YANGON UNIVERSITY OF ECONOMICS
DEPARTMENT OF APPLIED ECONOMICS
MASTER OF PUBLIC ADMINISTRATION PROGRAMME

A STUDY ON RURAL AQUACULTURE FARMS IN BAGO REGION IN MYANMAR

(Case Study: Selected Villages in Thanatpin Township)

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EMPA – 53 (17th BATCH)

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(Case Study: Selected Villages in Thanatpin Township)

A thesis submitted as a partial fulfillment towards the requirement for the degree of Master of Public Administration (MPA)

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ABSTRACT

The study is rural aquaculture farms situation at Thanatpin Township, Bago Region. The objectives are to identify the current status of rural aquaculture farms and to observe the income generating activities and problem of rural aquaculture farms in Thanatpin Township, Bago Region. The survey was conducted with 120 respondents randomly selected from five villages and using structured questionnaire. Most of the rural aquaculture farms were small ponds. The majority of respondents have common crap and rohu spices in the rural aquaculture farms. It was found that the most of respondents have got less than 100 viss fish production per month. The general constraints of rural aquaculture production improvement were identified as fish seeds supply and quality of fish seeds, fish feeds, various fish diseases, fish marketing system and fish training program. Most of the respondents said that the improvement of fish market system in such a way to direct local and export market. During COVID-19 period, the income has been significantly decreased reported by 80% of respondents in the study area. As the impact COVID-19, it happen fewer fishing activities and travelling within Thanatpin Township, Bago Region. As the rural aquaculture farms are mainly relying on the department of fisheries hatcheries for required fish seeds and to promote the department of fisheries hatcheries is unambiguous for development of rural aquaculture farms and its contribution to the family income.

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LIST OF ABBREVIATIONS

ADB	Asia Development Bank
AEC	Aquatic Education Centre
DoF	Department of Fisheries
FAO	Food and Agriculture Organization
GAD	General Administration Department
GDP	Gross Domestic Product
MSDP	Myanmar Sustainable Development Plan
NADP	National Aquaculture Development Plan
NES	National Export Strategy
SAP	Sustainable Aquaculture Programme
WFC	World Fish Center

CHAEPTER I

INTRODUCTION

1.1 Rationale of the Study

The word ‘aquaculture’, it has been widely used for the past two decades to refer to all forms of aquatic life and plant culture found in sandy and marine environments,

many people still use it in a more restrictive sense. Aquaculture has grown rapidly in recent decades and today produces almost as much fish and shellfish as fisheries (FAO, 2014).

The tradition of aquaculture farming dates back to about 3,000 years ago. In China, perhaps because of the emperor's wishes, there was a constant supply of fish. The technique of keeping fish in fishponds, with fishermen temporarily living in baskets submerged in water reservoirs dammed on one side of the river bank, is believed to have originated in China. Another possibility is that it developed from ancient practices for fishing, which evolved from capture to trapping, and finally evolved into fully fledged farming practices (Ling, 1977).

Aquaculture is a key way to get more food from the aquatic environment in the future. Impact of aquaculture on biodiversity: land, water, consumption of resources such as seeds and food; transformed into products valued by society. It results from the release of greenhouse gases and waste products from food waste into the environment. urine products. In addition to chemotherapy, microorganisms; Parasites and wildlife. (Troell, 2009).

Today, large quantities of fish are caught and feed for fish and shrimp species are important sources of protein and fatty acids (FAO, 2014). While non-food uses are gradually shrinking, high demand from the aquaculture industry can lead to unsustainable fishing practices for fish stocks and marine food webs (Cao, Naylor and Henriksson, 2015).

In Myanmar, aquaculture arming has grown rapidly over the past two decades and has played an increasingly important role in the national fish supply (Belton, Hein, Htoo, Seng Khan, Nischan, Reardon & Boughton, 2015). For aquaculture, Fresh water in the cultural environment; including freshwater and marine. The total area of freshwater aquaculture is about 198,840 hectares, most of which are in the southern regions of Myanmar, especially Yangon, Bago and Irrawaddy Region. Rohu is the dominant cultivated species and 75 percent of the production is for export (DoF, 2018).

In particular, commercial aquaculture is concentrated within 50 km of Yangon to benefit from trade and transport infrastructure. It is estimated that rohu carp make up 70% of all farmed fish in Myanmar and are highly dependent on rohu (Belton, Filipski, and Hu, 2017).

Fishing and aquaculture contribute significantly to Myanmar's economy. The fishing sector accounts for two percent of Myanmar's gross domestic product (GDP). The fifty percent of animal protein consumption. In some coastal areas, employment is as high as six percent and accounts for fifty six percent of state/regional government revenue (World Bank, 2019).

The government is committed to monitoring and improving opportunities for aquaculture and fisheries production enhancement. The fisheries sector plays an important role in Myanmar's cultural and socio-economic life (ADB, 2013). It is income generation after agriculture considered the second major contributor to job creation and livelihoods (Schmidt & Soe, 2014).

Fish farming provides twice as many jobs per acre as paddy farming (Belton, Hein, Htoo, Seng Khan, Nischan, Reardon & Boughton, 2015). Fisheries and aquaculture provide over 800,000 full-time jobs and 2.4 million part-time jobs. (DoF 2015). This study aims to examine the problem of rural aquaculture farms and income generation activities in Thanatpin Township, Bago Region.

1.2 Objective of the Study

The objectives of the study are

(a) to identify the current status of rural aquaculture farms in Thanatpin Township, Bago Region.

(b) to observe the income generating activities and problem of rural aquaculture farms in Thanatpin Township, Bago Region.

1.3 Method of Study

In order to meet the objective of the study, descriptive method was used with primary data and secondary data. Primary data was collected by a survey conducted using with structured questions, using a simple random sample method to select the 120

respondents in survey area. Secondary data was collected relevant publication from Department of Fisheries (DoF), Asia Development Bank (ADB), Food and Agriculture Organization (FAO), World Fish Center (WFC), libraries and internet.

1.4 Scope and Limitation of the Study

The study area was mainly based on the aquaculture farms area of Thanatpin Township in Bago Region, Myanmar. The survey was conducted with 120 respondents selected from five villages and used structured questionnaire by means of self-administered. The survey period is between April and May, 2021.

1.5 Organization of the Study

This thesis consists of five chapters. Chapter one is introduction with rationale of the study, objectives of the study, method of the study, scope and limitation of the study and organization of the study. Chapter two presents literature review on concept of aquaculture, type of aquaculture, aquaculture development and practices. Chapter three presents an overview of inland fisheries and aquaculture sector in Myanmar and chapter four is survey analysis on the situation of aquaculture farms in Thanatpin Township, Bagon Region. Chapter five is conclusion with findings and recommendations.

CHAEPTER II

LITERATURE REVIEW

2.1 Aquaculture Concept

Aquaculture is the manipulation of the aquatic environment, either natural or artificial, to increase the production of aquatic organisms such as molluscs and algae.

It is a movement with a long history, dating back 3000 years to the practice of Fan-Li in China in 475 BC (Milne, 1972).

The ancient Chinese carp culture is often cited as the earliest recorded form of aquaculture, but the recent discovery and excavation of earthen ponds along the shores of an old lake in Poland suggests it may have existed as far back as 7,000 years ago (Bogucki, 1983). The first forms of aquaculture were mainly concerned with the management of large enclosed natural bodies of water, such as ponds connected to the open sea.

Aquaculture has become the fastest growing agricultural production system in the world over the past 40 years (FAO, 2012). Aquaculture has grown rapidly in recent decades and today produces as much fish and shellfish as fisheries (FAO, 2014). Aquaculture is a major way to get more food from the aquatic environment in the future.

Impact of aquaculture on biodiversity whereas land, water, consumption of resources such as seeds and food transformed into products valued by society. It results from the release of greenhouse gases and waste products from food waste into the environment. In addition to urine products chemotherapy, microorganisms, parasites and wildlife.

Negative impacts include the release of eutrophicating substances, toxic chemicals, transfer of pathogens and parasites to wildlife populations and the introduction of genetic material into the environment, or indirectly through loss of habitat and range and changes in food networks.

Today, large quantities of fish are caught to produce fish meal and fish oil, important ingredients for protein and fatty acids in feed for many species of fish and shrimp. Although the amount of non-food use is gradually shrinking, demand from the aquaculture industry may still be high, with potential negative consequences for fish stocks and marine food webs (Cao, Naylor, and Henriksson 2015).

Global fish feed and fish oil use in the aquaculture industry tripled between 1992 and 2006, despite advances in livestock farming, declining feed conversion ratios and the development of viable alternatives to fish resources (Hasan and Halwart, 2009).

Although the life cycles of most aquaculture species have been successfully closed, some, particularly marine. The culture of farmed fish and shrimp includes larvae, larvae or still partially dependent on the capture of hatchlings from the wild.

This represents a loss in fishing and biodiversity, and can lead to both overfishing and overfishing.

Historically, large areas of critical habitats such as wetlands and mangroves have been lost due to aquaculture development and pollution, which has reduced biodiversity and reduced fishing stocks. Today, the value of coastal wetlands is better recognized, and regulations make it difficult for large-scale aquaculture development in sensitive coastal areas (eg mangroves, seagrass beds) in most countries.

Biodiversity loss from aquaculture development is generally scaled increases with resource use intensity and net production of waste. In some cases, aquaculture is done when ponds are built in dry areas. Local biodiversity can be increased when ponds are constructed with a combination of restocking and aquaculture. Its role in maintaining cultural diversity must also be recognized.

2.2 Aquaculture Development and Practices

Farming of aquatic plants and animals has been around for thousands of years. Nevertheless, it must be regarded as a major phenomenon after World War II. Global production of farmed fish and shellfish in 1950 was estimated at 2 million metric tons, largely confined to Asian regions. Aquaculture production has grown by about 7 to 11 percent per year over the past three decades.

Aquaculture production for 2012 was 44 million metric tons of eels. 6 million tons of desert; 15 million tons of shellfish and about 23.8 million tons of aquatic plants (FAO, 2014). Aquaculture production now accounts for about half of all fish consumed directly by humans, but most of that production comes from freshwater fish (mainly carp) and oysters (22 percent, oysters).

