong cities. Thus, farmer collectors were likely to take the extent of advantages in farmers' ignorance of the market price and extract a charge from them by offering very low prices for the fish farmers' fish products. The study results have shown that the FS households were the most vulnerable to market volatility and faced a lower level of bargain power with their buyers than that of the AF and New VAC households in their fish sales. This was because of the fact that they were operating the largest scale of fish production as compared to that of the AF and New VAC households in the region. Although they made more efforts on seeking more traders (here the traders referring to farmer collectors) in terms of the higher number of fish trader that households have had business relationships (average 5.53 fish traders) as compared to (4.7 fish traders and 4.1 fish traders of households operating the AF and New VAC models, respectively (table6.17). Regard to the negotiation time to sell the fish products and the days that households could prolong their fish farming to wait for better offers of farm gate prices, the FS model households appeared to accept the offer to purchase their fish products from fish farmer collectors in 5.3 days, on average, after the fish farmers got the first offer from a farmer collector and could extend the fish farming a little over 12 days in cases they felt this offer with farm gate prices being not unreasonable. The ANOVA test showed a significant difference in these study results (see table 6.17)between the FS, AF and New VAC households, respectively. With these results, the study can conclude that the FS model households had a lower level of bargain power with farmer collectors than that of the AF and New VAC model households in the study areas.

Table 6. 17 Negotiation Competencies of fish households

	FS model	AF model	New VAC model
Number of fish traders that households have had business relationships (traders)	5.53^{a} (1.57)	4.71^{b} (1.86)	4.09^{b} (1.20)
Negotiating time to sell fish products (days)	5.29^{a} (1.46)	7.17^{b} (2.64)	8.14^{b} (3.34)
Extend production for better prices of fish sale (days)	12.27^{a} (1.59)	16.11^{b} (2.69)	24.97^{c} (3.44)

Different superscripts. (^{a,b,c}) denote a significant difference between means within rows ($p< 0.05$). Bracket denotes the standard deviation

Sources: survey 2017

Besides, in order to understand more deeply the FS households' lower level of bargain power with fish farmer collectors, the study used the Likert scales to test the satisfaction with the farm gate prices of harvested fish products and other marketing conditions between fish farmers of the FS, AF and New VAC models. The study results are presented in table6.18. It has shown that the FS model households are really not satisfied with the farm gate prices of their fish sales (3.06). This finding was significantly different from the concerns of the New VAC model households (ANOVA test $P<0.05$). According to the 3.0 of the decisive rule, all households operating the FS, AF and New VAC models were not satisfied with the farm gate prices of fishes. This phenomenon reflects a fact that most fish farmers had shortages of price and market information due to the limited level of access to other marketing agents at the wholesale markets. Moreover, the relationships and levels of coordinated vertical (in the following section 6.4.2) between market participants in the current marketing chain of farmed fish products from study areas were relatively limited and poor particularly between the fish farmers and the farm collectors.

There was a significant difference in levels of the satisfaction with the farm gate prices of the "grade 1" fish products between the New VAC model households and FS and AF model households. This result reflects a truth that the New VAC households normally operated a small scale of fish production compared to FS and AF model households. It means that their harvested outputs were a relatively small volume of fish which also led to a small part of unqualified fish products during the fish sales to farmer collectors at the farm gate. In some case, a considerable part of unqualified fish products were rejected and purchased with low prices by farmer collectors due to the buyer's downgrading the fish commodities to gain more profits in their enterprise. However, the downgrading part of fish outputs did cause a much problematic matter for the New VAC farmers because they were able to market this part of fish outputs by themselves at local markets to obtain better selling prices, while the FS and AF farmers usually accepted this situation.

Table 6. 18 Levels of households' satisfaction with their current marketing situation

	FS model	AF model	New VAC model
Satisfying with selling prices of fish	3.06 [a]	3.91 [b]	3.77 [b]
	(0.79)	(1.03)	(1.26)
Low farm gate prices due to fish farmer collectors' coordination	4.22 [a]	3.65 [b]	2.77 [c]
	(0.78)	(1.11)	(0.73)
Traders respect their commitments of harvesting and buying date as agreed	4.18	4.06	3.89
	(0.84)	(0.83)	(0.76)
Traders' buying capacity	2.90 [a]	3.29 [a]	4.00 [b]
	(0.92)	(1.01)	(0.94)
Products grading standards not relevant	4.08 [a]	3.80 [a]	2.37 [b]
	(0.87)	(1.06)	(1.46)
Settlement for delay payment	3.93	3.09	2.80
	(0.73)	(1.14)	(0.84)

**) 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree; and bracket denotes standard deviation. Different superscripts. ([a,b,c]) denote a significant difference between means within rows (p< 0.05).*

Sources: survey 2017

Moreover, the study also found a poor coordinating level between the FS and AF farmers and fish farmer collectors. This argument was referred from the concerning the low farm gate prices of fish products due to fish farmer collectors' coordination. The coordination shows a weak level when the study result on the concern was accepted in respect to 3.0 of the decisive rule. In addition the commitments of harvesting and buying date as agreed between these fish farmers with fish farmer collectors. This study result reflects exactly the truth that this survey was conducted four months after the lowest market prices of fish (below the production cost)were recorded at the early year of 2017 and at that time all farmer collectors stopped their fish trading from fish farmers. This study result might be exacerbated by respondents who had just experienced a bad situation of fish marketing in their mind. However, this problem still reflected a weak point of marketing fish products resulted from poor coordination between market stakeholders in the freshwater chain in the areas of study.

In general, while the internal factor of the marketing fish products referring to the negotiation competencies of fish farmers made the FS farmers more dependent on the fish farmers collectors as compared to the AF and New VAC farmers, the external factor of the marketing the fish commodities referring to the poor level of coordination between the fish farmers and farmer collectors forced the VAC farmers to diversify their market outlets of the fish sales in the study region in Hai Duong province.

6.3.4. The fish farmers' share in the retail price

From the perspective of perfect competition, the marketing margin is expressed as the difference between prices at different levels of the marketing agents such as a difference between wholesaler and retailer. Table 6.19 shows the fish producers' share in the retail price, the margins of the farmer collector and the retailer and their share in the retail price according to several main fish commodities. In the previous sections of the study, fish farmers made a wholesale of their fish outputs to the fish farmer collectors at the farm gate. Therefore, the fish farmer's share in the retail price was calculated based on 100 kg of mixed fish products with farm gate prices received by fish farmers since the fish production was polyculture. From the study, the share of fish farmers in the retail price paid by the consumer was ranging between 85% and 90%. Black carp and grass carp give the farmer a higher share in the retail price while tilapia and common carp brought a higher rate of margin for the retailer and farmer collector. Gross marketing margin included the fish farmer-collector expenditure in the fish market, the farmer collector's profit, commission wholesaler's marketing cost and income, retailer expenses, and the retailer's profit. The share of the retailer's margin in selling price was higher than those of the farmer collector for all the species. The margin rate of the retailer was the highest (11.3%) for tilapias, the lowest (7.3%) for the black carp. When the share of fish producer, farmer collectors and retailers in the price paid by customers was put together, it is clear evidence that fish producer has accounted for a large share of the retail price while the farmer collector took a small fraction of the margin share. However, the farmer collector had a large volume of fish trading in a day; It was estimated that fish farmer collectors trade an amount of fish as over 30 times larger than that of the retailer. It means that the farmer collector still gained a great profit in their fish trading.

