UNIVERSITY OF HOHENHEIM

Master thesis

Socio-economic analysis of aquaculture groups in Hta Naung Wun Village and Shwe Baw Kyun Village in Shwebo Township, Myanmar

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Abstract

Myanmar is one of the largest fish producers in the world. In 2016, the country ranked eighth among the largest global inland aquaculture producers. Ninety percent of inland aquaculture in Myanmar is geographically concentrated in the Ayeyarwady Delta region, in lower Myanmar. Previous studies have indicated that aquaculture in Myanmar has the potential to grow with the improvement in production conditions, access to credit and post-harvest technologies. Given the promising conditions, intervention projects to develop aquaculture in the country such as Myanmar Sustainable Aquaculture Programme (MYSAP) are currently implemented. The Myanmar Sustainable Aquaculture Programme (MYSAP) is funded by the European Union (EU) and the German Federal Ministry for Economic Cooperation and Development (BMZ) and is implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Department of Fisheries. WorldFish Myanmar is realising MYSAP's inland component under a GIZ grant agreement, with Ar Yone Oo, BRAC Myanmar and Malteser International as sub-contracted implementing partners.

In order to reduce the deficit of information about aquaculture in regions different to the national cluster, the current study provides a general view of the current market dynamics faced by fish farmers in Shwebo township, Sagaing Region, as a contribution for the knowledge about aquaculture in Myanmar in regions where it has not been widely documented. To do so, this study implemented a qualitative explorative approach using content analysis based on grounded theory for the culture season 2018-2019. A total of 26 fish farmers and 5 key informants were interviewed in Hta Naung Wun and Shwe Baw Kyun villages, using structured questionnaires. Regarding the proportion of the fish harvested used for family consumption, this study found a difference of 5.2 percentual point on the quantity of fish used between the two villages. This study identified that processing companies bought 94.32% of the total fish traded in the study area during the last culture season. The main characteristic influencing the purchases made by the processor is the fish size, with a preference for fish at market size. This study found a gap between fish supply and demand, showing that 80% of the fish supplied do not correspond with the attributes demanded. Fish farmers reported production challenges that potentially limit the aim to produce fish at market size. The challenges reported in the surveys show limitations in access to fish feed and water supply. Exploring farmer-based perceptions regarding the importance of the role of MYSAP programme to the access, this study found that fish farmers gave the highest importance scores to the access to fingerlings and training, and the lowest scores to the access to fish feed and buyers. This study suggests encouraging collective actions among fish farmers in order to implement bulk purchasing, share used of equipment, improve the flow of information and coordinate harvest times, which might benefit fish farmers in the study area. In addition, to overcome the current challenges is important to coordinate with the local government.

Keywords: Market dynamics, aquaculture, Shwebo township, Myanmar.

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Chapter 1: Introduction

1.1 Background of the study

Global food security is threatened by multiple factors, including the effects of population growth and the persistence of poverty (FAO, 2018a). In 2050 the world's population will grow by 32%, compared to the population in 2015, to a total of 9.7 billion people (FAO, 2018a). This population growth represents a significant increase in global food demand, meaning that regions with the highest population growth could present the biggest food security challenges. South Asia and Africa will increase their population growth. It is expected that 82% of the world's population out of the total 11 billion estimated in 2100 will live in these regions (FAO, 2018a).

Poverty reduces food access and endangers food security (FAO, 2018a). The world has the challenge to provide food access to 2 billion people who have been exposed to any level of food insecurity (FAO, IFAD, UNICEF, WFP, & WHO, 2019). The majority of the global population who experience food insecurity live in specific regions: 52% live in Asia, 34% live in Africa and 9% live in Latin America (FAO et al., 2019). In addition, undernutrition in Asia and Africa will have economic effects (FAO et al., 2019). The two regions will lose economic productivity and increase the cost of healthcare, causing a decline in the GDP (Gross Domestic Product) by 11% (FAO et al., 2019).

Over 820 million people have experienced undernourishment (FAO, 2018a), and the prevalence of undernourishment persist in 11% since 2015 (FAO et al., 2019). The reduction of undernourishment should be prioritized in Asia. From the total world's undernourished population, more than 500 million live in Asia, with Southern Asia accounting for 15% of the global prevalence, and Western Asia for 12% (FAO et al., 2019).

Fish has a remarkable role in the global food security as an animal protein source, accounting for 17% of the global consumption in 2015 (FAO, 2018b). The global fish demand has been growing faster than the population growth since 1961, proving the need to achieve higher fish yields to satisfy the current demand (FAO, 2018b). In addition, fish is an important component of protein intake in the diets of households from developing countries, which depicts a global per capita consumption of 20.3 kg (FAO, 2018b). In 2016, global capture fishery and aquaculture produced 171 million fish tonnes for a value

of USD 362 billion (FAO, 2018b). Food fish accounted for 80 million tonnes in the same year, for a value of USD 231.6 billion (FAO, 2018b).

The reports about inland production in 2016 aggregate fish catches and aquaculture (FAO, 2018b). The report of global inland fish catches exhibit a food fish production of 11.6 million tonnes, mainly originated from Asia, with Myanmar being the fourth largest producer (FAO, 2018b). Considering food fish , the global inland aquaculture produced 51.4 million tonnes, Asia being the main production region and China the world's largest producer (FAO, 2018b). Myanmar ranked eighth among the largest global inland aquaculture producers (FAO, 2018b).

Fish trade is a dynamic economic activity, with exports of USD 152 billion in 2017 (FAO, 2018b). It should be noted that fisheries and aquaculture exports are increasing in developing countries (FAO, 2018b). Myanmar is located in the same region as the main exporters: China, Vietnam and Thailand (FAO, 2018b). The countries in the region are very active in the global value chain, as Bangladesh and Thailand for shrimp trade, China for tilapia and Vietnam for pangasius (Jespersen, Kelling, Ponte, & Kruijssen, 2014).

Aquaculture has the potential to reduce poverty (Béné et al., 2016). Aquaculture activities generates income, nutritious food and employment for fish farmers as well as off-farm actors (Béné et al., 2016). Fish farmers benefit directly from the production, since they have access to fish for consumption and receive income that is re-spent in local goods (Toufique & Belton, 2014). Furthermore, aquaculture is structured in a value chain with multiple actors as input suppliers, farmers, traders and processing companies who obtain profit from their activities (Béné et al., 2016). In 2016, 19.3 million people work in aquaculture's primary sector (FAO, 2018b). The share of aquaculture and fisheries workers in Asia is high, accounting for 85% of the world's labor (FAO, 2018b).

On the other hand, poor fish consumers also benefit from aquaculture (Toufique & Belton, 2014). The share of fish on food expenditure is high for low income households (Dey et al., 2005). Therefore, the rise of fish supply will decrease the market price, improving fish access for low income people (Toufique & Belton, 2014). In order to achieve poverty reduction and food security from fish farming, aquaculture development requires the implementation of tailored strategies that should be developed with the active participation of all stakeholders for decision-making (Krause et al., 2015).

Myanmar is one of the largest global fish producers (FAO, 2018b). In 2016, the country produced a total of 3 million fish tons, including the output from aquaculture, marine and

inland capture (Tezzo, Belton, Johnstone, & Callow, 2018). Inland fish farming contributed to 19.7% from the national fish production (Belton et al., 2015). The majority of Myanmar's fish production remains in the national market (80%), while 20% of the production goes to the global market (Belton et al., 2015).

One of the main characteristics of Myanmar's inland aquaculture is the geographical concentration of production, 90% of the fish is produced in the Ayeyarwady Delta region, spatially distributed within 50 km of Yangon, in lower Myanmar (Belton et al., 2015). Due to the relevance of the production in this cluster, the majority of the available literature about inland aquaculture in Myanmar refers to the production in the Ayeyarwady Delta region. Smaller inland aquaculture farms are located around Mandalay and Pyay, with ponds situated in the Central Dry Zone (Belton et al., 2015).

The national production corresponds to the high fish demand (Belton et al., 2015). Fish is a big component of the diet in Myanmar with an average consumption of 30 kg/person/year (WorldFish Center, 2018). According to Belton et al. (2015) fish represent 50% of the animal protein consumption in the country and describe 14% of the food expenditure in Myanmar. The high fish consumption in the country could be related to the consumer preferences and the lower price of fish compared to the other animal protein sources, that in 2010 was 35% lower than meat price (Belton et al., 2015). In addition, inland aquaculture accounts for 21% of the fish consumed in Myanmar (Belton et al., 2015).

Despite Myanmar is the eighth largest inland aquaculture producer in the world, aquaculture is underperforming (FAO, 2018b; Fodor & Ling, 2019). The country has the potential to produce higher yields by increasing the access to high quality fingerlings and fish feed, improving disease management, provide access to credit, and implementing post-harvest technologies (Fodor & Ling, 2019).

In order to promote aquaculture development, Myanmar Sustainable Aquaculture Programme (MYSAP) is currently implemented (Myanmar Sustainable Aquaculture Programme, 2018a). The Myanmar Sustainable Aquaculture Programme (MYSAP) is funded by the European Union (EU) and the German Federal Ministry for Economic Cooperation and Development (BMZ) and is implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Department of Fisheries. WorldFish Myanmar is realising MYSAP's inland component under a GIZ grant agreement, with Ar Yone Oo, BRAC Myanmar and Malteser International as sub-contracted implementing

partners. This project has an inland aquaculture component called INLAND MYSAP programme which currently supports fish farmers by distributing production inputs, to incentive fish production in fish ponds with an area below 0.5 acres (Myanmar Sustainable Aquaculture Programme, 2018a).

1.2 Statement of the research problem

The successful development of agricultural value chains requires an adequate market orientation, market access, available infrastructure, access to information and the supportive policies (Trienekens, 2011). The outcome of this development includes the improved access to markets for smallholders, which increases their assets and incomes (IFAD, 2016). The available literature encompasses value chain studies and socio-economic analysis for aquaculture production aimed for the global market, but more studies focused on local markets are required (Béné et al., 2016; Jespersen et al., 2014; Krause et al., 2015). Studies about aquaculture local markets might be useful to identify the constraints faced by small fish farmers in order to develop strategies and overcome limitations.

Despite Myanmar being one of the largest global fish producers, studies about aquaculture and market dynamics are scarce (FAO, 2018b; Tezzo et al., 2018). Most studies for the aquaculture sector in Myanmar describe the market dynamics in the national aquaculture cluster in the Ayeyarwady Delta (Belton, Filipski, & Hu, 2017; Belton et al., 2015; De Silva, 2008). The available information describes the role of two fish wholesale markets to trade the fish produced in Myanmar's aquaculture cluster and identifies large traders at the wholesale markets and local fish collectors as the main buyers (Belton et al., 2015). Therefore, in order to overcome the information deficit, it is relevant to generate knowledge about the dynamics in different regions with a particular focus on fish farmers perceptions.

The only available information about fish value chain in the study area is a report which contains a general description of the local value chain with information provided by final consumers and traders (Myanmar Sustainable Aquaculture Programme, 2018b). Therefore, the knowledge about market dynamics in Shwebo township gathering the experience of fish farmers' is still required to understand how access to markets is and to identify the challenges faced by the farmers.

1.3 Relevance of the study

The current research collects information from the past fish culture season to develop a general overview of the current situation of aquaculture in the study area, where there is a deficit of information. The gathered information includes socio-demographic data, production components, identification of challenges, description of the product traded and market components. Using the previous resources, this study analyses how fish farm's outcomes respond to the local fish demand and describes how is the interaction between fish farmers and their main buyer. In addition, this research depicts some effects and perceptions about INLAND MYSAP programme from the farmers point of view, presenting information for the first culture season in which the programme support producers in the study area. Therefore, this study is useful for the evaluation and adjustment of strategies for aquaculture development in Shwebo township.

1.4 Research objectives

The objective of this study is to provide a general view of the current market dynamics faced by fish farmers in Shwebo township, Myanmar and the effect of the implemented intervention programme on these market dynamics. The specific objectives are

1. To characterize the socio-economic features of the fish farmers in the study area
2. To determine the farmers' usage of fish production, according to these categories: family consumption, sales, gifts and ceremonial use
3. To identify the market dynamics between fish farmers and the main buyers in the study area
4. To analyse the farmers' perceptions about the effect of INLAND MYSAP programme

1.5 Research questions

This study will answer these pertinent questions:

1. How much fish was used for family consumption from the total quantity produced in the study area during the culture season 2018-2019? How much fish went to the categories of use sales, gifts and ceremonial use in the study area during the culture season 2018-2019?
2. Considering the sales made by fish farmers, who is the main fish buyer in the study area?