However, despite the great diversity, fish and shellfish farming in aquaculture systems is now dominated by 35 species that together account for 90 percent of total global production. A single species (carp, silver carp, Indian carp, oyster) accounts for 30% of global aquaculture production by volume (FAO, 2014).

Aquaculture involves the enclosure of species in a safe system under conditions where the species can survive. Life cycle interventions range from exclusion of predators and control of competitors (extensive aquaculture) to increasing food supply (semi-forced) or providing all nutritional requirements (intensive).

Production intensification refers to an increase in the number of people per unit area, reducing the need for land/sea area and instead using and managing more inputs. Waste management and technology and greater reliance on fossil energy are required. Aquaculture is a business that transforms natural aquatic resources into goods valued by society, and it is basically resource consumption, Biodiversity can be affected by transformation processes (aquaculture) and waste production. 2009).

Technical and economic inputs such as construction materials and energy are only a small part of the inputs required in traditional aquaculture systems. The main and important inputs are instead natural resources and to some extent labor. Together with ecosystem services, they are decisive for local and global aquaculture expansion.

However, the amount and type of resource use and impact of aquaculture on species rearing; farming system Much depends on the intensity of cultivation and management. Production practices and their impacts on aquatic ecosystems vary by species. Shellfish and clams, are generally farmed along the coast using wild-caught or hatchery seed grown on the seabed or on strings and ropes.

The animals depend entirely on a supply consisting of plankton and organic particles for food. Although no food is added high densities of filter organisms can cause irreversible local organic accumulation, which can have negative effects on benthic diversity and, if cultured in large numbers, can have an impact on pelagic plankton communities.

Most carp and other freshwater species farmed in tropical and subtropical areas are herbivores/omnivores and grown in ponds fertilized with supplemental feeds. In contrast, most soft-water marine fish, including tropical and temperate species, are intensively farmed in floating cages and rely to a large extent on nutritious fishmeal and fish oil-based diets.

Many so-called trash fish are used directly as food for some of the main farmed marine fish species in Southeast Asia, including freshwater species such as Pangasius catfish from Vietnam (Huntington and Hasan, 2009). Penaeid shrimps dominate crustacean farming cultivated in semi-intensive or intensive coastal lake systems.

Shrimps are formulated nut foods and seawater is pumped to replenish dissolved oxygen, soften air and pollution, and remove harmful biological processes. Shrimp fry are either derived from wild-caught hatchery/branching or collected directly from the

sea. This is also true for the freshwater shrimp macro brachium (Ahmed, Troell, Allison and Muir, 2010).

The aquaculture process can harm biodiversity due to increased road and boat traffic. A high density of farmed fish and food means wild fish, It often attracts predators and scavengers such as gulls and seals. They may come into conflict with farmers and displace sensitive local species, either accidentally (entangled in nets) or deliberately (shooting and trapping), or if they become established (Boyd, McNevin, Clay and Johnson, 2005).

2.3 Feed Resources

Inexpensive, nutrient-rich materials to stimulate the growth of algae and other food. Livestock feed based on locally available agricultural products. A small amount of homemade bone meal and fish meal is used as a supplement food in vast ponds. However, in the intensive production systems that favor tropical aquaculture growing in the tropics, farm animals rely on nutritious commercial feeds containing fish meal and fish oil.

Although marine fish species and shrimp have high demand for fish resources for food, carp, Freshwater fish species such as tilapia and catfish are also cultured using formulated diets containing varying percentages of fish oil and fish oil. In 2010, two-thirds of the world's farmed vultures and vultures depended on commercial shelled diets (Tacon and Metian, 2013).

Salmonids, sea bass, diets for seafood and other carnivores include a lot of fish meal and fish oil. Although it is possible to replace most of the baits used in intensive fish diets based on plant-based protein (Hasan and Halwart, 2009), requirements for essential amino acids, particularly cystine and methionine, remain largely unmet.

The product is competing with others for customers' attention, and it remains to be seen whether commercial plant protein-based foods can be developed in an industry that squeezes out more profits. The palatability of oilseeds depends on the source and content. Growth and profitability can be affected. A decrease in palatability or digestibility can worsen waste products into the environment. The problem of fish oils is even more important than fishmeal (Naylor, Hardy and Bureau, 2009).

Aquatic carnivores are poor in using starch to meet their energy needs, relying on protein and lipids. Substitution of vegetable oils in freshwater carnivorous or carnivorous fish diets is simpler in marine and unsaturated carnivorous fish species such as Atlantic salmon. Improvements have been made with respect to other sources such as rapeseed and linseed, which can be supplemented with various supplements while still achieving acceptable growth and quality (Naylor, Hardy and Bureau, 2009).

Low value fish, that is aquaculture, the so-called trash fish from lakes and seas, is used directly as food, especially in Asian countries, which has implications for both biodiversity and food security (Huntington and Hasan, 2009). Some intensive and semi-intensive aquaculture systems use more fish protein; Finally, to feed the farmed species rather than after harvest.

Fish meal and fish oil alternatives include soybean oil, livestock related products, vegetable oil includes single cells and other locally available resources. Other common feeds for many species of freshwater fish include rice and wheat bran, contains corn gluten and cassava meal (Naylor, Hardy and Bureau, 2009).

Increasing amounts of waste produced from aquaculture and fisheries are being converted into fish feed. As aquaculture production continues to grow, as aquaculture production continues to grow, it is likely that an increasing proportion of fish resources will be used for fish hatchery feed, although the potential for replacement of fish in aquaculture feed has improved.) and in major producing countries such as China, pond fish production methods are accelerating (Rana, Siriwardena and Hasan, 2009).

2.4 Land and Water

Although land is required for the construction of fish ponds or shrimp ponds or establishment of reservoir-based activities, fish cages, pens, Mussels and seaweed farms are located in lakes, Rivers and sea areas are occupied. Fish ponds are usually located on agricultural land and this is considered to positively contribute to the diversity of flowers and diversity of agricultural landscapes.

However, the unproductive of agricultural land, wetlands are often used because such border ecosystems, or ecotones, can serve as reserves for other species surrounded by a crop. This can actually reduce biodiversity. Scarcity of land and increased

competition with other users, for example agriculture and urban development, are putting pressure on aquaculture.

This has enhanced the intensity of high stocking density farming systems and external inputs, e.g. food It has led to greater dependence on energy and chemicals. On the positive side, less land is required per metric ton of fish production, and the resulting bulk waste is more suitable for treatment.

However, if left untreated, environmental damage can be severe. Large areas of tropical coastal wetlands and mangroves have historically been converted to fish and shrimp ponds, with consequences for local communities and local economies, leading to impoverished biodiversity and overfishing (Walters, Roonback and Kovace, 2008).

Aquaculture provides physical support to farm animals. Large amounts of water are needed to re-oxygenate and remove waste products. The impact of aquaculture has a direct impact on the quantity and quality of water resources and associated aquatic biodiversity. A large amount of water passes through cages and fountains (sea or lake) but does not remove the net from the system. It is important to distinguish between water consumption and water withdrawal; Formerly streams, Water diverted from rivers or waterways is lost through evaporation or seepage, and the water is later returned to the environment for reuse or recovery (Verdegem and Bosma, 2009).

The use of consumptive water in aquaculture has major impacts on downstream freshwater flows and depletion of groundwater resources (Boyd, McNevin, Clay and Johnson, 2005). In terrestrial-based systems, aquaculture not only borrows water, but also returns it in a more degraded form, consuming it or accelerating its loss to groundwater or the atmosphere (Boyd, McNevin, Clay and Johnson, 2005).

The intensification of the aquaculture sector has led to increased dependence on external energy inputs throughout the production chain. Feed is the main source of energy required for most fed aquaculture systems, pumping water. Although water purification and aeration can contribute significantly to closed systems.

Transport, in turn, is often documented as a surprisingly small energy input (Pelletier, Tyedmers and Sonesson, 2009), while holding aquaculture products in warehouses can be a site of energy consumption for organisms such as mussels and barnacles (Iribarren, Mcreia and Gumersindo, 2010).

Cumulative energy demand provides a good indicator of both carbon footprint and ecological footprint, but the true environmental consequences related to energy production depend on the energy carrier and country of production (Huijbregts, Hellweg, and Frischknecht, 2010).

2.5 Integrated Aquaculture

Integrated aquaculture can provide practical and creative solutions to some of the problems of waste management and pollution in a single package, increasing productivity and profitability through efficient use of water and nutrients (Neori, Chopin and Troell., 2004). Therefore, environmental impacts resulting from aquaculture and resource limitations (water, feed, energy, etc.) may find their solutions through integrated farming systems.

Traditional inland aquaculture, which involves diversified systems using on-farm or locally available resources, is still common in Asia, but these are being replaced by industrial-based aquaculture techniques (Edwards, 2009). Traditional integrated systems use inputs efficiently, minimize waste, and add to local and regional net food supplies at little environmental and social cost.

Traditional lake cultures of traditional fish species have survived for centuries, and their existence is a testament to sustainable integrated farming systems. Here, poultry and livestock farming are combined with fish farming, and the main links between the systems are animal manure and other agricultural wastes. Pond water is used to fertilize the natural food for juvenile to adult fish (Troell, 2009).

However, despite its environmental advantages, increasing global food demand cannot be met by traditional extensive production systems (due to space demands and low productivity). Although technological development and better management have increased the efficiency and environmental performance of some specific species aquaculture systems. This information can then be incorporated into current research on integrated aquaculture systems. Integrated aquaculture is not a panacea for aquaculture development, but should be seen as another potential means of supporting sustainable development.

Multiculturalism in tropical integrated systems; evolutionary synthesis; temporary integration; and includes mangroves and different associations (Troell, 2009). Mangroves and aquaculture are not necessarily compatible and guidelines have been developed for the responsible use of mangrove areas for aquaculture (Bagarinao and Primavera, 2005). However, the environment biodiversity, careful assessment of any development in or near aquaculture facilities is required to identify impacts and implications for ecosystem services and various stakeholders.