Table 6. 19 Fish farmers' share, farmer collector's, and retailers' margin share in the retail price

	Fish farmer 's share		Farmer collector's margin		Retailer's margin		Retailer price
	1000 VND	%	1000 VND	%	1000 VND	%	1000 VND
Grass carp	59.4	89.2	2.1	3.2	5.1	7.7	66.6
Black carp	88.7	90.1	2.5	2.5	7.2	7.3	98.4
Tilapia	32.4	85.7	1.6	4.2	3.8	10.0	37.8
Common carp	45.3	85.3	1.8	3.4	6.0	11.3	53.1

Source: survey, 2017.

6.3.5. Market participants' marketing cost of the freshwater fish products

Various costs occurred in the business of fish trading along with the marketing chain. Table6.20 presents the cost structure of selected fish market operators i.e., farmer collectors, commission wholesalers, merchant wholesalers, and retailers. The cost of the purchased fish products was the main cost item that accounts for more than 97 percent of the total cost for all market operators. Cost of dead fish presents for the highest proportion of the total marketing cost (16.9% or VND 65.3 thousand per 100 kg of mixed live fish) due to fish sold alive. Wage, fuel and the rent of a business place (shop or stall) also account for a large share of total marketing costs. Other cost items such as equipment depreciation, materials, repairs and maintenance, transportation, transaction, interest and tax and fees were minor. It means that all fish marketing agents were simply buying and selling fish. Higher expenses on fuel were found in for farmer collectors and the retailers in their total marketing costs representing 16.3% and 28.4%, respectively. While the farmer collector transported the live fish by trucks, the retailers' means of transportation was a motorbike. Every day retailers had to pass a far distance from 5 km to 20 km to buy the fish from the location of the seller to the retail markets where they retailed fish food to their clients. The farmer collector spent the highest cost of fuel at 17.9 thousand VND per 100 kg of fish to transport the fishes from production to the wholesale market. The distances from production areas to the Yen So wholesale market and Gia Loc wholesale market are 70 km and 30 km, respectively.

The cost of materials for storage of the fish was also found in all the marketing agents. These materials consisted of ice, salt, and water along the chain to preserve the fish alive. The farmer collectors owned the truck with the design of aeration system which does not require many materials to maintain the fish alive during the transportation to the wholesale markets. It was estimated that they can reduce a significant material cost for their enterprise while the merchant wholesalers spent the highest cost of materials (14.4 thousand VND/100 kg of fish) due to they had to retain the fish alive at their market stall to sell to subsequent market operators; follow-up was the retailers during their handling the fish to the end consumers. In the retail stage, fish were kept alive at the basin or cement tank at the selling place and the retailers preprocessed to make the fish ready to cook to sell the consumers. As a result, ice, electricity, water, and salt were contributed to the retailers' cost of materials.

Table 6. 20The structure of marketing costs by different marketing agents as per 100 kg of mixed fish

Cost items	Farmer-collector		Commission wholesaler		Merchant wholesaler		Retailer		Total	
	1000 VND	**%**	**1000 VND**	**%**	**1000 VND**	**%**	**1000 VND**	**%**	**1000 VND**	**%**
Equipment depreciation	12.6	12.0	1.6	3.1	4.1	3.4	9.0	8.1	27.2	7.0
Shop rent/land tax		-	5.0	10.0	15.0	12.4	33.3	30.0	53.3	13.8
Fuel	17.2	16.3	2.6	5.2	9.0	7.4	31.5	28.4	60.3	15.6
Materials (ice, salt, water, electricity, etc.)	4.0	3.8	6.1	12.1	14.4	11.9	10.4	9.4	34.9	9.0
Wage	13.2	12.5	19.6	39.0	32.4	26.8		-	65.2	16.8
Repairs and maintenance	2.7	2.6		-		-	4.9	4.4	7.6	2.0
Transportation		-	1.1	2.2	1.6	1.3		-	2.7	0.7
Transaction (tel. bill, etc.)	1.9	1.8	1.2	2.4	3.1	2.6	5.6	5.1	11.9	3.1
Interests	1.2	1.2	7.0	13.9	7.3	6.0		-	15.5	4.0
Tax and fees	7.4	7.1	2.1	4.1	5.4	4.4	3.9	3.5	18.7	4.8
Loss of dead fish	42.2	40.1		-	20.1	16.6	3.0	2.7	65.3	16.9
Others	2.8	2.7	4.1	8.0	8.5	7.1	9.5	8.6	24.9	6.4
Total	**105.3**	**100.0**	**50.4**	**100.0**	**120.9**	**100.0**	**111.0**	**100.0**	387.5	100.0

(1) Truck and motorbike depreciated for 10 years; metal equipment equal to 5 years; plastic and electric equipment depreciated by 2 years; (2) Rent of business space calculated based on the contract of 5 years and monthly for the retailer

Source: survey, 2017.

In general, all marketing agents had an equal amount of marketing cost per 100 kg of mixed fish commodities except the commission wholesaler. While the merchant wholesalers had a total marketing cost of VND 120 thousand per 100 kg of mixed fish commodities, the total marketing cost of commission wholesalers was recorded at VND 50 thousand. This was because the merchant wholesalers normally stored the fish commodities for a longer time which generated much cost of dead fish while the commission wholesalers did not bear this cost. Moreover, the merchant wholesalers hired more laborers for the jobs of fish shipment to their customers. The hired labors of commission wholesalers were mainly responsible for the tasks of unloading and loading fish commodities at the wholesale market. The total marketing cost of farmer collectors and retailers were recorded at VND 105 thousand and VND 100 thousand per 100 kg of mixed fish commodities. The gross marketing cost of all marketing agents reached to approximate VND 390 thousand per quintal of fish commodities.

6.3.6. Marketing margin of the freshwater fish products

The marketing margin found the differences between the price received by the fish farmers (farm gate price) and the price paid by consumers (retail price). Net marketing margins consisted of the marketing cost, profit, and loss incurred by all market participants. Table 6.21 shows the calculations of marketing costs, marketing margins by different middlemen involved in the marketing based on 100 kg mixed fishes. The fish farmers got the total return of 100 kg mixed fishes at nearly 5,000 thousand VND from their fish production. Therefore, fish farmer’s share accounts for 87.34% of the retail price paid by the end consumers.

Table 6. 21 Value distribution along the marketing channel 1 per 100 kg of mixed fishes produced in Hai Duong province

(Unit. 1000 VND)

	Fish farmer	Farmer collector	commission wholesaler	Retailer
Purchasing price		4,992		5,199
Selling price	4,992	5,199		5,715
Marketing cost		105	50	111
Marketing margin	4,992	**168**	88	405
Marketing margin (%)	87.3	2.94	1.54	7.1

Source: survey, 2017

The total calculated marketing margin (in the channel 1) was 12.7%, which included3.6% for the farmer collectors, 2.41% for commission wholesalers and 9% for the retailers. However, it is a very interesting point that the absolute margin for the farmer collector was reduced by VND 66 thousand per 100 kg of mixed fishes when they sold their fish commodities to the merchant wholesalers at the wholesale markets in the marketing channel 2 (see table 6.22). The farmer collector could gain an amount of 168 thousand VND per 100 kg if they sold the fish commodities directly to the retailers at the wholesale markets. This result could explain a fact that fish farmer collectors always look for their retail buyers who were able to pay them with good prices of fish commodities. In general, fish farmer collectors obtained the positive marketing margin in cases the wholesale markets highly demand for fish with more retailers' participation through which they got the good selling prices of their fish products. However, the days of poor demand for fish commodities sometimes occurred at the wholesale markets because the retailers were too lazy to do business on rainy days. Because of the poor demand on fish at the wholesale markets, the fish farmers collectors had no choice of selling their fish commodities to the merchant wholesalers with low prices. At the wholesale market, the merchant wholesalers were the unique operators who could solve the problem of fish commodities over the market demand through their availability of storing facilities and a considerable number of close customers in the suburban areas. Although many respondents claimed about the down pricing of the merchant wholesalers at the wholesale markets, in the view of marketing functions, the merchant wholesalers were playing an important role in connecting the sellers (farmer collectors)to buyers (retailers) in cases when the relationship of demand and supply happened at the wholesale markets. The role of merchant wholesalers at the wholesale markets was very important because they could assist the fish farmer collectors from a huge loss of the trading of fish commodities. It might reach VND 100 million – all purchasing cost of a daily trading fish commodities, if happened, farmer collectors might go into bankruptcy. In exchange, the merchant wholesalers could receive an absolute margin of VND 84 thousand per 100 kg of mixed fish commodities (table 6.22). The absolute margin VND 200 thousand per 100 kg of mixed fish commodities was recorded for the retailers in the marketing chain of the fish products.

