TILAPIA (*Oreochromis niloticus, Linnaeus*) PRODUCTION IN ABANDONED MINE QUARRYING MARSHLAND

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Master in Fisheries Technology (MFT)
Major in Aquaculture

ALEX NAVIDAD DE LUNA

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APPROVAL SHEET

In partial fulfillment of the requirements for the degree, **MASTER IN FISHERIES TECHNOLOGY**, this thesis entitled **"TILAPIA (*Oreochromis niloticus, Linnaeus*) PRODUCTION IN ABANDONED MINE QUARRYING MARSHLAND,"** has been prepared and submitted by **ALEX NAVIDAD DE LUNA** who, having passed the comprehensive examination and pre-oral defense, is hereby recommended for final oral examination.

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AND

DEDICATION

To my loving wife

Jinky

and sons

Mac Rajiv and Prince Alexander

ABSTRACT

The current study aimed to determine the development of a Resilient and Sustainable Tilapia (*Oreochromis nilticus*, L) Production in Abandoned Mine Quarrying Marshland. The study used the experimental research design of assessing the yield of Tilapia cultured in a fixed fish net cage enclosure measuring 5m x 5m x 2m, which had been installed in an abandoned mine quarried marshland or excavated lagoon that was stocked with 1000 fingerlings per unit of the fishnet cage at a stocking rate of 20 fingerlings/m3. The study conducted in Tolosa, leyte. For the salient findings of the study, the tilapia production in abandoned mine quarried marshland area had significant difference compared to Tilapia production in pond given that there were only four important variables or parameters out of six environmental physical, biological, and chemical parameters monitored in this study. So, the four environmental physical, biological, and chemical parameters of Tilapia Production in quarry marshland such as temperature, supplemental feeding, total dissolved solids, and dissolved oxygen must be given more attention during the actual production to get the expected yield and economical rate of return. The feeding or supplemental feeding had a significant positive effect on tilapia production; hence, this must be closely monitored to ensure higher yield.

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Chapter 1

THE PROBLEM AND ITS SETTING

Introduction

Since the early 19th century, Tilapia, a freshwater fish that is popularly known worldwide, has been cultured. Philippines is one of the major producers of farmed tilapias in the world.

As the phenomenon of the increasing population throughout the world is in occurrence, poverty pushes human society to engage in diversified means to augment income and lessen hunger among the poor. Government policies are implemented to alleviate this human condition. Global consumption of finfish and shellfish as food has doubled since 1973. Evidence suggests that the significant increase in aquatic resource production in recent decades has resulted from enormous growth in seafood demand in developing countries (Delgado et al., 2003:1).

In 2005, the Philippines ranked 8th among the top fish-producing countries globally with its total production of 3.62 metric tons of fish, crustaceans, mollusk, and aquatic plants. The country's 0.459 metric ton aquaculture production of fish, crustaceans, and mollusks in 2003 ranked 11th globally with a share of 1.1 percent to the global aquaculture production of 42.3 million metric tons. In terms of value, the country's aquaculture production of fish, crustaceans, and mollusks has amounted to over 600 million dollars (http://www.fao.org.com).

Aquaculture is regarded as one of the important sectors in Philippine fisheries, and since the decline of catches in marine fishing in 1976, it has been considered as the most dynamic (Aypa, 1995:137). It continues to increase in volume and value output, filling the gap between supply and demand for fish and other aquatic products, improving nutrition, creating new and additional employment, and contributing to the household economy, particularly in rural areas.

The Philippine Sea, as part of the Pacific Ocean, yields commercial varieties of fish such as mackerel, frigate tuna, yellowfin, and big-eyed tuna. Other species of fish that abound are dorado, anchovies, snappers, mullets, and garfish. Other marine products include lobster, crabs, squid, and fish stocks. Marine resources are being damaged by rampant illegal fishing activities, like cyanide, trawl, and dynamite fishing destroying the coral reefs, seagrasses, and fish sanctuaries, the marine habitat, and consequently lessened the catch of local anglers.

All sectors of the country posted increases in poverty incidence between the years 2003 and 2006. Fisherfolks, farmers, and children comprised the poorest three sectors with poverty incidences of 49.9 percent, 44.0 percent, and 40.8 percent, respectively. Region VIII recorded at 35.3 percent in 2003 and 40.7 percent in 2006 (www.nscb.gov.ph). The Leyte province posted a poverty incidence level of 25.1 percent in 2015 and 21.9 percent in 2018 (PSARSSO8, 2018), and 28.61 percent in 2018 (NEDA, 2018). The population growth of the province is substantially increasing from 1,413,697 in the year 2000 to 1,567,984 in 2010 with an average annual population growth rate (PGR) of 1.04 percent from 2000 to 2010 continuously, and a projected population that doubled in 67 years (NSO, 2010). With these statistical figures, it has been expected that there would be greater demand for food and protein requirements, most especially for those living below the poverty line.

Leyte is the highest fish-producing province in the region. In 2018, fish production totaled 9,585 metric tons, contributing 31.5 percent of the total fishery production in the area (http://rsso08.psa.gov.ph). During the fourth quarter of 2018, the annual total fish production of the province was recorded at 14,683 metric tons with 2,844 from commercial fisheries, 4,545 metric tons from municipal fisheries, and 7,294 metric tons from aquaculture (PSARSSO8, 2018). Therefore, the aquaculture sector must strive to become an active partner in affecting economic development to attain the food security agenda of the government by ensuring that production in the inland bodies of water and the coastal areas of the province of Leyte will be both profitable and sustainable.

On the other hand, fishing is one of the fundamental sources of income of the folks men in Tolosa, Leyte where coastal areas are regarded as the fishing ground not only to town fishers, full-time and part-time, but also to other fishers in neighboring towns. Fisherfolks from Tolosa shared the fishing ground with other coastal barangays within the municipal waters of the town itself to contribute to the municipality's total fish requirement of the community. Being part of the province of Leyte surrounded by marine waters where the major fishing ground is located that serves as primary source of fishery products, the major fishing ground is the long stretch of the Philippine Sea that hugs its southern portion encompassing the area of San Pedro Bay and the Leyte Gulf in the southwestern part of the province where Tolosa is.

On November 8, 2013, the strongest storm ever recorded, Haiyan (known as Yolanda in the Philippines), had affected the lives of 2.6 million families, 90.0 percent of whom lived in the Central and Eastern Visayas regions. The fisheries sector, mainly small-scale and artisanal fishers, suffered heavy damage, losing not only their sources of livelihood such as boats, gears, ponds, fish cages, and pens, but also their homes. To keep up with the rehabilitation of these locations, Catholic Relief Services (CRS) – INGO, in coordination with WorldFish Center (ICLARM) and the Bureau of Fisheries and Aquatic Resources Regional Office VIII, had employed and imposed a livelihood recovery program with several aquaculture options for the prospective beneficiaries, specifically the Tilapia Culture.

However, Tilapia culture is scarce in Tolosa even before super typhoon Haiyan. One of the reasons is that, before, the area is very rich with marine resources such as various kinds of fishes. Tilapia is not patronized by the locals because of the misconception that Tilapia has a bad taste and that it is fed with chicken dung. Hence, it is not safe to eat, which affects the acceptability and marketability of the local market, thus, altering local consumer, producer, and fisherfolk preference through Tilapia production.

Tolosa area had left the black sand mining excavation location due to the abundance of the mineral termed as magnetite. This is considered as a locally and naturally magnetized iron which was the basic raw material for high-quality steel. Iron, Nickel, and Copper Ore (INCO), and the predominantly stocked with freshwater by rain-fed others were supplied by underground spring which is a suitable condition for tilapia production. The environmental impact of mining includes erosion, formation of sinkholes, loss of biodiversity, and contamination of soil, groundwater, and surface water by chemicals from mining processes. Some mining methods may have significant environmental and public health effects.

Moreover, the main reasons for eating Tilapia were taste, freshness, availability, and low price. Other reasons included few fish bones, familiarity with the fish, and perception of a healthy alternative to meat. Fish is an essential source of protein, essential fatty acids, and micronutrients that are essential for good health and can help prevent undernutrition. This is specifically relevant in the Philippines wherein 3.6 million children below five years of age are found to be underweight, and four million has been discovered as stunted.

Tilapia in the Philippines is the fish of yesterday, the fish of today, and the fish of tomorrow. It is the people's fish because it is readily available, accessible, and affordable to every ordinary Filipino.

Statement of the Problem

The current study aimed to determine the development of a Resilient and Sustainable Tilapia (*Oreochromis niloticus, L*) Production in Abandoned Mine Quarrying Marshland. Specifically, it sought answers to the following questions:

1. What is the quality of water of the abandoned mine quarrying marshlands with regard to:

   1.1 Physical aspect in terms of:

      1.1.1 Temperature;

      1.1.2 Turbidity; and

      1.1.3 Color;

   1.2 Biological aspect in terms of:

      1.2.1 Plankton Density; and

      1.2.2 Macrophytes;

   1.3 Chemical aspect in terms of:

      1.3.1 pH;

      1.3.2 Dissolve Oxygen;

      1.3.3 Salinity; and

      1.3.4 Total Dissolved Solids ?

2. What Tilapia production techniques are employed for the above-mentioned environmental conditions along:

   2.1 stocking density;

   2.2 feeding;

2.3 sampling; and

2.4 harvesting?

3. What is the economic rate of return of the developed Tilapia production techniques?

Theoretical Framework

The study was fundamentally based and anchored on the theory of Allen, Botsford, Schurr, and Johnson (1984) which explicates that the evolution of the relationship between man and his/her food sources or domesticated crops is more of a pervasive process than a selective one.

It is accompanied by a technological development necessary to exploit new stocks fully and to increase productivity. The need, then, arises to shift from almost total dependence on domesticated resources, which can be achieved by increased development by Tilapia aquaculture production. The approach used reflects three (3) functionally essential areas of information about the aquaculture system:

Biological performance. To sustain life, all aquatic organisms must perform a series of biological functions, including reproduction, growth and development, uptake nutrients, respiration, and excretion.

Physical system. It presents a broad spectrum of choices that might be made to fulfill the objectives of production. Although physical systems can be widely used in form and functions, they all share unifying characteristics. These characteristics include a) resiliency; b) maintenance of the quality of water; c) provisions of adequate space to allow growth; d) a means of supplying the nutritional requirements of the culture organisms; and e) a means of interfacing various stages in the production process, each designed to enhance productivity and sustainability of different life stages of the organism.

Economic system. It involves the attainment of the goal of the culture system to achieve a certain level of profitability or return of investment.

Republic Act 8345, otherwise known as "The Agriculture Fisheries and Modernization Act," provides that it is the declared policy that the goals of the national economy are a more equitable equal distribution of opportunities, income, and wealth; a sustained hike in the amount of services and goods produced or provided by the country for the welfare of the people; and expanding productivity and improvements as the main instrument in raising the quality of life for all, most especially those who are considered underprivileged. Furthermore, R. A. 8550, otherwise known as "The Philippine Fisheries Code of 1998," stresses that "to achieve food security is an overriding consideration in the development, utilization management, conservation, and protection of fishery resources to provide the needs of the whole population for food."

During the technical conference on Aquaculture in Kyoto, Japan, the Food and Agriculture Organization of the United Nations (FAO-UN, 1976:8-9) reported the declaration on an issue, potential, and opportunities for the culture of fish and other fishery aquatic products. It declared that:

1. An imaginatively planned and intelligently applied aquaculture gives a means of supplying products of high nutritional value and revitalizing rural life, and that, aquaculture, in all of its forms, can be done in most countries, coastal and land-locked, developed and developing;

2. It has a genuine potential contribution to create for the enhancement and maintenance of wild aquatic stocks and, thereby, for the enrichment of capture fisheries, both commercial and recreations;

3. It can, in many instances, be combined with animal husbandry and agriculture with mutual advantage, and contribute substantially to integrate rural development.

4. It provides an intellectual issue and challenge to skilled professionals and to many disciplines, and it is a rewarding activity for farmers and other workers at several levels of skill and education;

5. It gives benefits now, and will continue to give, choices for sound investment of money, materials, labor, and skills; and

6. It benefits the most entire possible attention and support by national authorities for integration into comprehensive renewable energy, resources, land, and water use policies and programs, and for assuring that the natural resources on which it depends are enhanced and not flawed.

The principle of sustainable and resilient development, as a final note, adheres to the concept of conservation and management of the natural resources and the orientation of institutional and technological changes in such a manner as to assure the achievement of continuous satisfaction of needs of the human being or of the people for present and future generations. Such development conserves water, land, plant, and animal genetic resources that are non-degrading, non-environmentally, economically viable, technically appropriate, and socially acceptable (Csavas, 1995:8).

Conceptual Framework

Figure 1 presents the schema which conceptualizes the study. The study was conducted along the validated quarry area by BFAR Technical Staff at the barangays of Opong, Telegrafo, and Capangihan in Tolosa of Leyte province, where the tilapia culture is practiced by the fish farmers. The study concentrated on the assessment of the Production of Tilapia wherein its ecological requirements provide the best possible environment for the growth and survival of the fish. Physical, Biological, and Chemical parameters were the independent variables. However, the yield or production rate was a dependent variable, as well as mortality and flooded as the external factor. From these, findings and implications were made to improve technology adoption and enhance productivity for a resilient and sustainable tilapia aquaculture development.

Significance of the Study

Tilapia production is one of the fishery endeavors being undertaken by fish farmers in the Leyte province. Assessing the status of its resiliency, sustainability,

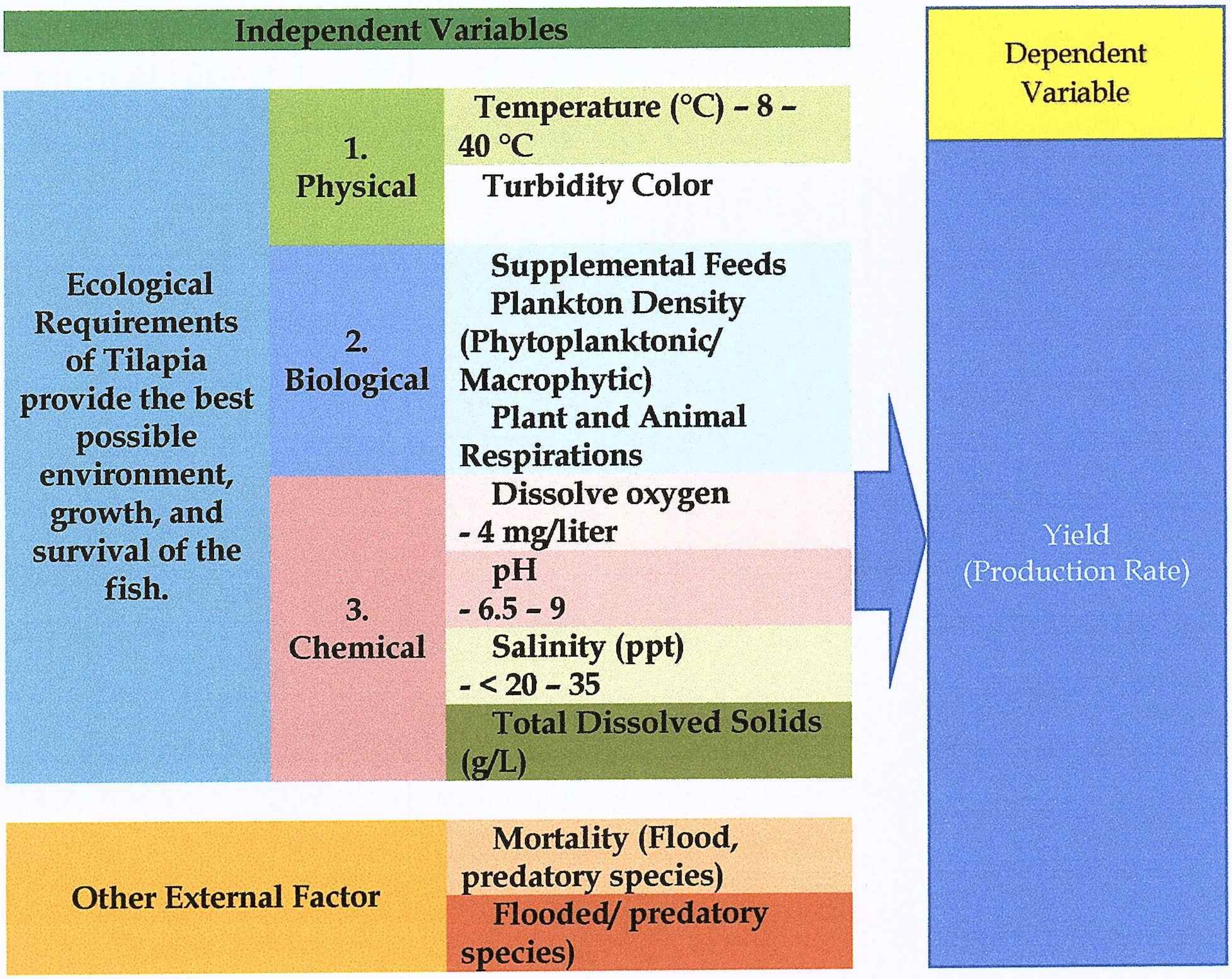


Figure 1. **The Conceptual Framework of the Study**

production, culture activities, problems, and training needs would give impetus to the rapid rural countryside development by the maximization of underutilized and idle resources through adoption of environment-friendly, responsible, and appropriate aquaculture practices while increasing income, generating employment, and enhancing the economic conditions of the fisherfolk in coastal societies. Through this investigation, methods and problems that are preventive in obtaining high aquaculture productivity could be identified, and remedial measures could be instituted to resolve difficulties.

The results of the study would be beneficial to the following sectors of society:

Tilapia Farmers. The study results would provide them with the necessary information on the level and extent of adoption on the various activities of tilapia culture technology. Through this information, they would be able to hone their competencies and capabilities in the production of the crops being cultivated. Moreover, this would serve as an avenue to strengthen their technical know-how on tilapia culture technology through training and technology transfer services offered by the various statuses of government agencies and other sectors of society offering socio-economic, resiliency, sustainability, and aquaculture productivity enhancement services.

Extension Workers. The results of this study would provide them a notion about the specific strategies that are needed to improve the economic conditions of tilapia farmers via effective delivery of their extension services.

Policy Makers. This study would provide them with adequate information on developing a framework for fisheries planning and development responsive to the food security agenda, poverty mitigation program, and sustainable agri-fisheries development program of the Leyte province, in particular, and the country, in general.