3. Do the characteristics of the fish supplied by the fish farmers coincide to the characteristics demanded by the main fish buyer?
4. Which factors might be improved in order to support fish farmers to supply the demanded product by the main buyer?
5. From the farmers perspective, how important was the programme to ensure the access to inputs?

1.6 Hypothesis

This study will test the following null hypothesis:

H_{01} At the current production conditions, it is expected that fish farmers in Shwebo Township use 10% of the total fish harvested for family consumption

H_{02} At the current market conditions it is hypothesized that fish farmers in the study area sell the production to a single main buyer who demands specific characteristics in the product

H_{03} Fish farmers are hypothesized to perceive the effects of support of INLAND MYSAP programme as absolutely essential

1.7 Scope of the research

This study provides a general overview of inland fish production in Hta Naung Wun and Shwe Baw Kyun villages, including socio-demographic data, production and market components. In addition, this study includes the available literature and the report of different stakeholders, presenting experiences and challenges as well from the perspective of fish farmers. It should be noted that the fish farmers who participated in this study are beneficiaries from INLAND MYSAP programme and currently receive inputs support.

1.8 Content overview

The current study begins with the introduction, including the general description of the study problem, the research objectives, hypothesis and questions that will be developed in this document. Chapter two contains the literature review required to understand this study. The materials and methods in this study are described in chapter three. Results and discussions are presented in chapter four, and final conclusions and recommendations are developed in the final chapter.

CHAPTER 2: Current State of Knowledge

2.1 Myanmar country profile

The Republic of the Union of Myanmar is the second largest country in Southeast Asia with 676,553 km² of surface area divided in 14 regions and states, with a total 330 townships (Kraas, Spohner, & Myint, 2017). The main freshwater resource is the country is the Ayeyarwady River, which is the largest stream in the country and crosses Myanmar from north to south (Kraas et al., 2017).

Myanmar has a total population of 51,486,253 inhabitants (Department of Population of Ministry of Immigration and Population of Myanmar, 2015). The population distribution is peculiar, since the rural population is greater than the urban population, being on average 70.4% of the total population (Kraas et al., 2017). According to the World Bank, is very likely that rural population in Myanmar experience economic disadvantages (The World Bank, 2019).

The history of Myanmar has shaped the current socio-economic situation. The country gained its independence on 1948 and further politic conditions structured different development phases (Kraas et al., 2017). Between 1988 and 1990 Myanmar was introduced into a market economy that is currently evolving (Kraas et al., 2017). Since 2011 the country started a period of economic liberalization, gaining a position of growing economy among Asian countries (Tezzo et al., 2018). According to The World Bank, Myanmar is classified as a lower-middle income economy with a GNI (Gross National Income) per capita of US$1,210 in 2017 and a GDP real growth rate of 6.8% in 2017 (The World Bank, 2019). The local currency is the Burmese kyat (MMK) with an average exchange rate of 1Euro = 1,720 MMK during the period of May 2018 to May 2019 (“Exchange rate of central bank of Myanmar,” 2019).

2.1.1 Primary sector in Myanmar’s economy

The economy in Myanmar receives relevant contributions from the primary sector. Agriculture, forestry, livestock and fisheries correspond to 27.9% of the national GDP, related to the 26% of Myanmar’s area which has a land use for agriculture and permanent crops (Kraas et al., 2017). The main agricultural product in the country is rice and their production cover 70% of the total arable land (Kraas et al., 2017). In addition, agriculture

in Myanmar is an important source of employment. According to Kraas et al. (2017) approximately 61.2% of the workers in Myanmar are employed in the primary sector.

2.2 Aquaculture in Myanmar

The aquaculture sector in Myanmar is developing. The production systems, the variety of fish species and the national yield are currently underperforming due to previous political decisions (Belton et al., 2015). Fish production is an important sector in Myanmar, with a total fish production of 3 million metric tons in 2016 accounting for aquaculture, marine and inland capture (Tezzo et al., 2018). Fish production in Myanmar generates employment in farm and post-harvest activities (Belton et al., 2015). Currently the sector is important for the national economy and has the potential to expand.

Aquaculture sector in Myanmar has particular characteristics. The production is mainly developed in semi-intensive polyculture systems where rohu carp (*Labeo rohita)* represents 70% of the farm harvest (Belton et al., 2015), which is congruent with the results from the field research. The additional species stocked are the major carps catla and mrigal, pangasius catfish, tilapia and pacu (Belton et al., 2015). About the final destination of fish farming, Belton et al. (2015) stated that 80% of the production supplies the national market, while 20% is exported.

2.2.1 Development of aquaculture in Myanmar

Aquaculture in Myanmar started as a private initiative in 1960 with some farmers in the Ayeyarwady Delta (South of the country) who decided to capture wild fish and grow them in their paddy fields (Belton et al., 2015). In 1970 fish farmers built the first ponds and used rice bran as feed in the same area where is currently located the national aquaculture cluster, the Ayeyarwady Delta, following the production practices implemented by some employees from the Department of Fisheries (Belton et al., 2015). Simultaneously the first hatcheries were installed by the government and private initiatives to obtain carp fingerlings (Belton et al., 2015).

The increase in the number of ponds is blocked by a law stablished in the socialist government, demanding the exclusive production in selected paddy land and therefore limiting the conversion of paddy rice fields to aquaculture. In 1989 the limitation for land conversion was partially relaxed by the aquaculture law which recognized the ponds constructed before 1989 and allows the construction in the so-called wastelands (Belton et al., 2015). The most recent growth in aquaculture area reported in the literature is from

2000, consolidating the Ayeyarwady Delta as the national aquaculture cluster (Belton et al., 2015). According to Belton et al. (2015) and Tezzo et al. (2018) aquaculture land use in Myanmar is controversial since official land conversion has been related to potential elite capture and unofficial fees.

The government institution on charge of aquaculture is the Department of Fisheries (DoF), which started in 2016 as part of the Ministry of Agriculture, Livestock, and Irrigation-MoALI (Tezzo et al., 2018). The institution has limited extension and technology support of farmers and has concentrated its efforts on tax collection to obtain revenue (Tezzo et al., 2018). The government provides limited investments for aquaculture development, represented by the 0.8% of the Ministry budget to finance the activities of DoF (Ko Soe, 2018).

2.2.2 Myanmar's aquaculture cluster

The majority of Myanmar's inland aquaculture take place in the Ayeyarwady Delta region, with farms located 50 km around Yangon, the former capital and main city of Myanmar (Belton et al., 2015). The production in the delta region is the most specialized in Myanmar and the fish value chain in the area is more complex and developed than the rest of the country (Belton et al., 2015). On average, fish farming in the area has a length between 9 to 12 months, there is a high use of fish feed and is common the practice of stocking large fingerlings (Belton et al., 2015).

The available information about inland aquaculture value chain in Myanmar describes only the situation in the national cluster. Belton et al. (2015) reported that the main actors in the value chain are hatcheries and nurseries, feed mills and feed traders, fish farmers, collectors, rural traders, fish wholesalers and actors who provide services as ice provision and transport. There are two wholesale markets in the Delta region, San Pya and Shwe Padauk, being the first one the most important from the amount of fish traded (Belton et al., 2015).

There are two options to market the fish harvest in the Delta region. The first option for small and medium fish farmers is to sale the fish to a local collector who will then sale the production to the traders in the wholesale market, while the second option is to sale directly to the traders in the wholesale market if the farmer has a high quantity of fish (Belton et al., 2015). At the end the fish goes to semi-wholesalers and retailers who finally deliver the product to the consumer (Belton et al., 2015).

It is relevant for this study that nearly 40-50% of the fish traded by the wholesales in the Delta region goes for the national consumption in other regions (Belton et al., 2015), potentially including Upper Myanmar, the region of this study. The frozen fish traded to other regions is packed in Styrofoam boxes and send by road, buses or trucks (Belton et al., 2015). Dried fish mainly goes to Mandalay and Myingyan (Kraas et al., 2017). To transport the fish to different regions a special licence is required. According to Belton et al., (2015), some fish is transported without the licence, through the payment of unofficial fees. 20% of the fish traded in Ayeyarwady Delta region goes to the export market, supplying Bangladesh and some countries on the Near East (Belton et al., 2015; De Silva, 2008). Some fish, mainly rohu is sold to countries on the Near East to cover the demand of workers who migrate from Bangladesh, Myanmar and India (De Silva, 2008).

2.2.3 Opportunities for aquaculture in Myanmar

According to the available state of knowledge, the aquaculture sector in Myanmar is in transition and has the potential to grow (Belton et al., 2015; Kraas et al., 2017; Tezzo et al., 2018).

Land use for aquaculture is one important point to adjust. Policies which allow a sustainable land conversion and the official recognition of ponds as agricultural land use, with simpler implementation and adequate policies enforcement, might formalize fish farming and reduce informal arrangements (Belton et al., 2015; Tezzo et al., 2018). In addition, allowing land conversion might encourage poor farmers to start fish farming (Belton et al., 2015) and diversify income sources.

Other opportunities are related with the access to electricity (Kraas et al., 2017) to spread the implementation of post-harvest activities and the improvement of on-farm production techniques which will contribute to the national productivity (Belton et al., 2015). The development of aquaculture in Myanmar also requires adequate training to farmers, the implementation of sustainable production techniques and the provision of financial services (Kraas et al., 2017).

2.3 Inputs distribution project implemented by WorldFish

The project Myanmar Sustainable Aquaculture Programme (MYSAP) is a national project funded by the European Union and the German Ministry for Economic Cooperation and Development (Myanmar Sustainable Aquaculture Programme, 2018a) with a duration from 2017 to 2021 (GIZ, 2017). The project has the objective to *“Contribute to poverty*

reduction and improved food security and nutrition in selected areas of Myanmar through sustainably intensified aquaculture" (Myanmar Sustainable Aquaculture Programme, 2018a, p. 1). MYSAP includes 6 working fields, including the freshwater aquaculture component known as INLAND MYSAP and the coastal aquaculture component, MYSAP COAST (GIZ, 2018).

The objective of INLAND MYSAP is to "*increase the availability and access of fresh water aquaculture products sustainably produced by small-scale aquaculture producers, and to provide nutritious, affordable food and incomes for the poor and vulnerable in Shan State and Sagaing Region"* (Myanmar Sustainable Aquaculture Programme, 2018b, p. 2). This component of MYSAP project aims to tackle production constraints as limited access to key inputs like fingerlings and fish feed, value chain and information access (GIZ, 2018) INLAND MYSAP is implemented by WorldFish Myanmar, covering five Townships, including Shwebo Township (Myanmar Sustainable Aquaculture Programme, 2018a). The partners for the implementation are the Department of Fisheries (DoF), which is part of the Ministry of agriculture, livestock and irrigation (MoALI) and the regional governments (Myanmar Sustainable Aquaculture Programme, 2018a). MYSAP Inland have contracted BRAC Myanmar, under a sub-grant agreement, to deliver extension and training services to direct beneficiary households in Shwebo Township (Inland Myanmar Sustainable Aquaculture Programme, 2019). Therefore, BRAC employees have direct contact with the fish farmers who participate on the project and the presence of WorldFish employees is more frequent in training sessions.

2.3.1 Distribution of inputs

Following INLAND MYSAP goal, the implementation of the project aims to support small-scale fish farmers, considering *"those with access to a pond of under 2000m² (0.5 acres)"* (Myanmar Sustainable Aquaculture Programme, 2018a, p. 2). BRAC Myanmar distributed inputs to 426 direct beneficiary households in 2019-20 culture season in Shwebo Township (Inland Myanmar Sustainable Aquaculture Programme, 2019). In order to implement the inputs support, WorldFish divided the townships into groups which might be compose by one or more villages, according to logistic conditions (WorldFish team Mandalay, personal communication, May 13, 2019). For the villages included in the study, each village corresponded to one group (WorldFish team Mandalay, personal communication, May 13, 2019).