2.6 Benefits of Aquaculture

(1) Productive Use of Poor Agricultural Lands

Ponds built on the best agricultural land have the highest natural production. Fish hatchery production can also be high in ponds built on land unsuitable for other forms of agriculture. Hillsides that are difficult to cultivate or easily erode can be used for fish ponds. It can be used in swampy areas with high salt or clay content or for aquaculture (Rajee & Mun, 2017).

(2) Natural Resource Conservation

Aquaculture and water harvesting can greatly contribute to the conservation of natural resources, especially water and soil. Many developing countries often allow surface water to be discharged instead of being harvested and stored for beneficial use. The aquacultures need for abundant water provides the justification and opportunity to build ponds for harvesting and storage. It is supplemental irrigation water and it also provides water for storage and domestic needs.

Reservoirs can reduce flood risks downstream by checking the force of sudden flows in watersheds. Ponds support plants and wildlife as they retain soil moisture in their vicinity. There are traps in topsoil that allow water to be recovered and redistributed to gardens and fields on unimproved and unprotected watersheds. Water and soil conservation problems are most common in mountainous areas where poor

people live. The topography in these areas lends itself to watershed development (Cao, Naylor and Henriksson, 2015).

(3) High Economic Value of Aquacultural Products

Aquaculture can produce a cash crop in a subsistence economy. Farmers often have a net profit for fish compared to other traditional crops. Even small fish ponds can be used to generate farm income or sell fish; Barter or consumption can reduce family spending. Production costs for fish, poultry, beef and pork have been compared in numerous studies. The initial construction costs for fish farming are high, but once the ponds are built, producing fish is usually the most profitable (Edward, 2000).

Using low-cost fertilizers such as plant clippings and animal waste, a one-hectare pond produces about 2,500 animals per year, about five kilograms. Production from grazing cattle on the same land area is rarely more than half that amount. The use of waste products from integrated farming and crop operations can reduce input costs in fish farming (Naylor, Hardy and Bureau, 2009).

Fish is efficiently converting food into meat. Dietary protein is converted into muscle protein as efficiently as chicken or pork, but they require a lot of starch for energy. Because fish are essentially weightless in water, they expend little energy to move or maintain a normal upright position. They are cold blooded animals and do not expend energy to maintain a relatively high body temperature as do poultry, swine and cattle. Therefore, the amount of food energy required to produce one kilogram of fish is much less than the amount required to produce an equivalent weight of terrestrial animals.

(4) Integrated Aquaculture is highly Sustainable form Agriculture

Aquaculture is sustainable due to the use of locally available resources. Integrating aquaculture with other forms of agriculture can diversify farm productivity (Neori, Chopin and Troell, 2004). This in turn means that it is land, rather than independent enterprises. water, labor A more efficient allocation of equipment and other limited capital provides opportunities for intensive production. Reservoir water can contribute to rural development as different activities can be carried out

simultaneously. gardening irrigation. Integrated fish culture with livestock irrigation and various domestic facilities is possible.

The practice of free-feeding several different species of fish together in the same pond (polyculture) is more complex, but makes more use of available natural food. Therefore, the yield is higher by better cultivation than is possible by raising a single species of fish. Polyculture also allows multiple varieties to be grown at different market prices. Therefore, one pool can serve many tastes and needs of consumers.

(5) Important of Aquaculture on Rural Household

Aquaculture is an important contributor to rural poverty reduction. Poverty is a complex phenomenon, and for food security and vulnerability reduction, rural people must not rely solely on the agricultural sector for their livelihoods, but on alternative livelihood options (Rajee & Mun, 2017). Aquaculture is the livelihood of the poor. It provides food by increasing employment and income. Due to its small operation size and lack of high-tech machinery, rural aquaculture is labor intensive.

Rural aquaculture creates a private enterprise where the entire family is devoted to the business (Edwards, 2000); Occasionally during the harvest season, additional manual labor is needed from manual laborers. Fish farming creates employment opportunities for women to generate side income for their households. As poverty tends to be worst among rural people, aquaculture is an opportunity to diversify income and protect against market fluctuations in farm produce prices.

In rural aquaculture, most households tend to consume small fish that do not match the market size, leaving behind more expensive fish. These small fish are eaten with their heads and bones, and micronutrients not found in lager fish (Ahmed & Garnett, 2011). Sometimes, some rural people practice this by giving fish as a form of payment to the laborers working on the farm (Irz, Stevenson, Tanoy, Villarante and Morissens, 2007).

Indirectly, the practice of collecting free fish from fish ponds contributes to the main source of nutrition for poor families in rural areas and helps reduce child malnutrition (Rajee & Mun, 2017). Aquaculture in rural areas is accused of inequity and inequality in access to good quality nutrition.

2.7 Review on Previous Studies

Saw Moe Oo (2013) studied the status of aquaculture farms for the fish farms in Twante and Maubin Township. The objective is to explore the farming system and aquaculture management in order to suggest future aquaculture development prospects. The findings emphasize that aquaculture technology and extension training and capacity building programs should be provided prior to future aquaculture development. The recommendation includes the provision of services such as the financial supporting and facilitate access to inputs such as fish seed, feed, and fuel for aquaculture sector development.

Wine Wai Wai Win (2014) conducted on the large scale and small-scale fish farming in aquaculture sector. The study suggested that there was an urgent need think carefully about the foundation on which to expand the aquaculture sector sustainable development. For the rapid growth of the aquaculture industry in Myanmar Both public and private organizations need to adopt more environmentally friendly technologies that do not have a negative impact on the community.

Soe Sandar Win (2018) studied on small-scale aquaculture project in Maw La Myaing Gyun Township. The study objective is to examine the effects of the small-scale aquaculture system of farmers in Maw La Myaing Gyun Township. The study found that freshwater fish culture is the main source of small-scale aquaculture production, as the rohu (Labeo rohita or Nge Myint Chin) is the rohu (Labeo rohita or Nge Myint Chin). Most of the farmers use fish paste. A jar of paste mixed with groundnut cake or rice bran and they put it in a basket or net bag. Development status of small-scale aquaculture production, production costs in general; fish seed supply and fish seed quality; experience technology; diseases water quality; market access; environmental conditions and other problems were identified.

CHAEPTER III

MYANMAR AQUACULTURE SECTOR

3.1 Aquaculture Farming

Aquaculture farming is important for food and nutrition security in Myanmar. Myanmar relies on the aquaculture sub-sector as an important contributor to national

and regional social and economic development through rural economy and foreign earnings contributions.

The aquaculture sector was established in 1954. Aquaculture sector within Agriculture and Rural Development Corporation. Continuing to expand the aquaculture sector, Myanmar's first aquaculture plan was implemented, focusing on the development of shrimp and fin fish farming. Myanmar was among the top 10 aquaculture producing countries in the world. At the regional level, annual freshwater aquaculture production reaches more than 900,000 metric tons, making Myanmar the third largest freshwater aquaculture sector in Southeast Asia, behind Indonesia and Vietnam, and has been larger than Thailand since 2007 (FIGIS, 2016).

The two aquaculture systems in Myanmar are freshwater pond culture and reservoir culture. Fish farming, especially freshwater finfish farming, is mainly carried out through pond-based culture systems. In addition to pond-based aquaculture, soft crab and seaweed farming were also carried out in coastal areas. Myanmar has 27 government hatcheries managed by the Department of Fisheries and over 70 private hatcheries. (DoF, 2019).

A state-level committee has been formed by the Myanmar government for the freshwater fish production project for aquaculture. It is continuously oriented towards food security (increasing freshwater aquaculture and fisheries) and export earnings (primarily shrimp aquaculture but also some freshwater culture and pond aquaculture).

Aquaculture can meet the growing demand for fish and improve income and food security in Myanmar. Currently, farmed fish accounts for a small proportion of consumption in Myanmar (22%), compared to Thailand (80%) and Bangladesh (55%). This ratio has increased with the development of the commercial aquaculture sector, characterized by large-scale industry. However, the expansion and commercialization of small-scale aquaculture has been limited by poor infrastructure and restrictive land use policies.

Myanmar's rapidly developing aquaculture sector has great potential to improve the lives of rural households, which make up 70 percent of the population and depend on low-yield agriculture for their livelihoods (FAO 2015).

3.1.1 Small-scale Aquaculture

The rural aquaculture is widely used, the term small-scale aquaculture is gaining popularity. Small-scale aquaculture covers a spectrum:

(1) Systems involving limited investment in assets, some small investment in operational costs, including largely family labor and in which aquaculture is just one of several enterprises; and

(2) Systems in which aquaculture is the principal source of livelihood, in which the operator has invested substantial livelihood assets in terms of time, labour, infrastructure and capital.

Common elements characterizing this small-scale aquaculture is ownership or access to, an aquatic resource; ownership by family or community; and relatively small size of landholding.

Development of Myanmar's small-scale aquaculture farming would be particularly effective for improving the livelihoods of vulnerable groups, including women and poor households in rural areas. Small-scale aquaculture requires relatively limited land and water resources, and it can be integrated as part of mixed resource management strategies. In addition, low investment technologies are accessible to poor women and men, and fish production provides dual income-nutrition benefits.

Small-scale aquaculture farming usually stands as main family livelihood operated by family members. Generally, the fish ponds areas are not more than ten acres in total comprising a good number of one acre or two acres fish ponds and sometimes integrating with other business such as poultry farming or plantation. In small-scale aquaculture semi-intensive culture system is widely used and the ponds are fitted with inlet and outlet water pipes for drainage or in areas with easy access to enough, good and clean water source. Almost all of the farms and ponds are in capability of water exchange by gravity or engine whenever needed.

3.1.2 Coastal Aquaculture

In Myanmar, coastal aquaculture is mainly limited to shrimp farming, with mud crabs and small groupers being raised. The sector contributes significant export earnings and shows potential for future development and diversification. The extensive brackish waters, tidal lagoons and pristine marine environments are located along nearly 3,000 km of coastline, providing significant scope for coastal aquaculture

development. Most of Myanmar's coastal aquaculture practices are based on traditional methods, but shrimp farming in particular is booming.