The fish products of FS, AF and New VAC model households with about 40% of the total harvest sold at the wholesale market in Hai Duong province and the rest sold at the wholesale market in Hanoi. The fish farmers' share in the retail prices accounted for87.3% of the total marketing margin. The absolute marketing margin of fish farmers recorded at amount of VND 4,992 thousand per quintal of mixed fish products (Table 6.21). At the wholesale market, through a commission wholesaler, a farmer collector might sell their fish commodities to retailers with the selling prices of VND5,400 thousand/ quintal of mixed fish commodities or sometimes to the merchant wholesalers with the selling prices of VND5,199 thousand per quintal of mixed fish commodities. However, the actual selling prices received by farmer collectors were less the amounts of VND 5,400 (to retailers) thousands and VND 5,199 thousand (to merchant wholesalers) since they had to pay a sale charge for commission wholesalers (the estimated amount of VND 88 thousand per 100 kg of mixed fish). The results of the study show that, on average, 87.3% of the farmer collectors' gross earnings was transferred to the farmers. This finding is consistent with the finding of another study on the marketing margin of mandarin(Pokhrel & Thapa, 2007) When farmers received a major share of the benefit generated by their products, the marketing system is considered to be providing a fair share of the benefits to all parties involved (Ellis, 1992). However, it does not mean that farmers have to be satisfied with the share that they have received. Wherever it is feasible, efforts should always be made to increase the farmers' share of the income.

Table 6. 22Value distribution along the marketing channel 2 per 100 kg of mixed fishes produced in Hai Duong province

(Unit. 1000 VND)

	Fish farmer	Farmer collector	commission wholesaler	merchant wholesaler	Retailer
Purchasing price		4,992		5,199	5,404
Selling price	4,992	5,199		5,404	5,715
Marketing cost		105	50	121	111
Marketing margin	4,992	**102**	88	84	200
Marketing margin (%)	87.3	1.8	1.54	**1.5**	3.5

Source: survey, 2017

Given the 12.7% gross marketing margin of intermediaries, critics may argue that fish middlemen receiving a large share without any investment in production is not fair. However, marketing intermediaries bear a lot of cost in the process of the transfer of the fish products from farm gate to the consumers, which needs to be taken into account while analyzing the marketing margin of intermediaries. Therefore, the profit margin or net marketing margin of intermediaries was calculated and presented in table 6.21. The wholesaling intermediaries have to pay laborers' wages for loading and unloading fish at the farm gate and the wholesale markets, accounting for nearly VND 65.2 thousand/quintal of mixed fish products and, then, the fuel, repair, and maintenance of trucks and facilities for transporting and storage fish along the marketing chain. According to the calculations of marketing costs, farmer-collectors bore a considerable amount of VND 42 thousand from dead fishes which lost from the purchased fish commodities with a farm gate value of VND4,992 thousand/quintal. They have to pay a transportation toll and some other marketing cost from the area of fish production to the wholesale market. As mentioned above, fish farmer collectors have to pay VND 800–1000 /kg of fish as the sale fee for the commission wholesalers, which represent about 1.8%.

Commission wholesalers, who have responsibility for selling fish to retailers, and other marketing agents, also incurred costs, though it is not as high as that of farmer collectors.

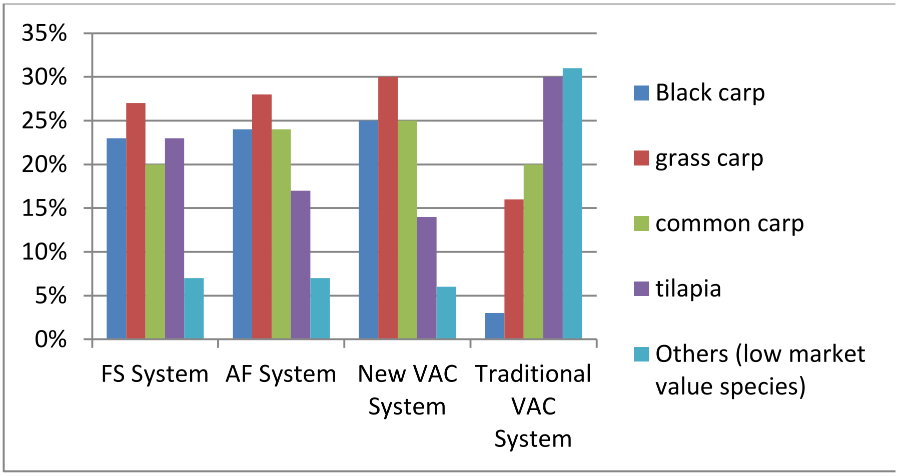
Out of the total 12.7% of the gross marketing margin of freshwater fish products produced in Hai Duong province going to the farmer collectors, commission wholesalers, merchant wholesalers, and retailers, the former group (in channel 2) received9.2%, of which marketing costs accounted for 4.83%. Thus, the farmer collectors received a net income (or net marketing margin) of 1.8%, reflecting the income that they could have earned from investment in other businesses, and time spent on providing services to both farmers and retailers, merchant wholesalers. The commission wholesaler received1.54% of the gross income, of which about 1% accounts for marketing cost and the rest was their net income. The merchant wholesalers gained3.59% of the gross margin, of which about 2.1% accounted for marketing cost and their net income represented 1.5%. The retailers received5.44% of gross marketing margin income after deducting 1.94% of the marketing cost. When putting together, the net marketing margin of these intermediaries accounted for about 8.34%, which was consistent with the findings of the study on marketing margin for a mandarin(Pokhrel & Thapa, 2007). We can consider 8.34% of the net income as a standard rate of income that an investment can earn from another business, the marketing margin that intermediaries were receiving should be considered fair. Moreover, the farmer collectors took a risk as the loss of dead fishes during the long-distance transportation from production to the wholesale markets. Live fishes are susceptible to transportation conditions and the process of distribution. The study results show the facts that wholesale markets and farmer collectors were playing an important role in fish production in Hai Duong province.

6.4. Market opportunities and constraints of the freshwater fish products from the SSA models in Hai Duong province

6.4.1. Increased market demand on the freshwater fish products

As mentioned in the previous sections, the freshwater SSA models provided the fish for both urban and rural markets where the urban market is preferred to the high market value species such as black carps, grass carp, common carp, and tilapia. The study results show that all households operating the traditional VAC model sold their fish to the rural consumers by the sale direct at the local markets with the low market value species such as Rohu, Mud carp, Vietnamese silver carp, Silver carp, and freshwater silver pomfret account for 31% of the total fish harvested (Figure6.5). These fish products provided a large part of fish protein for local communities in Hai Duong province.

On the other hand, the households of FS, AF, and New VAC models normally provided urban areas for a large proportion of the high market value fish commodities such as black carp, grass carp, common carp and tilapia. This source of fish protein with reasonable prices has been contributing to the animal protein source which has improved the nutritional status of the urban people, whereas the prices of meat products are still high and account for a large percentage of total income of suburban people. This result gives clear evidence that freshwater SSA models in Hai Duong could play an important role in producing fish food to supply not only the rural area but also suburban and urban areas in northern Vietnam.