The main components of the project include (Inland Myanmar Sustainable Aquaculture Programme, 2019):

- Around 4 training sessions per year with the distribution of booklets. The content of the trainings is focused on small-scale aquaculture and improvement of human nutrition
- Distribution of 339,885 fingerlings. Since the maximum production area supported by the project is 0.5 acres per farmer, the project distributed 1500 fingerlings for ponds with 0.5 acres as a reference value, providing to farmers with smaller ponds the quantity of fingerlings following the rate described.
- Financial support of one demonstration farmer per group. During the culture season 2018-2019 the project supported a total of 47 demonstration farmers
- Financial support for equipment and training for one feed miller per group, with a total of 43 feed millers financed in the 2018-2019 culture season
- Distribution of pH paper to control water quality
- Seedlings distribution for lowest income farmers

2.3.2 Duties of farm members

The farmers who benefit from the programme do not have to pay any partial financial consideration in order to receive the inputs provided by the programme. According to the information provided by the WorldFish, only the participation in the training sessions is required to receive the input support (personal communication WorldFish team Mandalay, May 13, 2019). In the conducted interviews, the farmer leaders and demonstration farmers reported that raising the provided fingerlings and attending all training sessions are the only duty they should accomplish (interviews May 21, 28 and 30, 2019; June 3, 2019).

2.4 The gaps in the literature

The available information regarding aquaculture in Myanmar describes the dynamics in the Ayeyarwady Delta but does not include information for other regions. Therefore, there is an opportunity to develop research. Exploring the development of aquaculture in the country will be useful to compare realities and identify specific challenges in each region. In addition, obtaining knowledge about the current situation of aquaculture is useful to make decisions to overcome challenges and support smallholders. The current study aims to contribute to the deficit of information regarding aquaculture in Shwebo township.

CHAPTER 3: Materials and Methods

3.1 The study area

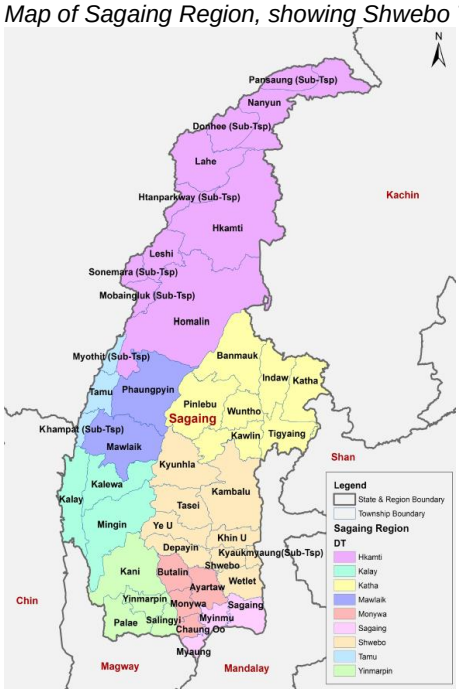
The Shwebo Township is located in the south of the Sagaing Region, which is the administrative region situated in north-west of Myanmar (Figure 1). Figure 2 shows that Sagaing Region is divided into 9 districts. Shwebo district is indicated with the orange area in Figure 2 and Shwebo Township is located in the south of the district. Shwebo Township has 62 villages and 10 wards (Ministry of labour immigration and population, 2017).

Figure 1. Administrative States and Regions in Myanmar

Source: Kraas et al., 2017, p. 31

The Shwebo Township is part of the Central Dry Zone of upper Myanmar (Kraas et al., 2017). This is a region characterized by erratic and insufficient rainfall (Kraas et al., 2017). The main crops produced in the area are mung bean, rice, pigeon pea, chickpea, sesame, and groundnut (Asian development bank, 2018). The Shwebo Township is, by majority, populated by Bamars (Asian development bank, 2018). Ethnic minorities make up the rest (Asian development bank, 2018) with a total population of 235.542 inhabitants who live in an area of 750 km² (Ministry of labour immigration and population, 2017). Shwebo Township has 29.3% of urban population (Department of Population, 2014).

Figure 2. Map of Sagaing Region, showing Shwebo Township



Source: Ministry of labour immigration and population, 2017, p.5

The report of the Ministry of labour immigration and population in 2017 indicates that 68.9% of the population in the studied villages are economically productive. The literacy rate is 95.5% according to the literature (Ministry of labour immigration and population, 2017), corresponding with the values obtained on the field. The average household size is 4.5 persons (Ministry of labour immigration and population, 2017), lower than the value found in this research.

3.2 The study region

This research was conducted in the villages Hta Naung Wun and Shwe Baw Kyun, located in Shwebo township. In addition, the interview to the processing company was conducted in the urban area of Shwebo Township since the facilities of the company are located there. It should be noted that all the fish farmers who participated in this study are beneficiaries from INLAND MYSAP programme in the study area, representing almost all fish farmers in the villages (BRAC employee, personal communication, May 13, 2019). According to the information provided by BRAC, Hta Naung Wun village has 29 fish farmers, and all of them are beneficiaries from the programme (BRAC employee, personal communication, May 13, 2019). On the other hand, Shwe Baw Kyun village has a total of 17 fish farmers, and only one of them is not a beneficiary from the programme. In order to distribute the support to the beneficiaries, the programme organized farmers' groups to make the logistics more convenient (WorldFish team Mandalay, personal communication, May 13, 2019). Therefore, the fish farmers from each village belong to

different groups (WorldFish team Mandalay, personal communication, May 13, 2019). Each group has one demonstration farmer funded by the programme, and one feed miller whose milling equipment was as well funded by the programme (WorldFish team Mandalay, personal communication, May 13, 2019). In addition, each group has a farmer representative, known as group leader (and referred in this study as a farmer leader).

Figure 3. Map of Shwebo Township, showing farms included in study

Screenshot Source: Google Maps. 15.08.2019

Hta Naung Wun village has a total population of 1855 inhabitants distributed in 358 households (Ministry of labour immigration and population, 2017). The village is located 5 km northwest from Si Pin Thar Yar Market, the main fish market in Shwebo city, and 4 km northwest from the contacted processing company. Paddy rice production is the main agricultural activity because the good access to water (Farmer leader, personal communication, May 21, 2019). The access to Hta Naung Wun is through dirt roads, the access to electricity is not continuous and there is access to primary school education.

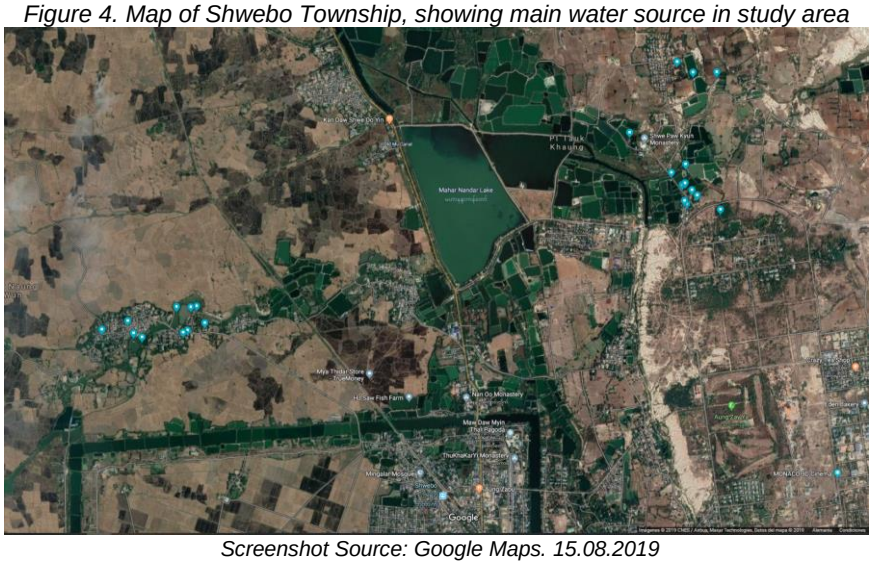
According to the WorldFish team, Shwe Baw Kyun village is part of Ward No. 10 and has a total population of 1.101 inhabitants distributed in 220 households (WorldFish team Mandalay, personal communication, May 13, 2019). The village is located 6 km northeast from Si Pin Thar Yar Market, and 5.4 km northeast from the contacted processing company. The village produces sesame, onion, peanuts and mustard (farmer leader, personal communication, May 30, 2019). Paddy production is rare in the village since the area is drier than Hta Naung Wun (farmer leader, personal communication, May 30, 2019). Shwe Baw Kyun is located in the vicinity of one industrial area and next to a military base. The access to Shwe Baw Kyun is through dirt roads, the access to electricity

is not continuous but more stable compared to Hta Naung Wun village and there is access to primary school.

The main water source in the studied area is Mahar Nandar Lake, which receives water from Tha Phan Sate dam, the biggest dam in the country (personal communication WorldFish team Mandalay, May 13, 2019). The earthen ponds in Hta Naung Wun village receive water from the irrigation channel that comes from Mahar Nandar Lake. The group of blue balloons in the down left corner in Figure 4 show the location of the farms in Hta Naung Wun village, where the interviews were conducted. It is important to note that Hta Naung Wun village has a good water availability, except on the rainy season when flooding might happen, being the case in 2018. According to the information provided by the farmer leader, fish farmers use water pumps in the village around 2-3 months each year (farmer leader, personal communication, May 21, 2019).

The fishponds in Shwe Baw Kyun receive water from Kopin reservoir, which takes water from Mahar Nandar Lake (WorldFish team Mandalay, personal communication, May 13, 2019). The group of blue balloons in the upper right corner in Figure 4 show the location of the farms in Shwe Baw Kyun village, where the interviews were conducted. According to the information provided by the farmer leader, fish farmers use water pumps in the village around 5 months each year, during the dry season (farmer leader, personal communication, May 30, 2019). This village sometimes faces water shortage, and temporary drought might happen (farmer leader, personal communication, May 30, 2019).

Figure 4. Map of Shwebo Township, showing main water source in study area



Screenshot Source: Google Maps. 15.08.2019

3.3 Research approach and methods

This research implements a qualitative explorative approach in order to collect the accurate data that describes the current market dynamics faced by fish farmers in the study area. According to Lune & Berg (2017), qualitative research *"refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things"* (Lune & Berg, 2017, p. 12).

In the interest of capture the general view of fish farming in Shwebo Township, including perceptions, expectations and challenges, this study has an inductive approach to identify which topics are meaningful for the stakeholders in the study area. Nevertheless, to propose hypothesis and to compare the results with other regions, deductive components were included based on the available reports and the field experience of WorldFish. In order to implement the inductive approach using content analysis, the study built categories within the grounded theory, which was developed by Glaser and Strauss in 1967 (Lune & Berg, 2017). Grounded theory is *"a research style that explicitly focuses on generating hypotheses and theories and aims to develop categories directly on the data through a multifaceted process"* (Kuckartz, 2014, p. 61). The quantitative component of this study includes descriptive statistics.

In addition to the conducted interviews, this study combines information from the literature review of published material, as well as reports provided by WorldFish Myanmar. Furthermore, the study considers field observations and personal communications that might cover deficits of information.

3.4 Sampling technique

3.4.1 Purposive sampling

This study as well as many social sciences studies, faced limitations to follow a probability sample, since special authorizations are required to visit and conduct research in Myanmar, only in approved areas. Considering the limitations, this study uses a nonprobability sample. This study uses a purposive sampling, the sampling technique in which *"researchers use their special knowledge or expertise about some group to select subjects who represent this population"* (Lune & Berg, 2017, p. 39).The WorldFish team and the University of Hohenheim decided together the study area based on the interest to obtain information about the aquaculture groups as well as the access to the area considering logistic restrictions. It should be noted that purposive sampling limits potential

generalizations, but provides benefits from obtaining information and descriptions about phenomena not available previously (Lune & Berg, 2017). From Hta Naung Wun village, 13 farmer members participated in the study, representing 45% out of the total number of members in the village. From Shwe Baw Kyun, 13 farmer members participated in the study, representing a 76% of the total number of members. In addition, 2 demonstration farmers (one per village) plus 2 farmer leaders (one per village) and one representative of the processing companies were selected to conduct key informants' interviews.