Due to the lack of urbanization and industrialization in coastal areas, water pollution caused by chemical and industrial wastes has limited opportunities to produce high-quality products. However, the destruction of the resource base and habitats such as coastal mangroves and coral reefs is a concern. So far, investment in coastal aquaculture has focused on export commodities. It seems to be mainly wealthy individuals/companies directly involved in shrimp and crab and to a lesser extent crab.

Investment by large companies and individuals has proven important in the development of technology and infrastructure for aquaculture. For example, private investment in shrimp farming and employment of hundreds of people (soft crab farming) involving hundreds of people (soft crab farming) and inputs (suppliing mud crabs, waste, fish, fish and fry from cages in cages, every Tanintharyi).

3.2 Aquaculture Legislation

Aquaculture activities are mainly under the Law Relating to Aquaculture (1989). The Marine Fisheries Law (1990) and the Freshwater Fisheries Law (1991) also contain some relevant clauses. The aquaculture legislation relating to fish farming focuses on regulating leases and licenses. The content of the law can be summarized as follows:

(a) Aquaculture depends on the issuance of land leases by state or regional fisheries officials.

(b) Production and sale of artificial fish seeds or issuing license for aquarium fish breeding shall be carried out.

(c) License holders are required to pay a subsidy or license fee as per the procedure prescribed by the Fisheries Department.

(d) The Department of Fisheries can designate agricultural land and virgin land for aquaculture for not more than 10 years.

The powers of the Director General in the law conditions relating to termination of lease or license. It contains provisions on the powers of inspectors and penalties for violations of the law (DoF, 2020).

The Director General of the Department of Fisheries shall issue a fish farming business license to any person who leases fish farming business on the land designated for this purpose, freshwater fishing industry that is not related to a government department or organization and any person who wants to work on fish farming on land other than the land designated for fish farming in freshwater fishing industry or any person who wishes to sell or commercially display fish hatchery in fish farming, after obtaining a permit, fresh water fisheries. A family consumption aquaculture carrier is exempted from applying for a license in a reservoir with a water surface not exceeding 25 feet X 50 feet (DoF, 2020).

Fish ponds can only be raised on land that has been officially allocated for fish farming and only on land that is not currently under cultivation. Excavation of ponds or ditches on land suitable for rice cultivation is prohibited even in areas where conversion to fishponds is more profitable than rice cultivation. Land confiscation is the consequence (Belton, Filipski & Hu, 2017).

Issues of social inequality in aquaculture management in Myanmar must be addressed sector by sector for better food and income security. Tackling the culture of land grabbing will contribute to the much-needed improvement in the security of property rights in the country.

The current aquaculture monitoring system for small scale enterprises should be reviewed. The aquaculture law requires licenses for ponds larger than 121 m^2, but in practice the Department of Fisheries often considers those smaller than 4,047 m^2 as backyard ponds. Because backyard ponds are not included in official reporting. The small sector is excluded from national statistics.

3.3 Aquaculture Production

Freshwater aquaculture contributes to the economy of Myanmar in a number of ways. The production of aquaculture in total fisheries production is shown in Table (3.1).

Table (3.1) Aquaculture in Total Fisheries Production (2010 to 2019)

Year	Total Fisheries (Metric Ton 000)	Aquaculture (Metric Ton 000)	Share in Total Fisheries (Percentage)
2010-2011	4163.46	830.48	19.95
2011-2012	4478.35	899.05	20.08
2012-2013	4716.22	929.38	19.71
2013-2014	5047.40	964.12	19.10
2014-2015	5316.95	999.63	18.80
2015-2016	5591.83	1014.42	18.14
2016-2017	5675.47	1048.69	18.48
2017-2018	5877.46	1130.35	19.23
2018-2019	5971.10	1121.35	18.78

Source: Department of Fisheries (2019)

According to data of Department of Fisheries (2019), total fisheries production was 4163.46 thousand metric ton in year (2010-2011) increased to 5971.20 thousand metric ton in year (2018-2019). Within ten years period of total fisheries production, the aquaculture production was about 20 percentage of share in fisheries production in Myanmar. And also, the aquaculture production was increased by year to year from (2010-2011) to (2018-2019). The aquaculture production was 830.48 thousand metric ton in year (2010-2011) increased to nearly 300 thousand metric ton in year (2018-2019).

The following Table (3.2) shows the aquaculture in total freshwater fisheries production from (2010-2011) to (2018-2019). The freshwater fisheries are including aquaculture fisheries, leasable fisheries and open fisheries.

Table (3.2) Aquaculture in Total Freshwater Production (2010 to 2019)

Year	Total Freshwater (Metric Ton 000)	Aquaculture (Metric Ton 000)	Share in Total Freshwater (Percentage)
2010-2011	1993.64	830.48	41.66
2011-2012	2145.51	899.05	41.90
2012-2013	2232.35	929.38	41.63
2013-2014	2345.15	964.12	41.11
2014-2015	2462.75	999.63	40.59
2015-2016	2595.09	1014.42	39.09
2016-2017	2639.05	1048.69	39.74
2017-2018	2725.32	1130.35	41.48
2018-2019	2721.40	1121.35	41.20

Source: Department of Fisheries (2019)

Regarding from fisheries statistics of Department of Fisheries (2019), the aquaculture production was about 40 percentage shares in total freshwater production in Myanmar Fisheries Sector. It is means that the aquaculture production was depended on the extension of the aquaculture ponds such as fish ponds and shipman ponds at the states and regions in Myanmar. The major freshwater fisheries product is Rohu (Labeo rohita or Nge Myint Chin) accounted for more than 60 percentage of freshwater fish.

3.4 Aquaculture Area and Ponds

The aquaculture farming in Myanmar is against a non-Buddhist tradition does not want or want to kill animals. Freshwater aquaculture is growing and the fastest growing is obviously the involvement of ethnic Chinese as this culture is not avoided. The Chinese can more easily raise input capital for aquaculture development, as well as access information and technology from China.

Freshwater aquaculture ponds are small, medium and large. The grow out farms are divided into three size categories as follows:

1. small pond (less than 10 acres);
2. medium pond (between 10 to 40 acres); and
3. large pond (40 acres and above).

Among agricultural products, 80% is simply defined as exclusively feeding agricultural products such as rice bran and groundnut oil cake. In intensive farms, 16% of farms raised fishmeal and 4% of farms were integrated with chicken houses built above fishmeal and nutrient tanks spill feeding.

Lands converted into fishponds with an area of less than 60 m^2 in fishpond size (50 x 25 feet) without a license issued by the Fisheries Department for the development of small fishponds are not controlled or recorded. However, small-scale ponds, initially managed with minimal capital, have proven highly successful for the livelihoods of poor farming families in neighboring countries. Especially big fingerlings can be stocked or tamed before release. It is highly recommended that Myanmar also consider developing food security with a focus on future poverty, including small-scale aquaculture. The production of fish fingerlings and stocking in aquaculture ponds is a typical form of aquaculture and is currently practiced for a variety of species. It is a form of aquaculture that is promoted by the Department of Fisheries along with some aquaculture.

Typically, the aquaculture industry observed by the mission has more than 1.2 heaters and is not generally acceptable to Myanmar farmers due to scale and capital requirements. The agriculutre department strict control over the conversion of paddy lands to other uses (especially aquaculture) is one of the strongest constraints to the wider development of aquaculture in freshwater areas.

Aquaculture is one of the few that is profitable enough to repay the cost of shifting grain. In areas where the profitability of rice cultivation is very low, fishpond aquaculture is an attractive alternative. Table (3.3) shows the aquaculture area and ponds (2010 to 2019) in Myanmar.

Table (3.3) Aquaculture Area and Ponds (2010 to 2019)

Year	Fish Pond (Acre)	Shrimp Pond (Acre)	Total (Acre)
2010-2011	218746	224949	443695
2011-2012	220171	228297	448468
2012-2013	221395	228297	449692
2013-2014	222028	228296	450324

2014-2015	232515	236638	469153
2015-2016	239671	238331	478002
2016-2017	245807	241718	487525
2017-2018	247007	244338	491345
2018-2019	247858	244337	492295

Source: Department of Fisheries (2019)

Regarding from fisheries statistics of Department of Fisheries (2019) total area of aquaculture ponds, in terms of fish ponds and shrimp ponds separately. In year (2010-2011), the fish pond area was 218746 increased to 247858 acres in year (2018-2019) within ten years period. The shrimp pond area was 224949 in year (2010-2011) increased to 244337 acres in year in (2018-2019).

Table (3.4) Aquaculture Fish Pond by States and Regions (2010 to 2019)

States/Regions	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Kachin	1938	1910	1990	2168	2313	2312	2312	2344	2355
Kayah	638	673	748	760	798	819	893	893	894
Kayin	400	400	464	464	589	675	711	731	741
Chin	108	107	296	296	296	296	296	304	344
Sagaing	5159	5465	5809	6023	6374	7128	7580	7575	7544
Taninthayi	351	922	922	923	1065	1120	1120	1120	1120
Bago	25748	26003	26009	26014	27158	28324	31121	31146	31132
Magway	430	425	425	425	425	425	425	425	424
Mandalay	6898	7154	7416	7624	7609	7970	7902	7873	7848
Mon	920	969	975	979	995	995	1001	1001	1001
Rakhine	0	0	20	20	20	20	20	20	20
Yangon	59870	59864	59864	59864	65848	66015	67038	66444	67328
Shan	3377	3387	3409	3409	3408	3408	3408	3408	3383
Ayeyarwady	112909	112892	112892	112892	115462	119993	121811	123551	123551
Nay Pyi Taw	0	0	162	171	171	171	175	175	175

Source: Department of Fisheries (2019)

Table (3.5) Aquaculture Shrimp/Prawn Pond by States and Regions (2010 to 2019)

States/Regions	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019
Kayin	80	80	80	80	80	130	130	130	130
Taninthayi	821	4141	4141	4140	4140	4138	4138	4138	4138
Bago	12	40	40	40	40	40	40	40	40
Mon	1125	1125	1125	1125	1125	1125	1125	1125	1124
Rakhine	155533	155533	155533	155533	155533	15648	156489	156488	156488
Yangon	10229	10229	10229	10229	17829	18442	18916	18681	18781
Ayeyarwady	57149	57149	57149	57149	57892	57968	60880	63736	63736

Source: Department of Fisheries (2019)

3.5 Aquaculture for Rural Development

Promote aquaculture as an integrated rural development activity within multiple use of land and water resources available through inter-agency coordination in policy formulation, project planning and implementation, stakeholder consultation, extension services and technology transfer. One of the national policies is the poverty alleviation and to carry out rural development through agriculture and other sectors. Actually, about 70 percent of the country people are living in country -side and rural areas. JICA incorporated and collaborated with DoF by establishing JICA unit at DoF and started its project plan in 2005.