Researchers and Educators. Researchable areas identified from the study results would give them the challenge to conduct in depth-studies and investigations to generate helpful information worthy of dissemination to the ultimate users through technology transfer programs of research institutions and extension functions of higher education institutions.

The Students. This study would serve them an essential educational material for their acquisition of knowledge and skills on the status of tilapia aquaculture and the production practices of tilapia farmers.

The Community. The good practices would be adopted by members of the communities whose human and material resources warrant their adoption to improve their economic conditions by engaging in this profitable aquaculture venture.

The Future Researchers. This study could be replicated or improved by those aspiring to undertake investigations of similar nature.

To address the issue, this study answered the gap in the supply of farm tilapia in the backyard, household of typhoon survivor. Through the program, this project aimed to address food security and facilitate the development of sustainable livelihoods in typhoon-affected areas like the municipality of Tolosa. A component of the project focused on improving the livelihood and productivity of tilapia culture to provide affected communities, especially the resource-poor and marginalized, with access to a reliable, affordable, and sustainable supply of fish and an income increase.

Scope and Delimitation

The study assessed the tilapia production in abandoned mine quarried marshland using a fishnet cage enclosure. It was set fixed through a surface of the water to the bottom of pond area and firmly tied to bamboo poles for an area of 50 cubic meters (5 m x 5 m x 2 m); (please see Figure 1), with a total stocking density of 1000 fingerlings per unit of the fishnet cage; as computed to 20 fingerlings per cubic meter.

Further, it was limited to 30 tilapia fish farmers wherein 10 beneficiaries were taken from each of the barangays, namely: Capangihan, Opong, and Telegrafo of the Tolosa municipality where the study was held and was considered as the research area. This study was descriptive and focused on the ecological requirement to a possible environment, growth, and survival of fish. Of which, the independent variables were the physical, biological, and chemical parameters, whereas, the dependent variable was the yield or production rate. Then, the external factor was mortality and flooded plus production techniques along with stocking density, feeding, sampling, and harvesting, and economical rate of return of the developed Tilapia production techniques.

Definition of Terms

Aquaculture. This term refers to the operations in fishery which involve culturing and raising fish and other fishery species in brackish, fresh, and marine water areas.

Average Body Weight (ABW). The term refers to the weight that is believed to be maximally healthful for a person based chiefly on height, but modified by factors such as gender, age, build, and degree of muscular development. Hence, in the current study, it is the mass or weight of a living organism and/or the mass or weight of the total number of fish sampled randomly over the number of fish actually sampled.

Backyard Fish Cage. The term means either a floating or stationary enclosure that is made up of screens or nets sewn and/or fastened altogether and installed in the water.

Backyard Fishpond / Earthen pond. This refers to a facility that is land-based and is enclosed with stone or earthen materials to impound water for growing fish (R.A. 8550:8). In this study, this pertains to the facility employed for the culture of tilapia from a fry stage up to marketable size, and is also termed as a fish farm.

BFAR. This term is an acronym which means for Bureau of Fisheries and Aquatic Resources.

Biochemical Oxygen Demand. This term intends to measure the approximate concentration of dissolved oxygen required by micro-organisms or bacteria to decompose organic matter in wastewater or surface water.

Biomass. This is the total mass of organisms in a given area or volume.

Cage Preparation. The term pertains to the several events to be undergone prior to the stocking of fried tilapia in the cage (combination of importation and domestic production or via pure importation (R.A. 8435).

Chemical Parameter. The term refers to water chemistry or reaction of parameters in the water.

CLSU-FAC. The term is an acronym which stands for Central Luzon State University-Freshwater Aquaculture Center.

Coastal Water. This is an open water body along the country's coastline, starting from the shoreline and extending outward up to 200 meters isobaths or three kilometers distance, whichever is farther.

Contamination. This term pertains to materials introduction not commonly found in water that makes it less desirable or unfit for its intended use.

Culture days. The term refers to a certain duration from the stocking of fry until the harvest of the marketable size.

Daily Weight Gain (DWG). This is an increase in body weight. This can involve increase in muscle mass, fat deposits, excess fluids such as water, or other factors.

Dissolved Oxygen (DO). It is provided that low DO level would result in poor growth, disease outbreaks, or mortality. The ideal DO level is five ppm. This can be sustained by preventing excessive feeding and stocking. This measures the concentration of oxygen dissolved in water. The higher is the DO level, that means that the better is the condition as well for the productivity and growth of aquatic resources.

Effluent. This term refers to a discharge from a not unknown source which is delivered into a body of water or land, or a wastewater flowing out of a manufacturing plant, industrial plant, including commercial, recreational, and domestic facilities.

Eutrophication. This refers to the too much richness of nutrients in a lake or any other bodies of water, usually due to runoff from the land, which causes death of animal life due to lack of oxygen, but a dense growth of plant life.

Feed Conversion Ratio (FCR). The term pertains to a ratio measuring the effectivity and efficiency with which the bodies of livestock alters or convert the animal feed into the desired output. It is the mass of the input divided by the output (thus, mass of feed per mass of meat and/or milk).

Feed Intake. This refers to a measure of feed efficiency and is regarded as the difference between an animal's actual feed intake and its expected feed intake based on its size and growth. It is independent from the production level, and the lower the value, the more efficient the animal is.

Fish Farmer. This term refers to a person who rears fish and other aquatic products. In the study, it pertains to the 30 tilapia farmers who served as the respondents in three the (3) barangays (Opong, Capangihan, and Telegrafo) of the municipality of Tolosa.

Food Security. This term pertains to any strategy, plan, or policy aspired at assuring sufficient supplies of appropriate food at very affordable prices. Food security may be attained through self-sufficiency (i.e., providing adequate food supplies throughout the year).

Freshwater. This refers to the water containing less than 500 parts per million dissolved in common dissolved salt, sodium chlorides, such as groundwater, rivers, and lakes.

Fully Developed Fishpond. This pertains to a clean leveled location that is enclosed by dikes, at least one foot higher than the highest level of floodwater in the community and is intense enough to evade or resist the huge and strong pressure at the highest flood tide. It consists of at least a transition pond, a rearing pond, and a nursery pond, or a combination of any or all said types of ponds, and a functional control system of water that is producing on a commercial scale (DAO No. 3, 1998). As used in the study, it refers to tilapia farms provided with dikes enough to impound a considerable amount of water during the cultured period, with water control structure and net enclosures, either in a totally cleared areas or with mangroves growing inside the compartments.

Groundwater. The term refers to subsurface water that occurs beneath a water table in soils and rocks or in geological formations.

Harvest Weight. This pertains to a measurement of the weight of a harvested product, or the yield of the crops, or the percentage of the total plant weight of a crop. This also refers to the origin of harvest index.

Heavy Metals. This is a collective term for high-atomic mass metals, particularly those transition metals, such as lead, mercury, and cadmium that are toxic and cannot be processed by living organisms. Its huge dimensions (e.g., submarine or surface landslide) affect local and regional socio-economy to a large extent (e.g., tsunamis).

ICLARM. The term is an acronym which stands for International Center for Living Aquatic Resource Management.

Inland Water. This term pertains to all flowing or standing water on the land's surface (such as lakes, rivers, and reservoirs) and all groundwater on the landward side of the baseline from which the breadth of territorial waters is measured.

Integrated Farming. This is a whole-farm management system that aims to deliver more sustainable agriculture. It also pertains to the agricultural systems that integrate crop and livestock production.

International Non-Governmental Organization (INGO). This is an agency, an institution, a foundation, or a group of people whose goal is to support and assist other people's organizations/associations in varied ways involving, but not limited to, organizing, educating, training, researching, and/or resource accessing.

Nitrates. These include nitrate salts of ammonium, sodium, potassium, and calcium. These come from soil fertilizers during agricultural runoff, sewage discharge, and septic systems, where they are formed as by-products of the decomposition of animal or human wastes.

pH. The term refers to hydrogen ion concentration which determines the acidity or alkalinity of the water. At pH 6.5 to 9.0, fish grows fast and thrives well. Below or above this range results in poor growth or mortality. pH level can be indicated through laboratory analysis at BFAR.

Physical Parameter. This refers to the water parameter which can directly see, feel, smell, and taste.

Phosphates. The term pertains to the quantity of phosphorus present as phosphates. It is a common constituent of fertilizers and organic wastes in sewage and industrial effluent.

Point Source. It is any identifiable source of pollution with a specific point of discharge into a particular water body.

Pollution Load. This is the amount of pollutants being discharged into the environment. It is also the product of the wastewater quality or concentration, and the volumetric rate of discharge.

Pond Preparation. This refers to the various activities undertaken before stocking fry tilapia in a pond.

Post-harvest Facilities. These involve, but are not restricted to, fish landing, fish port, ice plants, cold storages, and other fish processing plants.

Post-harvest Technique. This refers to all techniques and processes done on the fish after harvest, whether or not a change in physical or chemical form occurs (Espejo, 1992:78). As used in the study, it pertains to the handling of Tilapia in good condition after the harvesting process.

Production. The term refers to the elaboration of organic matter by the organism in the specified area of volume over a given period (Stickney, 1979:356). As used in the study, it pertains to tilapia fingerlings raised to a marketable size in a given culture duration.

Resiliency. It is the ability and the efficiency of a community, society, or a system exposed to hazards to absorb, resist, or accommodate to and recover from the effects of a risk or danger in an efficient manner and timely manner, including the restoration and/or preservation of its vital and basic functions and structures. It is the capacity to recover quickly from difficulties or its toughness. Further, it is the ability of a substance or object to spring back into shape or its being elastic.

Responsible Aquaculture. Almost half of the seafood we eat comes from farms, and seafood farming—also known as aquaculture—is the fastest-growing food production system, globally. As the majority of wild seafood is already overfished, we will have to rely on aquaculture to satisfy growing demand.

Runoff. It is a portion of rainfall or irrigation water flowing across the ground's surface and is eventually returned to streams.

Salinity. The freshwater tilapia can tolerate salinity up to 5 parts per thousand (ppt). However, beyond this amount is not desirable. Saline-tolerant tilapia can tolerate salinity as high as 15 ppt to 25 ppt. This breed is commonly cultured at brackish water areas. Salinity measures the salt concentration of water, usually measured in parts per thousand.

Sanitation. It is the improvement of environmental conditions in households that affect human health using drainage and proper disposal of sewage and refuse. Septage and Sludge are produced in individual on-site wastewater disposal systems, such as septic tanks.

Sustainability. It is something that improves "the quality of human life while living within the carrying capacity of supporting eco-systems."

Stocking Density. The term refers to the number of stocks per hectare on a grazing area or unit at any time and is usually used to describe the number of stocks per unit area in a high-density grazing situation.

Surface Water. It refers to all waters open to the atmosphere and subject to surface runoff.

Survival. It is the state or fact of continuing to live or exist, typically despite an accident, ordeal, or challenging circumstances. In this study, it pertains to the opening at the surface or which that is held and covered in a place by wooden/bamboo stalls and posts or varied floats and anchors.

Temperature. The term pertains to the optimum or ultimate temperature of water which is desirable for the growth of Tilapia, and that is 29 ˚C–31 ˚C. However, the cold-tolerant Tilapia could grow and thrive well in temperature as low as 15˚C to the average volume of the harvested products in weight under a given unit of space, expressed in kilograms per hectare.

Total Ammonia. The unionized ammonia is undoubtedly a highly toxic element to fish. The safe level of unionized ammonia is between 0.02 – 0.05 mg/l. However, the presence of too much ammonia in the pond water exhibits a pungent odor. Yet, this can be prevented by avoiding overfeeding.

Total Suspended Solids. These refer to the concentration of undissolved solid particles in water (e.g., silt, decaying plant and animal matter, and domestic and *industrial* wastes) which are indicative of the extent of sedimentation resulting from land-based activities.

Turbidity. The word refers to the existence of suspended solids in the water that contribute to its turbidity. These suspended solids involve silt, sediment particles, and organic matters (e.g., residues, fecal materials, and phytoplanktons). Turbidity can be harmful or beneficial in tilapia culture. If it is because of the existence of planktonic organisms (wherein water is green in color), it is beneficial since it acts as food for Tilapia and, thus, enriches growth. However, if it is due to suspended silt or other solids, it would only suffocate the fish and would eventually result in mortality of stocks. The ideal level of turbidity is 1,300 mg/l or 25-35 cm visibility using Secchi disc. Hence, below and above this level is a condition unfavorable for tilapia.

Wastewater. This pertains to the waste in a liquid state containing pollutants.

Water Body. This term refers to both man-made and natural bodies of fresh, saline, and brackish waters, and also includes, but is not restricted to, groundwater, aquifers, springs, streams, creeks, rivers, lagoons, ponds, water reservoirs, estuarine, bays, lakes, and marine and coastal waters. Water bodies do not refer to those constructed, developed, and used purposely as water treatment facilities and/or water storage for recycling and re-use that are integral to process industry or manufacturing.

Water Body Classification. It is the categorization of water bodies taking into accounts, among others, the following: 1) size, depth, surface area covered, volume, direction, flow rate, and stream gradient; 2) existing and present quality of the water body; 3) most beneficial existing and future use of said water body and its surrounding land; and (4) vulnerability of surface and groundwater to contamination from the pollutant sources.

Water Level/Depth. As used in this study, the term provides that the level of the water should be maintained at 1.2–2.0 meters. For semi-intensive culture management, it is recommended to freshen the water during the earlier months and change it (30% only) twice a month on the third month and weekly on the last month. Water freshening should be made instantly if problems are observed on the tilapia stocks.

Water Management. This pertains to some essential water parameters that need to be monitored.

Water Quality. The term refers to water characteristics that determine its use in terms of chemical, biological, physical, bacteriological, or radiological features by which the acceptability of water is assessed.

Water Quality Criteria/Guideline. This entails the level for a water constituent or the numerical values of chemical, biological, physical, bacteriological, or radiological parameters which are used to classify water resources and their use, not resulting in significant health risk and not intended for direct enforcement, but only for water quality management purposes, such as determining time trends, evaluating stages of enhancement or deterioration of water quality, and taking positive action in controlling, preventing, or lessening water pollution.

Water Quality Management Area. In this study, the term refers to certain designated areas using appropriate physiographic units (i.e., watershed, river basins, or water resources regions), having similar hydrological, hydrogeological, meteorological, or geographic conditions which affect the physiochemical, biological, and bacteriological reactions and diffusions of pollutants in the water bodies, or otherwise share a common interest or face similar development programs, prospects, or problems.

Weed Control. The term exemplifies that the growth of weeds such as water lily and kangkong in ponds affects the photosynthetic activity, thereby, limiting the natural food's production. During pond preparation, the excessive fertilization enhances the growth of aquatic weeds. Some fishpond operators use grass carp as a tool for biological control for weeds.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter presents the pieces of information that were found to be relevant to the current study. These were taken from books, journals, as well as from published and unpublished sources.

Related Literature

Tilapia, which is native to the Middle East and the Nile River region of Africa, became a popular choice for fisheries worldwide, given its durability, high survival rates, and culinary value.

Tilapia is a hardy, freshwater fish tolerating a wide range of water conditions. This entails that it is easy to farm, highly adaptable, omnivorous, and adapts eating habits to available food like phytoplankton or benthic algae, but readily accepts compound feed, can tolerate low oxygen levels and a range of salinities, occupies a wide range of habitats like ponds, rivers, lakes, canals, irrigation channels, and has high reproductive capacities. It is a significant source of protein, particularly in developing countries, making it a good choice for farming.

Tilapia is farmed in about 85 countries worldwide (FAO, 2002), and about 98% of them produced in these countries is grown outside their original habitats (Shelton, 2002). Although he basic and fundamental cultural industries are in the

Far East, still, they are increasingly being farmed in the Caribbean, Latin America, and lately, in temperate countries where warm water through artificial means (thermal effluents or geothermal springs) are also available.

There are approximately 70 species of tilapia. Most of them are native to the Western rivers of Africa (Anon, 1984). Among these, nine (9) species are used in aquaculture worldwide (FAO, 2002). However, tilapia production is concentrated mainly on Nile tilapia (O. niloticus), Mozambique tilapia (O. mossambicus), and Blue tilapia (O. aureus). Among these three (3) species, O. niloticus has for many decades been responsible for the paramount increase in global tilapia production from freshwater aquaculture and is accounted for about 83.0 percent of total tilapias produced worldwide (FAO, 2002) (Figure 1). Mair (2002), however, dissented that production data on O. niloticus might not accurately manifest the correct figure. In China, for instance, it is estimated that as much as 60.0 percent of the species produced is, in fact, production of an O. niloticus x O. aureus F1 hybrid. Albeit most of its reported productions are from feral populations, O. mossambicus is the succeeding predominant tilapia species, contributing about 4.0 percent of the world's total tilapia aquaculture production.

In the study of Pullin (1983), he differentiated various tilapia species with culture potential and suggested that research efforts be focused on O. niloticus and O. aureus. Shelton (2002), on the other hand, claimed that while the latter is still used to produce the hybrids, it has been effectively left behind, as O. niloticus has led as the principal species for culture in various parts of the globe. This species is the most favored by farmers due to its suitability for farming in various culture environments or systems, ranging from extensive, low input pond culture to intensive recirculating systems.

Tilapia is the cheapest and most easily digested animal protein obtained from natural sources for consumption since time immemorial. However, due to overexploitation and pollution, its availability in natural waters has declined considerably, forcing scientists to adopt several methods to increase its production. Fish farming in controlled or under artificial conditions has become the easier way of increasing fish production and its availability for consumption. Farmers can easily take up fish culture in tanks, village ponds, or any new water body and can improve their financial position substantially. It can also provide gainful employment for skilled and unskilled youths.

In 1970s, the Central Luzon State University (CLSU) has made known a species of tilapia from Israel and Thailand which is called Nile Tilapia. This has originated in Africa and the Middle East. It is the most widely farmed tilapia worldwide (85 countries outside its native habitat). Then, in the early 80s, the International Center for Living Aquatic Resources Management (ICLARM), now WorldFish, through its national research partners CLSU-Freshwater Aquaculture Center (FAC), AKVAFORSK, BFAR/ NFFTC, and UP-MSI, introduced the first tropical selective breeding program for Nile tilapia. This gave existence to the Genetically Improved Farmed Tilapia (GIFT) strain which is distributed locally and throughout Asia.