Figure 5. Farmers during harvest and farmers presenting their pond, Shwebo township. May 22 and 27, 2019

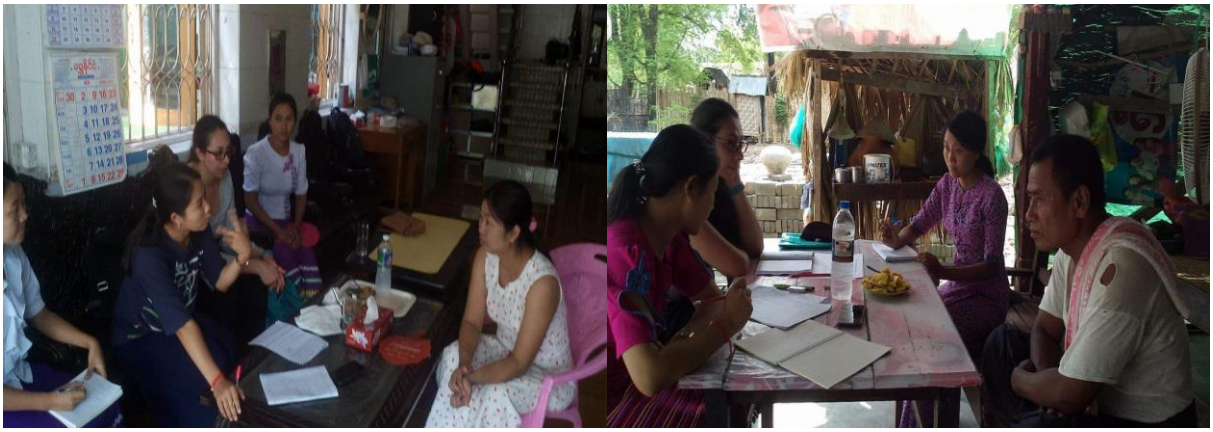
3.5 Data collection

From May 13 to May 17, 2019 the final logistic activities and short meetings were held in the office of WorldFish in Mandalay city, Myanmar. The field data collection was conducted in Hta Naung Wun and Shwe Baw Kyun villages, located approximately 80 kilometres northwest of Mandalay from May 20 to June 7, 2019. Final meetings to share partial results with the WorldFish team in Mandalay, as well as meetings with the WorldFish team and GIZ-MYSAP programme team in Yangon were held from June 10 to June 17, 2019.

As part of the preparation before the data collection, the questionnaires' content and structure were reviewed by the University of Hohenheim and the WorldFish team in order to tailor the instrument. Afterwards, the questionnaire was translated to Burmese. Before the data collection, one skype session and one personal session of training about the objectives and use of the instrument were held with the translator who supported this study. The training helped to coordinate the data collection procedures between the translator and the author. Following the suggestions from Larossi (2006), the training sessions included the purpose of the research, link of questions with possible answers, relevance of the translator's role to obtain accurate data and suggestions about how to

handle the survey. In addition, in the training sessions was reviewed fish species names in Burmese and English, using training material provided by WorldFish.

Figure 6. Implementation of interviews, Shwebo township. May 30 and June 5, 2019



3.5.1 Structured questionnaires

The primary data in this study was gathered using structured questionnaires. Each interview was conducted through personal interviews with the assistance of a translator, following the instrument designed (Appendix A). Before starting each interview, the informed consent to register the answers and to allow for audio recording was obtained from each participant in the study. The translator read the questions in Burmese, took notes and recorded the interviews. At the end of the collecting sessions, the translator processed the information and provided the interview transcripts to the author. It should be noted that in addition to the interviewee, the translator and the author, each interview was accompanied by a DoF employee, as a requirement to conduct the research from the local authority.

The farmer leaders and demonstration farmers of each group, as well as the representative of the processing company who was possible to access were selected to conduct key informants' interview. The questionnaire used for the four key informants' farmers was the same and was developed with open questions to capture experiences and further details (Appendix B). In the study was possible to access to one processing company. Therefore, the questionnaire design to record the processor-based perspective was implemented once (Appendix C).

3.5.2 Semi-structured interviews

The interviews in this study followed a semi-structure interview, in order to explore unexpected answers. Lune & Berg (2017) stated that this type of research is useful when *"researchers seek to approach the world from the subject's perspective"* (Lune & Berg,

2017, p. 70). Beforehand, the translator and the author agreed on questions with special interest for the research, meaning that if the answer of the interviewee had particular content, the translator made a short pause, explained the answer and ask the author whether or not make additional questions, developing the questions at the time of the interview implementation. These additional questions were asked in order to obtain additional details from the statements related to challenges, expectations, and significant perceptions. The research profited from semi-structured interviews since was possible to capture unanticipated answers and descriptions. The final overview of the interviews and number of participants is shown in Table 1.

Table 1. Overview of the interviews

	NUMBER OF INTERVIEWS
Farmers' interviews	26
Key informant interviews	5

Source: Field research Shwebo (2019)

3.6 Analytical techniques

Based on the data collected during the field research, the next procedure was to conduct the data entry of the interview transcripts in Excel sheets. Due to the exploratory aim of this study, descriptive analysis was implemented.

3.6.1 Content analysis

Content analysis is a qualitative technique to examine and interpret material in order to identify patterns, meanings and assumptions (Lune & Berg, 2017). This analysis requires first to transform the data collected into text, to later generate categories (Lune & Berg, 2017). In this research the defined categories were grounded from the finding in the collected data. After, categorical labels are generated from the codes and the collected data is sorted according to similar patterns and relationships (Lune & Berg, 2017). Finally, frequency distributions were built from the findings. It is important to note that the answers to the open questions to determine perceived production challenges, selling challenges, type of product expected to sale in two years and future plans for fish production consisted of multiple categories if the farmers considered convenient. In addition, the findings were support with direct quotes from the key informant interviews, which provided additional details about some findings. The quotes from the participants are cited are anonymously in this study.

3.6.2 Likert scale

In order to identify perceptions about the access provided by WorldFish programme to certain inputs, a Likert scale was included in the instrument. In a Likert scale, the participants are asked to express their degree of agreement about certain statements (Hair, Bush, & Ortinau, 2010). In the study, the scale measured the perception in a scale of importance of each statement.

3.7 Definition and measurement of variables

1. Viss: Local unit of mass. 1 Viss = 1.6 kg (Belton et al., 2015).
2. Burmese Kyat (MMK): Local currency with an average exchange rate of 1Euro = 1,720 MMK during the period of May 2018 to May 2019 (“Exchange rate of central bank of Myanmar,” 2019).
3. Working age: According to the 2014 Myanmar population and housing census, working age population is defined from 15 to 64 years (Department of Population of Ministry of Immigration and Population of Myanmar, 2015).
4. First and secondary occupation: The main and secondary occupations are the ones in which the household members invested more time during the 12 months previous to the date of this study.

CHAPTER 4: Results and Discussion

Chapter four presents and discusses the results of this study. This chapter is divided in nine sections: the first section describes socio-economic characteristics of the fish farmers. Section two presents the quantity of fish used for sale, family consumption, gifts and ceremonies during the las culture season. Section three identifies the main buyer for fish farmers in the study area and discusses the characteristics of the product demanded. Section four characterized the product supplied, followed by section five which discusses whether the supplied product corresponds to the characteristics demanded. Section six which presents production limitations. Section seven discusses the results regarding perception of importance of the INLAND MYSAP programme to ensure access to production inputs, finishing with section eight and nine, where limitations and challenges are presented.

4.1 Socio-economic characteristics of fish farmers

In this section, the answers from the 26 respondents is presented. The average family size of the sample is 4.7 family members. The smallest families had 2 members. Families with 2 members were found in village 1 and village 2. On the other hand, the highest family size was reported with 11 members in village 1. The highest family size in village 2 was 7 family members.

4.1.1 Age and gender of household heads

Table 2 presents the age of the household heads who were part of this study. The average age of the household heads was 51 years. The age of some questionnaire respondents is higher than the current life expectancy in Myanmar, which is for males 60.2 years and for females 69.3 years (Kraas et al., 2017).

Table 2. Age of household heads

	MEAN (years)	MIN. (years)	MAX. (years)
All household heads	51.19	30	70
Household heads village 1	54.15	35	70
Household heads village 2	48.23	30	65

Source: Field research Shwebo (2019)

The results presented in Table 3 shows that the vast majority of household heads are males. Only one family has a female household since the spouse died.

Table 3. Gender of household head

GENDER	FREQ.	PERCENTAGE
Male	25	96.15%
Female	1	3.85%
Total	26	100%

Source: Field research Shwebo (2019)

4.1.2 Education status in the study area

Table 4 presents the information about the education status among the household members included in this study. The study found that 50% of all household members completed the secondary education, while 36% completed the primary education. The results correspond to the report from Kraas et al. (2017), who stated that 75% of Myanmar's population achieve the primary education or higher study levels. In addition, the study villages are located approximately 10 to 15 km to two high education institutions in Shwebo Township: Shwebo university and Shwebo Technological College.

Table 4. Education status in study area

	FREQ.	PERCENTAGE
Secondary education	61	50%
Primary education	44	36%
No education	7	6%
Informal education	5	4%
Bachelor	5	4%
Diploma	1	1%

Source: Field research Shwebo (2019)

The literacy rate among the farmers and their family members is presented in Table 5. The participants have a high literacy rate of 91%. This result correspond to the values indicated by Kraas et al.(2017), with a literacy rate of 89.5% in Myanmar.

Table 5. Literacy rate in the study area

	FREQ.	PERCENTAGE
Can read and write	112	91%
Cannot read and write	9	7%
Only read	1	1%
Only write	1	1%

Source: Field research Shwebo (2019)

4.1.3 Occupation of participants

The results presented in Table 6 and Table 7 indicate the main and secondary occupation of the household members. The main and secondary occupations are the ones in which the household members invested more time during the 12 months previous to the date of this study. It should be pointed out that the occupations student and domestic work currently do not generate income to the households.

Main Occupation

The analysis of the occupations reveals diverse income sources. Rice, fish and textile production are important activities, followed by non-agriculture employment and trading. Rice farming is the main occupation for 16% of the household members, followed by fish farming for 12% of the household members. Only female household members are weavers, corresponding to the third most frequent occupation (Table 6). It is important to

note that 8% of the household members included in the study work as hired labor in non-agriculture activities. Another off-farm activity is trade. Trade is the occupation for 7% of the household members. The trade activity reported as main occupation was the operation of small grocery shops in the villages.

Table 6. Main occupation

	FREQ.	PERCENTAGE
Rice farmer	20	16%
Student	19	15%
Fish farmer	15	12%
Domestic work	15	12%
Weaver	12	10%
Non-agriculture labour	10	8%
Trader	8	7%
Retired	5	4%
No occupation	5	4%
Carpenter	4	3%
Unemployed	3	2%
Not healthy	3	2%
Private sector employee	2	2%
Tailor	2	2%

Source: Field research Shwebo (2019)

Table 7. Secondary occupation

	FREQ.	PERCENTAGE
No secondary occupation	68	55%
Fish farmer	25	20%
Animal production	7	6%
Domestic work	7	6%
Non-agriculture labour	5	4%
Other crops farmer	3	2%
Livestock worker	3	2%
Own enterprise	2	2%
Rice farmer	1	1%
Tailor	1	1%
Woodcutter	1	1%

Source: Field research Shwebo (2019)

Secondary Occupation

The study found 45% of the household members have a secondary occupation. Fish farming is the predominant secondary occupation for 20% of the household members. Considering fish farming as a secondary occupation correspond with the report that small-scale aquaculture is not a labor intensive activity (Belton et al., 2015). Animal production was the secondary occupation of 6% of the household members, corresponding to cattle and ducks production. Considering off-farm activities, non-agriculture employment is the secondary activity for 4% of the household members.

4.1.4 Years of experience in fish farming

On average the fish farmers interviewed have 10 year of experience in aquaculture (Table 8). However, there is a difference in the years of experience between village 1 and village 2. The farmers in village 2 have on average 8 years of experience more than farmers in village 1.