The strategic project plan is firstly conducting on-site training at appropriate areas to the villagers on small-scale aquaculture. Then secondly it implemented demonstration based on self-participatory approach. Thirdly JICA provides 70 percent of the cost for village level community farming that shared 30 percent. Profit sharing basis is to keep 50 percent for next operation, 20 percent for donation to the nearby school or village clinic and 30 percent is to share for community members. The first phase of JICA project completed in 2013 June. Based on evaluation of effectiveness and capacity needs, JICA was continued projects from 2014 March to 2019 February in Dry Zone Myanmar. JICA will provide one fishery development advisor to advise development of fisheries and aquaculture sector in Myanmar.

Moreover, ACIAR, KOICA, EU-GIZ, JIRCAS also supporting and cooperation with DoF for improving research & development of Myanmar's Inland & coastal fisheries. Fisheries sector of evergreen village development project supported 30 million kyats as revolving fund for each village of 390 villages where have potential to develop in fisheries sector in 15 Regions and States in this fiscal year from the funding sources of government's capital budget and Department of Fisheries will try the best to achieve the objective of the development of fisheries sector for rural people.

3.6 Aquaculture Farming Practices

Different farming practices are adopted substantially in Myanmar to be in accordance with environment conditions, infrastructure, land and water, markets requirements, buyer choice, farmer investment capacity etc. Moreover, it is not easy to

make thorough in aquaculture due to various factors such as total aquaculture farming areas, pond size, farmed species, culture period, stocking density and production rate.

The aquaculture farming is usually a major family livelihood operated by family members. General the ponds areas are not more than ten in total comprising a good number of one to two acres ponds and sometimes integrating with other business such as poultry farming or plantation. This aquaculture system is widely used and the ponds are fitted with inlet and outlet water pipes for drainage or in areas with easy access to enough, good and clean water source. Almost all of the farms and ponds are in capability of water exchange by gravity or engine whenever needed.

The ponds are made by manual labors based mainly on availability of funding, land, topography, way of water drainage, type of farming and the aquaculture owner's idea, the ponds are subsequently small in size, not in proper design, irregular in shape and shallow in depth. Before stocking with fish seeds the ponds get basic technical treatment such as drying, limiting, fertilization up to some extent and finally filled in with water. The water turns green taken as indication of fully furnished with natural food, the fish for hatcheries are stocked to be in accordance with pond size, culture period, season and to harvest targeted marketable size in contract agreement time as well.

The standardize stocking density is based on the fish species and pond area. The stocking is calculated as 2500 fingerling units per acre if the fish species are culture in long-term period, maximum 2 years such as Ronu (Labeo rohita or Nge Myint Chin). Short–term fish culturing needs 5000 fingerlings per acre for fish species such as Tilapia (Tilapia mossambica), Tarpian, which can be harvested after 6 months.

3.7 Development Activities for Aquaculture Sector

Sustainable Aquaculture Programme (SAP) seeks to support the sustainable intensification of the aquaculture sector, there by realizing its potential for food security, nutrition and livelihoods. The specific objective "Sustainably intensified aquaculture" with six results, covering the dimensions of food and nutrition security. Result areas nutrition and food security covers nutritional activities according to SAP's overall objective to contribute to improve the nutritional status of children under 5 years and women of reproductive age.

This will be achieved by raising awareness for a well-balanced diet and advocating consumption of fish and fishery products. Promotion events have been conducted in Ayeyarwady and Sagaing Regions as well as Shan State. An Aquatic Education Centre (AEC) was established on the grounds of the DoF hatchery in Nyaung Shwe, utilizing a previous building on the hatchery premises. The Centre deals with the conservation of indigenous fish species of the UNESCO Biosphere Reserve Inle Lake, provides a platform for the display of the local culture, traditional fishing methods and, due to its wet lab, functions as a research facility.

The AEC with its aquaria displays several Inle Lake species is open for national and international visitors as well as student researchers from national universities. In near future, the AEC will be supportive to small-scale fish farmers at the lake, for monitoring the status of indigenous fish species and for introducing innovative technology at the hatchery. The purpose of the National Aquaculture Development Plan (NADP) is to provide the policy and institutional framework for sustainable development of aquaculture sector in Myanmar in close alignment with the vision of Myanmar Sustainable Development Plan (MSDP), principles of Agriculture Development Strategy (ADS), strategies of National Export Strategy (NES) and other national frameworks.

National Aquaculture Development Plan (NADP) represents determinations and aspirations of all stakeholders of the sector and the nation as a whole to support the long-term sustainable development goals of Myanmar while the agriculture policy states that, by 2030, Myanmar achieves inclusive, competitive, food and nutrition secure, climate change resilient, and sustainable agricultural system contributing to the socio-economic well-being of farmers and rural people and further development of the national economy.

National Aquaculture Development Plan (NADP) provides a thoughtful list of actionable priorities to address some of the urgent needs of the aquaculture sector and demonstrates Myanmar’s commitment to attaining aquaculture development in sustainable and inclusive way. This plan is officially launched at 13th March 2020 by inviting multilevel stakeholders and decision makers.

CHAEPTER IV

SURVEY ANALYSIS ON RURAL AQUACULTURE FARMS

4.1 Thanatpin Township Profile

The study area was based on the aquaculture farms areas of Thanatpin Township and it is located in Bago District in the Bago Region of Myanmar. This township situated between North Latitude 17 degree 07 minutes to 17 degree 22 minutes and East Longitude 96 degree 30 minutes to 96 degree 55 minutes. The township area is 385 square miles and 19 feet above sea level.

Thanatpin Township is in the low-lying plains with nearly 75% have deep flooded area. The climate is tropical wet and dry season with the maximum temperature at 37° C and the minimum temperature at 22° C. According to Thanatpin Township General Administration Department report (2019), township population is 165738, the large population (147628 or 89%) are living in rural area and rest (18110 or 11%) in the urban. The majority of population is Myanmar and minorities are Kayin, Mon, Kachin, Rakhine, Shan, Pa O and other foreign immigrants such as Chinese and Indian.

Thanatpin Township is comprised on 99 villages, 60 village tracts and 6 wards. This township household main income is depended on agricultural production and fisheries production on aquaculture farming business. The primary employment for those that work locally, while a large percentage of the population resides in Thanatpin Township but working and trading with neighboring township, including in Yangon Region and Bago Region.

The following Table (4.1) is number of wards, houses, households, village tracts, villages and population by gender of Thanatpin Township.

Table (4.1) Wards, Houses, Households, Village Tracts, Villages and Population

Description	Urban (No.)	Rural (No.)
No. of House	2954	26224
No. of Household	3031	27154
No. of Wards	6	0
No. of Village Tracts	0	60
No. of Villages	0	99
Under 18 Total Male Population	4060	36384
Under 18 Total Female Population	4257	36049
Over 18 Total Male Population	4404	35366
Over 18 Total Female Population	5224	39829
Total Male Population	8037	85359
Total Female Population	16869	147863
Total Population	32047	292766

Source: General Administration Department (2019)

Table (4.2) presents the professional workers in Thanatpin Township (GAD, 2019).

Table (4.2) Professional Workers in Thanatpin Township

Description	Number	Percentage
Government office	3512	4.14`
Service	15	0.02
Agriculture	27681	32.63
Livestock	5437	6.41
Merchant	3665	4.32
Industry	211	0.25
Fisheries	36903	43.51
Casual	7399	8.71
Total	**84823**	**100**

Source: Thanatpin Township General Administration Department (2019)

Regarding from data of General Administration Department (2019), the highest percentage of professional workers are fisheries sector in Thanatpin Township, Bago Region. And also, total aquaculture fish ponds are 173 number on total area 2439.01 acres. (Table 4.3)

Table (4.3) Aquaculture Farms in Thanatpin Township (2018-2019)

Description	Number
Total Aquaculture Farms	173 Ponds
Total Area	2439.01 Acres

Source: Thanatpin Township General Administration Department (2019)

4.2 Survey Design

The main objectives of the study are to explore the aquaculture farms situation to exam the aquaculture farms support to income generation and employment creation in Thanatpin Township, Bago Region. The study was using quantitative method based on primary data and secondary data. The survey design for the study involves data collection by conducting a survey using random sampling method. This method uses some manner of a random choice. In this method, all the suitable individuals have the possibility of choosing the sample for the whole sample space.

Primary data was collected from 120 respondents of aquaculture farming the workers and owners of 40 out of 173 fish ponds in rural area of Thanatping Township using self-administered structure survey questionnaire within April and May of 2021. Secondary data was obtained information from Department of Fisheries (DoF), Asia Development Bank, Food and Agriculture Organization (FAO), World Fish Center (WFC), libraries and internet.

The survey questionnaire is developed and this includes questions on (1) profile of respondents, (2) status of rural aquaculture farms, (3) cost and revenue of rural aquaculture farms, (4) problem of rural aquaculture farms.

The questionnaire had multiple choice questions and respondents were asked to select one or more of the alternatives and dichotomous questions that had only two response alternatives, Yes or No. And also used five points ‘Likert Scale’ (Strongly disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, and strongly agree = 5).

4.3 Survey Findings

The survey findings from the analysis of collected information are presented in this section. Section one shows the characteristics of respondents. Section two presents the current situation of aquaculture farming in the survey area. Section three is technical knowledge of aquaculture farming on respondents. And the last section is the respondent's perception on improvement of aquaculture farming.

