IJBPAS, March, 2019, 8(3): 594-616

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

PROFILING OF THE CULTURAL AND MANAGEMENT PRACTICES OF TILAPIA GROW-OUT OPERATORS IN LUBAO, PAMPANGA, PHILIPPINES USING GEOGRAPHIC INFORMATION SYSTEM

ALVIN T. REYES* AND ALFRED T. REYES

College of Fisheries-Freshwater Aquaculture Center, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines

***Corresponding author: Alvin T. Reyes; E-mail: alvinreyes1845@gmail.com**

Received 14th Oct. 2018; Revised 15th Nov. 2018; Accepted 20thNov. 2018; Available online 1st March 2019

https://doi.org/10.31032/IJBPAS/2019/8.3.4673

ABSTRACT

The study was conducted in order to document the tilapia farm practices in Lubao, Pampanga, Philippines. The survey was held from June to August 2014. The profiles of farm practices were projected into digital maps using the ArcGIS Software. A total of 200 tilapia operators from the 44 barangays of Lubao were interviewed for the making of digital maps.

The study was able to determine the following information: (1) Most of the tilapia farmers in Lubao were operating a medium-scale fishpond at semi-intensive stocking density. The fishponds were sun dried and limed first before stocking size #22 tilapia fingerlings. Most of the operators were using deep well as water source. The fish were fully fed using commercial feeds and the duration of culture usually lasted for 5 months; (2) Most of the farms experienced fish diseases and fish kills and these were associated to bacteria, fungi and virus. Disease-related problems happened during dry season and fish kill outbreaks were experienced all throughout the year. Factors such as extreme environmental condition, unsafe source of water and poor water quality in ponds contributed to the occurrence of the problems; and (3) The operators were receiving limited technical support from the government or private agencies with respect on the occurrence of fish diseases and fish kills.

Keywords: Nile tilapia, tilapia aquaculture, cultural and management practices, Geographic Information System

INTRODUCTION

Aquaculture started in Asia, especially in China and it is considered as the fastest growing food-production industry but it was only 3-4 decades that this spectacular growth took place [1].

Tilapia has become the 3rd most important fish in aquaculture after carp and salmon. The worldwide production exceeded 1,500,000 MT in 2002 and increases annually [2]. Because of their high protein content, large size, rapid growth and palatability, a number of tilapiine cichlids specifically, various species of *Oreochromis*, *Sarotherodon* and *Tilapia* are the focus of major aquaculture efforts [2].

Tilapia is the second most important fish cultured in the Philippines next to milkfish [3]. Central Luzon alone has produced 50% of the total tilapia production in the country in the last five years [4]. In 2003, the province of Pampanga has yielded 65,000 MT of tilapia earning for it the title "tilapia capital of the Philippines" [4].

Tilapia growers in Pampanga operate fishpond with size range of 1,000-10,000 m^2.Polyculture is one of the most dominant types of aquaculture system in the province wherein tilapia is usually stocked with shrimp, milkfish and/or crab. Majority of the grow-out operators practice 1-2cycles per year but a third cycle is also possible in the province [5]. Tilapia operators in the province procure their fingerlings from local hatcheries. The extent of dependence on commercial feeds was very pronounced, thus, typical culture duration was 4 months [5].

According to Sumeldan *et al*. (2013) [6], the growth of tilapia production in Pampanga is accounted to the intensification of their culture practices and management. However, the intensification of fish culture might create problems on diseases and water quality [7, 8, 9]. The limited baseline and updated information on the current practices of tilapia farm operators in Pampanga also contributed to this present problem [6].

Geographic Information System (GIS) is able to store, analyze, plan, synthesize and make a map of spatial data [10].GIS techniques have been used in a wide range of disciplines, including environmental science, traffic management, land management, agriculture, forestry, hydrology, public health and oceanography [11]. The capabilities of evolving GIS provide a powerful tool for the efficient and cost effective management for sustainable aquaculture [12]. In the Philippines, GIS and related geospatial technologies are increasingly being used to address and solve

problems in governance, economic development, basic services, emergency response, climate change, crime monitoring and other everyday concerns of citizens [13].