Table 8. Years of aquaculture experience

	OBS.	MEAN (years)
All farmers	26	10.17
Farmers village 1	13	6.12
Farmers village 2	13	14.23

Source: Field research Shwebo (2019)

4.1.5 Production system

The aquaculture production in the study area is developed in earthen ponds under polyculture located next to the household. It is worth mentioning that farmers only sold the species which reached larger sizes, frequently rohu and tilapia, and used fish at smaller size for family consumption. In this study, only one farmer had a small area of paddy-fish production additional to the main earthen pond. The other 25 farmers did not have any agri-aquaculture system. The report from one farm leader pointed out, that farmers in the region do not like paddy-fish production since that production system limits the application of pesticides and other products to the rice field, in order to do not affect the fish (personal communication, May 25, 2019).

From the participants, 25 farmers reported to be landowners and only one reported to rent ponds. The information about the pond area was not gathered since the respondents reported incomplete answers. Some farmers said that they were unsure about the area or responded with values including house or other farm areas plus ponds area. This point will be discussed the section 4.9. From the observations during the farm visits during the interviews, fish farms in village 2 seem to have two or three times more pond area compared to farms in village 1. Pond areas among the same village did not seem to be different, with the exception of one farm in village 2 which was remarkable for having multiple ponds with big area. The information from De Silva (2008) in Myanmar's fish cluster describes a similar situation. In that region, *"large sized farms co-exist with small sized farms"* (De Silva, 2008, p. 14). The author reports in the Ayeyarwady Delta cluster area that fish farmers with areas greater than 400 ha co-exist with farmers of 1-2 ha (De Silva, 2008). In the studied area probably, there are no farms with 400 ha as in the cluster area but the difference of pond areas between villages was significant.

4.2 Quantity of fish for sale, family consumption, gifts and ceremonies

The total harvest is divided by the farmers for different purposes. Table 9 exhibits the total quantity of fish produced from May 2018 to May 2019 by the fish farmers from the two villages who participated in the study. The total amount produced on the period was 35.108 tons. Analysing the results by village, the study found that the proportion of fish used for family consumption out of the total harvest is higher in village 1, with 6.5%, compared to the quantity consumed in village 2, equals to 1.3% (Table 9). Both values are lower than the 10% use for family consumption initially hypothesized.

Table 9. Quantity of fish for sale, family consumption, gifts and ceremonies by village

		Sale	Family consumption	Gifts and ceremonies	*Total production*
Village 1	QUANTITY (kg)	2573.12	189.92	158.72	2921.6
	PERCENTAGE	88.1%	6.5%	5.4%	
Village 2	QUANTITY (kg)	31184	432	571.2	32187.2
	PERCENTAGE	96.9%	1.3%	1.8%	

Source: Field research Shwebo (2019)

Given the potential changes in the proportion of fish used for family consumption, depending on the total farm harvest, the calculation by quartile of quantity produced was estimated. Table 10 confirms that farmers with the higher production quartiles have a lower proportion of fish for family consumption, compared to the farmers with lower production quartiles. The effect appears not only in the use of fish for family consumption, but also for gifts and ceremonial use. This effect is explained by the fact that the quantity consumed by the households has a limit, probably related to the number of family members. The previous point means that even when the quantity produced increases, the family will maintain or increase the quantity of fish consumed until a maximum amount, using the rest of the harvest for sale.

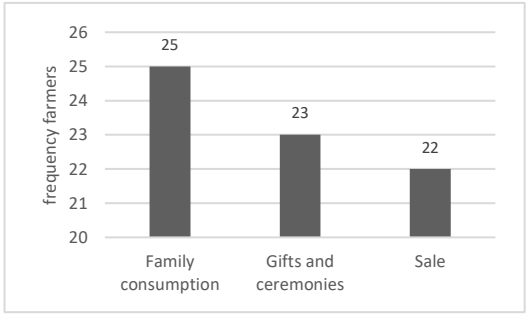
Table 10. Quantity of fish for sale, family consumption, gifts and ceremonies by production quartile

		Sale	Family consumption	Gifts and ceremonies	*Total production*
1st quartile	QUANTITY (kg)	104	75.2	44.8	224
	PERCENTAGE	46.4%	33.6%	20.0%	
2nd quartile	QUANTITY (kg)	598.72	86.72	135.52	821
	PERCENTAGE	72.9%	10.6%	16.5%	
3rd quartile	QUANTITY (kg)	1854.4	132	125.6	2112
	PERCENTAGE	87.8%	6.3%	5.9%	
4th quartile	QUANTITY (kg)	31200	328	424	31952
	PERCENTAGE	97.6%	1.0%	1.3%	

Source: Field research Shwebo (2019)

It is important to note that not all the farmers dedicate a proportion of the harvest for sale, or for gifts and ceremonies. The harvest proportion used for gifts and ceremonies includes activities as merit making and religious events as the Buddhist novitiation ceremony, robe offering ceremony and weddings (farmer participant, personal communication, May 21, 2019). Figure 7 shows that four farmers did not sell, including one farmer who lost the total production because of flooding; therefore, he did not obtain any benefit from sales nor from family consumption. All farmers, except the case mentioned before, dedicated a share of the fish production for family consumption. From the 26 participants, three farmers (including the farmer who experienced the total loss) did not use part of the fish production for gifts and ceremonies. In Bangladesh, Hernandez et al. (2018) found that 75% of the fish farmers sold a share of the harvest. In this study, 88% of the participants who produced fish traded the product.

Figure 7.Final use of fish production



Source: Field research Shwebo (2019)

The production used for family consumption, as well as the production used for gifts and ceremonies, is clearly a local consumption. In this study the total quantity of fish consumed by the farmers, considering family consumption, gifts and ceremonies is equal to 11.9% in village 1, and 3.1% in village 2. This result is greater than the proportion reported in Myanmar's aquaculture cluster, where own consumption and gifts accounted for 1% out of the total production (Belton, Filipski, et al., 2017). In neighbouring Bangladesh, most production is sold and a maximum 10% of fish is own consumed (Hernandez et al., 2018), closer to the proportion found in village 1.

According to the representative from the processing company, the fish produced in the region is traded only in the national market (representative processing company, personal communication, June 5, 2019). This point represents a difference compared to the fish traded in the Ayeyarwady Delta, where 20% of the fish production goes to export markets (Belton et al., 2015).

4.3 Main buyer identification

The study found that the processing companies bought 94.32% of the fish sold by the farmers participants from May 2018 to May 2019 (Table 11). Therefore, the processing companies are clearly the main buyers. The results found in this study are similar to the values reported by Belton, Filipski, et al. (2017), in a study carried out in the national aquaculture cluster of the Ayeyarwady Delta region. The authors found that wholesale traders who implement simple processing activities as freezing and packing bought 96% of the fish sold in the cluster, followed by 0.3% of the sold production which supplied local retailers (Belton, Filipski, et al., 2017; Belton et al., 2015). In Bangladesh, 62.8% of the fish produced was sold to wholesales-processing companies and 8.4% went to regional collectors (Rashid & Zhang, 2019).

Table 11. Total quantity sold to each buyer during last 12 month

	QUANTITY	PERCENTAGE
Processors	31,840.73 kg	94.32%
Growout farmers	1,158.40 kg	3.43%
Final consumers	638.49 kg	1.89%
Retailers	119.45 kg	0.35%

Source: Field research Shwebo (2019)

In India, Bangladesh and Myanmar the main buyers in the fish farming value chain are wholesale traders who implement processing activities (Belton et al., 2015; De Silva, 2008; Hernandez et al., 2018). Hernandez et al. (2018) described a value chain where large wholesalers directly buy the harvest from fish farmers and small rural brokers do not play a relevant role. In Kolleru Lake, India, the processors stablished their own association (De Silva, 2008). The association coordinated activities which limit direct sales from fish farmers to the local fish markets or to secondary processors (De Silva, 2008). In Myanmar, according to Belton et al. (2015), processing companies in the Ayeyarwady Delta have their own farms and additional quantities required are traded via contract farming (Belton et al., 2015).

The role of the buyer is different on each village. In village 1, growout farmers are important buyers. Growout farmers bought 31% of the quantity sold, coming after the final consumers who bought 21% of the sold production (Table 12).

In village 2 the processing companies bought 98.52% of the sold production (Table 13). In this village, retailers did not participate as buyers. The differences on the percentages sold to each buyer between the villages are related to the particular quantities of fish produced. Village 2 sold high quantities of fish, which are easily traded by the processing companies, compared to lower quantities produced in village 1 which can be traded

directly by the farmers to local buyers. According to the interviews, the processing companies buy fish from the farmers in the study area, regardless the quantity traded.

In both villages is visible the essential role of processing companies as the main clients.

Table 12. Quantity sold per buyer village 1

	QUANTITY	PERCENTAGE
Processors	1,119.13 kg	43.49%
Growout farmer	800.00 kg	31.09%
Final consumer	534.49 kg	20.77%
Retailers	119.45 kg	4.64%

Source: Field research Shwebo (2019)

Table 13.Quantity sold per buyer village 2

	QUANTITY	PERCENTAGE
Processors	30,721.60 kg	98.52%
Growout farmer	358.40 kg	1.15%
Final consumer	104.00 kg	0.33%

Source: Field research Shwebo (2019)

Table 14 shows the number of fish farmers who sold to each reported buyer. From the 22 farmers who traded fish, 9 sold the production to the processors, 3 sold part of the production to the processors and part to the final consumer, and two sold to the processor and to the growout farmers. The results confirm the relevant role of processing companies to trade the harvest in the study area.

Table 14. Number of suppliers by buyer

Buyers identification	
	Frequency
Processor	9
Final consumer	6
Processor and final consumer	3
Processor and growout farmer	2
Growout farmer	1
Retailer, final consumer, processor	1
Farmers who did not sell	4

Source: Field research Shwebo (2019)

4.3.1 Sale price variation among buyers

This study found a slight difference in the sale price paid by each buyer (Table 15). On average, farmers who sold fish to final consumers received 128 MMK per viss more, compared to farmers who sold fish to processing companies. The farmers who sold fish only to growout farmers reported the lowest sale price for fish at medium size. The difference is related to the strategy implemented by the growout farmer, in order to increase his profit at the end of the culture cycle. In addition, two farmers sold fish at the smallest size to growout farmers and received the same price per viss as the ones who sold the same fish size to processing companies. The lowest price received for fish at the

smallest size was paid by the final consumer. It is worth nothing that fish at the smallest size is the less desirable among buyers and is usually sold when the farmer has a difficulty with an input that hinder the production cycle. Therefore, the farmers sold to the buyer who was willing to buy the fish at the smallest size.

Only one farmer sold part of the harvest to the retailer, trading fish at market size. The price difference from selling fish at market size to different buyers is less than 40 MMK, which is negligible.

Table 15. Average sale prices by buyer

	Sold to processing companies	**Sold to final consumer**	**Sold to growout farmer**	**Sold to retailer**
	Average price per viss	Average price per viss	Average price per viss	Average price per viss
Market Size	2,600 MMK	2,640 MMK	-	2620 MMK
Medium Size	2,189 MMK	2,200 MMK	2,000 MMK	-
Small Size	1,750 MMK	1,767 MMK	-	-
Small Size1	1,050 MMK	-	-	-
Small Size2	500 MMK	375 MMK	500 MMK	-
MEAN	1,618 MMK	1,746 MMK	1,250 MMK	2620 MMK

Source: Field research Shwebo (2019)

Current access to sale price information

To evaluate how sale price information is obtained by the farmers, the question *How do you receive information about the sale price?* was included in the questionnaire. The results show two different trends: Farmers who sold fish to processing companies, retailers and growout farmers received information about the sale price directly from the buyer. On the other hand, the farmers who sold their production to the final consumer obtained information about the sale price from the local fish market and then decided to charge a similar price.

In the first scenario, the farmers who sold the production to processors, retailers and growout farmers received a price set by the buyer and did not have any intervention on the sale price taken. Considering that 16 of the 22 participants traded their production to the buyers mentioned above, it is clear that they face a buyer-driven sale price.

The second scenario, where farmers sell fish to the final consumer shows that the producer had an influence on the sale price and, different to the first scenario, the farmer set the sale price and therefore had a higher bargaining power. Nevertheless, farmers who sold only to the final consumer traded lower fish quantities compared to the farmers in scenario 1. This point demonstrates that the final consumer market is more limited, compared to the amount that processors are willing to buy. In addition, there are logistical

restrictions when selling fish to the final consumer. The limitations include the lack of a proper cooling system to preserve fish quality, since the access to electricity in the villages is not constant. Another restriction is transportation, because the farmers do not have tricycles or bigger vehicles than a motorbike to transport the product.