This strain was further enhanced; hence, the GIFT-derived strains like ExCEL, GenoMar tilapia, and GIFT-Malaysia were developed. CLSU–FAC also generated its own genetically enhanced Nile tilapia strain, the FaST (FAC Selected Strain, a.k.a. IDRC strain), and produced the 35th generation of selected breeds. Despite these innovations in tilapia production and the Philippines being one of the 10 most prominent Tilapia producers worldwide, its production mainly goes to the domestic market. The national marketable size still fails to address the international requirement for live and fillet fish. Hence, it is necessary to have better technological innovations to boost its production (PCAARRD ISTP flyer, 2012).

The concentration should also be on product enrichment, specifically on packaging and marketing Tilapia as fillets, selecting appropriate pricing, and distributing mechanisms to compete in the global market (Yosef, 2009). This is also termed as Nile mouthbrooder or Nile perch. The most important and abundant in production, capture, and aquaculture is the Nile Tilapia (Oreochromis niloticus), followed by the Blue Tilapia (Oreochromis aureus), Mango tilapia (Sarotherodon galilaeus), and Sabaki tilapia (Oreochromis spilurus). In the 21st century, tilapia is dubbed as "wonder fish." Most tilapia consumed in the United States came from China and Taiwan (frozen) or Central and South America (fresh). Less than 10.0 percent of tilapia consumed in the U.S. was farmed domestically.

Tilapia is now the second most popular farmed fish in the Philippines (after the bangus). A report from Globefish.org depicted that Nile Tilapia (Oreochromis niloticus) was made known to the Philippines in the mid-1960s. An excerpt from Globefish report on the Nile Tilapia stated that while the significant worldwide distribution of tilapias, primarily Oreochromis mossambicus, happened during the 1940s and 1950s, the distribution of the more desirable Nile tilapia occurred during the 1960s up to the 1980s. Nile Tilapia from Japan was made known to Thailand in 1965, and from Thailand, they were sent to the Philippines. Nile Tilapia from Cote d'Ivoire was, then, introduced to Brazil in 1971, and from Brazil, they were sent to the United States in 1974.

In 1978, Nile Tilapia was made known to China, which led the world in tilapia production and constantly produced more than half of the global output every year from 1992. A mild, white fish, Tilapia has been available year-round. It is available whole, fresh, frozen, or even live in some Asian restaurants. It can also be found as fresh or frozen fillets. Tilapia is well-known as izumidai when prepared for sushi. Tilapia was the 4th favorite seafood in the U.S. in 2010, moving up from its previous position as 5th favorite. And because it is an affordable fish, worldwide demand continues to grow (Globefish.org).

Based on the report of Seafood Watch by the Monterey Bay Aquarium, tilapia is the most widely grown among any farmed fish. Tilapia was the world's top aquaculture fish as posted on April 20, 2012.

Approximately 16.0 percent of the world's population relies on fish as their primary source of nutrition. At the same time, third of the global fish stocks are fished over the limits of biological sustainability. This means that there is direct food competition in which the more affluent populations are risk-taking fish from groups without other means of acquiring similar sustenance. Wild fish harvest has effectively increased. The continued world hike in demand must be met by aquaculture. However, off-shore tilapia aquaculture is faced with a raft of environmental predicaments, including eutrophication caused by the spread of disease, leakage of antibiotics to combat the conditions, fish excrement, and the creation of antibiotic-resistant bacteria. These ecological problems restrict the growth of off-shore aquaculture. Deep-water open farming is mooted as a solution, but does not solve any of the ecological issues which somehow dilutes them at a significant expense, instead.

Five classifications of Red Tilapia have been cultivated with an annual estimated production of 80,000mt per year. The semi-intensive culture of Red Tilapias in 6-18 m3 cages has allowed Brazilian producers to obtain a productivity rate of 100 to 305 kg per m3 per cycle (Alceste & Jory, 2002; Costa et al., 2000). Tilapia cage ranching in large lakes has also become dominant in Colombia and Mexico where fisheries had been established in new reservoirs that were repeatedly stocked with tilapia fingerlings (Fitzsimmons, 2000).

Dr. Kevin Fitzsimmons reported that one crucial issue in tilapia aquaculture was how to handle effluents to lessen the impact of aquaculture on the environment. Water quality problems led to significant fish kills due to eutrophication from effluents of aquaculture facilities. In the olden days, animal wastes from farms were recycled and used to fertilize crops. As aquaculture activities intensified, there was a need to reuse the nutrients and return them to plant/crop production systems. The Philippines was a significant world producer, ranking eleventh among the 80 fish producing countries of the world. The fishing industry contributed 3.8 percent to total GDP and 18.6 percent to GVA in the agriculture industry group, valued at P34 billion (constant prices). The importance of this sector was to further emphasize that fish was the primary source of animal protein in the diet of the average Filipino and constituted 12.0 percent of total annual food intake (Siason, 2014).

Many of the Philippine population reside in the coastal zone. Most of the families in coastal communities depend chiefly on the sea for subsistence; coastal populations are young and expanding at rates that exceed regional and national averages. Inshore fishing is a significant source of fish, food, and livelihood for many coastal areas. Through the vast fishing history, the marine resources are now slowly disappearing. As a result, the income of fishers is not enough to sustain the needs of their families, so that alternative source of livelihood like tilapia aquaculture farming are encouraged to find a way to get more income for their families.

Philippine fisheries are endangered and need management. While huge benefits are gained from fisheries in the Philippines, their integrity is threatened by many decades of poor management. Fisheries contribute significantly to revenue, employment, foreign exchange, earnings, and security and, thus, the security of the country. However, these benefits are continuously being dissipated due to declining fish catch, habitat degradation, and an increasing people dependence on the resources. Municipal fisheries also include tilapia aquaculture operations in ponds either on land or in mangrove area, fish pen, or cages in nearshore areas. Consequently, the fishing status declines.

In the Philippines as well as globally, the fisheries system is facing collapse and is generally overfished. World fish production has reached a plateau at 90 million t/year (McGinn, 1998a). The total Philippine fish production has leveled off at around 2.7 million t/year in the 1990s. The increase in total production is accounted for by the growth in aquaculture.

The constant decrease in fish catch shows a grave threat to food security and results in greater poverty and contrasts between commercial and municipal fishers. As a result of decreasing fish catch and increasing population is also a decline in the per capita consumption of food fish. In 1988, the per capita consumption was about 40 kg/year. Ten years later, this figure had dropped to 36 kg/year and was continuing to fall. This decline was much more pronounced in fishing communities that made consumption of fish possible for urban consumers. This was because fishers tended to sell the most valuable fish for cash income as prices rose in the cities, thus, leaving only little stocks and a more inadequate quality fish for their consumption.

This trend is worldwide and is producing a protein deficiency in many fishing communities (Courtney et al., 1998; McGinn, 1998a, 1998b). If the growth of the population remains at its current and rapid pace and nothing is done to arrest the overfishing and habitat destruction patterns dominant in the country, it was anticipated that by the year 2010, only 10 kg of fish would be available per capita (Bernascek, 1996). While the government had embarked on various food security programs, there had not been sufficient importance given to fish compared to its more privileged cousins, rice, corn, chicken, and other livestock, declining municipal fisher income. Hence, Smith (1979) provided a graphic description of the ordinary life of a municipal fisher.

Tilapia has come into existence from mere obscurity to one of the most generative and internationally traded food fish around the globe. The farming of tilapias in its crudest form is believed to have been made known more than 4,000 years ago from Egypt. The first reported scientifically oriented Tilapia culture was held in Kenya in 1924 and later spread throughout Africa.

Tilapia was then transplanted and had been established as a potential farmed species by the late 1940s in the Far East. A decade later, it spread in the Americas. The last three decades had seen prominent developments in the farming of tilapias worldwide.

Due to the increasing commercialization and continuing growth of the tilapia industry, the said product is not only the second most significant farmed fish globally, next to carps, but is also regarded as the most essential aquaculture species of the 21st century (Shelton, 2002).

It is, indeed, an important source of protein, especially in developing countries, making it a good candidate for farming. In the Philippines, the land provided 122,316 metric tons (MT) of tilapias in 2002 which signified 93.0 percent from freshwater ponds and cages, and only 7.0 percent from brackish water ponds (BFAR, 2003). In 1991, tilapias found in the brackish water ponds of the country was 14,072MT or 18.0 percent of the total output for Tilapia (Guerrero, 2004).

Since the emergence of the Mozambique tilapia (Oreochromis mossambicus) in the country in 1950 and the Nile tilapia (O. niloticus) in 1972, Tilapia had become the second most crucial food fish grown in ponds. Milkfish (Chanos chanos) was the predominant culture species in the country's 239,323 ha of brackish water ponds, followed by the tiger shrimps (Penaeus monodon), and the Mozambique tilapia (Guerrero, 2004).

Despite these innovations in tilapia production and the Philippines being one of the 10 most prominent Tilapia producers worldwide, its production mainly goes to the domestic market. National marketable size still fails to meet the international requirement for live and fillet fish. Thus, there is a need for better technological innovations to boost its production (PCAARRD ISTP, 2012).

In sustainable fisheries development, the coordination among the stakeholders could be impoved through the consolidated process of collaboration. The famous quote of John Donne: "No man is an island" is very suitable for the fisheries sector because not one fisher-stakeholder could be self-adequate without relying on another for survival. As human beings, fisher-stakeholders must interact with consumers, for without the consumers and the market, fishers' fish and fishery products could be wasted, depriving them of their incomes. In organizations, interaction with others within and outside their environment is imperative because working alone could exhaust and weaken one's available resources hindering the ability to attain the desired goal, as demonstrated in another quotation which goes "alone, very little could be done, but together, much could be achieved."

Following the above sayings, the Southeast Asian Fisheries Development Center (SEAFDEC) had collaborated with the concerned agencies and organizations to speed up the sustainable development of Southeast Asian fisheries. During the fast-changing world of action, SEAFDEC had been receiving accolades in sustainable aquaculture and fisheries development. It had accomplished in a much shorter time because of its efforts in establishing collaboration and cooperation with various concerned agencies, notwithstanding the need to safeguard its human and financial resources (Ordonez et al., 2019).

This study highlighted the growing significance of aquaculture and explored the benefits and barriers to transforming flooded pits and impoundments into aquaculture operations. Among other services, tilapia aquaculture may provide a much-needed source of revenue, employment, and in some cases, food to communities impacted by mine closure.

Further, tilapia aquaculture in a controlled closed environment may be more acceptable to critics of fish farming who are concerned about fish escapes and viral transmissions to wild populations. Despite the potential benefits, tilapia aquaculture in flooded pits and impoundments is not without its complications. It requires a site-specific design approach that must consider issues ranging from metals uptake by fish to the long-term viability of the aquatic system as fish habitat to the overall contribution of aquaculture to sustainability. Published by the Proceedings of the International Forum on Tilapia Farming in the 21st century (Tilapia Forum, 2002), the term 'environmental sustainability' may be defined as the continued enhancement of human welfare while protecting the source of raw material for human necessities and assuring that the capacity of sinks for human wastes is not exceeded. Waste production should be within the assimilative power of the system, and that the use of resources should be within the regeneration rates of the system.

The factors contributing to this sustainability include the intensity of inputs depending on the level of productivity, security of the crop, investing in human capital, corrected sited structures, degree of dependence on equipment, selection of suitable candidate aquatic organisms, and introduction of other cultivable species. The three (3) components of sustainable culture systems are bio-physical and socio-economic development, an enabling environment, and marketing innovation. The scale of operation of sustainable culture systems also needs to be addressed as to whether it should be many small culture systems or a few big ones.

There should be a mechanism to ensure the sustainability of culture systems by enacting laws and their enforcement. Examples are the Fisheries Code of the Philippines and the regulations for protecting the "internal environment" of India and Thailand. Sustainable culture systems for Tilapias, with the decline of natural resources due to extensive urbanization and industrialization, the government should provide support to industry for culture systems that can utilize water for integration of aquaculture with other crops. The use of purified water from sector should also be considered.

Sustainability can be improved by making new technology available to the industry including improved feeds that will provide just the nutrients that the fish needs and will reduce pollution, and the integration of tilapia aquaculture with various plant production systems to reduce eutrophication from effluents.

To enrich production of food and bolster the fish-export business in Eastern Africa, the Tilapia was made known to Lake Victoria, the biggest tropical lake in the world, which is regarded as the primary source of sustenance for the people of Kenya, Tanzania, and Uganda (U.S. Department of State Website, 2018).

After almost thirty years, the socio-economic situation of rural fishers is the same. Socio-economic reports for the Fishery Sector Program (FSP) in 1996 noted that 80 percent of fisherfolk households were living below the poverty threshold. The average family was 5.5 members, more significant than the national average (PRIMEX, 1996). House was made of light materials, while 60 percent did not own the land in which their houses were built, i.e., they were renting or squatting. Access to education, electricity, and water was limited.

Shortage of cheapest source of protein after Yolanda had been a significant, major setback brought about by the damages caused to the essential habitat like mangrove, corals, and seagrasses including river system. Hence, Tilapia has already been recognized as one of the alternate sources of protein. However, the supply of Tilapia in this part of the country was too limited. Secondly, Leyte province has vast areas for backyard freshwater ponds, particularly in Tolosa, Leyte.

Related Studies

Relevant findings of previous studies conducted that are useful to expound the discussion on Tilapia Production were reviewed by the researcher and stipulated in this section to shed light on the current research.

Masser (2018) stated that majority of cage culture was practiced in quarries or ponds. However, not all quarries or ponds were suitable for the cage culture of fish. Several failures in cage production had existed because of poor site selection. It was recommended that before one attempts to cage culture, it must be made sure that the body of water chosen would support the increased biological demand placed upon it.

In Asia, the Philippines was the first to cage culture in reservoirs and lakes, and practiced semi-intensive and intensive farming (Guerrero, 2002). It was recorded that in 2000, the country's cages in 2000 ha of water produced a total of 33,067mt of O. niloticus. The average yield of 540 kg/100m2 enclosure was achieved with O. niloticus (mean weight of 175g each) after five months of rearing fingerlings. Unlike in the country where most cage farmers used Nile tilapia, farmers in Malaysia, China, and Singapore preferred to grow Red Tilapia hybrids in cages in former rivers, mining pools, irrigation canals, reservoirs, and lakes utilizing the semi-intensive and intensive method (Orachunwong et al., 2001; Guerrero, 2001).

In Thailand and Indonesia, the cage culture of O. niloticus and Red Tilapias in rivers, irrigation canals, reservoirs, and lakes, and the use of semi-intensive and intensive methods are practiced. Tilapia cage culture in Indonesia is primarily found in West Java, Jambi, South Sumatra, and Kalimantan (Guerrero, 2002). On the other hand, little information is available on cage culture in Africa. Jamu (2001) emphasized that cage culture systems which existed as a pilot or fully operational, primarily in Southern and West Africa, had not prominently contributed to actual tilapia production. However, a few had become successful in their cage culture operations, and the biggest was found in Northern Zimbabwe.

According to Costa et al. (2000), in America, it was Brazil that dominated the tilapia cage culture industry, and commercial cage culture operations were the major suppliers of the fish sold within and outside the country. Food production systems were of specific interest because food production was among the most prominent drivers of global environmental transformation by contributing to freshwater use, climate change, land system change, biodiversity loss, and interference with the global nitrogen and phosphorous cycles. Within food production, protein was of certain interest, as global demand was increasing and as populations became more affluent. This was, indeed, causing a nexus conflict.

Several different locations may be adapted to cage culture. Potential sites include lakes, reservoirs, quarries, ponds, streams, and rivers. The following are the criteria that should be taken into account before attempting to have cage culture in an existing quarry or pond. The surface area should be at least one half acre and preferably an acre or larger (but should not involve weed-infested areas of the pond). The pond should be at least six feet deep over a sizable place, and most of it should be more than three feet deep. Also, it must have good water quality and should be positioned at a place where prevailing winds blow across it. It should not have direct access to livestock or huge numbers of livestock in the watershed. It should not have a highly erodible watershed nor should allow the accumulation of large amounts of organic debris. The water level of the pond should not fluctuate greatly (2 to 3 feet) during the summer. It should not have chronic problems with surface scums, aquatic weeds, overpopulations of wild fish, or oxygen depletion issues. It should have all the weather access roads.

Issues do frequently arise when small ponds (less than one acre) are used for cage culture. Those issues commonly focus on water quality deterioration, ammonia or nitrite buildup, low oxygen, and excessive algal blooms. Bottomless ponds are more likely to encounter the usual dissolved oxygen problems in the summer. Certain features of the pond's watershed can be crucial to thriving cage culture. Livestock with direct access to the pond, or located in huge numbers within the watershed, may cause water quality problems. Livestock wastes can over-fertilize the pond resulting in water quality deterioration, severe algal blooms, and eventually disaster.

These problems may also exist in ponds bigger than one acre, but the center is not as expected. Adequate depth of the pond (six feet or greater) is important for keeping the fish wastes away from the cage, sustaining an adequate circulation through the cage, and reducing the chance of weed encroachment around the cage. Livestock should be fenced out of the pond and must not be allowed to use the immediate pond watershed as a loafing area. As shorelines are trampled, erosion increases and ponds age prematurely. Even ponds frequented by livestock in previous years may contain huge amounts of organic matter.

Chapter 3

METHODOLOGY

This chapter covers the research methodology on how the study was conducted. It includes the research design, study site, experimental set-up, stocking, feeding, sampling, and monitoring of water parameters, harvesting, ethical considerations, data collection, and data analysis.

Research Design

The study used the experimental research design of assessing the yield of Tilapia cultured in a fixed fish net cage enclosure measuring 5 m x 5 m x 2 m (see Figure 2), which had been installed in an abandoned mine quarried marshland or excavated lagoon that was stocked with 1000 fingerlings per unit of the fishnet cage at a stocking rate of 20 fingerlings/m^3.