This study was designed to create maps of the cultural and management practices of tilapia grow-out operators in Lubao, Pampanga, Philippines using GIS.

MATERIALS AND METHOD

The Study Area

Lubao is a first class municipality, which is located at the southwestern part of Pampanga. It is noted for the production of rice, sugar cane, fish and sampaguita [14]. Lubao has a total land area of 15,600ha and it ranked 1st among the 22 municipalities of Pampanga based upon total hectares of land allotted for aquaculture (8,381 ha) [15].

Field Interview and GPS Reading

The survey questionnaire that was used in the study was already pre-tested to grow-out tilapia operators in some municipalities of Pampanga. A total of 200 (15% from the total respondents) tilapia grow-out operators in Lubao, Pampanga were interviewed from June to August 2014 using a structured survey questionnaire as a guide. The survey questionnaire has tried to explore the cultural and management practices of the respondents. Some of the information included in the questionnaire was: GPS reading, farm/fishpond area, species cultured, level of operation (e.g. extensive, semi-intensive, intensive), level of feeding, and fish kill outbreak occurrences. The scaling of the area of grow-out ponds was devised by the researchers of the Fisheries Information and Learning Center of the Freshwater Aquaculture Center-Central Luzon State University (FAC-CLSU).As reference in mapping, the exact location of the farm was marked using a handheld GPS.

Mapping

Each grow-out farm per barangay in Lubao, Pampanga, Philippines was represented by digital map of the barangay using ArcGIS Software. ESRI base map was used to create the digital map of the grow-out farm per barangay. Collected data on cultural and management practices from every farm per barangay was averaged and incorporated in the digital maps. Digital maps on scale of production, pond preparation practices, level of management, level of feeding, water source and water exchange, diseases and preventive measures and culture duration were created.

RESULTS AND DISCUSSION

Based upon the project “Development of Comprehensive Geo-referenced Database

for Ecological Risk Analyses of Tilapia Pond Culture in Pampanga, the municipality of Lubao, Pampanga is composed of 44 barangays. Thirty eight (38) of these barangays had existing tilapia grow-out ponds. The six barangays without tilapia ponds include San Antonio, San Miguel, San Pablo 1st, San Pedro Palcarangan, San Vicente and Santo Cristo (Figure 1). All of the barangays with existing tilapia ponds were covered in the survey with 4-8 interviewed farm operators per barangay. The study interviewed a total of 200 tilapia grow-out farms in 38 barangays of Lubao, Pampanga (Table 1).

Scale of Production

Scale of production was based upon the averaged area of ponds being operated: Small-scale = <3ha; Medium-scale = 3-6 ha; Large scale = >7ha. Majority of the interviewed respondents (80.0%) were operating medium-scale tilapia ponds. Meanwhile, small-scale production ranked 2ndwith share contribution of 8.0%. Large-scale ponds (12.0%) were only found in barangay San Nicolas 1st, Santa Lucia and Santo Tomas (Figure 2).

Small-scale and medium-scale farms were easier to manage in terms of physical, technical and economic aspects. Physically, few laborer will be hired only and the farm owner or any member of the family will share some responsibilities in the maintenance (e.g., grass cutting, repair of dike, etc.) of the farm. Technically, problems such as deteriorating water quality, mortality and outbreak of diseases are easily addressed if the scale of operation is only small-scale or medium-scale. Economically, small to medium scale of operation will require lower cost of investment and operating expenses. Most of the tilapia farms could not afford to operate larger fishponds because of very high cost coming from feeds. Commercial feeds used in the operation were lent from feed companies operating in the province.

Pond Preparation Practices

Pond preparation practices include drying, plowing, liming, fertilization, application of other chemicals (e.g. probiotics, antibiotics, etc.), and combination of the mentioned practices. The most common pond preparation practices in the municipality were combination of drying and liming which accounted for 79.5%. The combined drying, plowing and liming were practiced by 9.5% of the respondents. Meanwhile, the combined drying, liming and application of other chemicals were practiced by 8.0% of the respondents. Only 3.0% of the respondents adopted the combined drying,

liming, fertilization and application of other chemicals.