4.3.1 Profile of Respondents

Table (4.4) presents the profile of respondents such as gender, age, education level and marital status.

Table (4.4) Profile of Respondents

Description	Respondents	Percentage
Gender		
Male	113	94.2
Female	7	5.8
Total	**120**	**100**
Age (Years)		
Between 21 to 30	42	35.0
Between 31 to 40	56	46.7
Between 41 to 50	14	11.7
51 and over	8	6.6
Total	**120**	**100**
Education Level		
Primary school	12	10.0
Middle school	66	55.0
High school	38	31.7
Graduated	4	3.3
Total	**120**	**100**
Marital Status		
Single	36	30.0
Married	84	70.0
Total	**120**	**100**

Source: Survey Data (2021)

According to Table (4.3), the distribution of gender for 120 respondents, male is higher than female. The majority of respondents were married. The Respondents by age group show that (42 respondent or 35%) have between 21 years to 30 years, (56 respondents or 46.7%) have between 31 years to 40 years, (14 respondents or 11.7%) have between 41 years to 50 years and (8 respondents or 6.6%) have 51 years and over respectively. The most of respondents were middle school level. The respondent's education level was not directly related with rural aquaculture farms work experiences.

Table (4.5) Aquaculture Farms Working Experience of Respondents

Description	Respondents	Percentage
1 year to 5 years	26	21.7
6 years to 10 years	48	40.0
11 years to 15 years	40	33.3
16 years to 20 years	6	5.0
Total	**120**	**100**

Source: Survey Data (2021)

According to result of 120 respondents (Table 4.5). The mostly respondents have worked experience more than 6 years. This means that the respondents have understanding of the aquaculture farms working environment in the survey area.

4.3.2 Status of Rural Aquaculture Farms

Type of rural aquaculture farms are divided by small pond, medium pond and large pond in the survey area shown in Table (4.4).

Table (4.6) Type of Rural Aquaculture Farms

Description	Respondents	Percentage
Small Ponds (Less than 10 acres)	76	63.3
Medium Ponds (Between 10 acres to 40 acres)	38	31.7
Large Ponds (40 acres and above)	6	5.0
Total	**120**	**100**

Source: Survey Data (2021)

According to Table (4.6), it is found that the majority of respondents were small ponds (less than 10 acres). The rural aquaculture farms size has chosen according to the aim of the production unit and the land available for production development. Maintenance of water quality in pond is very important for the growth rate of fish. Thanatpin Township area is water sources from Sittaung River and other creeks. So that, the aquaculture farm owner or supervisors have used water exchange method and other aquaculture farm management for easy to control of fish production.

The following Table (4.7) shows the fish species of rural aquaculture farms in the Thanatpin Township, Bago Reigon. The species are Rohu (Labeo rohita or Nge Myint Chin), Common Craps (Cyprinus carpio or Shwe War Nga Gyin), Grass Carps (Cirrhius mrigala or Nga Gyin), Tilapia (Tilapia mossambica) and Sutchi (Pangaslus hypophtalmus or Nga Tan). These species are mainly culture in study area because of market demand from domestic and export market condition.

Table (4.7) Fish Species of Rural Aquaculture Farms

Description	**Respondents**	**Percentage**
Common Craps and Rohu	62	51.7
Grass Craps and Rohu	30	25.0
Sutchi	13	10.8
Tilapia	15	12.5
Total	**120**	**100**

Source: Survey Data (2021)

According to the survey data (Table 4.7), the majority of respondents have common crap and rohu spices in the rural aquaculture farms. Fresh water pond fish culture is the major source of aquaculture farming product as Rohu (Labeo rohita or Nge Myint Chin), Common Craps (Cyprinus carpio or Shwe War Nga Gyin), and Grass Carps (Cirrhius mrigala or Nga Gyin), being the most dominant species in the Thanatping Township, Bago Region. Common Craps and Rohu are the most influence fish species among the aquaculture farms in the study area. It represents above 50 percentage of other fish species.

Table (4.8) presents the fish seed sources in the rural aquaculture farms at Thanatping Township, Bago Region.

Table (4.8) Fish Seed Sources

Description	Respondents	Percentage
Department of Fisheries Hatcheries	52	43.3
Private Hatcheries	39	32.5
Own Breed	22	18.3
Natural Stock Collection	7	5.9
Total	**120**	**100**

Source: Survey Data (2021)

According to result of 120 respondents, there are four main sources of fish seed whereas 52 respondents (43.3%) from Department of Fisheries Hatcheries, 39 respondents (32.5%) from Private Hatcheries, 22 respondents (18.3%) from Own Breed and 7 respondents from (5.9%) from Natural Stock Collection. Most of the respondents said that they can buy the fish species from the Department of Fisheries.

Table (4.9) Stocking Rate of Rural Aquaculture Farms

Description	Respondents	Percentage
0 - 1000	58	48.3
1001 – 2000	25	20.8
2001 – 3000	16	13.3
3001 – 4000	12	10.0
4001 – 5000	9	7.6
Total	**120**	**100**

Source: Survey Data (2021)

According to data from the 120 respondents (Table 4.6), the most of the respondents practiced stocking density of fish per pond between 0 to 1000. The highest stocking density of fish per pond was 48.3 percentage of total respondents and the lowest stocking density of fish per pond was 7.6 percentage of total respondents in the survey area.

The respondents practiced inconsistency of feeds and feeding methods including their ambiguity in understanding of technology know-how and culture

system. Most of the respondents feed the fish at least when they had retreated into the rural aquaculture farms normally once or twice a day as shown in Table (4.10).

Table (4.10) Feeding Items in Rural Aquaculture Farms

Kind of Feeds	Respondents	Percentage
Fish Paste	36	30.0
Rice Bran	45	37.5
Soya Bean	10	8.3
Groundnut Meal	12	10.0
Coconut Cake mixed Rice Barn	17	14.2
Total	**120**	**100**

Source: Survey Data (2021)

From Table (4.10), many respondents made kinds of feed such as fish paste, rice bran, soybean, groundnut meal, coconut cake mixed with rice bran which was then placed in either a pot, basket or net bag hung in the aquaculture farms.

According to the result from the 120 respondents, the higher percentage of respondents (45 respondents or 37.5) have used rice barn followed by (36 respondents or 30%) used fish paste, (17 respondents or 14.2%) used coconut cake mixed rice barn, (12 respondents or 10%) used groundnut meal and (10 respondents or 8.3%) used soya bean.

Table (4.11) Total Fish Production per Month

Description	Respondents	Percentage
Less than 100 Viss	68	56.7
100 Viss – 200 Viss	42	35.0
More than 200 Viss	10	8.3
Total	**120**	**100**

Source: Survey Data (2021)

In the study area, it was found that the most of respondents have got less than 100 viss fish production per month. Only few respondents have more than 200 viss production per acre. In order to ensure year-round availability or at least to extend the

period of availability and thereby improve the market acceptance of farmed products, the respondents adopted the continuous culture and harvesting techniques. In continuous culture the rearing facilities are stocked only once during a production cycle at a comparatively higher rate and harvesting is done selectively at regular intervals for marketable size to ensure the production and sale on a more or less continuous basis.

Table (4.12) Fish Marketing

Description	Respondents	Percentage
Selling Rural Area Markets	18	15.0
Selling Urban Area Markets	57	47.5
Selling Fish Dealers	45	37.5
Total	**120**	**100**

Source: Survey Data (2021)

Regarding from Table (4.12), the majority of respondents have said that the fish collector at their villages and sent to urban area markets. And also, 45 respondents (37.5) have sold to fish dealers. A few respondents have sold to near village markets and in the village market. Most of respondents said that the small size fish in the village market and other market size fish sold to fish dealers (or) send to Yangon Fish Markets

The rural aquaculture farms are labor saving because all family members are working in the aquaculture farms and the labor contribution is very highly in the fish farming.

4.3.3 Cost and Revenue of Rural Aquaculture Farms

The rural aquaculture system relies on the monsoon season. So many fish move from the ponds, rivers, creeks and canals to the flooded rice paddies where they reproduce and feed. Various approaches were used to entice the fish to the ponds. Many respondents had dug canals that channeled the fish to the ponds. The following Table (4.13) shows the cost of aquaculture farms in the study area.

Table (4.13) Cost of Rural Aquaculture Farms

Description	Respondents	Percentage
Cost of Ponds		
Less than 500,000 Kyat	48	40.0
500,000 Kyat – 1,000,000 Kyat	40	33.3
More than 1,000,000 Kyat	32	26.7
Total	**120**	**100**
Cost of Fish Seeds		
Less than 500,000 Kyat	65	54.2
500,000 Kyat – 1,000,000 Kyat	33	27.5
More than 1,000,000 Kyat	20	18.3
Total	**120**	**100**
Cost of Fish Feeds		
Less than 500,000 Kyat	72	60.0
500,000 Kyat – 1,000,000 Kyat	35	29.2
More than 1,000,000 Kyat	13	10.8
Total	**120**	**100**

Source: Survey Data (2021)

Regarding from 120 respondents, most of respondents said that they have less than 1,000,000 Kyat for the aquaculture farms such as cost of ponds, cost of fish seeds and cost of fish feeds.

Table (4.14) Revenue of Rural Aquaculture Farms

Description	Respondents	Percentage
Less than 1,000,000 Kyat	12	10.0
1,000,000 Kyat – 1,500,000 Kyat	68	56.7
More than 1,500,000 Kyat	40	33.3
Total	**120**	**100**

Source: Survey Data (2021)

As a one season revenue rural aquaculture farms (Table 4.15), the majority of respondents (68 respondents or 56.7%) said that they have got between 1,000,000 Kyat to 1,500,000 Kyat, (40 respondents or 33.3%) got more than 1,500,000 Kyat. Although,

a few respondents (12 respondents or 10.0%) received less than 1,000,000 Kyat income from rural aquaculture farms.

4.3.4 Point at Issue of Rural Aquaculture Farms

The following Table (4.15) presents the point at of rural aquaculture farms in the study area.