The study was conducted in Tolosa, Leyte as the locale of the survey, a pre-selected municipality, and its fish farmer-beneficiaries as validated and identified by a Barangay Selection Committee (BSC) being organized by the CRS Technical Staff, and in which said organization, the members were all represented by various stakeholders within the community or barangay. It was also with the coordination of LGU Tolosa's Local Chief Executive (LCE) and in collaboration with Bureau of Fisheries and Aquatic Resources (BFAR) Regional Office VIII and WorldFish

Figure 2. **Tilapia Fishnet Cage 5m x 5m x 2m**

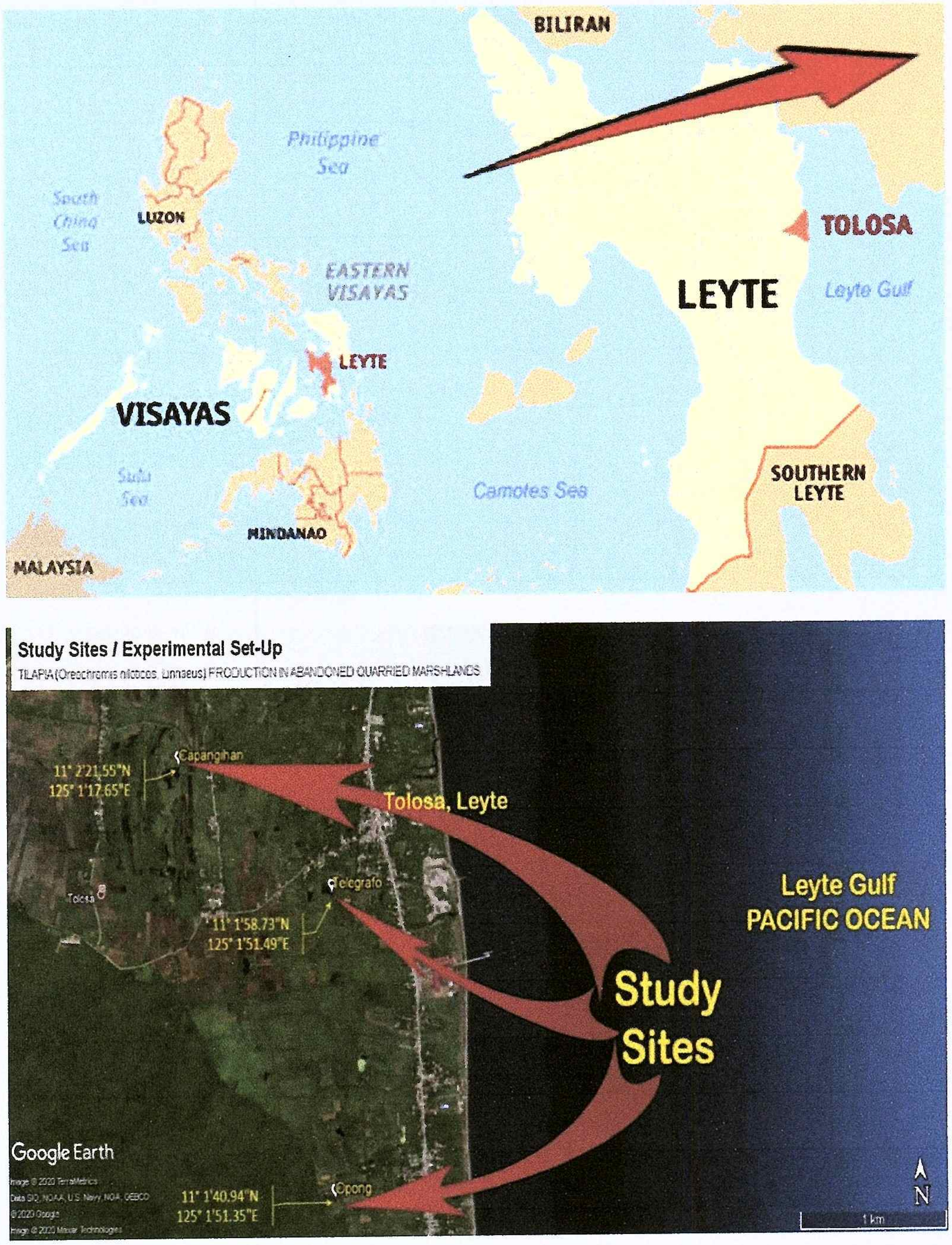


Figure 3. **The Chart Shows the Study Site and Experimental Setup**

(ICLARM) and Catholic Relief Services – United States Catholic Conference Bishops (CRS - USCCB) - INGO program intervention to typhoon Haiyan survivors.

A number of 30 fish farmers/beneficiaries were employed as respondents to the study, in which 10 fish farmers/beneficiaries were from Brgy. Opong, 10 from Brgy. Telegrafo, and another 10 from Brgy. Capangihan. These fish farmers were given an individual cage, tilapia fingerlings, and fed to start cultivating Tilapia for grow-out production.

Experimental Setup

A total of 30 units of net fish cages was setup in three sites of quarried marshland lagoon, and the validated sites, located in the three barangays, i.e., Opong, Capangihan, and Telegrafo, with 10 identified and selected tilapia farmer-beneficiaries for each of barangay, the size or dimension of the fishnet cage enclosure used for tilapia production is 5m x 5m x 2m. It was set fixed through a surface of the water to the bottom of pond area and firmly tied to bamboo poles. The total stocking density of each net cage was 1000 fingerlings, as computed to 20 fingerlings stocked per cubic meter through using a total area of 50 cubic meters of the net cage. The initial size of each tilapia fingerling stocked was two grams. The tilapia production was done in one cropping period or four-month duration. It was given with commercial feeds (Fry Mash, Starter, Grower, and Finisher pellet) for the diet or nutrition of the tilapia fish.

For the suitability of the project, the ecological requirements of Tilapia provided the best possible environment, growth, and survival of the fish. In terms of significant physical, biological, and chemical parameters, as well as production techniques of the environment profile mentioned along with stocking density, feeding, sampling, and harvesting, and the expected yield on the economical rate of return of the developed tilapia production techniques.

The profile of the study site included demography and available features which has a total population of 20,978. It is found 24 kilometers (15 mi) south of Tacloban City. Due to the abundance of the mineral found in the place which is called magnetite, the areas of the study were the abandoned black sand mining excavation sites. Predominantly stocked with freshwater by rain-fed, this naturally magnetized iron was the primary raw material for high-quality steel, INCO (Iron, Nickel & Copper Ore). Others were supplied by underground spring.

Study Site

The study site on Tilapia culture was located in three barangays of Tolosa Leyte, namely; Barangay Opong, Barangay Capangihan, and Barangay Telegrafo. Its approximate location is at Latitude 11.01804° N and Longitude 125.03093° E – Barangay Opong; Latitude 11.03932° N and Longitude 125.02157° E – Barangay Capangihan; Latitude 11.03298° N and Longitude 125.03097° E – Barangay Telegrafo; These sites have an area of about 10,000 m^2 (Barangay Opong); 10,000 m^2 (Barangay Capangihan); and 5,000 m^2 (Barangay Telegrafo) with an average depth of 3 - 5 meters.

The study site topography was plain, and bottoms type were clay loam, sandy, and muddy and predominantly stocked with freshwater by rain-fed, while others were supplied by underground spring. The project involved using mine pits and was existing for more than three decades already unutilized by a Mining corporation/s engaged in the mining activities. The project utilized these mine pits for tilapia culture has a dimension of 5m x 5m x 2m fish net cage enclosure. Based on the water physicochemical results gathered on-site in Tolosa, Leyte by BFAR VIII – EMU Technical Team, the parameters were generally within a normal range for the cultured fish to grow based on the standard range indicated in DAO 34 (Class C) or YSI Handheld Multiparameter Instrument.

However, three stations were considered suitable for tilapia culture based on the water quality parameters and size of the area. The total number of fish cage structures was suggested per identified station or site, since only 10.0 percent of the total area was used for aquaculture to avoid organic pollution or contamination of the entire capacity of the pond area, because the area was also predominant of runoff waters. Also, some of the portions unutilized were intended for the subsequent cropping, though the number of cages must be limited depending on the depth of the assessed area as this would affect the growth and survival of the cultured species.

With these stations, the depth of the assessed area was suitable and enough for Tilapia production through the use of a fishnet cage made of a net enclosure with the size structure of (5m x 5m x 2m dimension project design by CRS). In contrast, the number of cages was also limited.

Moreover, results on the heavy metal analysis on sediments samples taken were highly considered before establishing any aquaculture activities in the area as recommended by Dr. Nancy Dayap, head of Environmental Monitoring Unit of BFAR Regional Office VIII. However, there were 14 sediment samples weighing 1-2 kilogram of each, for 14 sites (including the three sites used in the study) being collected by BFAR-EMU Technical Team, and these were brought to First Analytical Services Technical Cooperative (F.A.S.T.) Laboratories based in Mandaue, Cebu City, a licensed private firm which has the expertise for analysis and soil test parameters on heavy metals (Lead and Total Chromium) and which was hired and contracted by Catholic Relief Services – INGO for said analysis and test. The aquaculture products that were harvested from these areas were free of any trace of heavy metal contaminants as the safety of the consumer was of utmost importance.

Fish Stocking

The fingerling's stocking size was nearly related to the planned output target, culture period, water source, and market size. Also, it referred to a growth period, stocking density, climate of the culture area, and mode of fish farming. As a principle, it was always better to stock bigger fingerlings, but the transportation, survival rate, and the cost must be taken into account. Tilapia fingerlings that were stocked in one cage were of uniform size (individual differences were controlled within 10 percent). Indeed, it was recommended to stock fingerlings that were larger than 5g/piece.

Before stocking, acclimatization of tilapia fingerlings was done to avoid the thermal shock that caused mortalities on the fingerlings. This was done by letting the polyethylene bag float in the cage or pond for 10–20 minutes before releasing the fingerlings. The polyethylene bag was opened thereafter for at least 10 minutes and eventually allowed the pond water into the polybag. When the temperature of the water in the polybag became similar to that of the pond's, it excreted the fingerlings into the hapa cage/net. Stocking was done early in the morning or late in the afternoon to reduce stress on the stocks. It was made sure that fingerlings were acclimatized first before releasing them into the hapa net/cage. Before stocking, the newly transported fingerlings were allowed to rest or get acclimatized (a conditioning cage is advisable); hence, the fish were allowed to go out of the transport plastic bags on their own.

Feeding Management

The fish were fed regularly. The fish in cages had limited access to natural food and needed a nutritionally complete diet. The monthly feeding plan was done based on the feed supply, temperature, and growth performance for each month. Table 1 shows the reference of the monthly and daily feeding rates.

Table 1

Feeding Regime of the Study

Days	Type of Feeds	Feeding Rate	Feeding Frequency	Estimated Daily Feed	Ideal Weight of Stock
1 to 15	Fry Mash	8% of BW	2 - 3x a day	640 g	5 - 8g
16 - 31	Fry Mash	7% of BW	2 - 3x a day	1.96 kg	8 - 28g
32 - 46	Starter pellet	6% of BW	2 - 3x a day	3.78 kg	28 - 63g
47 - 61	Grower pellet	5% of BW	2 - 3x a day	4.5 kg	63 - 90g
62 - 76	Grower pellet	4% of BW	2 - 3x a day	5 kg	90 - 130g
77 - 91	Grower pellet	3% of BW	2 - 3x a day	5.1 kg	125 - 170g
92 - 105	Finisher pellet	3 - 2% of BW	2 - 3x a day	6.3 kg	170 - 210g
106 - 120	Finisher pellet	2% of BW	2 - 3x a day	5 kg	210 – 250

Determining. In determining the daily feed ration (DFR), the average body weight (ABW), and the feed conversion ratio (FCR), the following formulas were employed:

1. $$\text{ABW (g)} = \frac{\text{total weight of fish randomly sampled}}{\text{\# of fish sampled}}$$

2. DFR – the amount of feed given daily
   = ABW x total number of stocks x feeding rate

3. TFR – total amount of feeds given for the whole culture period
   = DFR x feeding duration

4. $$\text{FCR} = \frac{\text{Amt. of feeds given during the culture period}}{\text{weight gain of fish (Kgs)}}$$

During feeding, the fish were given 5.0 to 8.0 percent of their body weight for two months and reduced to 2.0 to 4.0 percent for the remainder of the grow-out period.

The feeding amount given to the fish was only appropriate to be consumed for a particular day. If the feed given consumed about 80.0 to 85.0 percent of the actually administered feed within 15 to 20 minutes, it entailed that the given feed to them was just adequate (refer to Table 1 for the feeding times made daily).

For the newly stocked fish, the feeding usually began from the second day of stocking. Special compound feed was utilized for fingerlings with 35.0 percent protein of the crude or higher than it. The method for feeding of stockfish employed the following process:

Hand-feeding (sabog) - Broadcast Method Use of feeding bags/feeding trays - feeds were placed in B–nets (32mm mesh size) called feeding bags. The bags were tied in poles, and they were suspended in the pond water surface. Fish were obtained in the broken bags by picking or suction.

The feed had broadcasted a handful at a time to allow the fish to gather in the feeding area and maximize the use of the feed. The feeding continued in as much as the fish would consume within minutes. The feeding would be reduced or stopped when the fish responded eagerly to the feed.

The following fixed principles in feeding were practiced during the administration of the study:

i) Fixed quality: the compound feed utilized must have good palatability, must be nutritionally comprehensive, with suitable pellet size, and must be stable in water. Feed that is decayed must be avoided and feeds must be used/consumed within 4-6 weeks of its manufacture date;

ii) Fixed quantity: the feeding rate each day is typically around 5.0-8.0 percent of the total fish weight and must be eaten up within 30 minutes;

iii) Fixed time: feed twice to thrice every day, between 8:00~9:00 AM and 15:00~16:00, or 8:00 AM, 11:00 AM, and 4:00 PM; and

iv) Fixed site: choose a relatively primary site near the pond edge/cage where it is convenient for its passage and which can be considered as the fixed feeding site.

During the study's conduct, three (3) "observation" principles were practiced and included:

i. Observing weather: whenever it was sunny, and when the dissolved oxygen (DO) was desirable in the pond water, more feed was given; while whenever it was cloudy and rainy, and the condition of the DO was not likable, feed was given less; whenever it was stuffy, without wind and a thundershower was expected, feeding was given more. Hence, whenever the weather suddenly changed, the appetite of the fish would decrease, and the feeding would also have decreased.

ii. Observing water quality: more feed was given whenever the quality of the water was good, brown or glossy dark green in color, moderately fertilized, and the fish was fed vigorously. However, whenever the water was too thick, the water quality was lacking such as when watercolor turned black, and over-fertilized, less feed was given and there would be adding or changing of the water from time to time. Feeding would be put into halt whenever the water deteriorated, and whenever the fish came to the surface gasping for air.

iii. Observing fish conditions: every morning and evening, the feeding place was checked when monitoring the pond to find out the feeding situation of the fish. Feeding amount was increased appropriately if the feed was eaten up immediately after feeding. Then, the amount of feeding was reduced accordingly if the feed was not eaten up for a long period after feeding.

In feeding, the fish farmers adopted the techniques such as using a "slow-fast-slow" and "little-more-little". This means that one must feed little and slowly at the onset of feeding when only a few fish have gathered at the feeding place. However, one must feed fast and more, and must scatter the feeds to a larger area to satisfy the feeding needs of all fish when most of the fish come to the site. After a little while, one must slow down and reduce feeding gradually when about 50.0 to 60.0 percent of the fish have adequately eaten, until feeding is stopped totally when 80.0 to 85.0 percent of the fish have had enough. Using this method, one can boost the balanced growth of all fish, prevent the big fish from suppressing the small ones, minimize injuries among fish from smashing with one another, eliminate disease outbreaks, save the feed cost, and finally obtain higher economic benefits.

The sites of the feeding were fixed at a relative windward, central, and deep place where access with feed was more convenient. The catwalk or feeding platform was centered on the molded net cage depending on the area's size, and a feeding tray so that the fish could easily access the feed from a wider location. This way, it lessened the chances of hypoxia whenever fish were competing for feed, and also avoided the overcrowding during feeding which may have damaged the fishnet cage.

A method called semi-starvation was employed to domesticate the fish a few days before the regular feeding. First, prior to feeding, sounds were made by splashing water or knocking barrels to stimulate schools of fish, then, a handful of feed was given. This was repeated at an interval of a dozen of seconds, and took about 20 to 30 minutes as one training session. Indeed, fish domestication needed one's patience and diligence and must be insisted on whether fish were actually feeding or not. Thereafter, the fish were very likely to have a conditioned reflex just after one week of acclimatization, and they eventually developed the habit of clustering to the fixed point whenever feeding was done.

Feeding was done during the daytime only between 8:00 AM to 4:00 PM. The daily feed ration was divided into two or three times daily (8:00 AM and 4:00 PM, or 8:00 AM, 11:00 AM, and 4:00 PM) as applied in the research study.

Sampling Procedure

During culture, there arose the need to recount, especially when mortalities were higher than 200 pieces/cage. Monitoring of growth (every two weeks or 15 days) and mortalities determined accurate fish biomass, which was the basis in computing feed ration and projected harvest. Ideally, 3.0-5.0 percent of the population was taken during sampling, but for practical purposes and to avoid stressing the fish, the study practice took 30 individuals per 1000 of the fish population.

Table 2

First Run of the Study

Fish	Weight (g)
1	130
2	120
3	118
4	125
5	120
6	122
7	130
8	128
9	125
10	133
Total weight	**1,251 g**
Average weight	**125.1 g**
Total weight of fish in the cage	**125.1 x 1000 pcs = 125.1 kg**

125.1 kg (total weight of fish) x .04 (4%)
5.00 kgs. Kilograms of grower pellet per day for 62 -76 days (as used in the study)
5.00 kgs. = 1.67 kgs per feeding

Sampling of stock was made every after two weeks or every 15 days to determine the ABW for the adjustment of feed. Hence, the sample size was 30 pieces to assure the precise computation of the total daily feed ration for the fish. Mortality was recorded, if any, and adjusted the amount of feeds accordingly. Materials needed for stock sampling were pail, weighing scale, plastic bags, rubber band, record book, pencil/ballpen, scoop nets, marker (pentel pen), and sampling net (3 x 3 m net which looked like an inverted mosquito net).

Table 3

Feeding Amount and Frequency Daily

Quantity	Time
1.67 kg	8:00 AM
1.67 kg	11:00 AM
1.67 kg	4:00 PM

Harvesting

Harvesting was generally conducted at the end of four months as when the fish achieved the average weight of 250 gm in just three to four months. Production of 200 kg/50 cubic meters as used in the study was obtained in one crop of four months. Harvesting was done by partial scooping and repeated netting. The fish, thus, harvested was iced and sold. The fish farmers resorted to even selling live fishes to fetch better returns. Partial culling depending on the market demand was also tried out.