The respondents believed that the combination of drying and liming was already enough to prepare their tilapia ponds. In addition, this type of combination was perceived by them as manageable and cost-effective. There was also possibility that they refused to use other chemical applications such as antibiotics and probiotics because of the high prices of these products in the market. It was also observed that tilapia farms in barangays (San Nicolas 1st, Santa Lucia and Santo Tomas) having large-scale productions have resorted on the use of fertilizer and other chemical applications (Figure 3). These two adds-on in their operation were perceived by the operators to improve the growth and immunity of the cultured tilapia.

Water Source and Water Exchange

Based upon the result of the survey, water sources for tilapia operation in the municipality include deep well, rainfall, main river channel, irrigation canal (water from river tributaries) and combination of the four. Majority (68.5%) of the respondents were relying in deep well source of water. Only a portion of them used the following water source and combinations: deep well and rainfall (11.5%), main river channel (7.5%), irrigation canal and main river channel (5.5%), irrigation canal (3.0%), irrigation canal and deep well (2.0%), and canal, deep well and rainfall (2.0%).

Most municipalities in the province of Pampanga relied on water source coming from Pampanga River and irrigation canals. In contrast, most of the tilapia grow-out ponds in Lubao (Figure 4) were using deep well because of their farness to the main channel of Pampanga River and related irrigation canals which were located and concentrated in the upper and middle parts of Pampanga. Tilapia farms in barangays (San Nicolas 1st and Santa Lucia) having large-scale productions relied on Pampanga River as water source to reduce the cost of pumping (Figure 4).

Water exchange was seldom (1-2 times per cycle) (88.0%) done by the tilapia grow-out operators in Lubao. Water exchange was only done if the quality of water in ponds was already deteriorating, if there was imminent fish kill and disease outbreak, and if the quality of water in the river and irrigation canals was in good condition. Barangays that relied on irrigation canal or main river channel (San Agustin San Pablo 2nd, Santa Lucia, Santa Monica and Santa Rita) did frequent (at least once a month) water exchange (Figure 5).

Level of Stocking Density and Feeding

Level of management was based upon the practiced stocking density (fish/m^2): Extensive = <4; Semi-intensive = 4-8; Intensive = >9. Almost all of the respondents (97.5%) were practicing semi-intensive level of management; extensive level of management was practiced in barangay San Agustin only (Figure 6). The normal size of tilapia fingerlings for stocking was #22; sizes #17 and #14 were seldom used because of higher price. Most of the farmers preferred the tilapia strain FaST (FAC Selected Tilapia). Other tilapia strains used in the municipality were BFAR GET-EXCEL (Bureau of Fisheries and Aquatic Resources Genetically Enhanced Tilapia-Excellent strain that has Comparable advantage with other tilapia strains for Entrepreneurial Livelihood), GIFT (Genetically Improved Farmed Tilapia), GenoMar and Chitralada. Most of the tilapia farms preferred full feeding (86.0%); only a portion of them (14.0%) practiced supplemental feeding (e.g. macrophytes, snail, etc.) with fertilization and those farms were located in barangay Baruya,De Lapaz, Prado Siongco, San Agustin, San Nicolas 1st and Sta. Maria (Figure 7).

According to the interviewed tilapia operators, moderate stocking density was being advised by the technical staff of their preferred feed companies (e.g. Ace Feeds,B-Meg, Feed Mix, Hocpo, Santeh, Vitarich, etc.). This level of management could reduce the risk of deteriorating water quality and diseases in tilapia. According to the farmers, full feeding could shorten the culture period of tilapia because the important nutrient requirements of the fish were already contained in the feeds.