Table (4.15) Point at Issue of Rural Aquaculture Farms

Description	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean
Fish Seeds	0 (0%)	0 (0%)	18 (15%)	72 (60%)	30 (25%)	4.1
Fish Feeds	0 (0%)	25 (20.8%)	35 (29.2%)	57 (47.5%)	3 (2.5%)	3.3
Fish Diseases	0 (0%)	0 (0%)	5 (4.2%)	94 (78.3%)	21 (17.5 %)	4.1
Fish Market	0 (0%)	0 (0%)	0 (0%)	85 (70.8%)	35 (29.2%)	4.3
Fish Training	0 (0%)	0 (0%)	0 (0%)	92 (76.7%)	28 (23.3%)	4.2

Source: Survey Data (2021)

The general condition of rural aquaculture production improvement was identified as fish seeds supply and quality of fish seeds, fish feeds, various fish diseases, fish marketing system and fish training program. In the study area, the mostly respondents said that they have problem on fish seeds, fish diseases, fish market and fish training. They want to get technology transfer to improve for their fish production. Although the aquaculture production technology is limited, the respondents share their experience and exchange for information of the aquaculture farming. Most of the respondents said that the improvement of fish market system in such a way to direct local and export market.

Due to favorable conditions of natural resources such as land, water resources and water quality, study area have potential to promote rural aquaculture production. There is much availability and varied resources for the expansion and growth of rural aquaculture production based on fish. In the study area have potential for further development of its contribution to food security, employment in rural area.

Table (4.16) shows the effects of COVID-19 on the fisheries production at the aquaculture farms connected with income, harvested fish and catch size.

Table (4.16) Effects of COVID-19 in Rural Aquaculture Farms

Description	Yes	No
Reduced Income	80 %	20 %
Reduced Harvested Fish	45%	55 %
Reduced Catch per Day	36%	64 %
Reduced Fish Price	50%	50 %
Reduced Demand of Markets	40%	60 %

Source: Survey Data (2021)

Before COVID-19 period, the respondents could do regular aquaculture farms activities and easily access to other townships. With COVID-19 period, the income has been significantly decreased reported by 80% of respondents in the study area. The impacts are strongly connected with less fishing activities and less travels or movements with Thanatpin Township, Bago Region that caused reduction of harvested fish and catch per day.

COVID-19 has created unstable business and unemployment at all levels of fisheries sectors. For the small ponds' fishers, they have to find random jobs near to the living places with under wages or paid. Most of respondents have said that they have lost their jobs for temporary or permanent in COVID-19 period. For the medium ponds and larger ponds fishers, they had to reduce numbers of labors and workers due to unstable business that was not able to provide regular jobs. They were even had to release skilled labors those who have been working with them for years.

According to the 120 respondents, fish price has been decreased by 50%. Market prices for fishing and aquaculture products have declined due to reduced

demand from local markets and travel restrictions. The direct sellers in the local markets faced reduced of sale amount per day by decreasing from 5 – 8 viss to 3 - 4 viss. They could not sell the extra fishes to the collectors or other markets as regularly due to travel bans. Some women found the solutions for the remaining fish by making dry fishes.

CHAEPTER V

CONCLUSION

5.1 Findings

The study was based on the aquaculture farms areas of Thanatpin Township, Bago Region. This township is in the low-lying plains with nearly 75% have deep flooded area. The highest percentage of professional workers are fisheries sector in Thanatpin Township, Bago Region. And also, total aquaculture fish ponds are 173 number on total area 2439.01 acres.

The main objectives of the study are to explore the aquaculture farms situation to examine the aquaculture farms support to income generation and employment creation in Thanatpin Township, Bago Region.

According to result of 120 respondents, mostly respondents have worked experience more than 6 years. It is means that the respondents have understanding of the aquaculture farms working environment. The rural aquaculture farms size of mostly were small ponds (less than 10 acres). The rural aquaculture farms size has chosen according to the aim of the production unit and the land available for production development.

The fish species of rural aquaculture farms were Rohu (Labeo rohita or Nge Myint Chin), Common Craps (Cyprinus carpio or Shwe War Nga Gyin), Grass Carps (Cirrhius mrigala or Nga Gyin), Tilapia (Tilapia mossambica) and Sutchi (Pangaslus hypophtalmus or Nga Tan). These species are mainly culture in study area because of market demand from domestic and export market condition. The majority of respondents have common crap and rohu spices in the rural aquaculture farms.

According to result of 120 respondents, there are four main sources of fish seed whereas 52 respondents (43.3%) from Department of Fisheries Hatcheries, 39 respondents (32.5%) from Private Hatcheries, 22 respondents (18.3%) from Own Breed and 7 respondents from (5.9%) from Natural Stock Collection.

The most of the respondents practiced stocking density of fish per pond between 0 to 1000. The highest stocking density of fish per pond was 48.3 percentage of total respondents and the lowest stocking density of fish per pond was 7.6 percentage of total respondents in the survey area.

According to the result from the 120 respondents, the higher percentage of respondents (45 respondents or 37.5) have used rice barn followed by (36 respondents or 30%) used fish paste, (17 respondents or 14.2%) used coconut cake mixed rice barn, (12 respondents or 10%) used groundnut meal and (10 respondents or 8.3%) used soya bean.

In the study area, it was found that the most of respondents have got less than 100 viss fish production per pound. Only few respondents have more than 200 viss production per acre. In order to ensure year-round availability or at least to extend the period of availability and thereby improve the market acceptance of farmed products, the respondents adopted the continuous culture and harvesting techniques.

The majority of respondents have said that the fish collector at their villages and sent to urban area markets. And also, 45 respondents (37.5%) have sold to fish dealers. A few respondents have sold to near village markets and in the village market. The rural aquaculture farms are labor saving because all family members are working in the aquaculture farms and the labor contribution is very highly in the fish farming.

Most of respondents said that they estimated cost of 1,000,000 Kyat for the aquaculture farms such as cost of ponds, cost of fish seeds and cost of fish feeds. The majority of respondents said that they have got between 1,000,000 Kyat to 1,500,000 Kyat.

In the study area, the mostly respondents said that they have problem on fish seeds, fish diseases, fish market and fish training. They want to get technology transfer to improve for their fish production. Although the aquaculture production technology is limited, the respondents share their experience and exchange for information of the aquaculture farming. Most of the respondents said that the improvement of fish market system in such a way to direct local and export market.

The effects of COVID-19 on the fisheries production at the aquaculture farms connected with income, harvested fish and catch size. Before COVID-19 period, the respondents could do regular aquaculture farms activities and easily access to other

townships. Within COVID-19 period, the income has been significantly decreased reported by 80% of respondents in the study area. The impacts are strongly connected with less fishing activities and less travels or movements with Thanatpin Township, Bago Region that caused reduction of harvested fish and catch per day.

Most of respondents have said that they have lost their jobs for temporary or permanent in COVID-19 period. Market prices for fishing and aquaculture products have declined due to reduced demand from local markets and travel restrictions. The direct sellers in the local markets faced reduced of sale amount per day by decreasing from 5 – 8 viss to 3 - 4 viss. They could not sell the extra fishes to the collectors or other markets as regularly due to travel bans.

5.2 Suggestion

In order for the improve of rural aquaculture farms in Myanmar, not only for the purpose of food security, poverty reduction, but also for commercializing. The study is suggested to adopt more effective programs such as monitoring and coordination with farmers to solve their difficulties from technical factors.

The study suggested that farmers can be persuaded to strictly follow the guidelines and instructions of fish farming trained by the Department of Fisheries so that the production rate will increase. The annual production amount, cost and profits should be recorded in a document to consider better approaches for improvement of rural aquaculture farms. In addition, provision of healthy fish seeds and fingerlings and development of advanced breeding techniques in hatcheries are recommended.

As rural aquaculture farms rely mainly on government hatcheries for the necessary fish seed, it is not clear how to develop government seed farms and support family income. Finally, there is a need to realize the huge contribution potential of rural aquaculture farms, as it has been neglected by most aquaculture professionals. Only then, it can realize its potential to contribute to poverty alleviation through rural aquaculture farms.

REFERENCES

ADB (2013), Myanmar agriculture, natural resources, and environment initial sector assessment, strategy, and road map, Asian Development Bank, Manila

Ahmed, N., & Garnett, ST., (2011), Integrated Rice-Fish Farming in Bangladesh: Meeting the Challenges of Food Security. Food Security, 3(1)

Ahmed, N., Troell, M., Allison, E.H., and Muir, J.F., (2010), Prawn Post Larvae Fishing in Coastal Bangladesh: Challenges for Sustainable Livelihoods, Marine Policy

Bagarinao, T.U and Primavera, J.H., (2005), Code of Practice for Sustainable Use of Mangrove Ecosystems for Aquaculture in Southeast Asia. Philippines SEAFDEC, Aquaculture Department

Belton, B., Hein, A., Htoo, K., Seng Kham, L., Nischan, U., Reardon, T., & Boughton D. (2015), Aquaculture in transition; Value chain transformation, fish and food security in Myanmar. International development working paper 139, Michigan, USA: Michigan State University

Belton, B, Filipski, M & Hu, C (2017), Aquaculture in Myanmar: fish farm technology, production economics and management, Food Security Policy Project, research paper 52, Feed the Future Innovation Lab for Food Security Policy, Michigan State University, Michigan

Bogucki, P., and Grygiel, R.., (1983). Early farmers of the Nort h European Plain. *Scientific American*, 248, Issue 4, 104

Boyd, C.E, McNevin, A., Clay, J., and Johnson, H. M., (2005), Certification Issues for Some Common Aquaculture Species. Reviews in Fisheries Science 13

Cao, L., Naylor, R., and Henriksson, P., (2015), China's aquaculture and the world's wild fisheries. *Science 347* (6218), 133–135.

Diana, J.S., (2009), Aquaculture Production and Biodiversity Conservation, *Bioscience*

DoF (2018), *Fisheries Statistic Book.* Department of Fisheries- Ministry of Agriculture, Livestock and Irrigation. Nay Pyi Taw, Myanmar.