Harvest started once a significant percentage of the tilapia fish stock had reached the minimum size for the market. The usual market size in Leyte was 250 g (four pieces/kg), but the large-sized tilapia fish (0.5 kilograms or bigger) commanded a higher price, although the volume absorbed by the market was small. There was, therefore, an opportunity to do partial harvesting based on the market demand. It was essential to monitor fluctuations in market price to determine the best time to harvest and realize maximum profit. However, should there be a forthcoming typhoon, it was always prudent to gather regardless of the market price to avoid losing the stock. The operator usually maintained two to three major buyers.

Harvesting was done by simply lifting the net cage. For large pens, the pens were untied from the frame, and a bamboo pole was placed under the netting to gather the stocks on one side and, then, scooped by a net. Harvested fish were then sorted, counted, and weighed. Although partial harvesting was done depending on the prevailing market prices or volume that could be absorbed, it was not recommended because it stressed the remaining fish and affected their quality when eventually harvested. Excessive water allowance in harvested fish was avoided because it could be a disadvantage when marketing was delayed.

The seines were chosen with their appropriate mesh size based on individual size in staggered stocking and harvesting. The larger fish were harvested and the smaller ones were left behind. After collecting the fish, the small fish were gently put back to the pond to prevent fish mortalities caused by crowding fish altogether for a long time especially when the mesh was small.

Tilapia harvesting followed the principle of "market-oriented and balanced marketing." Since Tolosa has a warm climate with a year-round average water temperature of above 20 °C, as long as the water sources were guaranteed, tilapia farming was conducted annually. However, in May and August, it was relatively dry and cold. Those ponds that did not have water sources eventually dried up; hence, it was recommended to harvest these ponds. This consequently resulted in an oversupply of Tilapia on the market, lower prices, and obviously less profit for farmers. Therefore, when conditions allowed, farmers avoided harvesting during this period. Fish were not fed for 24 hours before harvesting or transporting.

Aquaculture could easily be affected by extreme weather events or natural disasters in Tolosa. There was a risk of drought during dry seasons and a threat of flood during rainy seasons, and when severe, farmers would make nothing from aquaculture. Nonetheless, preparations were done to lessen the risks and economic losses. Instead of improving the fishing opportunities in the lake, however, the Tilapia had caused the decimation of several fish populations (published by the U.S. Department of State Website at http://www.state.gov maintained by the Bureau of Public Affairs. Retrieve 2-22-18).

Some precautionary measures were taken before natural disasters occurred:

i) Attention was given to weather forecast and people would always update themselves of the extreme weather information and red alerts;

ii) Prior to the existence of extreme weather, a marketable size of fish in the cage were taken or harvested and sold at the appropriate time to prevent losses when disaster would strike;

iii) There was reinforcement of aquaculture buildings and infrastructure and avoidance of leakage;

iv) The DO in the pond water was commonly at its low level prior to extreme weather events; thus, close attention was also given to possible changes of the water quality to avoid the tilapia gasping for air because of hypoxia;

v) Again, prior to extreme weather events, the water level was properly lowered in tilapia ponds because heavy rains would also make the water level rise. Lowering the water level at an appropriate time could efficiently and effectively prevent tilapia from escaping when said water level rises too high;

vi) The posts, catwalk, rope, ties, and cover of the net cage were reinforced. Before a disaster, the net cage was inspected, those nets which were old and damaged were reinforced or heightened to avoid breakages, and all sides of the net and the cover were ensured to be tightened, thereby, preventing deterioration of the cage, leaking, and escaping of fish when water levels rose;

vii) Also, prior to extreme weather events, nutrients like Vitamin-C complex were mixed into the feed to enrich the anti-stress capabilities of the farmed species; and

viii) Whenever disaster was coming, ponds were assessed and monitored more frequently to easily find and resolve problems in due time.

The following were some suggestions to timely recover the production after extreme events. After a disaster, the farm must be inspected in time to find out the impact and to make efforts to recover production:

i) If there was any fish net/cage that had been damaged, the debris were cleaned up as soon as possible and dead fish were taken out to prevent environmental pollution and emergence of disease. The net/cage that was damaged was repaired in due time to resume the fish production as soon as possible;

ii) Nevertheless, the main task was to control the reproduction of pathogens for those cages that have no damage. Quicklime, one of the disinfectants known, were spread at an appropriate time to enhance the quality of the water;

iii) Also, the fish were disinfected with drugs, also at an appropriate time, to avoid secondary diseases such as fungal infections and skin ulcers due to the abrasion of fish bodies;

iv) For cages that were disinfected, proper DO levels were assured. Whenever it was convenient for draining and filling and vice versa, fresh water was used to replace some parts of the pond water, and fertilizer was mixed in the pond at a timely fashion to stimulate natural food production in it, which in turn boosted the fish growth; and

Table 4

Economic Rate of Return

Total No. of Fish Stocked per Cage	Estimated			Reported Mortality Rate		Computed Yield Based in the Reported Mortality Rate		Actual		Variance	ERR%	Remarks
	Mortality Rate @20% @ 250grams per piece	Price per kilo @80.00 pesos	Gross Income	%	Pieces	Pieces	Kilos @250 grams per piece	Price per kilo	Gross Income	Actual vs. Estimated Gross Income		
1000	200	80	16,000.00	100	1000	0	0.00	0	-	(16,000.00)	0%	Stolen
1000	200	80	16,000.00	100	1000	0	0.00	0	-	(16,000.00)	0%	Stolen
1000	200	80	16,000.00	12	120	880	220.00	80	17,600.00	1,600.00	110%	
1000	200	80	16,000.00	25	250	750	187.50	80	15,000.00	(1,000.00)	94%	
1000	200	80	16,000.00	100	1000	0	0.00	0	-	(16,000.000	0%	Stolen
1000	200	80	16,000.00	25	250	750	187.50	100	18,750.00	2,750.00	117%	
1000	200	80	16,000.00	35	350	650	162.50	100	16,250.00	250.00	102%	
1000	200	80	16,000.00	5	50	950	237.50	100	23,750.00	7,750.00	148%	
1000	200	80	16,000.00	12	120	880	220.00	100	22,000.00	6,000.00	138%	
1000	200	80	16,000.00	25	250	750	187.50	100	18,750.00	2,750.00	117%	
1000	200	80	16,000.00	19	190	810	202.50	100	20,250.00	4,250.00	127%	
1000	200	80	16,000.00	40	400	600	150.00	100	15,000.00	(1,000.00)	94%	
1000	200	80	16,000.00	20	200	800	200.00	100	20,000.00	4,000.00	125%	
1000	200	80	16,000.00	15	150	850	212.50	100	21,250.00	5,250.00	133%	
1000	200	80	16,000.00	5	50	950	237.50	100	28,500.00	12,500.00	178%	Affected by flooding
1000	200	80	16,000.00	35	350	650	162.50	100	16,250.00	250.00	102%	Affected by flooding
1000	200	80	16,000.00	5	50	950	237.50	120	23,750.00	7,750.00	148%	Affected by flooding
1000	200	80	16,000.00	12	120	880	220.00	100	22,000.00	6,000.00	138%	
1000	200	80	16,000.00	25	250	750	187.50	90	16,875.00	875.00	105%	
1000	200	80	16,000.00	19	190	810	202.50	90	18,225.00	2,225.00	114%	
1000	200	80	16,000.00	40	400	600	150.00	100	15,000.00	(1,000.00)	94%	
1000	200	80	16,000.00	20	200	800	200.00	100	20,000.00	4,000.00	125%	
1000	200	80	16,000.00	15	150	850	212.50	100	21,250.00	5,250.00	133%	
1000	200	80	16,000.00	5	50	950	237.50	100	23,750.00	7,750.00	148%	
1000	200	80	16,000.00	10	100	900	225.00	100	22,500.00	6,500.00	141%	
1000	200	80	16,000.00	10	100	900	225.00	100	22,500.00	6,500.00	141%	Affected by flooding
1000	200	80	16,000.00	25	250	750	187.50	100	18,750.00	2,750.00	117%	
1000	200	80	16,000.00	12	120	880	220.00	100	22,000.00	6,000.00	138%	Affected by flooding
1000	200	80	16,000.00	20	200	800	200.00	100	20,000.00	4,000.00	125%	
1000	200	80	16,000.00	10	100	900	225.00	100	22,500.00	6,500.00	141%	
Subtotal			**480,000.00**						**542,450.00**	**62,450.00**	**113%**	

v) As mentioned, vitamin C-complex, one of the necessary nutrients for fish production, was mixed to the feed to enrich the anti-stress capacities and resilience capabilities of the tilapia after the strike of a disaster or other extreme weather events.

A total of 113.0 percent overall economic rate of return was developed based on the total actual vs. the approximated gross income as shown in the table below.

Chapter 4

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

The chapter depicts the environmental profile of quarried mine marshland in terms of physical, biological, chemical, and other external factors. Also, manifested in this chapter are the significant findings of the study based on the gathered data on stocking, feeding, sampling, and harvesting, the physical, biological, chemical parameters, and the economical rate of return of the developed Tilapia production in abandoned mine quarried marshlands of Tolosa, Leyte.

Tilapia production techniques with environmental conditions along; stocking density, feeding, sampling, and harvesting were recorded. The results of the field trials clearly show the growth rates of survivorship and yields were favorable in the abandoned quarried mine, artificial lagoon, and were similar to those of circular concrete tanks (Siddique et al., 1991; Sadek et al., 1992). Initial stocking rates were low, and results obtained suggest that the stocking rates can be markedly increased in the future stocking to attain higher profitability. However, whether similar yields can be achieved at abandoned quarried mine marshland at elevated stocking densities with this comparison with circular tanks cannot be determined.

Results also indicate that males and females grew fast and that recruitment was minimal since very few small fish were harvested. Spawning would have taken place in the lagoons, but most likely, the fry would have been consumed by juvenile Tilapia or other predators such as birds that might have entered the lagoons. The number of small fishes produced was surprisingly low, and these results are very encouraging for the future of this system since there are concerns about Tilapia that have been masculinized using hormones (Ramnarine, 2003).

Yield. As shown in Table 5 below, the fishponds in Barangay Capangihan had the highest yield among the three areas studied (35.0 kgs). This is followed by Barangay Telegrafo (20.7 kgs), then by Barangay Opong (16.1kgs).

Temperature. Table 5 below shows the temperature range in the said barangays of Tolosa, Leyte. Water temperature, as it can be gleaned from the table, affects the metabolism of Tilapia. Being too hot slows down the metabolic activity of the Tilapia and, consequently, there is poor feed conversion ratio (FCR) of the feed that also makes its growth rate decline.

Table 5

Physical, Biological, Chemical Profile of the Quarried Mine Marshland

Location	Average						
	Yield (kgs)	Temp. (°C)	Salinity (ppt)	Dissolved Oxygen (mg/l)	pH	Total Dissolved Solids	Feeds (kgs)
Barangay Opong	16.1	35.44	0.12	5.44	7.60	0.12	44.60
Barangay Capangihan	35.0	32.26	0.09	6.06	8.04	0.07	66.10
Barangay Telegrafo	20.7	33.27	0.11	6.07	7.79	0.18	52.50
Mean	**23.93**	**33.65**	**0.11**	**5.86**	**7.81**	**0.13**	**54.40**

The table above reveals the homogeneity of the water temperature in abandoned mine quarried marshland. Capangihan has a lower temperature mainly because of the presence of vegetative cover like trees that are found around Opong and Telegrafo, which were the open canopy of the artificial lagoons as culture system. The temperature ranges from 32.26°C to 35.44°C of the three sites, which favors the growth of Tilapia. Tilapia cannot tolerate a temperature below 10°C. Temperature at the mid-20s, however, could still suppress growth. Low temperature is usually felt in upland areas, but this usually is not a problem in the tropics. Oreochromis niloticus shows better growth tolerance at a lower temperature as compared to other tilapia species. All tilapias can tolerate high water temperature. However, too much handling at high temperature could result in high mortality. In a previous study, Nile tilapia have a complex sex determination mechanism with major and minor genetic factors and a temperature effect on genetic sex determination (GSD+TE) (Nivelle, 2019).

Salinity. The table above also shows the salinity reading of the 30 sampling sites in the three barangays of Tolosa, Leyte. The salinity range was 0.05 to 0.15 ppt which was typical for a freshwater environment suited for Tilapia. Although some species of Tilapia can tolerate higher salinity, up to 25ppt small amount of salt can be detected due to the process of weathering. Salinity fluctuation can be a factor like the rainfall that dilutes the pond water. A recent study shows that the addition of NaCl to the fish feed increases its digestibility. The apparent digestibility coefficient (ADC) values depend on the feed composition, the marker used, and the fecal collection methods. Fish receiving the salt-enriched (SED) diet had higher growth parameters than the controlled ones, with a specific growth rate (SGR) of 1.54 ± 0.1 compared to 1.13 ± 0.2 for the controlled group, and daily weight gain of 2.78 ± 0.2 compared to 1.89 ± 0.4 for the controlled ones. They also had better FCR, 1.78 ± 0.1 compared to the 2.02 ± 0.3 of the controlled group. However, these differences were not significant (Eyal et al., 2020). This study also corroborated with Eyal's hypothesis that adding sodium to fish feed would enhance the uptake of short peptides, resulting in higher protein digestibility. Nile tilapia (Oreochromis niloticus) is one of the world's most popularly known and most widely cultured fish species, partially because of its ability to utilize a broad range of nutritional sources and its suitability to fit in various culture systems. A number of studies have reported that the mixture or addition of salt to fish feed has a prominent effect and big impact on feed utilization, growth, and other physiological parameters in the specie's intestines and blood. In studies aimed at understanding the specific effects caused by dietary salt, supplementation found effects on both the essential intestinal enzymatic activity and on the intestinal bacterial populations.

The most accurate performance of the fish cultured in the lower water-salinity levels in this study could be compared to the cost of energy for the ionic regulation which was lower when the fish were kept in an isotonic environment where ionic gradients between the water and the blood were minimum. According to Boeuf and Payan (2001), this energy economy could be directed and related toward growth. Aside from osmoregulation, the water salinity's effect on the capability of the fish can be exemplified by its action upon digestive enzymes where its exposure to various salinities alters the water ingestion, modifying the salinity of the contents in the intestines and affecting the digestive enzymes' activity (Moutou et al., 2004). As stressed out by Vieira de Azevedo (2015), this phenomenon can explicate the worsening in the alimentary conversion and the succeeding deterioration in the weight gain of tilapias in the highest salinities in this study.

Total Dissolved Solids. The table above shows the total dissolved solids of the lagoon in Tolosa, Leyte used in tilapia production. The minimum of total dissolved solids was 0.05 to a maximum of 0.20 g/L with a mean of 0.12 g/L. Particulate matters or the total dissolved solids, when smoother, the water column may trap sunlight necessary to the photosynthesis of the plankton, thereby affecting the production of the natural food for tilapia culture. It has a significant impact both on the survival rate and growth rate of the Tilapia; hence, turbidity should be prevented. Flooding from outside the lagoon was suspended in the water column, also known as TDS, as it may introduce detritus and sediments. TDS are inorganic compounds that can be seen in water such as heavy metals, salts, and some traces of organic compounds that are already dissolved in water. The total dissolved solids found in water are just one of the main causes of sediments and turbidity in drinking water. Total dissolved solids can be the cause of various diseases when left unfiltered. In drinking water, various substances comprise the total dissolved solids. Bacteria and viruses can also be found in total dissolved solids as they are a natural flora of water and the environment and these are the organic compounds found in water (Ajah et al., 2020).

Dissolved Oxygen. The previous table also shows the DO level in three sampling sites and ranges from 5.16 mg/L to 6.54 mg/L within the tolerable level for growth of Tilapia. It has been proven that DO prominently made impact to feed utilization, fish growth, whole-body composition, and innate immunity. However, feed intake and fish growth were negatively affected by low DO. In addition, innate immunity increased as DO levels increased. After the 10-day post-challenge, the DO had adversely affected the total fish mortality, and the highest mortality was found at low DO in smaller fish. In contrast, at average DO in larger fish, no mortality was found. These findings entail that feed utilization, fish growth, and innate immunity were, indeed, adversely affected by low DO. Meanwhile, smaller fish appeared to have better performance than the larger ones at normal DO (Abdel-Tawwab, 2010).

Feed utilization and fish growth were adversely affected by low DO level. The shortage in the availability of oxygen for fish growth exemplified the low growth acquired at low DO conditions. Along with this, Bergheim et al. (2006) and Duan et al. (2011) reported that fish growth and feed efficiency were affected by DO availability, and fish always manifested good feed efficiency when fed at an adequate DO in water. Also, Abdel-Tawwab et al. (2014) emphasized that the growth of Nile Tilapia was dominantly retarded at a low DO level. The low feed intake and low growth found in fish at low DO conditions were due to the reason that digestibility and/or fish appetite were reduced (Tran-Duy et al., 2012; Gan et al., 2013).

It was observed that fish immunity was higher in bigger fish than in smaller ones, entailing that fish weight and/or age may be a prominent factor affecting the innate immunity and bacterial infection in farmed fish. As a conclusion, DO and fish size undoubtedly appeared to influence feed utilization, fish growth, and innate immunity. Fish should be maintained at an exact and appropriate DO level to suffice the functions accountable for enhancing fish performance and health.

Water Ph. Table 5 above also shows the pH reading of the three sampling sites. It could be gleaned that pH recorded was within the tolerable range from 7.05 to 8.46 with a mean of 7.81 that was notable to all areas of the study. A wide range of pH can be tolerated by the tilapia fish. Direct pH toxicosis would be unusual for cultured Tilapia. However, pH interacts with other water chemistry variables and strongly influences the toxicity to aquatic animals of ammonia and hydrogen sulfide. In terms of disease, pH effects mediated through these interactions are much more likely to be encountered in culture systems that support abundant phytoplankton. In phytoplankton rich in culture water, the pH changes gradually on a daily cycle. During periods of increased sunlight, carbon dioxide is reduced through uptake by plants for photosynthesis. As the CO_2 level declines, the pH of the water increases. At night, photosynthesis is replaced by oxidative metabolism, CO_2 has released into the water, and pH value declines. The amplitude of the diurnal fluctuation is mediated by the density of phytoplankton, availability of sunlight, and the buffering capacity of the water (as indicated by the alkalinity). Hence, as espoused by Makori et al. (2017), low alkalinity in source water can have a profound effect on the pH of the culture water.