Fish Diseases

Disease agents in their cultured tilapia include bacteria, fungi, virus and their combinations. Nobody claimed that they experienced parasites in their cultured tilapia. Almost all of the respondents (97.5%) said that their cultured fish were being exposed to bacteria, fungi, virus or combination of the three based upon physical observations of the symptoms of the disease-causing agents (Figure 8).

According to them, skin lesions and fin ulcerations in tilapia were associated to bacterial or viral attacks. Meanwhile, cottony growth in tilapia was a sign of fungus infection. The history of disease agents in their cultured fish was not reliable since there was no technical person who isolated and identified the microorganisms from the diseased or healthy fish.

In the study conducted by Esteban and Reyes (2014) [16] and Gascon and Reyes (2014) [17], bacteria isolated from tilapia in Minalin and Pampanga River include *Streptococcus thermophillus, Staphylococcus epidemidis, Staphylococcus aureus, Proteus vulgaris, Proteus mirabilis, Bacillus subtilis, Pseudomonas aeruginosa, Aeromonas hydrophila, Enterococcus fecalis, Escherichia coli, Vibrio vulnificus, Vibrio cholera, Vibrio parahaemolyticus, Vibrio alginolyticus, Enterobacter aerogene, Lactobacillus bulgaricus, Providencia alcalifaciens*, *Salmonella enteritidis*, *Salmonella typhi* and *Shigella flexneri*. Some of the isolated bacteria are pathogenic to fishes (e.g., *A. hydrophila*, *P. aeruginosa*, *Vibrio* spp.) and most of the bacteria are pathogenic to humans and indicators of poor water quality (*E. coli*, *S. flexneri*, *E. fecalis*, *Salmonella* spp.).

According to them, the appearance of the mentioned physical signs of diseases usually happened during dry season (75.5%) (Figure 9) and the fish kill outbreak or localized die-off of cultured fish occurred in both seasons (dry and wet) (57.0%) (Figure 10). The occurrence of fish diseases and fish kills were linked to extreme environmental conditions (e.g. elevated temperature and nitrogenous waste, low dissolved oxygen), abrupt change in the water environment due to weather, and poor water quality and contaminated water source (e.g. Pampanga River and irrigation canals).

The most common remedy being done to prevent the occurrence of fish kill was water exchange (95.5%); only few of the respondents (barangay San Jose Apunan and San Matias) practiced water exchange with incorporation of chemicals in the water (4.5%) (Figure 11).

Harvest Data

Harvesting of tilapia in Lubao usually commenced after 5 months (97.00%) culture period (Figure 12). The culture duration seemed shorter in case of tilapia fed with commercial feeds than those with supplemental feeding. Average body weight of tilapia upon harvest ranged from 140-330 g. The farm gate price of harvested tilapia ranged from PhP55-74/kg.