Changes on sale price over time

The participants on this study pointed out that the sale price has been stable. One of the comments mentioned about fish sale price was *"Fish sale price doesn't change at all as we get the price that the processors pay"* (Demonstration farmer, personal communication, May 28, 2019). Another comment from the interviews supports the idea that the sale price has been stable*: "The fish sale price has not changed for many years and the prices are different according to the fish size"* (Farmer leader, personal communication, May 30, 2019).

A stable on-farm fish sale price in a scenario when fish feed price is increasing may affect the farmers' profit. One farmer reported that *"sale price depends on the processors, since the processors decide sale price…Although fish feed gets higher and higher, sale price of fish does not change"* (personal communication, June 5, 2019). This information is consistent with the report from Belton, Filipski, & Hu, (2017), showing in Myanmar aquaculture cluster that fish feed price, the most expensive input, was higher than rohu sale price by 38 percentage points.

4.3.2 Characteristics of fish demanded by processing companies

Considering the processing companies as the main buyers in the study area, the next step is to identify the characteristics demanded by this buyer. The information obtained from the processor's interview was the main source in this phase of the study. The processing facilities are located in Shwebo township and post-harvest activities are implemented to produce fish on ice and minced fish balls. According to information provided by DoF employees, in the region there are in total 5 processors, producing similar products but in different scale (DoF employee, personal communication, May 23, 2019). Therefore, is it possible to consider that all they look for similar product characteristics. To confirm the identified characteristics, the analysis of the statements from the fish farmers interviewed is used.

The interview with the contacted processor revealed that the main characteristic considered at buying is fish size, with preference for fish at market size (approximately 650 - 800 gr/fish). The processor mentioned that *"there are no fish farmers whom we*

assume as good suppliers as we usually go to their ponds and look for the fish that has a size suitable for us" (representative processing company, personal communication, June 5, 2019), referring to fish at market size. One viss of fish at market size contains approximately 1 to 7 fish units. In addition, the processor expressed a preference for a non-seasonal fish supply, helping the company to receive fish during the year.

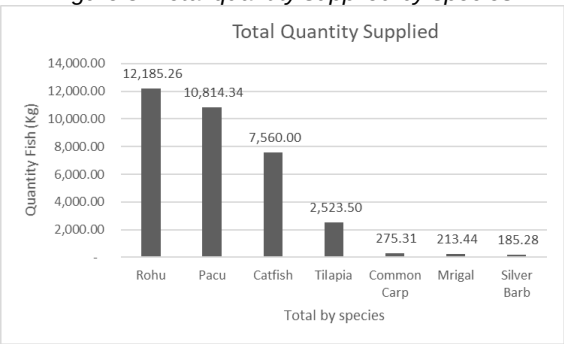
Preferences for fish species from the processors' perspective during the last 12 months were explored. The results demonstrate that the processor does not have a species preference. The processing company buys 7 different fish species, including rohu and tilapia. The lack of species preference is clear with the next statement: "*We bought all kinds of fish species and we don't need one in specific"* (representative processing company, personal communication, June 5, 2019).

To sum up, the processing companies require whole fresh fish at market size, without any species preference.

4.4 Characteristics of fish supplied by fish farmers

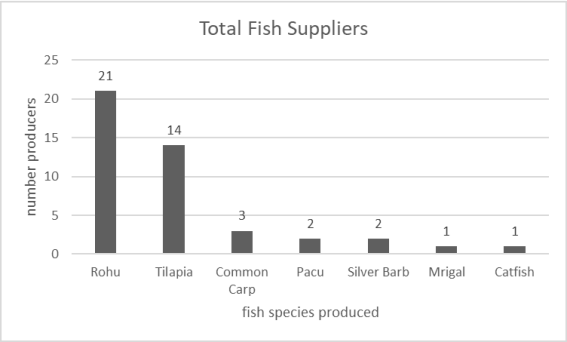
The interviewed farmers sold a total of 33,75 tons of fish from May 2018 to May 2019. As Figure 8 and Figure 9 indicate, the species of whole fresh fish sold were Rohu *(Labeo rohita)*, Tilapia *(Oreochromis niloticus)*, Common carp *(Cyprinus carpio)*, Pacu *(Colossoma brachypomum)*, Silver Barb *(Barbonymus gonionotus)*, Mrigal *(Cirrhinus cirrhosis)* and indigenous catfish (different species). The species produced in the study area correspond to the freshwater fish species produced in Myanmar aquaculture cluster (Belton et al., 2015) as well as the species produced in Bangladesh (Hernandez et al., 2018). All farmers interviewed had polyculture production and sold the fish which reach the highest size. Therefore, not all the species produced were sold. From the 22 farmers who sold fish, 60% sold two different species, followed by farmers who sold 3 species, representing 23%. The maximum number of different species offered was 4 species, supplied by two fish farmers. From the farmers who sold fish, 21 reported one harvest per year, and 1 farmer reported 3 harvests per year. The result shows a potential to coordinate the harvest time among the farmers or implement strategies to increase the supply frequency.

Figure 8. Total quantity supplied by species



Source: Field research Shwebo (2019)

Figure 9. Number farmers by species



Source: Field research Shwebo (2019)

4.4.1 Size of fish supplied

This study found that farmers produced fish in five different sizes. A single farmer might supply fish in multiple sizes. The participants mostly reported fish size using the categories market size, medium size and small size. However, some farmers reported fish sold in very small sizes. In some cases, they reported a size slightly bigger than a fingerling. Given that clarification, the category small size was separated into 3 different groups: first the biggest size among small size fish, called small size, followed by an intermediate small size, called small size1, and finally the smallest fish, called small size2. Considering the previous point, it is clear that the fish size definition is not uniform among farmers.

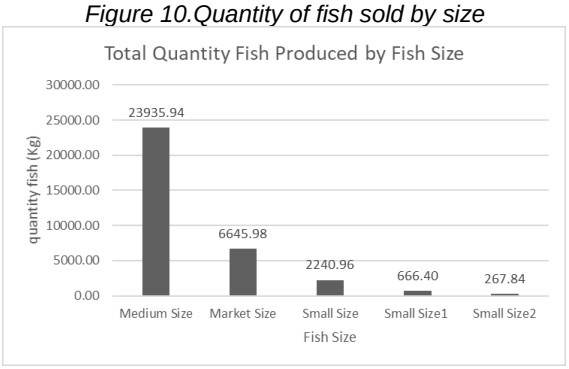
The reports describing fish on specific size categories were based on the number of fish units per viss sold. The farmers who reported the production of fish at market size, described that one viss of fish at market size contains approximately 1 to 7 fish units. The farmers who reported the production of fish at medium size, described that one viss of fish at medium size contains around 8 to 19 fish units. The decision to categorize the fish reported as small size into three groups was based on the high variation of the reports about the fish units contained in one viss. The reports fish at small size described that one viss of fish at small size contains from 20 to 50 fish units. The farmers who reported

to trade fish at the smallest size (which later was categorized as small size 2), reported that one viss of fish contains around 100 fish units. Therefore, one viss of fish at small size contains approximately 20 to 39 fish units; one viss of fish at small size 1 contains around 40-50 fish units and one viss of fish at small size 2 contains more than 50 fish units, and includes the report of 100 fish units/viss.

Of the small size fish subcategories, 8 farmers produced fish at small size. Followed by, 2 farmers that produced fish at small size1. Finally, 5 farmers produced fish at small size2, the smallest fish size reported. The farmer who sold the smallest fish among the participants stated that *"The consumers prefer big sized fish and so we had to reduce our fish price so that they want to buy. Some clients buy the fish at that size to feed their cats"* (personal communication, June 7, 2019).

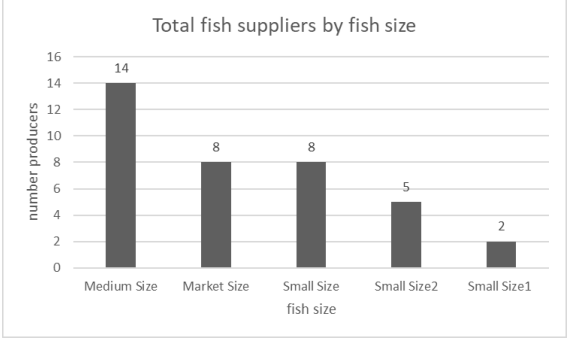
Figure 11 exhibit that medium size fish was the main product supplied by 14 out of 22 farmers, corresponding to 70.91% of the total fish sold in the study area. Market size fish was supplied by 8 out of 22 farmers, representing only 20% of the total fish sold. On this point, the study found one opportunity for improvement. Considering that on the last culture season, 80% of the harvest did not attain the size required by the market, strategies should be created to increase the supply of fish with the main buyer's preferred size.

Figure 10.Quantity of fish sold by size



Source: Field research Shwebo (2019)

Figure 11.Number fish suppliers by fish size



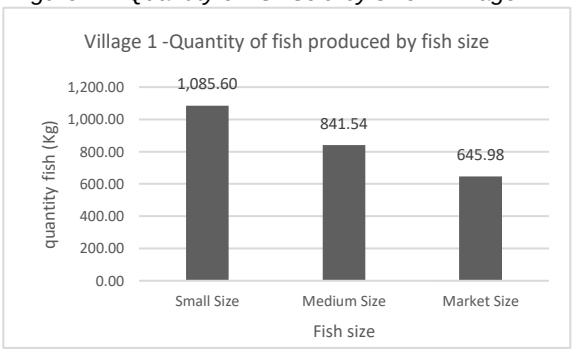
Source: Field research Shwebo (2019)

4.4.2 Differences of fish size by village

Analysing the quantity of fish sold by village, Figure 12 shows that village 1 traded 646 kg of fish at market size, representing 25.11% of the total amount supplied by this village. Furthermore, 42.19% of the fish sold in village 1, was fish at small size, and only 32.70% was fish at medium size.

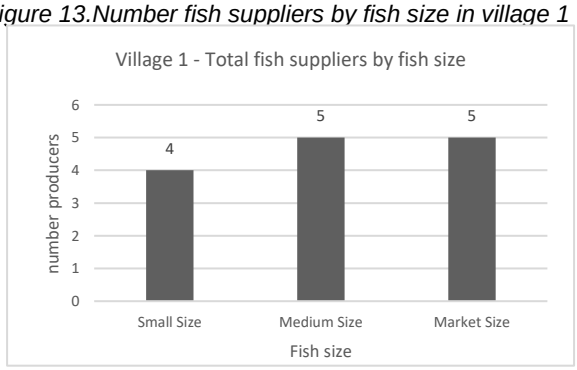
Considering the number of farmers who traded fish, from village 1, Figure 13 presents that just 4 producers, out of 9, traded fish at small size. Medium size fish and market size fish were supplied by 5 out of 9 fish farmers.

Figure 12. Quantity of fish sold by size in village 1



Source: Field research Shwebo (2019)

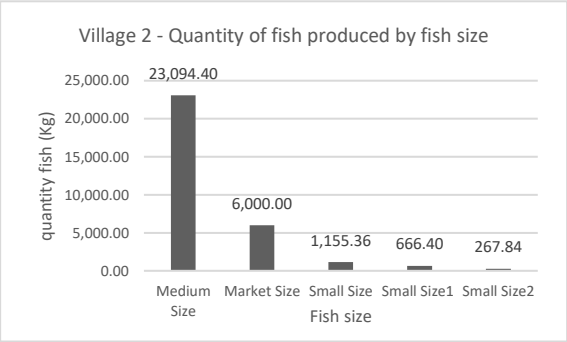
Figure 13.Number fish suppliers by fish size in village 1



Source: Field research Shwebo (2019)

Figure 14 shows that village 2 sold 6 tons of fish at market size, representing 19.24% of the total amount traded. The biggest share of harvest sold in village 2 was fish at medium size, reaching 23 tons and representing 74.06% of the total quantity. Analysing the number of producers who supplied fish by fish size category in village 2, fish of market size was supplied by 3 out of 13 farmers. Additionally, 9 out of 13 farmers sold fish at medium size, followed by 5 out of 13 farmers who sold fish at small size 2, which was the smallest fish size traded among the participants. It should be mentioned that the price per kilogram of fish at small size 2 is around 156-313 MMK.