Source: survey, 2017.

Figure 6. 4 Proportion of harvested fish species in different freshwater SSA models in Hai Duong province

6.4.2. Poor co-ordinated vertical in marketing channels and some market challenges of the freshwater fish products

In the study area, the marketing channel of freshwater fish was the trade or distribution channel as a series of interdependent stakeholders involved in the process of making farmed fish products available for use or consumption. The fish marketing channels followed a vertical structure through which flows of fish products went from producers to the final consumers and in which marketing actors met each other at both wholesale and retail markets.

Fish producers, farmer collectors, commission, merchant wholesalers, and retailers, as well as other channel actors, existed in channel arrangements to perform marketing functions (business operations) that smoothly facilitated the flows of fish products. Stakeholders stood between producers and ultimate users are known as intermediaries. Good marketing channels should enable fish farmers to interact with marketing agents in their economic realization and the provision of consumer needs. The power bargain of fish farmers (section 6.3.3) was discussed about the external factors of the marketing fish products concerning the poor level of vertical coordination between fish farmers and farmer collectors in the marketing chain of fish products. In general, all marketing agents made a considerable impact on making decisions of the fish households on the types and characteristics of production and marketing of the fish products in the study area. The current marketing channels of fish products have played an important role for fish farmers in facilitating social interaction, general communication, and information about the concerns of market demand and storing facilities and technologies. However, the marketing channels of fish products in Hai Duong were poorly coordinated between marketing participants, particularly between fish households and farmer collectors. For example, all trading arrangements were oral contracts, and several disputes commonly occurred during the transactions of fish products. Especially, when market volatility happened, both fish farmers and farmer collectors did not have any solutions to cope with the poor demand of the market (the beginning year in 2017).

On the other hand, the marketing channels of fish products in Hai Duong had, to some extent, reflected the principal functions of marketing in terms of trading fish commodities. Fish farmers could get more market information to make their decision on the production and marketing of their products through the channel stakeholder (farmer collectors) and channel environment as Fig 6.5. This is because the fish marketing channel was a two-way flow of market signals. The character and means of farm operation had a major formative effect on the organization and operation of the marketing channel. Simultaneously, the dynamics of the marketing process itself had a direct influence on fish production.

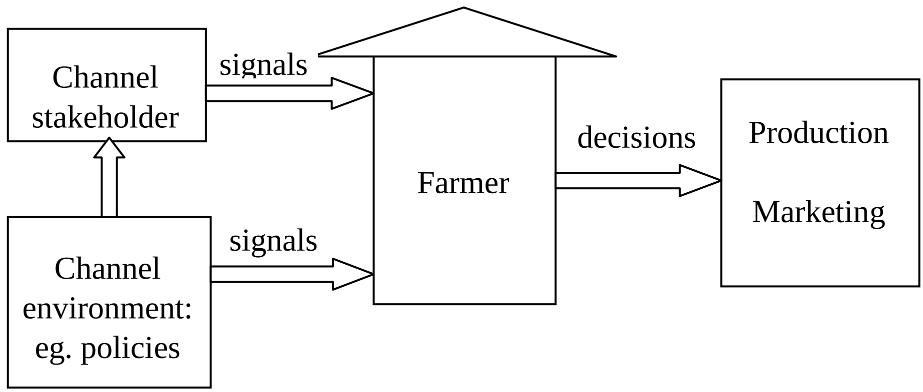


Figure 6. 5 Farmer's decision-making based on signals from stakeholders and environment of the marketing channel

Fish households would make appropriate decisions on resource allocation and on other management matters depending on the extent to which correct market channel signals were sent, clearly received and not distorted by market imperfections. However, fish farmers did not always get correct or clear market signals from the marketing channel, which had unforeseen effects on fish farmers' income and the economic efficiency of the freshwater SSA models.

Table 6. 23 The encountered problems of marketing fish products by fish farmers and marketing agents

Main problems	Fish farmers (N=167)		Marketing agents (N=38)	
	Respondent	%	Respondent	%
Low prices	101	59.9	7.0	18.4
Price volatility	119	71.9	18.0	47.4
Unstable supply	92	53.9	21.0	55.3
High levels of competition	51	29.9	14.0	36.8
Lack of market and price information	143	83.8	11.0	28.9
Lack of financial capital	93	53.9	21.0	55.3

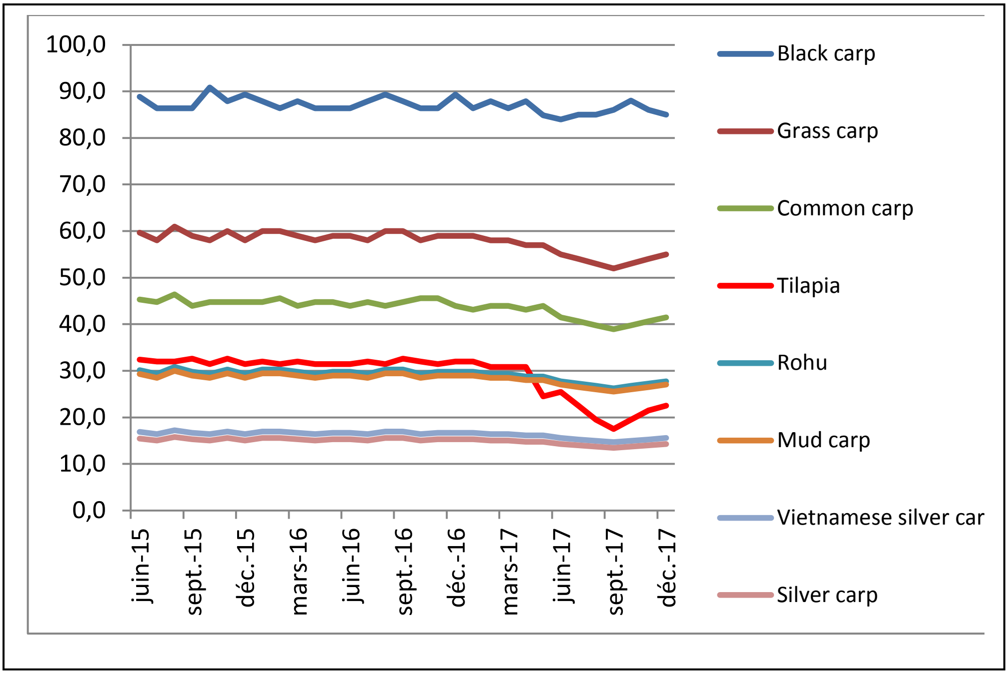
Source: survey, 2017.

There were several problems that all marketing stakeholders faced in the marketing of the fish products such as price fluctuation, the unstable supply of fish commodities, high level of competition and lack of financial capitals. The first problem was the price fluctuation in the markets. For example, 60% and70% of the respondents of fish farmers claimed the low prices and price volatility, while 47%of marketing middlemen reported the price volatility in the fish market. This result shows that the fish farmers were less updated with the price information in the fish market than the marketing middlemen were. Moreover, the price fluctuation seems not to cause many effects to the marketing middlemen in terms of direct income loss. The second problem was the unstable supply of fish products with (approximate 55% of respondents) which was equally claimed by both fish farmers and marketing agents. This result referred to the seasonality of fish production in Hai Duong province where the fish products were normally harvested in the period from March to December annually. The peak of the harvested season is September every year because warm weather is appropriate for the quick growth of farmed fishes. Particularly, over 80% of fish farmers claimed that they had lack of market and price information which affected directly to their income from generating from fish production while marketing agents stressed on the lack of financial capital as their main problem when they participated in the business of fish trading in markets. The lack of market and price information for fish farmers is understandable due to the fish farmers simply making wholesale at their farm gate without any access to wholesale market access, and the lack of financial capital can be explained by the fact that most marketing agents had to pay a monthly interest payment due to getting a loan for their business of fish trading such as farmer collectors (VND 831 thousand/month), commission wholesalers (VND 5,300 thousand/month) and merchant wholesalers (VND 1,900 thousand/ month). These problems can be solved with some governmental interventions and support to the marketing information centre of the fish market and price forecast as well as financial funds with low-interest rates to provide financial capital for marketing agents who will be more participated in the fish-trading business, making fish markets more available to facilitate the development of fish farming more stable and profitable in Hai Duong province.