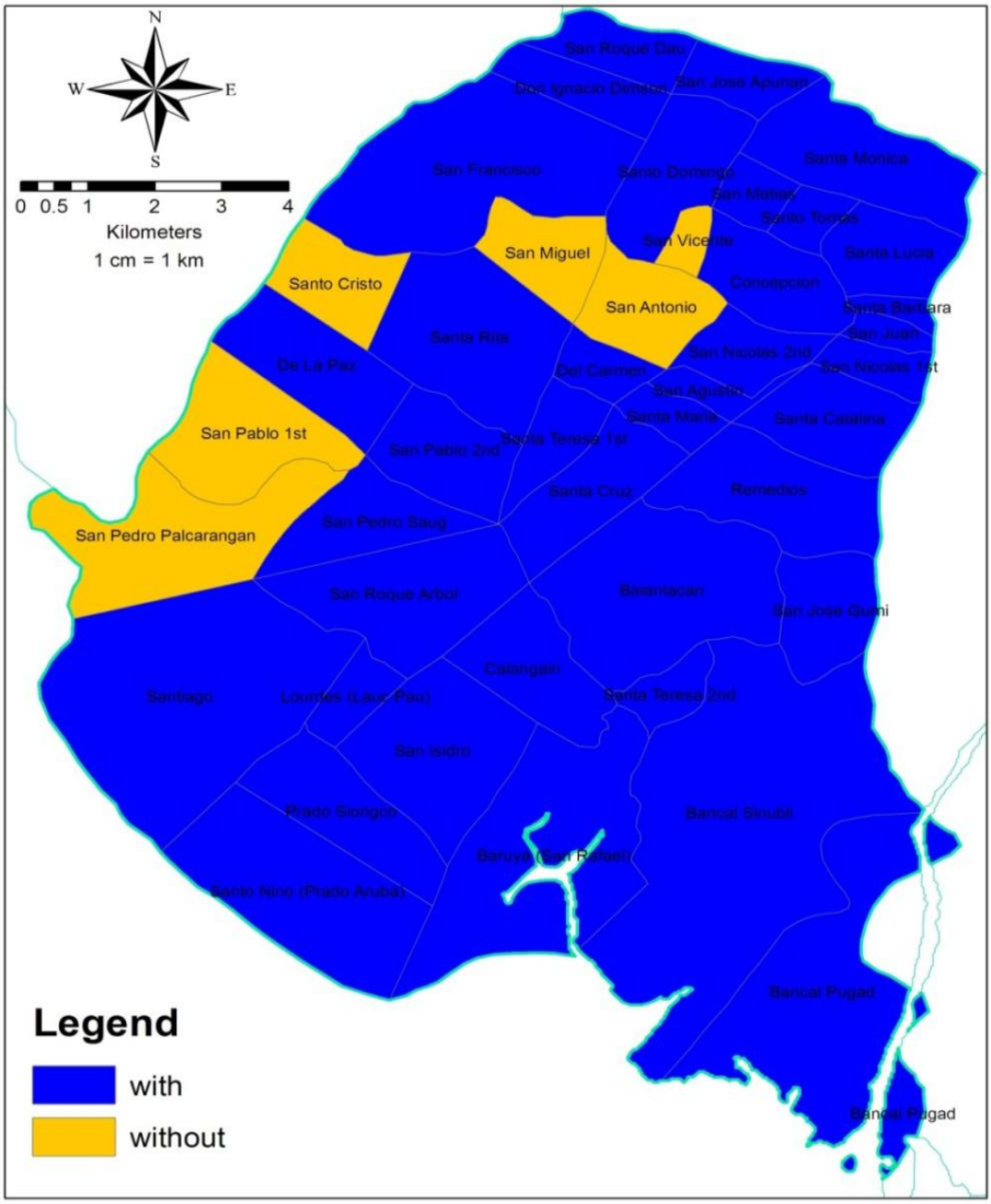

Figure 1: The 44 barangays of Lubao, Pampanga with and without existing tilapia grow-out ponds

Table 1: Distribution of interviewed tilapia grow-out operators in 44 barangays of Lubao, Pampanga

Barangay	No. of Respondents per Barangay	Barangay	No. of Respondents per Barangay
Balantacan	8	San Nicolas 2nd	4
BancalPugad	8	San Pablo 1st*	0
BancalSinubi	7	San Pablo 2nd	4
Baruya (San Rafael)	6	San Pedro Palcarangan*	0
Calangain	7	San Pedro Saug	5
Concepcion	4	San RoqueArbol	4
De Lapaz	6	San RoqueDau	5
Del Carmen	5	San Vicente*	0
Don Ignacio Dimson	4	Santa Barbara	5
Lourdes (Lauc Pau)	4	Santa Catalina	5
Prado Siongco	5	Santa Cruz	5
Remedios	4	Santa Lucia	6
San Agustin	4	Santa Maria	7
San Antonio*	0	Santa Monica	5
San Francisco	6	Santa Rita	6
San Isidro	7	Santa Teresa 1st	5
San Jose Apunan	4	Santa Teresa 2nd	4
San Jose Gumi	5	Santiago	7
San Juan	5	Santo Cristo*	0
San Matias	5	Santo Domingo	5
San Miguel*	0	Santo Nino (Prado Aruba)	5
San Nicolas 1st	5	Santo Tomas	4