Differences in Yields Between Different Physical, Biological, and Chemical Factors

Table 6 below shows the statistical comparison of Tilapia yields between different temperature ranges, 1) 31.9°C and below; 2) 32.0°C – 33.9°C; and 3) 34.0°C and above.

Table 6

Comparison of Yield Between Different Temperature Range

Temperature Range (°C)	N	Mean Yield (kgs.)	F-value	Sig.	Pairs with significant differences
31.9°C and below	8	30.75			
32.0°C – 33.9°C	6	27.00	5.67	0.009*	31.9°C and below > 34.0°C and above
34.0°C and above	16	19.37			

**Significant at 0.01*

The findings and their respective analyses revealed that there is a significant difference in the Tilapia yield among the different ranges of temperature. This is, indeed, significant at a 0.01 level of significance which obviously entails a 99% level of confidence. In addition, the test for the significant difference revealed that the temperature range of 31.9°C and below has a significantly and prominently higher yield than those tilapia fish having a temperature range of 34.0°C and above. There is, however, no significant difference in the outcome between the ranges of 31.9°C and below and 32.0°C – 33.9°C, and between 32.0°C – 33.9°C and 34.0oC and above.

As shown in Table 7, a number of salinity ranges were compared in terms of Tilapia yield. These salinity ranges were the following: 1) 0.09 ppt and below; 2) 0.10 ppt – 0.12 ppt; 3) 0.13 ppt and above. As it can be gleaned from the table, there is no significant difference in the yields of the various salinity ranges in the study. This entails that among all the various salinity ranges, there is a statistically equal yield of Tilapia. This implies that the salinity in the fishponds in the study is within the optimal salinity range for Tilapia production.

Table 7

Comparison of Yield Between Different Salinity Range

Average Salinity (ppt)	N	Mean Yield (kgs.)	F-value	Sig.	Pairs with significant differences
0.09 ppt and below	9	29.55			
0.10 ppt – 0.12 ppt	13	22.15	2.63	0.090^{ns}	None
0.13 ppt and above	8	20.50			

^{ns}*Not Significant*

Table 8 below shows the statistical comparison of Tilapia yields between different dissolved oxygen ranges: 1) 5.5 mg/l and below; 2) 5.56 mg/l - 6.0 mg/l, and, 3) 6.01 mg/l and above. The results revealed a significant difference in the Tilapia yield among the different ranges of dissolved oxygen. This is significant at a 0.01 level of significance which entails a 99% level of confidence. Test for the significant difference revealed that dissolved oxygen range of 5.5 mg/l and below has a significantly lower yield than of those with dissolved oxygen range of 6.01 mg/l and above. There is, however, no significant difference in the yield between the ranges of 5.5 mg/l and below and 5.56 mg/l - 6.0 mg/l. Yield between 5.56 mg/l - 6.0 mg/l and 6.01 mg/l and above has also no significant difference.

Table 8

Comparison of Yield Between Different Dissolved Oxygen Range

Average Dissolved Oxygen (mg/l)	N	Mean Yield (kgs.)	F-value	Sig.	Pairs with significant differences
5.5 mg/l and below	8	15.50			
5.56 mg/l - 6.0 mg/l	8	23.25	7.94	0.002*	5.5 mg/l and below < 6.01 mg/l and above
6.01 mg/l and above	14	29.14			

**Significant at 0.01*

In terms of statistical comparison of Tilapia Yield among the different pH ranges (7.55 and below; 7.56 - 7.9; and 8.0 and above), Table 9 presents that there is no significant and prominent difference in the yields of the different ranges of pH in the study. This means that among all the various pH ranges, there is a statistically equal yield of Tilapia. This could mean that the pH in the fishponds in the study is within the optimal pH range for Tilapia production.

Table 9

Comparison of Yield Between Different pH Range

Average pH	N	Mean Yield (kgs.)	F-value	Sig.	Pairs with significant differences
7.55 and below	8	18.37	2.50	0.101^{ns}	None
7.56 - 7.9	9	23.89			
8.0 and above	13	27.38			

^{ns}Not Significant

Table 10 below shows the statistical results of comparing Tilapia yield among the different ranges of total dissolved solids (TDS) in the fishponds that were studied. Following are the ranges of TDS in the study: 1) 0.10 ppt and below; 2) 0.11 ppt - 0.15 ppt; and 3) 0.16 ppt and above. As depicted in the table, the results and their corresponding analyses revealed that there is a significant difference in the Tilapia yield among the various ranges of dissolved oxygen. This is significant at a 0.001 level of significance which entails a 99.1% level of confidence. Test for the significant difference revealed that the TDS range of 0.10 ppt and below has a significantly and prominently higher yield than of those with TDS range of 0.11 ppt – 0.15 ppt. There is also a significant difference in the yield between the ranges of 0.10 ppt and below and 0.16 ppt and above. Yield between 0.10 ppt and below and 0.16 ppt and above has no significant difference.

Table 10

Comparison of Yield Between Different Total Dissolved Solids Range

Average Total Dissolved Solids	**N**	**Mean Yield (kgs.)**	**F-value**	**Sig.**	**Pairs with significant differences**
0.10 ppt and below	11	34.54	51.736	0.000*	0.10 ppt and below > 0.11 ppt – 0.15 ppt; 0.10 ppt and below > 0.16 ppt and above
0.11 ppt – 0.15 ppt	11	16.00			
0.16 ppt and above	8	20.25			

**Significant at 0.001*

Table 11 shows the statistical comparison between the ranges of feeds supplemented in terms of Tilapia yield. The ranges of feeds supplemented are as follows: 1) 50 kgs and below; 2) 1kgs – 60 kgs; 3) above 60 kgs. The table shows a significant difference in the Tilapia yield among the different ranges of feeds supplemented. This is significant at a 0.001 level of significance which entails a 99.1 percent level of confidence. Test for the significant difference revealed that feeds range of 50 and below has a significantly lower yield than of those with feeds range of 51kgs – 60 kgs. There is also a significant difference in the yield between the ranges of 50 kgs and below and above 60 kgs. Furthermore, yields between 51kgs – 60 kgs and above 60 kgs also have a significant difference.

Table 11

Comparison of Yield Between Feeds Range

Feeds (kgs)	N	Mean Yield (kgs.)	F-value	Sig.	Pairs with significant differences
50 kgs and below	10	13.60	49.97	0.000*	50 kgs and below < 51kgs – 60 kgs;
51kgs – 60 kgs	10	24.50			50 kgs and below < Above 60 kgs;
Above 60 kgs	10	33.70			51kgs – 60 kgs < Above 60 kgs

**Significant at 0.001*

Correlation between Physical, Biological, and Chemical Factors with Tilapia Yield

Table 12 shows the correlation coefficients between the Physical, Biological, and Chemical Factors with Tilapia yield. A shown in the table, temperature, total dissolved solids, and feeds significantly correlate with Tilapia yield at 0.001 level or 99.9 percent confidence. Likewise, salinity, dissolved oxygen, and pH are significant at 0.05 level or 95.0 percent confidence. A low positive correlation is found between pH and Tilapia yield with an r-value of 0.366. Temperature, salinity, and total dissolved solids have a moderate negative correlation with

Tilapia yield with r values of -0.554, 0.401, and 0.662, respectively. Further, a moderate positive correlation can be found between dissolved oxygen and Tilapia yield (r-value = 0.543. Finally, a very high positive correlation manifests between feeds and Tilapia yield with an r-value of 0.921.

Table 12

Correlation Coefficients of Physical, Biological, and Chemical Factors with Tilapia Yield

Variables	r-value	Sig.	Verbal Description
Temperature	-0.554	0.001**	Moderate negative correlation
Salinity	-0.401	0.028*	Moderate negative correlation
Dissolved Oxygen	0.543	0.002*	Moderate positive correlation
pH	0.366	0.047*	Low positive correlation
Total Dissolved Solids	-0.662	0.000**	Moderate negative correlation
Feeds	0.921	0.000**	Very high positive correlation

**Significant at 0.05*
***Significant at 0.001*

Influence of Physical, Biological, and Chemical Factors on Yield

Table 13 presents the result of the multiple linear regression analysis employed in the study. The independent variables used were the physical, biological, chemical factors of the fishponds, while the dependent variable is the Tilapia yield. Theoretically, it was assumed that these factors would influence the yield of Tilapia in the fishponds. Using the stepwise regression method, two factors (Feeds and TDS) were found to significantly affect Tilapia yield in the fishponds (Adjusted $R^2 = 0.87$). The B coefficient for Feeds (in kilograms) means that for every increase in feed supplementation in the studied fishponds, an increase of 0.654 kilograms in Tilapia yield is expected. Likewise, every increase in TDS by one ppt leads to a decrease in Tilapia yield by 39.942 kilograms (for better illustration, this is equivalent to a decrease of 0.399 kilograms for every increase of 0.01 ppt of TDS). The beta coefficient (β) tells that feeds (in kilograms), which have a higher value, have a more significant influence on yield than TDS, which has a lower beta coefficient value (-0.214). The sig value means that feeds (in kilograms) is a significant predictor of Tilapia yield at 0.001 level or 99.9 percent confidence level. On the other hand, TDS is a significant predictor of yield at 0.01 level or 99.0 percent confidence level.

Table 13

Multiple Linear Regression Results with Yield as Dependent Variable

Independent Variables	B	β	t	Sig.
Constant	-6.654		-1.355	0.187
Feeds (kilograms)	0.654	0.802	9.972	0.000
Total Dissolved Solids (ppt)	-39.942	-0.214	-2.661	0.010

Chapter 5

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter presents the summary of findings with the corresponding conclusions based on the findings of the study, and the recommendations on the conclusions drawn from the findings of the study.

Summary of Findings

The following were the salient findings of the study:

1. The Tilapia production in abandoned mine quarried marshland area had significant difference compared to Tilapia production in pond given that there were only four important variables or parameters out of six environmental physical, biological, and chemical parameters monitored in this study.

2. The temperature, dissolved oxygen, total dissolved solids, and feeding had significant effects on Tilapia yield. Salinity and pH, however, were not shown to either increase or decrease Tilapia yield in the study area.

3. Another external factor, such as mortality or stealing of stocks on or before the harvest period, was also taken into account, and it also gave significant, yet, negative influence as revealed in this study.

4. Feeding or supplemental feeding had a significant and positive effect on the production of tilapia.

5. The stocking density, feeding, sampling, and harvesting technology for tilapia production in the pond were applied during the production period.

6. Supplemental feeding and total dissolved solids were significant predictors of Tilapia yield in the study area.

7. The overall economy the rate of return garnered 113%. However, there were five sites that had below the expected economic rate of returns.

Conclusions and Recommendations

Based on the findings of the study, the following conclusions and recommendations were drawn:

1. The four environmental physical, biological, and chemical parameters of Tilapia Production in quarry marshland such as temperature, supplemental feeding, total dissolved solids, and dissolved oxygen must be given more attention during the actual production to get the expected yield and economical rate of return.

2. Strengthen the capacity of the tilapia farmers on the management of their tilapia production to prevent stealing of stocks during or before the harvest period.

3. The feeding or supplemental feeding had a significant positive effect on tilapia production; hence, this must be closely monitored to ensure higher yield.

4. Data recording of the stocking density, feeding, sampling, and harvesting technology for the production of tilapia in the pond must be done exhaustively to ensure expected production.

5. All the four significant parameters – environmental, physical, biological, and chemical requirements – laboratory test of the sites before the stocking, monitoring, and recording of stocking density, feeding, sampling, and harvesting, and most all, the strengthening of the capability of the tilapia farmers to prevent stealing of their products, must be taken into account during the tilapia production to ensure the expected yield and the expected economic rate of returns.

REFERENCES

Abella, T. A. (2016). Role of public sector in genetics research and its partnership with M.R. Guerrero-del Castillo (eds.). Proceedings of the International Forum on and Z. Yaron (eds.). *International Symposium on Tilapia in Aquaculture development.* WorldFish Center Conf. Proc.; pp 72.

Abdel-Tawwab M, Ahmad MH, Khattab YAE, Shalaby AME (2010). Effect of dietary protein level, initial body weight, and their interaction on the growth, feed utilization, and physiological alterations of Nile tilapia, Oreochromis niloticus (L.). *Aquaculture* 298: 267-274

Abdel-Tawwab M, Hagras AE, Elbaghdady HAM, MMonier MN (2014). Dissolved oxygen level and sticking density effects on growth, feed utilization, physiology, and innate immunity of Nile tilapia, Oreochromis niloticus. J *Appl Aquacul* 26:340-355

Ajah, Paul Onu, Efio-Okon Bassey Ita, Nneka Love Allison (2020). Characterization of Nematode Infestation on Parachanna obscura (Gunther, 1861) (Channidae) and Infection in the Blood. *Aquaculture Study. Faculty of Oceanography,* University of Calabar, Calabar, Nigeria.

Alceste, C.C. and D.E. Jory (2002). *World tilapia farming.* Available: http://www.aquaculturemag./com.siteenglish/printed/buyers/web.tilapia.html

`Allen, G.P., Botsford, L.N., Schurr, A.M. and Johnston, W.E. (1984). *Bioeconomics of aquaculture*. New York: Elsevier.

Anon (1984). *Introducing the tilapias.* ICLARM Newsletter. January 1984. 7(10:3.

Bagarinao, T. U. and E. E. Flores (eds.) (1995). *Towards Sustainable Aquaculture in Southeast Asia Japan.* Iloilo: Southeast Asian Fisheries Development Center.

Baluyot, E.A. (1989). *Aquaculture systems and practices: A selective review.* Rome: Food and Agriculture Organization.

Baustista, G. and Serrano, A.C. (1987). *Manual in Fish Culture III.* Quezon City: University of the Philippines in the Visayas.

Bergheim A, Gausen M, Naess A, Holland PM, Krogedal P, Crampton V (2006). A newly developed oxygen injection system for cage farms. *Aquacul Eng* 34;40-46

Bureau of Fisheries and Aquatic Resources (2003). P*hilippine Fisheries Profile 2002.* Department of Agriculture, Quezon City. 57 p.

Boeuf, G. & Payan, P. (2001). How should salinity influence fish growth? Comp. Biochem. Physiol. C, Toxic. *Pharmacol.*, 130(4): 411-423.

Calderon, J.F. and Gonzales, E.C. (1993). *Methods of research and thesis writing.* Mandaluyong City: National Book Store.

Census, Imre. "*Recommendations for Responsible Aquaculture*" Towards Sustainable Aquaculture Development in Southeast Asia and Japan. Iloilo: Southeast Asian Fisheries Development Center, 1995.

Corre, V. L. (1981). *"Culture of Nile Tilapia in Brackishwater Fishponds Using Supplemental Feeds Containing Various Levels of Protein."* M. S. Thesis. University of the Philippines, College of Fisheries, Diliman, Quezon City. 38p. Fisheries Association Inc. Los, Banos, Laguna, Philippines.

Costa, F. H., Sampajo, A.H., Saker-Sampajo, S., Lima, F.M., Matias, J.F.N., Rocha, I.R.C.B, Santos, J. A. R. and Rochas, P.J.C. (2000). In K. Fitzsimmons and J.C. Filho. Tilapia cage culture in reservior in Cear State, Brazil. Tilapia Aquaculture in the 21st Century. *Proceedings from the Fifth International Symposium on Tilapia Aquaculture,* 3-7 September 2000, Brazil. Vol. 2.

Dey, M. (2001). Tilapia production in South Asia and the Far east. p. 17-27. In Subasinghe, S. and S. Tarlochan. 2001. Tilapia: production, marketing and technological developments. *Proceedings of the Tilapia 2001 International Technical and Trade Conference on Tilapia,* 28-30 May 2001, Kuala Lumpur, Malysia.

Duan Y, Dong X, Zhang X, Miao Z. (2011). Effects of dissolved oxygen concentration and stocking density on the growth, energy budget and body composition of juvenile Japanese flounder, Paralichthys olivaceus (Temminck et Schlegel). *Aquacul Res* 42:407-416

Eyal Hallali, Fotini Kokou, Tapan Kumar Chourasia, Tali Nitzan Pazit Con, Sheenan Harpaz Itzhak Mizrahi, Avner Cnaani (2020). *Effect of dietary salt on Nile tilapia.* Institute of Animal Science Agricultural Research Organization Rishon LeZion, Israel Faculty of Life Sciences Bar-Ilan University Ramat-Gan, Israel.

FAO (2002). Fishery Statistics. *Aquaculture production.* 90(2).

FAO (Food Agriculture and Organization of the United Nations) (1979). *"Technical Conference on Aquaculture, Kyoto Japan-1976"* In: Advances in Aquaculture. Surrey: Fishing News (Books) Ltd.

Gan L. Liu YJ, Tian LX, Yue YR, yang HJ, Liu FJ, chen YJ, Liang GY (2013). Effect of dissolved oxygen and dietary lysine levels on growth performance, feed conversion ration and body composition of grass carp, Ctenopharyngodon idella. *Aquacul Nut* 19:860-869

Fitzsimmons, K. (2000). Tilapia: the most important aquaculture species in the 21st century. In Fritzsimmons, K. and J.C. Filho (eds) Tilapia Aquaculture in the 21st century. *Proceedings from the Fifth International Symposium on the Tilapia Aquaculture.* Rio de Janeiro, Brazil. Vol. 1.

Fortes, R. D. (19877). *"Culture studies on Tilapia sp. Under saline Conditions at the Brackishwater Aquaculture Center,"* pp. 21-23. In: Guerrero, R. D., D. L. Guzman and C.M. Lantican (eds.). Tilapia Farming. PCARRD, Los Banos, Laguna. 68 p.

Fortes, R. D. & Villa, V. U. (1975). "Monoculture and Polyculture of Bangus and All-Male Tilapia in Brackishwater Ponds (1)." Inland Fish. Proj. Tech. Rep. No. 7, Second half of FY 1975 NSDB-assisted Project No. 7103 Ag. UPV College of Fisheries, Diliman, Quezon City.

Guerrero R.D. &7 Guerrero, L. A. (2004). Brackishwater Culture of Tilapia in the Philippines: An Assessment. *In Proceddings 6th International Symposium on Tilapia in Aquaculture.* Eds. Rmedios Bolivar, Graham Mair, Kevin Fiztsimmons, ISTA, Sept 12-16 Manila. Philippines pp. 421-425.