6.4.3. The fluctuated prices of the marketable freshwater fish products

The total aquaculture revenue of farm households' fish products is affected by total harvest, proportion of premium quality "grade 1" and farm gate prices of fish commodities. While the traditional VAC households harvested a large volume of low market value species and sold these farmed fishes at local markets with reasonable selling prices, the remaining (FS, AF, and New VAC)model households sold their harvested fish products to fish farmer collectors at their farm gate and obtained larger profits thanks to intensification in the high value and marketable species such as black carp, grass carp, common carp and tilapia which were highly demanding in urban areas. However, these high value and marketable species reared by FS, AF and New VAC model households show considerable fluctuated levels of the farm gate prices of the "grade 1" fish products during the period of study(see figure 6.4). The farm gate prices of tilapia (with around VND 30 thousand) and grass carp (with VND 60 thousand) show relatively fluctuated levels during the period from June 2015 to December 2017. The findings reflect the fact that the profitability of fish production operated by FS, AF and New VAC models also fluctuates accordingly. This profitability also fluctuates as the results of oscillated levels from the farm gate prices of "grade 1" fish products of black carp (with VND 90 thousand) and common carp (with VND 45 thousand), however, the effect degrees are lower than those of tilapia and grass carp. Interestingly, the farm gate prices of "grade 1" low-value species such as Rohu, Mud carp, Vietnamese silver carp and silver carp are very stable during June 2015 – December 2017. This finding implies the truth that the traditional VAC households did not mention the effects of selling prices in fish products occurred at the beginning of the year 2017.

In general, the commercial fish production models such as FS, AF and New VAC in Hai Duong are relatively susceptible to market volatility in terms of selling prices of their main farm fish species, particularly the FS model when the fish income of farm households operated this FS model represented for the main income source in their total on-farm income. With stable selling prices of farmed fish products, the traditional VAC households could sustainably improve their livelihoods through the development of small-scale fish production. This result is consistent with the role of the VAC model when it was first introduced to develop widespread to help the poor in improving their livelihoods in many localities in Vietnam during the 1980s.



Source: survey, 2017.

Figure 6. 6 The variation of farm gate prices by fish species (June 2015 - Dec 2017)

6.4.4. Increasing prices of the freshwater fish feeds

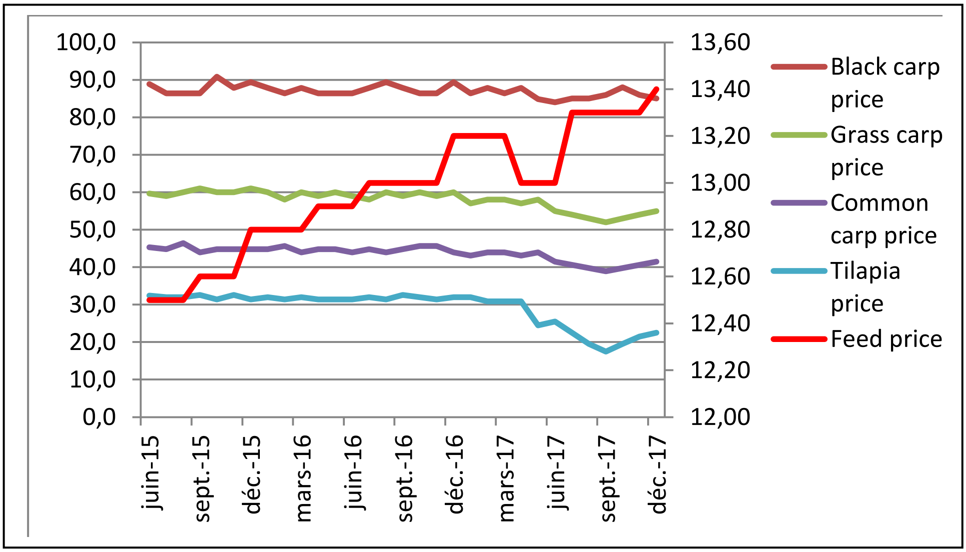
The increase in feed prices might be the most noticeable matter that was paid much attention by fish farmers in Hai Duong since it accounted for a large proportion of total fish production cost. The feed cost occupied for a large proportion of the total fish production cost ranging from 53% to 67% among the freshwater SSA models in Hai Duong (see table 6.23). This cost directly affected the profitability of fish production operated by different models. Although fish farmers applied a good strategy of feed management which could reduce a considerable cost of feed in their fish production as compared to the case of striped catfish with the percentage of 82.9% in the total production cost in southern Vietnam, they have been being faced a challenge that was the increasing growth in feed prices during the period of study (June 2015 – December 2017) (see figure 6.8 below). This challenge reflects the fact that the net returns of fish farmers operating the FS, AF and New VAC models become narrow during the period of study and it may still occur in coming years as the author's prediction. This prediction will be discussed in the following paragraph in line with the problems of managing commercially fed quality and the strategies of using farm-made feeds which were common issues for fish farmers in Hai Duong province.

Table 6. 24 Percentage of the production cost per "Sao" by freshwater SSA models in Hai Duong province

	FS Model (N=51)	AF Model (N=65)	New VAC Model (N=35)	Traditional VAC Model (N=16)
All variable costs	100.0	100.0	100.0	100.0
Fingerlings	26.4	26.3	32.2	28.9
Feed	67.3	65.7	60.6	53.6
Fertilizer	0.0	0.0	0.1	0.0
Lime	1.1	1.1	0.9	2.0
Chemicals	2.9	2.9	2.2	6.2
Energy	2.2	3.4	3.6	4.8
Other	0.6	0.5	0.3	4.4

Source: survey, 2015-2016.

In Hai Duong province, the feed market consisted of various kinds of commercially manufactured feeds supplied by different manufacturers. It made convenience for fish farmers, however, managing the feed quality term of protein content was an issue for fish households in the region. The unit price for manufactured pellet fees depended on protein levels. The highest quality of feeds was the manufactured pellet feeds containing 30% protein which was commonly used by fish farmers in the region. However, it should be noted that the feed quality varied according to the percentage of protein content. Increasing feed quality would increase its price. The study found that the prices of feed increased while the farm gate prices of fish decreased during the period of June 2015 - June 2017 (see figure 6.7). The lowest expenditure on feed was found in the traditional VAC and New VAC households since they commonly used the farm-made feed for their fish production. The increase in the use of home-made feed helped farmers operating the VAC models to reduce the feed cost (53% and 60%, respectively in Table 6.23)in the total fish production cost and obtained higher net returns of fish when putting the feed costs of FS, AF and New VAC models together. This result implies that the VAC models are less affected by the increase in prices of commercially manufactured feeds in the regional market. However, the strategy of using the farm made feeds in the fish farming has been less common due to the scarcity of by-products and natural material of fish feeds such as natural grass, rice bran … while the fish farming has become more commercial production with higher levels of intensification which require increasingly supplements of fish feeds. Therefore, fish farmers will be more dependent on commercial fish feed for their fish farming. The feed manufacturers will take advantage of this situation to increase the selling prices of their fish feed products to gain more profit until the fish farmers' fish profit becomes marginal.