Note: Asterisk signifies barangay without existing tilapia grow-out ponds

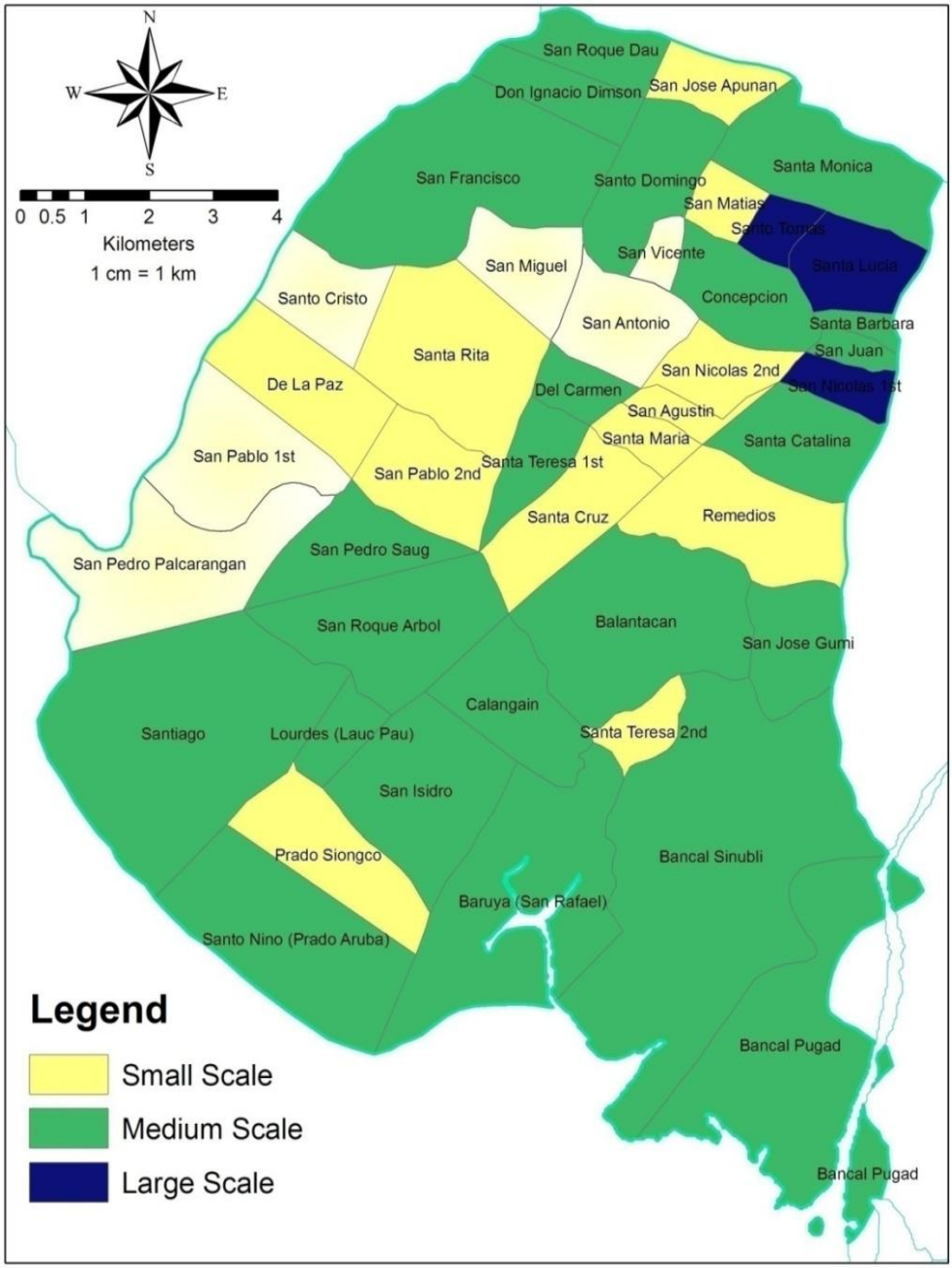