Figure 14. Quantity of fish sold by size in village 2



Source: Field research Shwebo (2019)

Figure 15. Number fish suppliers by fish size in village 2

Source: Field research Shwebo (2019)

It is important to acknowledge that the villages in this study have different production capacities. Farmers in village 2 produced a harvest 12 times higher than the harvest in village 1. Table 16 shows that village 2 contributed 92% of the total quantity traded in the study area, while village 1 contributed 8%. The reasons for that was not part of the scope of the present study, but the field observations lead to the idea that the pond area is higher in village 2, which is related to the limiting policy for the conversion of paddy rice fields into fish ponds that affects village 1.

Table 16. Quantities of fish traded per fish size in each village

		Village 1	Village 2	Total
Market Size	Kg	645.98	6,000.00	6,645.98
	PERCENT.	9.7%	90.3%	100.0%
Medium Size	Kg	841.54	23,094.40	23,935.94
	PERCENT.	3.5%	96.5%	100.0%
Small Size	Kg	1,085.60	1,155.36	2,240.96
	PERCENT.	48.4%	51.6%	100.0%
Small Size1	Kg	-	666.40	666.40
	PERCENT.	0.0%	100.0%	100.0%
Small Size2	Kg	-	267.84	267.84
	PERCENT.	0.0%	100.0%	100.0%
TOTAL Kg		2,573.12	31,184.00	33,757.12
PERCENTAGE		8%	92%	100%

Source: Field research Shwebo (2019)

4.4.3 Fish size perceptions from farmers

The questionnaire gathered information about the type of product the fish farmers expect to sell in two years and their future plans for fish production. The answers reveal that fish farmers aim to produce fish at market size.

Fish product aim to sell in the coming two years

The information obtained was classified into eight categories as shown in Table 17.Fish product expected to sell in two years. As described in the methodology section, the respondents were allowed to answer with statements that could contain more than one category when desired. 14 out of 26 farmers interviewed, informed that they expect to sell fish at market size, which correspond to the processing companies' preference. This finding may indicate that the producers recognize fish size as an important characteristic in the product supplied.

In addition, 6 farmers out of the 26 farmers interviewed, reported that they would like to sell the same whole fresh fish as they are producing today.

Table 17.Fish product expected to sell in two years

	FREQ. (TOTAL PARTICIPANTS)
Fish at market size	14
Same product as now	6
Fish at market size and fingerlings	3
Sell other additional species	2
Any product with high profit	1
Fish for family consumption	1
Sale ornamental fish	1
Fish at small size	1

Source: Field research Shwebo (2019)

Future plans for fish production

Analysing the answers about the future plans for fish production (Table 18.Future plans for fish production), harvest fish at market size was the second most reported response, with a frequency of 9 out of 26 farmers. The most frequent answer shows that 12 out of 26 farmers interviewed are planning to repair or implement modifications to the ponds. One farmer stated: *"I would like to produce market sized fish and make our ponds deeper as well"* (personal communication, May 29, 2019).

Table 18.Future plans for fish production

	FREQ. (TOTAL PARTICIPANTS)
Repair or modify pond	12
Produce fish at market size	9
Increase pond area	6
Increase stock density	5
Produce more species in farm	4
Produce for family consumption	3
Increase harvest	1
Build pond to separate fish by size	1
Change paddy production to fish production	1
Improve fish quality	1
Buy water pump	1
Get better water access	1

Source: Field research Shwebo (2019)

4.5 Identified gap in the market

Comparing the characteristics of the fish demanded by the processors with the characteristics on the product supplied by the farmers in the study area, a gap was identified. The comparison shows that 80% of the production is not fulfilling the preference of the main buyer in the region. Therefore, there is a clear opportunity to increase the production of fish at market size.

Table 19. Identified gap in the market

Attributes of fish demanded by processor	**Attributes of fish supplied by farmers**	**Gap in the market**
• Preference for fish at market size • Alive fish	• Total production: 33.75 tons • 6.65 tons at market size • 8 out of 22 farmers produced market size fish	80% of the harvest not at market size

Source: Field research Shwebo (2019)

4.6 Limitations to achieving fish at market size

The answers in the survey reveal that farmers perceived the cost of fish feed and climatic conditions with impact on water availability as the main challenges. Table 20 shows that the high price of fish feed was considered a challenge by 15 out of 26 participants. Drought was the challenge reported by 11 out of 26 farmers. The third most frequent challenge reported was flooding, expressed by 4 out of 26 participants. The constraints identified by the farmers correspond to some of the factors which were improved in Bangladesh to enhance the production system (Rashid & Zhang, 2019). The use of improved fingerlings, commercial fish feed and increase of hired labor were key factors for aquaculture intensification in Bangladesh (Rashid & Zhang, 2019).

Table 20. Perceived fish production challenges

	FREQ. (TOTAL PARTICIPANTS)
High price of fish feed	15
Drought	11
Flooding	4
No money to buy equipment	2
Limited income	2
No challenge perceived	2
Time of pond preparation and rice planting overlaps	1
Restrictions land conversion	1
Fish theft	1
Suboptimal ponds	1
Fuel cost (water pump)	1

Source: Field research Shwebo (2019)

4.6.1 Fish feed

Fish feed is an input which affects the fish growth and size. Suboptimal feeding strategies because of the high cost of the feed, as well as the use of low-quality feed were identified as challenges in this study.

The current cost of fish feed in the study area restricts the access to this input and directly affects the fish size achieved. The farmers in the study area reported that the limited access of fish feed led to the implementation of changing feeding techniques. One farmer expressed: *"We cannot feed the fish regularly as the feed price becomes expensive"* (Personal communication, May 31, 2019). Meaning that the feeding frequency fluctuates according to feed availability.

In addition, other farmers reported that restrictions on fish feed led to the reduction on the quantity of feed provided to the fish. One farmer stated: *"we have difficulties with the fish feed, therefore, we could not feed enough"* (Personal communication, May 31, 2019).

In aquaculture it is possible to implement nutritional strategies using two sources of nutrients: Direct nutrient sources and indirect nutrient sources (Lucas, Southgate, & Tucker, 2019). The first nutrient sources refer to the feed provided by the farmer, as farm-made feed and pelleted feed. The second source refers to the natural production of organisms as *"algae, protozoans, bacteria and particulate organic matter*" (Lucas et al., 2019, p. 179) with potential to feed the fish. This second source increases with pond fertilization but fluctuates and does not cover the total nutrient requirements for the fish (Lucas et al., 2019). Therefore, to ensure an adequate fish size at the end of the culture season, the provision of feed is required. Unfortunately, the high price of fish feed generates changes in the feeding frequency and the provision of suboptimal feed quantities in the study area. Variations in the feeding strategy affect fish farming, since

the fish is forced to use only the available secondary source of nutrients (algae, bacteria, etc.). The dependence on secondary nutrient sources affects fish growth (Lucas et al., 2019). The farmers in the study area noticed that fluctuating feed supply has a negative effect on fish growth. One farmer expressed: *"we cannot afford for fish feed and so we have to feed little by little, but the fish don't grow well, and we can only sell small size fish"* (Personal communication, May 29, 2019).

Feed quality is a factor with effects on fish growth as well. Considering feed quality, De Silva (2008) affirm that farm-made feed has a variable quality, depending on the by-products used to prepare the feed. The fish feed used by approximately 80% of the fish farmers in the Ayeyarwady Delta corresponds to the feed used in Shwebo Township: Farm-made feed with a mixture of by-products including broken rice, rice bran and peanut oilcake (Belton et al., 2015; De Silva, 2008). Formulated feed like pelleted feed has a standardized production, therefore, it has a better quality (De Silva, 2008). Floating pelleted feed improved the productivity of fish farmers in Andhra Pradesh, India (Belton, Padiyar, Ravibabu, & Gopal Rao, 2017).

4.6.2 Fluctuating water supply

In aquaculture, water is essential. According to Belton et al. (2015), water supply should be available at adequate quality and volumes, with a minimal use of water pumps. The last condition is stated because of the high cost of fuel for pumping (Belton et al., 2015). In the study area, water availability depends on climatic conditions and the occurrence of drought and flooding was reported. As described previously, farmers from village 1 reported the occurrence of flooding, while farmers from village 2 reported the occurrence of drought. One farmer from village 1 said: *"When it rained heavily, the pond flooded, and fish were gone with water flow. That was the main problems for us"* (Personal communication, May 24, 2019). Another farmer from village 2 reported: *"We have enough water supply only when it rains heavily. If not, we have to take water from the lake into our ponds and it is far from our farm"* (Personal communication, June 5, 2019).

The farmers in the study area cope with water variations by using of water pumps. Nevertheless, fluctuations in the amount of water in the pond affect water quality variables such as dissolved oxygen and have effects on fish growth (Lucas et al., 2019). This leads to the conclusion that the achievement of fish at market size is limited by the variable water supply. In addition, when drought or flooding occurs, the farmers are forced to sell their fish, disregarding the fish size that fish have reach at that moment. It should be noted

that in the study area there is a lack of strategies and infrastructure to mitigate the negative effects from drought and flooding.

4.6.3 Production of fish species with faster growth rate

According to some authors, improved fingerlings have a faster growth rate (Belton, Filipski, et al., 2017; De Silva, 2008). Currently, WorldFish is working on the adoption of GIFT tilapia (Genetically Improved Farmed Tilapia), which is expected to increase the yield among fish farmers. This strategy may support the objective of achieving fish at market size, but some important conditions should be evaluated before, like the adaptation of the fish to the local conditions. Since some information about GIFT tilapia has been shared in the training sessions with the farmers, one farmer reported the willingness to test the fish on his farm (Personal communication, May 27, 2019).

4.7 Perception of importance of the INLAND MYSAP programme to ensure access to production inputs

As described in section 2.3.1, INLAND MYSAP programme supports fish farmers in the study area (Inland Myanmar Sustainable Aquaculture Programme, 2019). It should be mentioned that the direct support in the field is implemented by BRAC. The key components of the programme are training sessions, fingerlings distribution and the installation of one feed mill per farmers' group (Inland Myanmar Sustainable Aquaculture Programme, 2019). Each village in this study had one feed milling equipment to share.

Considering that the detected limitations in producing fish at market size are related to the constrained access to fish feed, the fluctuation of water supply and the use of fingerlings with fast growth, this study explored the farmers' perceptions about the role of the programme to access fingerlings, trainings, fish feed and buyers, which can potentially alleviate the limitations.

Table 21.Farmers' perceptions by areas of support

	ABSOLUTELY ESSENTIAL		IMPORTANT		MODERATELY IMPORTANT		SLIGHTLY IMPORTANT		NOT IMPORTANT AT ALL		N
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	
Access fingerlings	16	61%	9	35%	1	4%	-	-	-	-	26
Access trainings	12	46%	14	54%	-	-	-	-	-	-	26
Access fish feed	-	-	1	4%	1	4%	24	92%	-	-	26
Access to buyers	-	-	2	8%	1	4%	22	84%	1	4%	26

Source: Field research Shwebo (2019)

4.7.1 Perception of access to fingerlings and training

The distribution of fingerlings and training sessions had the highest scores among the areas of support. Table 28 shows that 61% of the participants perceived that the role of the programme is absolutely essential to access fingerlings. In addition, the program is currently developing activities with the local hatcheries in order to distribute improved GIFT tilapia in the coming culture seasons.

The programme focuses on training provision that improves the human capital endowment among fish farmers. According to The World Bank (2007), the knowledge acquired is a relevant factor for rural development. The role of the programme to ensure access to training sessions was positively weighted. Fifty four percent of the participants rated the role of the programme as important in order to access training sessions, while forty-six percent rate it as absolutely essential.