Mair, G. (2002). Tilapia genetics and breeding in Asia. P. 100-123. In: Guerrero, R. D. III private sector in the Philippines. In: Acosta, B. O., R. C.

Sevilleja, M. Gupta (eds.) *Public and Private partnership in aquaculture: a case study on tilapia research.*

Makori, A., Abuom, P. O., Kapiyo, R., Anyona, D. N. & Dida, G. O. (2017). Effects of water physico-chemical parameters on tilapia (Oreochromis niloticus) growth in earten ponds in Teso North Sub-County, Busia County, *Fisheries and Aquatic Sciences volume 20*, Article number: 30

Nivelle, R. (2019) Research and Education Center in Aquaculture (CEFRA), Liege University, Tihange, Belgium, laboratory for Organogenesis and Regeneration (LOR), *Interdisciplinary research institute in the biomedical sciences* (GIGA013), Liege University, Sart Tilman, liege, Belgium

"Province of Leyte". *Municipality Population Data.* Local Water Utilities Administration *Research Division.* Retrieved 17 December 2016.

"Province: Leyte". *PSGC Interactive.* Quezon City, Philippines: Philippine Statistics Authority. Retrieved 12 November 2016.

Pullin, R.S.V. (1983). Choice of tilapia species for aquaculture. P. 64-76. In: L. Fishelson and Z. Yaron (eds.). *International Symposium on Tilapia in Aquaculture.* Tel Aviv University, Israel.

Ramnarine, I.W. (2003). *Marketing Tilapia.* Paper presented at ASA tilapia farming workshop, Kingdom, Jamaica. 12 pp.

Sadek, S., Kallafalah, H. Adell F. (1992). Tilapia biomass yield in commercial farm using circular tanks. *Journal of Applied Ichthyology* 8(1-4): 193-200.

Siddique, A.Q. Howlader, M.S., Adam, A. (1991). Effect of water exchange on Oreochromis niloticus (L) growth and water quality in indoor concrete tanks. *Aquaculture* 95 (1-2): 67-74.

Shelton, W. L. (2002). *Tilapia culture in the 21st century. P. 1-20. In: Guerrero, R.D. III and Tilapia Farming in the 21st Century* (Tilapia Forum 2002), 184p. Philippine Fisheries Association Inc. Los, banos, laguna, Philippines.

Tilapia- the world's top aquaculture fish Posted on April 20, 2012

Tran-Duy A, Schrama JW, van Dam AA, Verreth JAJ (2008). Effects of oxygen concentration and body weight on maximum feed intake, growth and hematological parameters of Nile tilapia, Oreochromis niloticus. *Aquaculture* 275: 152-162

U. R.R. (1995). Livelihood options for Coastal Communities. Silang, Cavite: *International Institute fro Rural Reconstruction.*

Viera de Azevedo, R., dos Santos-Costa, K., Figueiredo de Oliveira, K., Flores-Lopes, F., Arruda Teixeira-lanna, E. & Tavares-Braga2, l.G. (2015). Responses of Nile tilapia to different levels of water salinity. Lat. Am. J. *Aquat. Res.*, 43(5): 828-835, 2015 DOI: 10.3856/vol43-issue5-fulltext-3

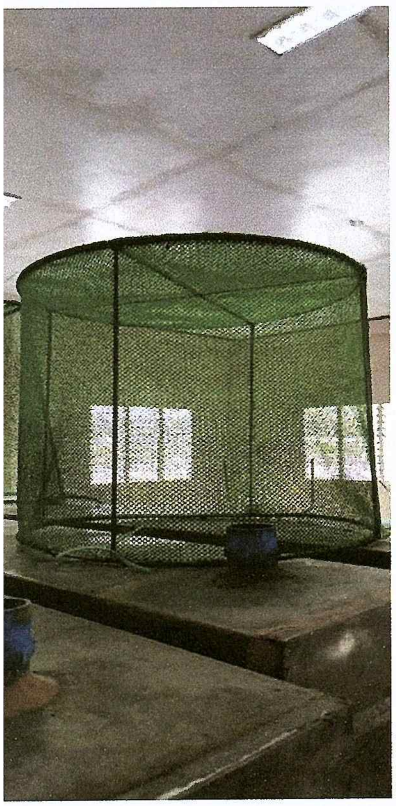
Yosef, S. (2009). Rich Food for poor people: *Genetically improved tilapia in the Philippines.*

IFPRI Discussion Paper No. 925. Washington D.C. *International Food Policy Research Institute.*

APPENDICES

Appendix A

Tilapia Fish Grader (Size and Sorting) used in BFAR-RFAPC, Babatngon Leyte, which was the source of Tilapia fingerlings used in the study



Size 22 (0.21-0.40g)
3.0g)

Size 17 (0.61-1.0g)

Size 14 (1.1-2.0g)

Size 12 (2.1-
used in the study

Appendix B

Letter from Director Juan D. Albaladejo, BFAR VIII Regional Director, to CRS-Catholic Relief Services, Results of the Assessment conducted on PHYSICO-CHEMICAL PARAMETERS TEST REPORT for the proposed Tilapia Culture in Tolosa, Leyte

Republic of the Philippines
Department of Agriculture
BUREAU OF FISHERIES & AQUATIC RESOURCES
Regional Office No. 8
SDC Bldg. 1 Brgy. 77 Marasbaras, Tacloban City
Telefax : (053)3211732/3254705/3213152
Email ad: region8bfar@yahoo.com
Website: http://region8.bfar.da.gov.ph

5-14-15
035-7

May 14, 2015

SUSANA BENCIO
Program Manager
Agri – Livelihoods
Catholic Relief Services (CRS)
Leyte

Ma'am:

Greetings!

Respectfully submitting herewith the result of the assessment conducted for the proposed Tilapia culture in Tolosa, Leyte.

For your information and reference.

Very truly yours,

DR. JUAN D. ALBALADEJO
Regional Director

Received: [illegible] 5-14-15

Appendix C

Physico-Chemical Parameters Test Result

Republic of the Philippines
Department of Agriculture
Bureau of Fisheries and Aquatic Resources
Regional Office No. 8, SDC Bldg. 1, Marasbaras Tacloban City
Fax No. (053) 321-1732/325-4705

PHYSICO-CHEMICAL PARAMETERS TEST REPORT

Type of sample(s) : Freshwater
Place of sampling : Tolosa, Leyte
Collected by : **BFAR 8 – EMU Technical Staff**
Address : Tacloban City

SAMPLE ANALYSIS

Examination performed : On-Site Physico-Chemical Analysis
Methodology : YSI Handheld Multiparameter Instrument

Station	Physico - Chemical Parameters								Remarks	Allowed No. of Cages
	Dissolved Oxygen (mg/L)	Salinity (ppt)	Temperature (°C)	Total Dissolved Solids (g/L)	pH	Area (m²)	Coordinates	Location		
Station 1	7.34	0.21	32.00	0.29	8.06	35 m²	N11.03433 E125.03207	Telegrapo	Not Suitable	
Station 2	7.08	0.27	33.50	0.37	7.64	100 m²	N11.03328 E125.03216	Telegrapo	Not Suitable	
Station 3	5.09	0.08	34.10	0.11	7.74	2,500 m²	N11.03298 E125.03097	Telegrapo	Suitable	5
Station 4	5.79	0.07	34.80	0.10	7.86	900 m²	N11.03320 E125.02969	Telegrapo	Not Suitable	
Station 5	4.98	0.09	34.20	0.13	8.52	750 m²	N11.02964 E125.02588	Telegrapo	Not Suitable	
Station 6	7.48	0.03	34.90	0.05	8.29	10,000 m²	N11.01804 E125.03093	Opong	Suitable	20

Appendix D

Continuation of Physico-Chemical Parameters Test Result

Station 7	6.95	0.13	36.00	0.18	8.18	5,000 m^2	N11.02077 E125.03535	Opong	Suitable	10
Station 8	3.94	0.08	34.90	0.11	7.73	10,000 m^2	N11.02433 E125.03294	Opong	Suitable	20
Station 9	6.14	0.03	32.20	0.04	8.73	1,125 m^2	N11.03429 E125.02094	Capangihan	Suitable	2
Station 10	6.61	0.05	32.40	0.08	8.49	375 m^2	N11.03413 E125.02071	Capangihan	Not Suitable	
Station 11	4.41	0.07	32.40	0.10	8.41	900 m^2	N11.03502 E125.02082	Capangihan	Not Suitable	
Station 12	5.34	0.01	31.80	0.02	8.63	375 m^2	N11.03621 E125.02080	Capangihan	Not Suitable	
Station 13	6.42	0.03	32.90	0.05	8.51	1,600 m^2	N11.03840 E125.02093	Capangihan	Suitable	3
Station 14	4.99	0.08	32.40	0.11	8.56	10,000 m^2	N11.03932 E125.02157	Capangihan	Suitable	20
Station 15	8.81	0.02	33.10	0.03	7.88	10,000 m^2	N11.04520 E125.02403	Malbog	Suitable	20

NOTE: *This report is exclusively related to the above test sample(s) as received basis. Copy or duplication of the report or part of it is not allowed without written consent from BFAR VIII - EMU.*

*Water Quality Standards based on DAO 34 series of 1990: pH (range) 6.0 – 8.5, Dissolved Oxygen: mg/L 5.0 %sat 70.

Findings:

The project site of Catholic Relief Services (CRS) on Tilapia culture were located in four barangays of Tolosa, Leyte; mainly: (1) Brgy. Telegrapo, (2) Brgy. Opong, (3) Brgy. Capangihan and (4) Brgy. Malbog. The proposed project of CRS basically involved the use of mine pits and was existing for more than three (3) decades already unutilized by a Mining

Appendix E

Pond Site of Tilapia Farmers in Brgy. Opong, Tolosa Leyte

Figure 2. Picture showing the pond site in Brgy. Opong (Station 6).

Appendix F

Pond Site of Tilapia Farmers in Brgy. Telegrafo, Tolosa Leyte

Figure 3. Picture showing pond site in Brgy. Opong (Station 7).

Appendix G

The BFAR Technical Staffs who prepared and analyzed the test result of Physico-Chemical Parameters of Pond Sites in Tolosa Leyte and noted by Chief, LRED

Figure 4. Freshwater mussel observed in Station 5 located in Brgy. Telegrapo, tolosa, Leyte

Prepared and Analyzed by:

DARL ELICOR SEROHIJOS
Technical Staff

DAN A. DE SAN MIGUEL
Technical Staff

MATT T. ALCANTARA
Technical Staff

Noted:

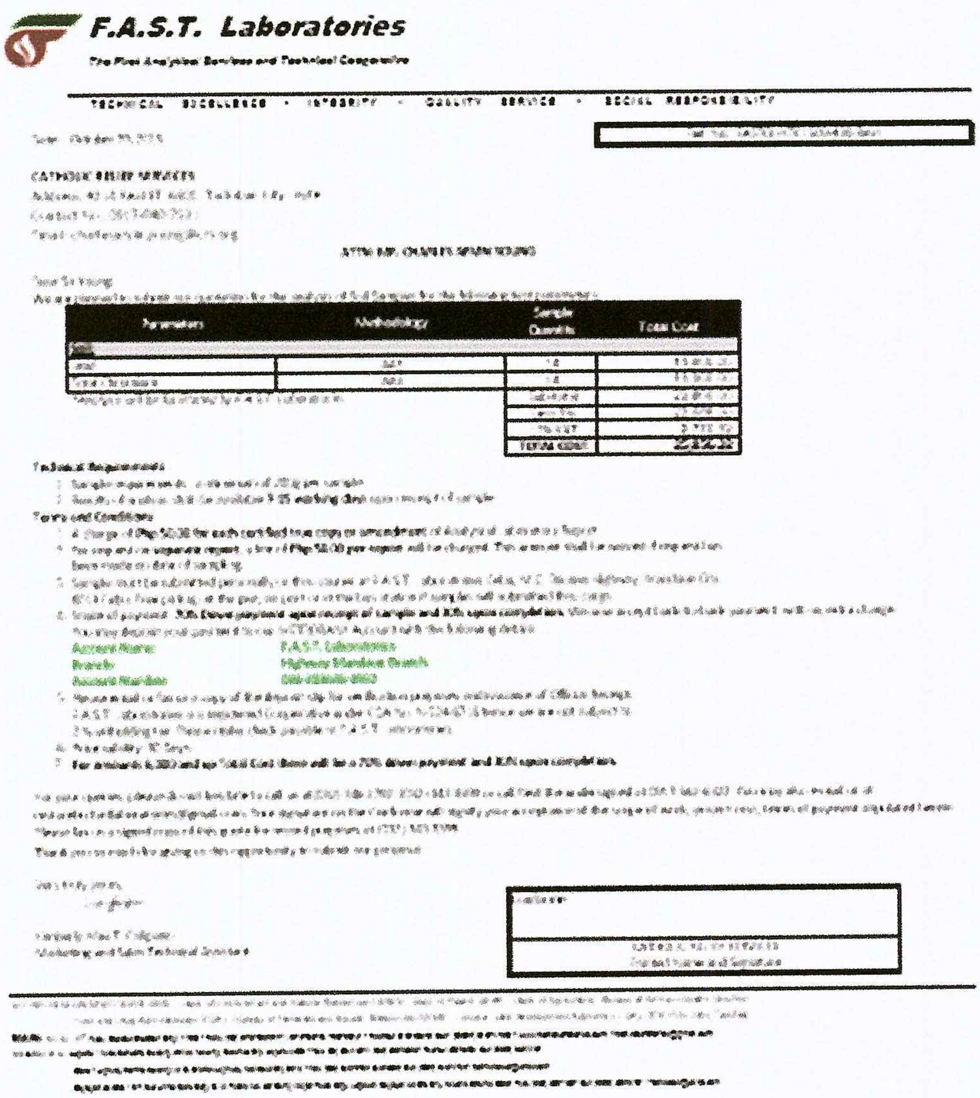
DR. NANCY A. DAYAP
Chief, LRED

Appendix H

Pond Site of Tilapia Farmers in Brgy. Capangihan, Tolosa Leyte

Appendix I

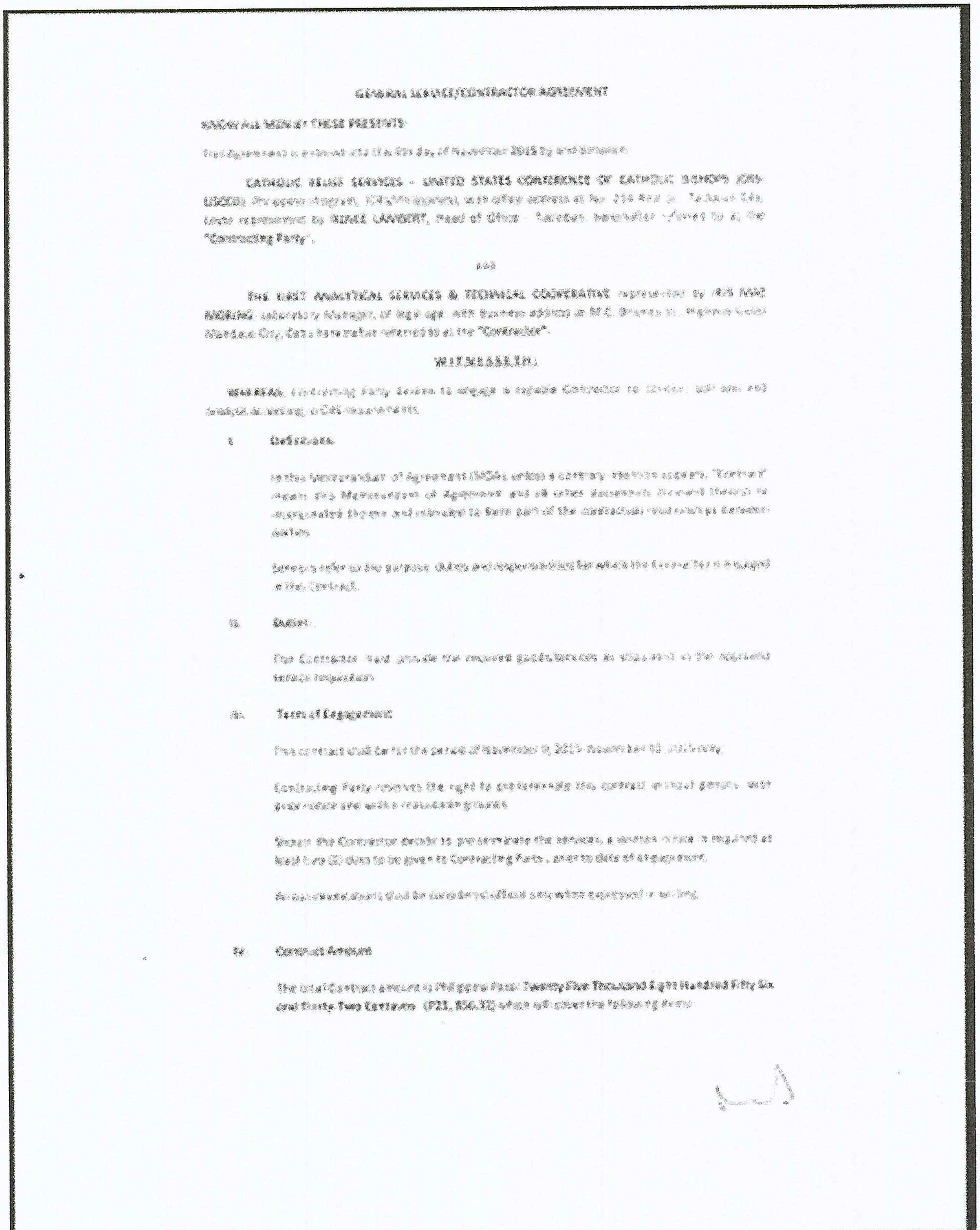
The quotation of F.A.S.T. Laboratories for the analysis and test of heavy metals (Lead and Total Chromium) of soil sample collected from proposed pond sites of Tilapia Farmers of Tolosa, Leyte


F.A.S.T. Laboratories

Parameters	Methodology	Sample Quantity	Total Cost
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]

Appendix J

General Services/Contractor Agreement between FIRST ANALYTICAL SERVICES AND TECHNICAL COOPERATIVE and CATHOLIC RELIEF SERVICES for the analysis and test of heavy metals of soil sample



Appendix K

Continuation of General Services/Contractor Agreement between FIRST ANALYTICAL SERVICES AND TECHNICAL COOPERATIVE and CATHOLIC RELIEF SERVICES for the analysis and test of heavy metals of soil sample

Appendix L

Continuation of General Services/Contractor Agreement between FIRST ANALYTICAL SERVICES AND TECHNICAL COOPERATIVE and CATHOLIC RELIEF SERVICES for the analysis and test of heavy metals of soil sample

Appendix M

Test Results of Heavy Metal Analysis (Lead and Total Chromium) for 14 soil samples used in the study of Tilapia Culture

F.A.S.T. Laboratories
The First Analytical Services And Technical Cooperative
TECHNICAL EXCELLENCE • INTEGRITY • QUALITY SERVICE • SOCIAL RESPONSIBILITY

F.A.S.T. Laboratories - Cebu
M.C. Briones Highway, Mandaue Cebu

TEST REPORT

Reference No. MC1511-2351
Page 1 of 3

CUSTOMER : CATHOLIC RELIEF SERVICES
ADDRESS : #214 Real St. 6500, Tacloban City, Leyte
SAMPLE(S) SUBMITTED : SOIL SAMPLES
SAMPLE CODE : MC1511-2351-01 to 05
Date / Time Received : 18 November 2015 / 09:20 AM
Date / Time Analyzed : 19 November – 02 December 2015
Date Reported : 03 December 2015

Samples	Lead, ppm	Chromium, ppm
S1 – 2.75 kg (MC1511-2351-01)	Less than 10*	18.8
S2 – 2.05 kg (MC1511-2351-02)	Less than 10*	37.9
S3 – 3.75 kg (MC1511-2351-03)	Less than 10*	18.5
S4 – 3.70 kg (MC1511-2351-04)	Less than 10*	3.81
S5 – 2.55 kg (MC1511-2351-05)	Less than 10*	Less than 2.0*
Test Method	Flame Atomic Absorption Spectrophotometry	

Note: * Method detection limit
Reference: Perkin Elmer Analytical Methods for Atomic Absorption Spectrophotometry (AAS)

Results are those obtained at time of examination and relate only to the sample(s) tested.