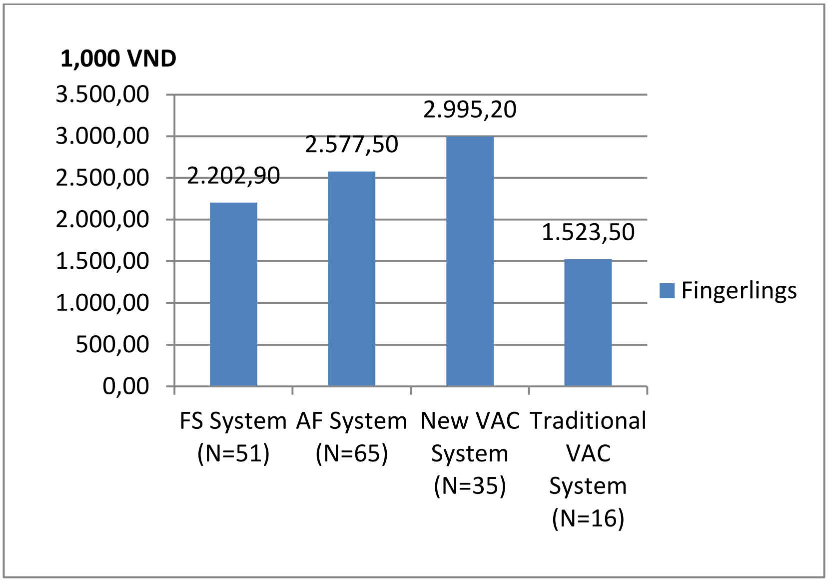
Source: survey, 2017.

Figure 6. 7 Comparison between feed price and farm gate prices of the fish commodities produced in Hai Duong province

The study results of the increase in farm gate prices of "grade 1" fish products and purchasing price of "30% protein content" pellet feeds are illustrated in figure 6.8. While the purchasing prices of pellet feed have increased by 12%, the farm gate prices of 'grade 1' fish products have decreased by nearly 7% during the period of study from June 2015 to December 2017.

6.4.5. Supply of fingerlings and control of seed quality

The seed of fish plays an important role in fish production since it determines the harvest of fish farming. The study results of the seed cost show that the cost of fingerlings of the FS model households was lower than that of AF and New VAC model households. This finding refers to a fact that the FS model households normally bought the fries from different hatcheries to nurse in a small fishpond. This nursing practice could provide these households with an available source of fingerlings and a considerable amount of fingerling cost. However, many FS households claimed that they sometimes bought a poor source of fries which led to a loss of some money invested in purchase of fries and nursing costs including feeds, energies... Although the production, trading and distribution of fish seed are clearly guided and regulated by the government, the practices of supervising and controlling fish seed seem to be limited in the study areas. This is a minor issue which can be solved when local authorities pay more attention to the fish seed control to private hatcheries which has rapidly developed the study recently.



Source: survey, 2015.

Figure 6. 8 Fingerlings cost per Sao of different freshwater SSA models in Hai Duong province

On the other hand, it is undeniable that the availability of fish hatcheries created a good opportunity for farm households in Hai Duong province to develop their fish farming easily. Improve seed quality with stable prices of fries and fingerlings have been observed in the study areas. The study on fingerlings cost of fish households operating the different SSA models did not find many changes in this cost while almost all of them reported that the quality of fish seed has much improved for 5 years so far./.

7

CONCLUSIONS AND RECOMMENDATIONS

7.1. Conclusions

7.1.1. Diversity of freshwater SSA models

There are four main freshwater SSA models found in the study. The freshwater small scale aquaculture production is very complex and diverse in terms of production scale, integrated degree, and commercial levels which are all designed to be an alternative livelihood for farm households to produce fish products to improve household food security, increase household income, and generate more employment for local villagers in Hai Duong province. While the VAC (both traditional and New) models tend to be employed to produce various kinds of food for home consumption and generate a certain cash income for fish farmers, the AF model and FS model are more commercialized to produce fish commodities to supply to urban markets and get a significant profit as the net returns of fish.

The traditional VAC model has the smallest scale of aquaculture production but obtains the highest level of integration between fish production with other farm components within the farm household's agricultural activities. The fish production provides farmers with a large number of fish products for their home consumption which generates a good source of protein to improve the household food security in terms of improvement in nutritional status. With fish farming, farm households can utilize farm resources available to generate a considerable amount of food (the most productive model) in comparison with other SSA models in the region. This model is really appropriate for the farmers who are poor resources of production and capital investment. The study has found that total farm income was VND 63 million (2,800 USD) per year which is the lowest among the freshwater SSA models in survey areas. However, this model can generate considerable sources of cheap foods (low-value fish species), crop and animal products from a reasonable initial investment. This model is really suitable for farmers who are poor and preferred to operating fish production for a stake of subsistence production. This model is also discussed relatively concrete in chapter 3 of this dissertation about the important role and the appropriation of the model during the transitional period when Vietnam faced with the drastic shortages of food. Although, it is now not commonly seen and much attention by Vietnamese people, it is still encountered in some rural areas because it is really appropriate for poor farmers in their sustainable livelihoods.

The New VAC model is a "hybrid" model of the traditional VAC model when it moves from inside the village to the rice fields. The farm components of VAC models such as aquaculture, livestock and garden are organized in balance structure with a larger scale in order to both provide farm households for foods and reasonable sources of income from the sale of surplus. The total on-farm income is more improved than the VAC model due to the contribution of fish income (over VND 60 million – 2,600 USD accounting for more than 70% of the total farm income). This kind of model has been being promoted to develop in many localities recently in Vietnam. However, the integrated degree between farm components is lower than the traditional VAC model, it seems to be a suitable model for farmers to invest their farm enterprises due to the appropriation of employment, food and income generation in the current natural socio-economic situation in Hai Duong province.

The AF model is ranked second on the scale (little over 12 sao) of fish production which is more commercialized in livestock production and aquaculture farming in comparison with the two models mentioned above. Although livestock income (VND 106 million) accounts for 22.5% of the total on-farm income, it could provide farm households for a good opportunity to diversify their income and stabilize their farm businesses, particularly fish farming through less dependence on fish production.

The FS model has been found to operate the largest scale (more than 14 sao - 5,200 m^2) of fish production with the most commercial fish production which generates over VND 105 million (USD 4,700) of fish income for producers. With this model, farmers can get more economic benefits from their agricultural production. However, the fish income presents for nearly 90 per cent of the total farm income which clearly reflects the fact that fish households are more dependent on fish farming. This leads to some problematic issues related to production uncertainty and market risks in fish operation which might cause fish farmers several difficulties and vulnerable degrees such as production loss due to epidemics, natural disasters, and market loss because of low selling prices of fish even not being able to sell fish products in markets for poor market demand (this used to occur in the early year of 2017).

7.1.2. Economic efficiency of fish production among different freshwater SSA models in Hai Duong province

The study results show the different levels of profit as the net returns of fish farming through analyzing the aquaculture practices of four main SSA models existing in the agro-aquaculture system in Hai Duong province. There are two types of small-scale aquaculture. The first type of SSA is considered to be more or less commercial production of fish products which belongs to the FS, AF and New VAC models with fishponds converted from rice fields. The second type is viewed as the subsistence production of food with more low-value fish species stocked in the homestead fishpond which originates from the traditional VAC model with a long history of practicing in the Red River Delta - northern Vietnam.