4.7.2 Perception of access to fish feed

The farmers rated with a low score the role of the programme to ensure access to fish feed. Ninety-two percent of the participants rate the role as slightly important. The result is related to the fact that the feed mill equipment was installed in March, at the end of the culture season, when some farmers had already harvested (BRAC employees, personal communication, June 6, 2019). It is expected that the farmers obtain benefits from the use of the feed mill equipment in the coming culture seasons. It is important to note that MYSAP programme does not directly provide fish feed to the farmers. The support comes from the training on fish feed preparation as well as the mill equipment provided. According to information reported by BRAC, the farmers who want to use the equipment have to bring the raw material and fuel used for processing the feed (BRAC employees, personal communication, June 6, 2019). During the field research, it was detected that farmers did not clearly understand the procedure to benefit from the equipment. During the interviews with farmer leaders and the demonstration farmers, the participants said that feed mill support has not been implemented. One farmer reported: *"The feed mill is still in progress and we have not tested how it works"* (Farmer leader, personal communication, May 21, 2019). Other participant stated: *"We have not produced any fish feed from this equipment. I think it will work only in the dry season as the feed needs to be dried. The project for feed mill is still in progress, then the farmers have not received benefits from it"* (Demonstration farmer, personal communication, May 28, 2019). Another farmer reported: *"It is heard that Mr. (name farmer with mill equipment) produced fish feed*

in the mill. The other farmers can also produce fish feed by that feed mill with our own raw materials. The equipment was provided recently and the fish in our pond was harvested before and so, no farmer produce fish feed from that mill" (Demonstration farmer, personal communication, June 6, 2019). It is important to improve the communication and share the information among all the farmers who participate in this input distribution programme. This way, the benefits can be shared among all the beneficiaries and they can start collective activities to obtain cheaper feed with good quality. For example, the farmers might coordinate activities to buy the raw material as a group and then reduce the production cost.

4.7.3 Perception of access to buyers

Strategies to improve the access to markets for fish farmers are important for smallholders (Trienekens, 2011). Currently the programme does not implement activities that improve access to buyers, but this research wanted to explore the indirect effects of the support for fingerlings, trainings and fish feed access on that component. Fish farmers rated with a low score the role of the programme to ensure the access to buyers. Eighty-four percent of the farmers perceived the role in that area of support as slightly important. Related to this component, one farmer stated: *"To have a better selling process, we would like to receive advice from the organization"* (Personal communication, May 22, 2019). This shows the potential for improving the program in that area, improving farmers' access to markets.

Water supply limitation

Currently, there are no strategies to mitigate the constraints related to the water supply. It is not easy to cope with the water supply limitation since climate conditions mainly regulate the access to this resource. Nevertheless, available water pumps under correct used and maintenance can improve the water access. In addition, the intervention of the local government is required for the public infrastructure to guarantee adequate water supply and to mitigate the negative effect of extreme weather conditions such as drought and flooding. Not only for the fish farmers, but to generate rural development with long term effects for the population in the study area, public investment in *"irrigation, roads, transport, power, telecommunications, markets, rural finance, and research"* (The World Bank, 2007, p. 114) is required.

4.8 Limitations

The current study uses purposive sampling, a nonprobability sampling, therefore, it is not possible to make inferences or generalize the results. Furthermore, in order to obtain the authorization to conduct the field research, the author and the translator were accompanied by one DoF employee during the interviews. The presence of the official could have affected the quality of the data collected, considering that some responses in the survey might be influenced by *"the social environment, the survey design, and the respondent's state of mind"* (Larossi, 2006, p. 147). According to Larossi (2006), some topics might provoke unpleasant emotions or sound distrustful to the respondents, and the presence of the DoF employee could have limited the reported information. In addition, questions about financial information generate unpleasant emotions to the respondents because of distrust regarding to the use of information (Larossi, 2006). These phycological effects on the respondents could have caused the incomplete responses in the question about farm area (discussed in section 4.6.5). In addition, in the study it was only possible to interview one processing company out of the five companies in the region. As described by Larossi (2006), probably the companies were unwilling to participate because of doubts about the use of the information collected. Furthermore, in order to obtain a deeply understand farmers' dynamics related to collective activities, for example in the use of the mill provided by WorldFish programme, additional time on the field would have been needed.

4.9 Challenges

Apart of the two challenges reported by the farmers: Limitations in the access of fish feed and water supply, and the challenge reported in the literature related to the use of not efficient fish breeds, the constraint in the paddy fields conversion to aquaculture might be the main factor that affect the quantity produced in village 1. In addition, the governmental support in the study area regarding public infrastructure and provision of services is limited, making farmers vulnerable to flooding and drought.

Regarding the areas of support provided by MYSAP programme, it is important to ensure that all farmers equally benefit from the programme, particularly from the use of the mill. Further, activities to reduce the dependence of the farmers to the inputs distributed and to generate a sustainable production should be implemented, in order to not produce future negative effects at the end of the project.

Another challenge detected during the study was the lack of consensus on the definition of fish size among farmers. Although the definition about fish at market, medium or small size were similar, they were not exactly the same.

CHAPTER 5: CONCLUSIONS

5.1 Conclusions

This study provided a general view of the current market dynamics faced by fish farmers in Shwebo township, as a contribution to the knowledge on aquaculture in Myanmar, in regions where it has not been widely documented. The present study found that the farmers in the study area have polyculture aquaculture systems on earthen ponds, are mostly landowners, they use farm-made fish feed and are beneficiaries of INLAND MYSAP programme. In addition, this study identified differences among fish farmers regarding quantity of fish produced and years of experience. From the total twenty-six survey participants, three farmers did not sell fish during the culture season 2018-2019 and one reported to lose the complete production because of flooding, and a total of four farmers who did not trade fish in the season. There were differences between village 1 and village 2. On average, fish farmers in village 2 had more than double years of experience (14 years), compared to fish farmers in village 1 that had six years of experience. Furthermore, village 1 was a rice production area; therefore, farmers experienced limitation in the conversion of paddy rice fields into aquaculture practices. Village one's contribution to the total fish production in the study area was 8.3%, compared to the 91.7% of the contribution from farms in village 2 during the past culture season.

Testing the first hypothesis, this study found that the proportion of fish used for family consumption is lower than the 10% of the total fish harvested. In fact, differences in the production capacity between the two villages had an effect on this proportions. The households in village 1 used 6.5% of the fish harvested for family consumption, and 5.4% for gifts and ceremonial use. On the other hand, the households in village 2 used 1.3% for family consumption, and 1.8% for gifts and ceremonial use. It is important to consider the quantity used for self-consumption, to confirm that aquaculture has an impact on the local households' food provision, corresponding to improvement of food security and nutrition component aimed by MYSAP programme.

The study identified local processing companies as the main buyer in the study area, considering that 94.32% of the total quantity of fish traded was bought by the processing companies. Selling to processors is convenient, specially to trade big quantities of fish, since they take the harvest directly from the farm, reducing transportation costs.

Although processing companies are the main buyers in both villages, growout farmers and final consumers are important buyers in village 1. This study found that to sell fish to these two buyers offers an alternative to trade small quantities of fish, as the capacity of these buyers is more constrained compared to the processors' capacity. Farmers who sold fish to final consumers received on average 128 MMK per viss more, compared to farmers who sold fish to processing companies. On average, processing companies paid 1618 MMK per viss, while final consumers paid 1746 MMK per viss.

This study found that the final product supplied by the processing companies have a reduced added value. The processors produce fish on ice and minced fish balls that are later packed and traded. Regarding to the fish characteristics demanded by the processing companies, they look for whole fresh fish at market size, the biggest available size, and without preference for any fish species. In addition, the processing companies would like to receive a constant supply during the year. On the other hand, considering the share of fish traded in the study area, medium sized fish was the main product supplied. From the total fish sold during the past culture season, 70.91% was medium sized fish.

Fish at market size corresponded to 20% of the total fish sold during the culture season of 2018-2019. The relevance of fish at market size is recognized by the fish farmers. Considering future expectations from the fish farmers about the product they aim to sell in the coming two years, 14 out of the 26 participants reported the aspiration to sell fish at market size. In addition, 9 out of 26 farmers reported the production of fish at market size as one of the future plans for fish production. The previous results show that, as initially hypothesized, there is a main buyer, who in the study region is represented by the processing companies, demands fish at market size. In addition, the current study found that the size of 80% of the fish supplied do not correspond with the attributes demanded.

In addition, the reports from the farmers that sold fish during the past culture season show that all households had at least one family member working in activities different to aquaculture.

After observing a gap between supply and demand, the study identified the production challenges perceived by the famers, which limit the production of fish at market size. The main constraints were the access to fish feed and access to water supply. The limitation on fish feed is related to the high feed price as well as a potential low quality. This limitation has two components: first, fish farmers are implementing suboptimal feeding

strategies based on fluctuations of the feeding frequency which depends on feed availability. In addition, the quantity of feed provided to the fish changes according to the available feed. Second, farm-made feed does not have a standard quality, because the feed's quality depends on the by-products used to prepare the feed. Regarding the water resources, this study found that water supply in the study area depends on climatic conditions and the occurrence of drought and flooding. In addition, there are no strategies nor sound infrastructure to mitigate the negative effects from drought and flooding experienced by the farmers. It should be noted that during temporary extreme weather conditions, the fish farmers are forced to sell their fish, even without finishing the production cycle, impeding the growth of the fish to optimal size. Considering the main challenges faced by the farmers which limit the production of fish at market size, the factors that improve production are: A regular access to good quality fish feed and a regular access to water supply in the quantities required.

Considering the hypothesis to test the perception of the role of MYSAP programme to ensure the access to fingerlings, trainings, fish feed and buyers, the farmers gave the highest scores to the access to fingerlings and training. Out of the total participants, 61% considered the access to fingerlings as absolutely essential. The access to training was rated by 46% of the farmers as absolutely essential, while 54% rate it as important. The role of the programme to ensure the access to fish feed received a low score from the farmers. Out of the total participants, 92% mentioned it as slightly important. The results from this item are related to the fact that during the past season the fish farmers did not use the feed mill to process their feed. There are two main reasons: first, the mill was installed at the end of the culture season, when some farmers had already harvested. Second, the procedure explaining how to benefit from the feed mill was unclear to the farmers. In addition, the role of the programme to ensure the access to buyers received a low score as well. This was expected as the programme does not implement activities that improve access to buyers, but this research wanted to explore the indirect effects of the support for fingerlings, trainings and fish feed access of that component. The study found that 84% of the farmers rate it as slightly important.

In light of the findings of this study, there is a clear shift in the development of aquaculture in the Shwebo township, working not only on the development of the production system, but focusing also on the market conditions. This study contributes information which may help as guidance on strategies to overcome current challenges and guide fish production

according to market demand, in order to support fish farmers and ensure income generation from aquaculture.

5.2 Recommendations

As a result of the findings of the study, limitations, challenges and opportunities, the following recommendations were perceived as a guideline that could ameliorate the overall wellbeing of the aquaculture farmers.

1. Firstly, improving the access to fish feed and water supply is key to overcome some of the current limitations. Encouraging collective actions among fish farmers might represent multiple benefits for them. First, if fish farmers coordinate activities in order to implement bulk purchasing , they might benefit from cost reduction. Second, the farmers would have some production equipment as dragnets and water pumps and collectively use them and further share maintenance of the tools. Third, fish farmers might coordinate their harvest times to increase the frequency of supply to the market. Finally, strong cooperation among the farmers will improve the flow of information about market prices and benefits. It is important to encourage collective action among farmers, in order to develop strategies to ensure sustainable aquaculture, even at the end of MYSAP programme.

2. Implement communication strategies ensuring that all farmers have a timely and complete access to the information, in particular for information about the procedures to obtain benefits from the programme. This point is key to ensure that all farmers receive benefits from the feed mill support, responding to the constraints related to the access to fish feed.

3. Identify the factors which generated mortality during the past culture season and implement activities to reduce the mortality rate during the coming seasons.

4. Coordinate activities with the local government in order to make strategies and develop the required public infrastructure to mitigate the negative effects from drought and flooding.

5.3 Future research

A following research could explore alternative markets, where fish farmers would receive better sale prices. One option could be the supply of products with more value added such as salted fish. Another option might be establishing a hatchery to sale fingerlings, which might generate income if there are enough customers available.

It is appropriate to assess the importance and success rate of distributing fish fingerlings as a development tool. Consequently, it is essential to assess the potential adoption of new species among fish farmers, as well as evaluate the adaptability of improved fingerlings to the local conditions.

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