ANALYZED BY: [illegible]
ROSEMARIE C. MILANO
Laboratory Analyst

REVIEWED BY: [illegible]
KAREN MAE G. LAID
Laboratory Supervisor
Chem. Reg. No. 11653

APPROVED BY: [illegible]
IRIS MAE Q. MORINO
Laboratory Manager
Chem. Reg. No. 11359

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Appendix N

Continuation of Test Results of Heavy Metal Analysis (Lead and Total Chromium) for 14 soil samples used in the study of Tilapia Culture

F.A.S.T. Laboratories
The First Analytical Services And Technical Cooperative
TECHNICAL EXCELLENCE • INTEGRITY • QUALITY SERVICE • SOCIAL RESPONSIBILITY

F.A.S.T. Laboratories - Cebu
M.C. Briones Highway, Mandaue Cebu

TEST REPORT

Reference No. MC1511-2351
Page 2 of 3

CUSTOMER	CATHOLIC RELIEF SERVICES
ADDRESS	#214 Real St. 6500, Tacloban City, Leyte
SAMPLE(S) SUBMITTED	SOIL SAMPLES
SAMPLE CODE	MC1511-2351-06 to 10
Date / Time Received	16 November 2015 / 09:20 AM
Date / Time Analyzed	19 November – 02 December 2015
Date Reported	03 December 2015

Samples	Lead, ppm	Chromium, ppm
S6 – 4.45 kg **(MC1511-2351-06)**	Less than 10*	8.83
S7 – 3.35 kg **(MC1511-2351-07)**	Less than 10*	27.2
S8 – 3.5 kg **(MC1511-2351-08)**	Less than 10*	14.1
S9 – 2.15 kg **(MC1511-2351-09)**	Less than 10*	8.99
S10 – 2.3 kg **(MC1511-2351-10)**	Less than 10*	3.74
Test Method	Flame Atomic Absorption Spectrophotometry	

Note: *Method detection limit
Reference: Perkin Elmer Analytical Methods for Atomic Absorption Spectrophotometry (AAS)

Results are those obtained at time of examination and relate only to the sample(s) tested.

ANALYZED BY	REVIEWED BY	APPROVED BY
ROSEMARIE C. MILANO	KAREN MAE G. LAID	IRIS MAE Q. NORING
Laboratory Analyst	*Laboratory Supervisor*	*Laboratory Manager*
	Chem. Reg. No. 11653	*Chem. Reg. No. 11359*

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1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]

[illegible]

Appendix O

Continuation of Test Results of Heavy Metal Analysis (Lead and Total Chromium) for 14 soil samples used in the study of Tilapia Culture

F.A.S.T. Laboratories

The First Analytical Services And Technical Cooperative

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F.A.S.T. Laboratories - Cebu
M.C. Briones Highway, Mandaue Cebu

TEST REPORT

Reference No. MC1511-2351
Page 3 of 3

CUSTOMER	: CATHOLIC RELIEF SERVICES
ADDRESS	: #214 Real St. 6500, Tacloban City, Leyte
SAMPLE(S) SUBMITTED	: SOIL SAMPLES
SAMPLE CODE	: MC1511-2351-11 to 14
Date / Time Received	: 18 November 2015 / 09:20 AM
Date / Time Analyzed	: 19 November – 02 December 2015
Date Reported	: 03 December 2015

Samples	Lead, ppm	Chromium, ppm
S11 – 3.25 kg (MC1511-2351-11)	Less than 10*	8.57
S12 – 2.8 kg (MC1511-2351-12)	Less than 10*	Less than 2.0*
S13 – 2.85 kg (MC1511-2351-13)	Less than 10*	Less than 2.0*
S14 – 3.5 kg (MC1511-2351-14)	Less than 10*	Less than 2.0*
Test Method	Flame Atomic Absorption Spectrophotometry	

Note: * Method detection limit
Reference: Perkin Elmer Analytical Methods for Atomic Absorption Spectrophotometry (AAS)

Results are those obtained at time of examination and relate only to the sample(s) tested.

ANALYZED BY	REVIEWED BY	APPROVED BY
ROSEMARIE C. MILANO	KAREN MAE G. LAO	IRIS MAE G. MORENO
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Appendix P

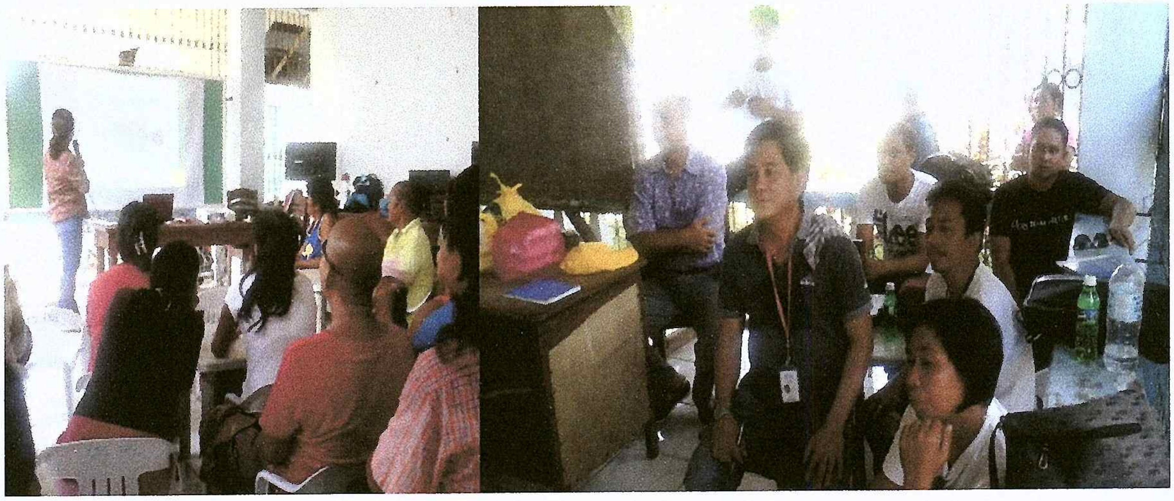
Tilapia Fingerlings used in the study sourced out by BFAR-RFAPC, Babatngon, Leyte

Appendix Q

DOCUMENTATION

The researcher joins during the ToT-Training of Trainer with the WorldFish Center consultant and Tilapia farmer beneficiaries during the actual construction of the 5m x 5m x 2m fish net cage

The Tilapia farmer beneficiaries both men and women done the actual construction of the fish net cage (5m x 5m x 2m) during the ToT-Training of Trainer with the WorldFish Center consultant and assisted with CRS Staffs

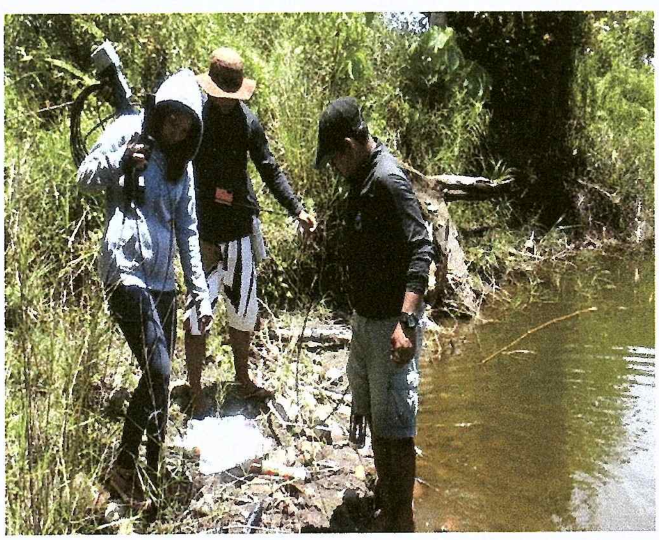


The Tilapia farmer beneficiaries and CRS Staffs attending with the discussions of WorldFish Center and CLSU-FAC consultants during the ToT-Training of Trainer of Tilapia Production at Tolosa Leyte

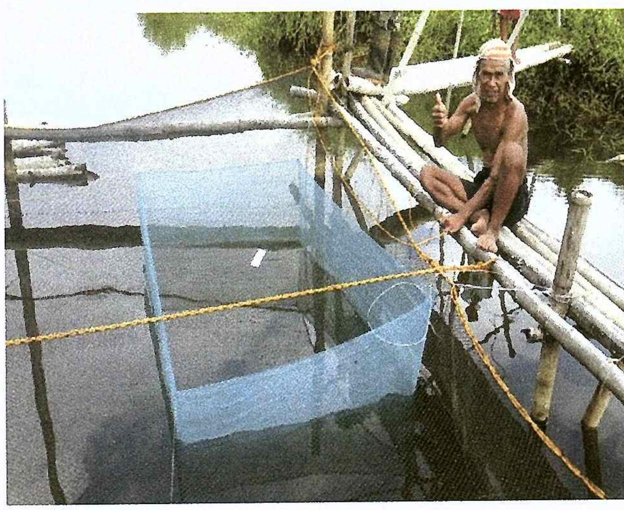
The Tilapia farmer beneficiaries, CRS Staffs and consultants from WorldFish Center and CLSU-FAC took a pose after the ToT-Training of Trainer of Tilapia Production at Tolosa Leyte

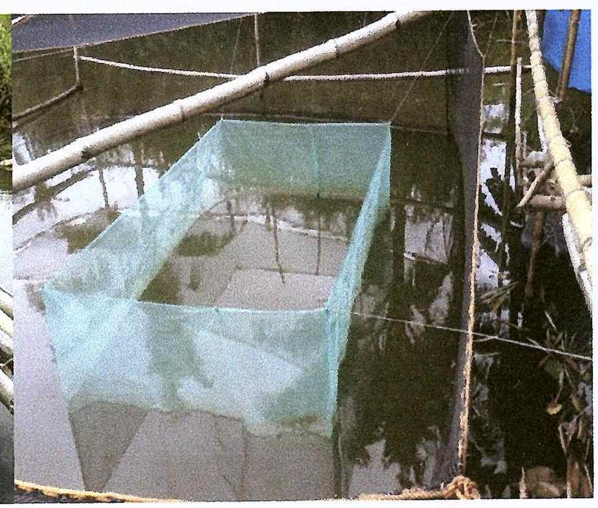
The BFAR Technical Staffs collects soil sample for heavy metal test and analysis from proposed pond sites of Tilapia farmer beneficiaries at Barangays Opong, Capangihan and Telegrafo, Tolosa Leyte

The BFAR Technical Staffs conduct on-site monitoring on physico-chemical parameters (Temperature, Salinity, Total Dissolved Solids, Dissoslved Oxygen, pH) using a Handheld Multi - Parameter Instrument from proposed pond sites of Tilapia farmer beneficiaries at Barangays Opong, Capangihan and Telegrafo, Tolosa Leyte



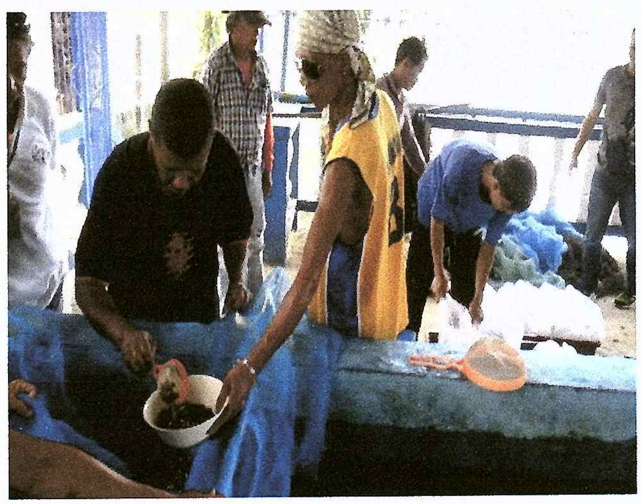
The fish net cage (5m x 5m x 2m) installation of Tilapia farmer beneficiaries at Barangays Opong, Capangihan and Telegrafo, Tolosa Leyte





The Hapa Net installed by Tilapia farmer beneficiaries ready for use of rearing tilapia fingerlings at early stage of stocking at Barangays Opong, Capangihan and Telegrafo, Tolosa Leyte

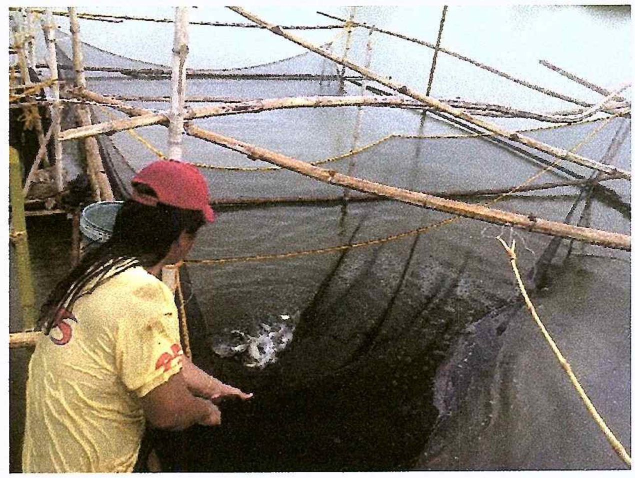
BFAR-RFAPC, Babatngon Leyte, the reputable source of FREE tilapia fingerlings sourced out by tilapia farmers in Barangay Opong, Capangihan and Telegrafo, Tolosa Leyte



Above are the process in the preparation of tilapia fingerlings: upper left preparation of polybags by filling a water, upper right scooping of tilapia fingerlings, center at left filling of fingerlings to polybag, center at right putting up of oxygen to polybag and lower left are fingerlings ready for transport

Tilapia farmers from Barangays Opong, Capangihan and Telegrafo, Tolosa Leyte, happily receives their FREE tilapia fingerlings for their recovery livelihood support program after "TY HAIYAN" given by CRS-INGO in partner with BFAR, LGU Tolosa and WorldFish Center

Photo left was the acclimatization process while at right was the releasing of tilapia fingerlings after acclimatized in 15 - 20 minutes during stocking

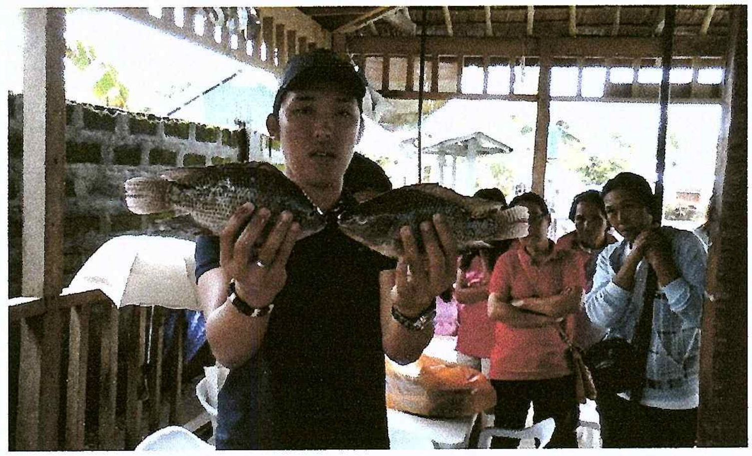


Partial harvest of Tilapia

Sampling of Tilapia




The tilapia farmer beneficiaries were trained by BFAR on Tilapia value addition: upper left is meat ball, upper right nuggets, lower right quekiam and lower left are Tilapia adobo, hamonado, lamayo, garlic kalamansi and garlic pepper

The tilapia farmer beneficiaries proudly and humbly posed their produced tilapias

Types of Commercial Feeds used in the study

Fry Mash

Starter

Grower

Learning journey of the tilapia farmer beneficiaries and CRS Staffs to the Tilapia fish cages of BILIFFA - Bito Lake Integrated Farmers Fisherfolk's Association in Barangay Villa Imelda, Mac Arthur Leyte

CURRICULUM VITAE

CURRICULUM VITAE

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Course	:	Bachelor of Science in Fisheries (BSFi) Major in Marine Fisheries
Year Graduated	:	1998
Secondary	:	Samar Regional School of Fisheries
Year Graduated	:	1984
Elementary	:	Mercedes Elementary School
Year Graduated	:	1977

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		Catbalogan City
Inclusive Dates	:	June 1, 2019 - Present
Position	:	Fishery Program Officer
Department/Office	:	Catholic Relief Services-United States Catholic Conference Bishops (CRS-USCCB)
Office Address	:	Intramuros, Metro Manila, Phillipines
Inclusive Dates	:	November 1, 2014 - May 31, 2019

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