The traditional VAC model is significantly different from three other models in terms of fingerling stocking, feeding practice, the goal of fish farming and attainable profit. The study results have shown that the traditional VAC model is really a difference in fish stocking (a lower value and various kinds of fish species) from that of FS, AF and New VAC models. The strategy of the fish stocking seems to be related to historical characteristics of the traditional VAC model from which farm households could operate their fish at the lowest levels of total variable cost (VND 5,263 thousand per sao) thank a considerably decreasing of feeding cost through utilizing a certain farm-made feed from by-products available in the households' agricultural activities. As conceived in chapter 3, this traditional VAC model was initially introduced and promoted to solve the shortfalls of food during the transitional time when Vietnam is in the progress of shifting from the autarky to market-oriented economy. Thus, the fish farming of the traditional VAC model mainly aims to produce more diversified products of fish with the objective of providing different kinds of fish protein for home consumption. Therefore, the net return of fish from the traditional VAC is the relatively lowest level (over VND 7,000 or USD 316 per sao) among the four identified SSA models in Hai Duong province.

The New VAC model can generate the best profit from fish farming (VND 9,807 thousand – USD 436) among four identified SSA models in Hai Duong province. This result was obtained thanks to fish farmers paid more attention to intensifying high market value species and utilization by-products available on their farms to reduce the fish production cost of feeds. In addition, the less dependence of fish production can help them to gain better fish prices whenever the fish products are ready to harvest and sell to the fish traders in comparison with the FS model and AF model. This not only supports the New VAC farmers to achieve a higher income but also stabilizes their fish production in both short term and long term in consideration fish farming as an alternative livelihood in the region.

The AF model with more commercialization in both livestock and fish businesses which still could support a better profit of fish production in comparison with FS models due to the affordability of proper investment in fingerlings and feed of the fish farming. Although the seed and feed costs of the AF model are higher than the FS, the revenue and profit from fish farming of the AF model are still better than those of the FS model. These findings can be explained by two reasons. The first is that the AF households have more expenditure on larger sizes of high value (also marketable species) fingerlings which, in exchange, could provide fish farmers higher productivity (358 kg per sao against 325 kg per sao in the FS model). It means that the AF farmers could obtain a higher fish revenue than that of the FS model. The second is the investment appropriation of the fish enterprise which is affordable to farm households in terms of managerial skills and unorganized market condition. While the FS farmers are significantly susceptible with market volatility, the FS households can resist this unfavorable condition of the market through the replacement of the pellet feed by home-made feed to reduce feeding cost. Moreover, with the smaller scale of fish production, the AF households could prolong their fish farming to wait for good prices of fishes in several cases when the market is poor demand and selling prices of fish setting very low, even below the level of fish production cost.

The FS model is less profitable in fish farming than that of the AF and New VAC models due to the high level of dependence on the market. This statement is supported by referring to the high degrees of purchasing market pellet feed, and lower farm gate prices in selling the fish products when farm gate prices are compared among these three models. Although the FS farmers can reduce a considerable variable cost (VND 8,349 thousand less than that of AF and New VAC model) of fish farming thank to their improvements in access to the technical knowledge, management and main inputs such as seeds and feeds, they have been being coped with the problem of the selling fish products with low price as observed. Selling fish with lower farm gate prices leads to lower revenue and profit which may be a result of poor access to market information. The study found that the FS farmers were easily accepted to sell their fish products to the fish farmer collectors within 12 days since they got an offer from buyers, whereas the farmers in the other models can extend the fish farming for a longer period for a stake of gaining the best quotation. This also means that the FS model is likely to be vulnerable to fish farmers concerning the marketing of fish products.

Besides, the study also examines the contribution of fish production to household food security (nutritional improvement by consuming more fish produced) and employment generation to household livelihoods among different SSA models in the study sites. The research findings show that the traditional VAC model can provide fish farmers with the greatest of fish food (53 kg of mixed fish) and employment (50 man-days) per sao (360 m^2) of fish farming among the study SSA models. It is a very interesting point that the New VAC model can also provide better the fish food (28 kg of mixed fishes) and employment (32 man-days) as per sao of fish production in comparison with those of AF and FS models; 13.5 kg, 12 kg of fish food and 16.4, 14 man-days of working labor, respectively. These research results support the evidence that the New VAC model should be more appropriate and developed to sustain the farmers' livelihoods from which indirectly enhance the provincial rural economy as well as economic development in some rural areas operating this new VAC model in Vietnam.

7.1.3. Marketing channels and several problems in marketing of fish products impacted on the economic efficiency of SSA models in Hai Duong province

7.1.3.1. Market outlets and marketing channels of freshwater SSA models

In accordance with the existence of four SSA models found in the study, the marketing of fish products is investigated and examined accordingly. There are also two types of marketing channels employed by fish farmers in Hai Duong province. Fish farmers of SSA models used different strategies of marketing to sell their fish product through the availability of local market outlets, several local fish retailers and fish farmer collectors. While the traditional VAC households all market their harvested fish to local markets by direct sale to local fish retailers, FS, AF and New VAC households all used the farm gate wholesale to the fish farmer collectors and some small local retailers. The marketing channels of fish have been found from the study as follows:

1, Fish farmers -> local (rural) consumers

2, Fish farmers -> local retailers -> local consumers

3, Fish farmers -> fish farmer collectors -> commission wholesalers -> urban retailer -> urban consumers

4, Fish farmers -> fish farmer collectors -> commission wholesalers -> merchant wholesaler -> urban retailers -> urban consumers

The two formers marketing channels are used by all the traditional VAC farmers, while the marketing channel (2), (3), (4) are used by most fish farmers of the New VAC, AF and FS models. While the fish producers of FS model face with some negotiation competencies with fish buyers due to high dependence on aquaculture production, the AF and FS models can get better competencies of negotiation with buyers through the appropriate investment on fish farming and diversifying the marketing channels of selling their fish products, particularly the New VAC farmers.

The farmers of traditional VAC models coped with difficulties of marketing fish products due to lack of local customers, shortages of local market outlets and marketing facilities. On the other hand, the ownership of small fish production scale and low market demand for farmed fish species, the traditional VAC farmers could not help them to access to new buyers (fish farmer collectors) to obtain good prices to increase their fish returns. This problem can be explained for the scarcity of the traditional VAC model when the author took a survey in the region.

The New VAC households can market their fish products to both local markets and urban markets through indirect marketing channels of local retailers and fish farmer-collectors available in the region. This strategy seems to be helpful for them to strengthen the negotiation competencies of marketing their fish products in order to gain better farm gate prices in comparison with the FS farmers.

The AF and FS farmers market most of their fish products to fish farmer collectors at the farm gate. This farm gate wholesale represented some problems of marketing their fish products when the quality of harvested fish is over the trading capacity (loading truck) of the fish farmer collectors conveying to the wholesale markets in suburban areas for sale. In addition, the disputes between fish producers and buyers sometimes happen. This phenomenon is likely to refer to poor coordination and lack of market information (fish grading, selling prices, market demand) along the marketing chain, as a result, they directly impact the fish profit (net returns) of the FS and AF farmers in the region. Another problem hinders the marketing of fish products for these households concerned with poor road infrastructure and collective marking activities (this problem was mentioned in the research paper Nguyen V. H., Nguyen, V. P., Lebailly Ph., Tran H. C. (2018). Factors influencing assessing small scale fish farmers in accessing markets: a case study of the fish value chain in Hai Duong province, Vietnam - International Journal of Agriculture, Environment and Bioresearch Vol. 3, No. 05, 2018, 299-311,ISSN:2456-8643. http://ijaeb.org/link2.php?id=253.