DoF (2019), *Fisheries Statistic Book.* Department of Fisheries- Ministry of Agriculture, Livestock and Irrigation. Nay Pyi Taw, Myanmar.

DoF (2020), *Annual* Report. Department of Fisheries- Ministry of Agriculture, Livestock and Irrigation. Nay Pyi Taw, Myanmar.

Edwards, P., (2000), Natural Resource Perspectives: Aquaculture, Poverty Impacts and Livelihood, London, U K, Overseas Development Institute.

Edwards, P., (2009). Traditional Asian Aquaculture: Definition, Status and Trends. New Technology Efficiency, Quality and Environmental Management, Cambridge, UK: Woodhead Publishing Ltd.

FAO, (2012), The State of World Fisheries and Aquaculture 2012. Rome, FAO.

FAO, (2014), The State of World Fisheries and Aquaculture 2014, Rome, FAO.

FAO (2015), The State of World Fisheries and Aquaculture 2015, Rome, FAO.

General Administration Department (2019), Thanatpin Township Report (2019), Thanatpin Township General Administration Department, Ministry of Home Affairs, Myanmar

Hasan, M.R., and Halwart, M., (2009). Fish as Feed Inputs for Aquaculture: Practices, Sustainability and Implications. Rome, FAO *Fisheries and Aquaculture Technical Paper* No. 518.

Huijbregts, M., Hellweg, S., and Frischknecht, R., (2010), Cumulative Energy Demand as Predictor for Environmental Burden of Commodity Production, Environmental Science Technology 457

Huntington, T.C., and Hasan, M.R., (2009). Fish as Feed Inputs for Aquaculture – Practices, Sustainability and Implications: A Global Synthesis. Rome, FAO *Fisheries and Aquaculture Technical Paper* No. 518.

Iribarren, D., Mcreia, M., and Gumersindo, F., (2010), Revisiting the Life Cycle Assessment of Mussels from Sectorial Perspective, *Journal of Cleaner Production* 18.

Irz, X., Stevenson JR., Tanoy, A., Villarante, P., and Morissens P., (2007). The equity and poverty impact of aquaculture: Insights form the Philippines. *Development Policy Review*, 25(4)

Ling, Shao-Wen (1977), Aquaculture in Southeast Asia: A Historical Overview, University of Washington Press, USA

Milne, P. H. (1972) .in coastal waters. London. Fish and shellfish farming Fishing News (Books) Ltd., London

Naylor, R., Hardy, R.W., and Bureau, D.P., (2009), Feeding Aquaculture in An Era of Finite Resource. Proceeding of the National Academy of Science of the United States of America 106

Neori, A., Chopin, T., and Troell, M., (2004). Integrated Aquaculture: Rationale, Evolution and State of the Art Emphasizing Seaweed Biofiltration in Modern Aquaculture 231

Pelletier, N., Tyedmers, P., and Sonesson, U., (2009). Not all salmon are created equal: Life cycle assessment of global salmon farming systems. Environmental Science and Technology 43

Rana, K.J., Siriwardena, S., and Hasan, M.R., (2009). Impact of Rising Food Ingredient Prices on Aquafeeds and Aquaculture Production. Rome, FAO. FAO Fisheries and Aquaculture Technical Paper 541.

Rajee, O., & Mun, A.T.K (2017), Impact of Aquaculture on the Livelihoods and Food Security of Rural Communities. *International Journal of Fisheries and Aquatic Studies*, 5(2)

Saw Moe Oo Tun (2013), A Study on the Status of Aquaculture Farms (Case Study: Fish Farms in Twantae and Maubin Townships), Unpublished EMPA Thesis, Yangon University of Economics

Schmidt, U & Soe, K.M., (2014), Myanmar fisheries sector identification/scoping mission, technical report, Danish International Development Agency, Yangon, Myanmar

Soe Sandar Win (2018), A Study on Small Scale Aquaculture Project (Case Study: Maw La Myaing Gyun Township), Unpublished EMPA Thesis, Yangon University of Economics

Troell, M., (2009). Integrated Marin and Brackish Water Aquaculture in Topical Regions: Research, Implementation and Prospects. Integrated Mariculture; A Global Review. Rome, FAO. *Fisheries and Aquaculture Technical Paper* 529

Verdegem, M.C.J., and Bosma, R.H., (2009). Water Withdrawal for Brackish and Inland Aquaculture and Options to Produce More Fish in Ponds with Present Water Use. Water Policy 11

Walters, B., Roonback, P., and Kovacs, J., (2008). Ethnobiology, Socio-economics and Management of Mangroves. A Review: Aquatic Botany 89

Wine Wai Wai Win (2014), A Study on the Large Scale and Small Scale Fish Farming in Aquaculture Sector in Myanmar (Case Study of Selected Townships in Myanmar), Unpublished EMPA Thesis, Yangon University of Economics

World Bank (2019), MYANMAR COUNTRY ENVIRONMENTAL ANALYSIS, Sustainability, Peace and Prosperity: Forests, Fisheries, and Environmental Management, FISHERIES SECTOR REPORT, World Bank, Washington, DC

Websites

www.fao.org/fishery/facp/MMR/en

www.fao.org/nr/water/aquastat/countries_regions/MMR/index.stm.

www.worldfishcenter.org/our-research/projects/developing-capacity-myanmar

www.worldfishcenter.org/country-pages/myanmar.

SURVEY QUESTIONNAIRE

I am studying Master of Public Administration at Yangon University of Economics. I have designed the following questionnaire for the study on "**A Study on Rural Aquaculture Farms Situation in Bago Region in Myanmar (Case Study: Selected Villages in Thanatpin Township)**" which requires for my thesis as an integral part of the study to complete the Master Program. Please be answered that your responses will be strictly confidential. Please put a (√) mark to indicate your preference. I would highly appreciate if you answer the following questionnaire. It will take approximately 15-20 minutes. I expect your kind cooperation in this respect. Thank you for your time.

Section (I) Profile of Respondents

1. Gender (a) Male ☐ (b) Female ☐

2. Age Level

(a) 21 Years to 30 Years ☐ (b) 31 years to 40 years ☐ (c) 41 years to 50 years ☐

(d) 51 Years and Over

3. Educational Qualification

(a) Primary School ☐ (b) Middle School ☐ (c) High School ☐ (d) Graduate ☐

4. Marital Status

(a) Single ☐ (b) Married ☐

5. Working Experience

(a) 1 year to 5 years ☐ (b) 6 years to 10 years ☐

(c) 11 years to 15 years ☐ (d) 16 years to 20 years ☐

Section (II) Status of Rural Aquaculture Farms

1. Type of Rural Aquaculture Farms

(a) Small Ponds (Less than 10 acres) ☐

(b) Medium Ponds (Between 10 acres to 40 acres) ☐

(c) Large Ponds (Above 40 acres) ☐

2. Fish Species _____

3. Fish Seed Sources

(a) Department of Fisheries Hatcheries ☐

(b) Private Hatcheries ☐

(c) Own Breed ☐

(d) Natural Stock Collection ☐

4. Stock Density

(a) 0 – 1000 ☐ (b) 1001 – 2000 ☐ (c) 2001 – 3000 ☐ (d) 3001 – 4000 ☐ (e) 4001 – 5000 ☐

5. Feeding Items

(a) Fish Paste ☐ (b) Rice Bran ☐ (c) Soya Bean ☐

(d) Groundnut Meal ☐ (e) Coconut Cake mixed Rice Barn ☐

6. Total Fish Production per Pound

(a) Less than 100 Viss ☐ (b) 100 Viss – 200 Viss ☐ (c) More than 200 Viss ☐

7. Fish Marketing

(a) Selling Rural Area Markets ☐ (b) Selling Urban Area Markets ☐

(c) Selling Fish Dealers ☐

Section (III) Cost and Revenue of Rural Aquaculture Farms

1. Cost of Ponds

(a) Less than 500,000 Kyat ☐

(b) 500,000 Kyat – 1,000,000 Kyat ☐

(c) More than 1,000,000 Kyat ☐

2. Cost of Fish Seeds

(a) Less than 500,000 Kyat ☐

(b) 500,000 Kyat – 1,000,000 Kyat ☐

(c) More than 1,000,000 Kyat ☐

3. Cost of Fish Feeds

(a) Less than 500,000 Kyat ☐

(b) 500,000 Kyat – 1,000,000 Kyat ☐

(c) More than 1,000,000 Kyat ☐

4. Revenue

(a) Less than 1,000,000 Kyat ☐

(b) 1,000,000 Kyat – 1,500,000 Kyat ☐

(c) More than 1,500,000 Kyat ☐

Section (IV) Point at Issue of Rural Aquaculture Farms

1. Do you agree with the fish seeds as a constraint to the farm's development?

(a) Strongly Disagree ☐ (b) Disagree ☐ (c) Neutral ☐

(d) Agree ☐ (e) Strongly Agree ☐

2. Do you agree with the fish feedss as a constraint to the farm's development?

(a) Strongly Disagree ☐ (b) Disagree ☐ (c) Neutral ☐

(d) Agree ☐ (e) Strongly Agree ☐

3. Do you agree with the fish diseases as a constraint to the farm's development?

(a) Strongly Disagree ☐ (b) Disagree ☐ (c) Neutral ☐

(d) Agree ☐ (e) Strongly Agree ☐

4. Do you agree with the fish market as a constraint to the farm's development?

(a) Strongly Disagree ☐ (b) Disagree ☐ (c) Neutral ☐

(d) Agree ☐ (e) Strongly Agree ☐

5. Do you agree with the fish training as a constraint to the farm's development?

(a) Strongly Disagree ☐ (b) Disagree ☐ (c) Neutral ☐

(d) Agree ☐ (e) Strongly Agree ☐

6. Effect of COVID-19

(a) Reduced Income (i) Yes ☐ (ii) No ☐

(b) Reduced Harvested Fish (i) Yes ☐ (ii) No ☐

(c) Reduced Catch per Day

(i) Yes ☐ (ii) No ☐

(d) Reduced Fish Price (i) Yes ☐ (ii) No ☐

(e) Reduced Demand of Markets

(i) Yes ☐ (ii) No ☐

Thank You.