7.1.3.2. Several challenges and constraints of marketing fish products encountered by the freshwater SSA models in Hai Duong province

Selling at the farm gate is a traditional activity for most small-scale farmers. Farmers often market their products to farmer collectors or local retailers in the pond area. Small scale fish farmers often have wholesale their harvested fishes to middlemen who are also commonly seen in many regions in the world. Small fish farmers are characterized by poor bargaining power in comparison to middlemen leading to lower prices and income receipt(M. Ahmed & Lorica, 2002). The study also revealed that, with the greater commercial levels of aquaculture production, fish farmers encountered some difficulties and challenges in marketing their fish products. This section aims to discuss the problems encountered in the marketing channels of fish products associated with FS, AF and New VAC models.

The main weaknesses of the current marketing system are the lack of written contract mechanism and constraints of market information flow between market participants including fish farmers. No written contract mechanism was found in all stages of marketing fish products from the fish producers to end buyers for the fish commodities produce in Hai Duong province. This leads to the vulnerability of fish producers and wholesale stakeholders such as fish farmer collectors, and merchant wholesalers who are playing key roles in marketing channels to supplying fish foods to urban markets. They might easily get a loss from their fish trading business whenever their buyer-customers refuse to buy fish commodities as advanced orders under the oral contracts. Moreover, the disputes between seller and buyer are commonly seen in fish transactions (both at farm gate and wholesale markets) due to not clearly defining the quality of fish commodities (such as fish size, weight, appearance …). Regarding the constraints of market information flow, as most fish are sold through wholesale markets, the selling prices of fishes follow the basic principle of relationship between supply and demand which are many variables in the daily market. Live fish products are very perishable within a day's time. These features lead to risks for marketing participants at wholesale markets, particularly the fish farmer collectors.

Interestingly, the study results reveal a fact that absolute marketing margin of fish farmer collectors is reduced by VND 66 thousand per 100 kg of mixed fish commodities in their business of trading fish when they sell their fish through the merchant wholesalers. However, in normal business days, these fish farmer collectors often sell their fish directly to retailers with the support (empowerment) of commission wholesalers at the wholesale markets. Following this way, fish farmer-collectors can earn VND 168.15 thousand for trading 100 kg of mixed fish commodities at a good market day with more fish retailers participating in wholesale markets. This situation of poor retailers' participation can be referred the phenomenon of the early year 2017 when the fish prices dropped deeply below the production cost of fish, but the fish farmers could not sell their fish products to the fish farmer collectors because fish farmer collectors usually sold their fish commodities to merchant wholesalers and got a smaller profit from their trading fish business at that time. Good coordination between market agents both in production and distribution stages would help to solve this problem such as collective marketing between fish farmers reorganized wholesale markets with contracted mechanisms between market operators.

The study findings of marketing margins for different intermediate levels are similar for the freshwater fish products in some previous studies in Bangladesh, Turkey. For example, the fish producers' share in retail price accounted for over (80%) higher than that in Bangladesh (65%), Turkey (32-54%) (Faruque, 2007; Kaygisiz & Eken, 2018)). The retailers received the highest rate (about 7.1% in the short marketing channel and 3.5% in the long marketing channel) of consumer prices among intermediary levels. However, the small quantity of fish trading business in every day only provides them for a modest profit (200 thousand VND / day) if they bought fish commodities from the merchant wholesalers and they could earn a double profit (VND 405 thousand) when buying fish commodities from farmer collectors. This figure coincides with the opportunity cost that fish retailers mentioned if they stop their business to find alternative earnings from jobs at factories in other sectors. This story implies that the fish retailer is another issue which needs to be paid attention to improve the selling environment as well as working conditions such as allocated more business places in both wholesale and retail markets, more public investment of the retailing live fish products in order to maintain a group of fish retailers in the markets, indirectly enhancing fish farming more developed in Hai Duong province.

7.2. Recommendations

Based on the study findings, several recommendations are proposed to help fish farmers to get better economic efficiency of freshwater aquaculture production. These implications can be categorized into two groups: (1) those targeted directly at fish farmers and (2) those related to the implications of Vietnamese government policies on the development of freshwater aquaculture in particular and on rural development in general.

7.2.1. Recommendations for fish farmers

- ***Diversifying in farm components of agricultural production.***

Small scale aquaculture under the VAC ecosystem was introduced and developed to operate by smallholder households in the Red River Delta, more specifically in Hai Duong province, up to now, it has undertaken for nearly 40 years. Over time, it has been kept a natural appropriation to enhance the livelihoods for the farm households in rural areas in this region. The study results show clear evidence that fish farmers can earn more net returns of fish from SSA models (except the traditional VAC model) with the diversification of farm components. The high levels of integration between these farm components would enhance agricultural food production with low-cost production and less dependence on market inputs. As a result, the attainable profit of fish farming may be stabilized and significantly contribute to the total on-farm income which much improves the economic conditions of farm households. The New VAC model is the first priority to suggest for farm households who would love to develop an agro-aquaculture system in their agricultural activities; follow up the AF model and the last option is FS model if the fish market availability with the high demand for fish products.

- ***Collective marketing for inputs and outputs of fish production***

Fish farming is more commercial production to generate more income for farm households. Households operated SSA models will be more susceptible to market volatility. The study results clearly described several limitations of access to main inputs for fish production and some constraints of bargain power between fish farmers operating the FS, AF and New VAC models and fish farmer collectors. All these problems lead to the hindrance of profitable fish farming. Collective marketing of inputs and outputs in fish production should be considered as suitable measures to overcome the limitations and constraints of market access to fingerlings, feed and sale the finished fish products. The collective marketing activities are only implemented by a producer-organization or fish cooperative which provides the small scale member of farmers' fish farming a better level of market access to inputs and outputs for the sake of maintaining the profit of fish production. This is more urgent when the study results have illustrated the rapid growth in feed prices and decreasingly growth in farm gate prices of fish products.

- ***Diversifying markets and marketing channels of fish products***

Among three SSA models with commercial fish production, the New VAC model is the most diversified in their marketing of fish products. Although the New VAC farmers did not produce the larger size of marketable fish products as compared with that of AF farmers, they could sell their fish products with reasonable prices both to local retailers to serve the communal/ district markets and to fish farmer collectors supplying to urban markets. With this marketing strategy, the New VAC households can earn the best profit among farmers of the three SSA models in the regions. Moreover, these households can obtain better the levels of bargain power when compared to FS and AF households in the same pattern of market condition (the same fish farmer collectors)

7.2.2. Policy Implications

- ***The traditional VAC ecosystem as a sustainable food production model***

The traditional VAC ecosystem is a really good model of agricultural farming for producing food to improve nutritious diets and create more employment for the poor. It does not require much agricultural production resources in terms of land, and other variable costs for fish farming. With the traditional VAC model, the poor farmers can accumulate gradually both technical knowledge and capital to shift their agricultural production from subsistence level to more commercial levels which may help them to become medium and wealthy farmers. However, governmental support should be provided with the poor farmers for the initial technical training on farming knowledge, seeds, and feeds as well as developing market outlets for further expansion of the fish production.

- ***The New VAC, AF and FS models – the new spectrum of the food production system***

While the traditional VAC model is recommended to be as a tool of solving the hunger reduction and poverty for the poor with limited farm resources, the New VAC, AF, FS models are good options for medium and better-off farmers who wish to develop their aquaculture farming with more commercial production for the sake of improving their economic condition. However, the development of commercial (even small) aquaculture should be taken into account the market availability, proper fish products, and other marketing concerns such as marketing channels, storing facilities,... which require both private and public agents involved in developing a contracted marketing system. This contracted marketing system provides both fish farmers and middlemen who participate in supplying fish products to the end buyer through written contracts with high enforcement of commitments in order to stabilize the fish food production system in the region./.

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