Figure 2: Scale of production based upon pond area

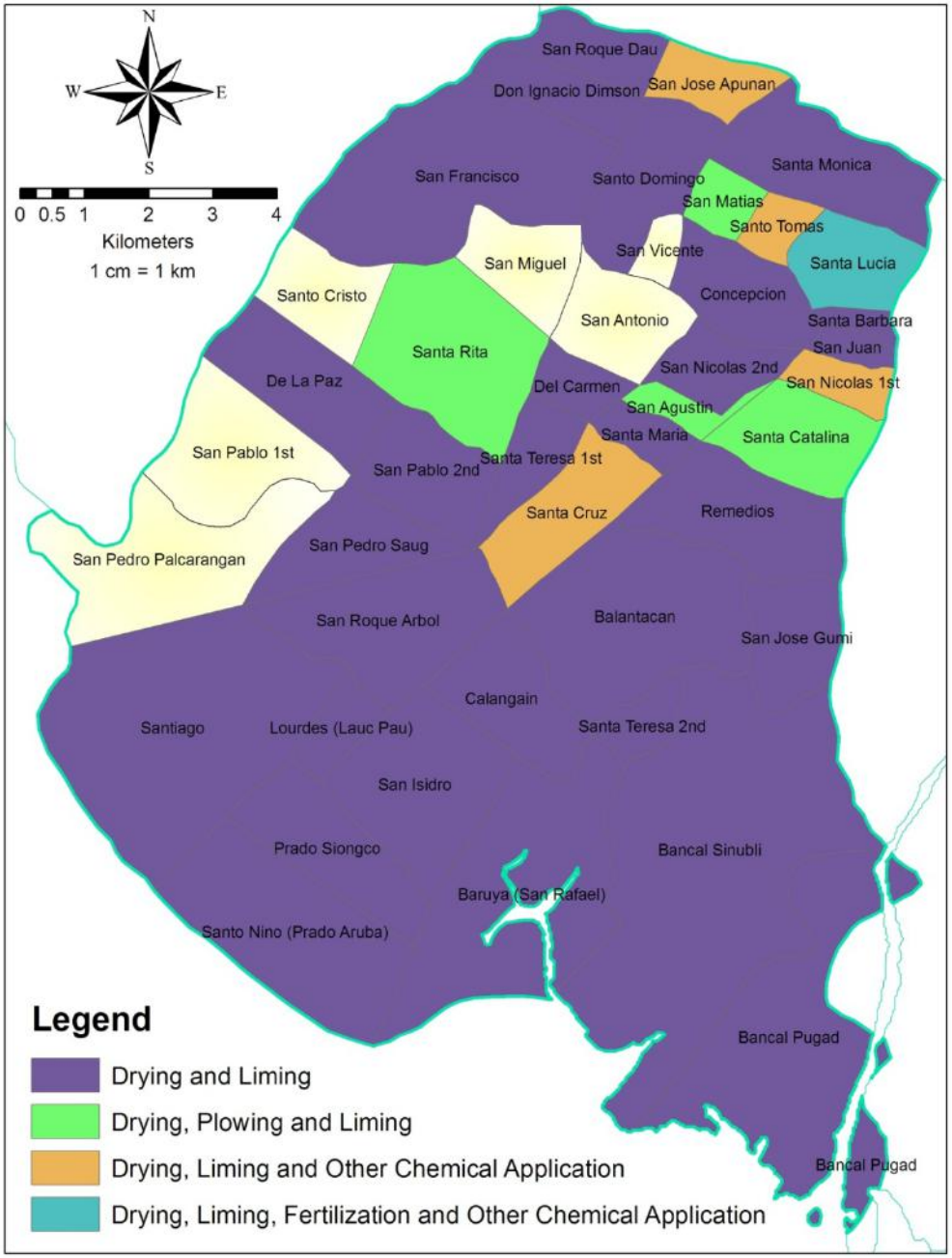

Figure 3: Pond preparation practices

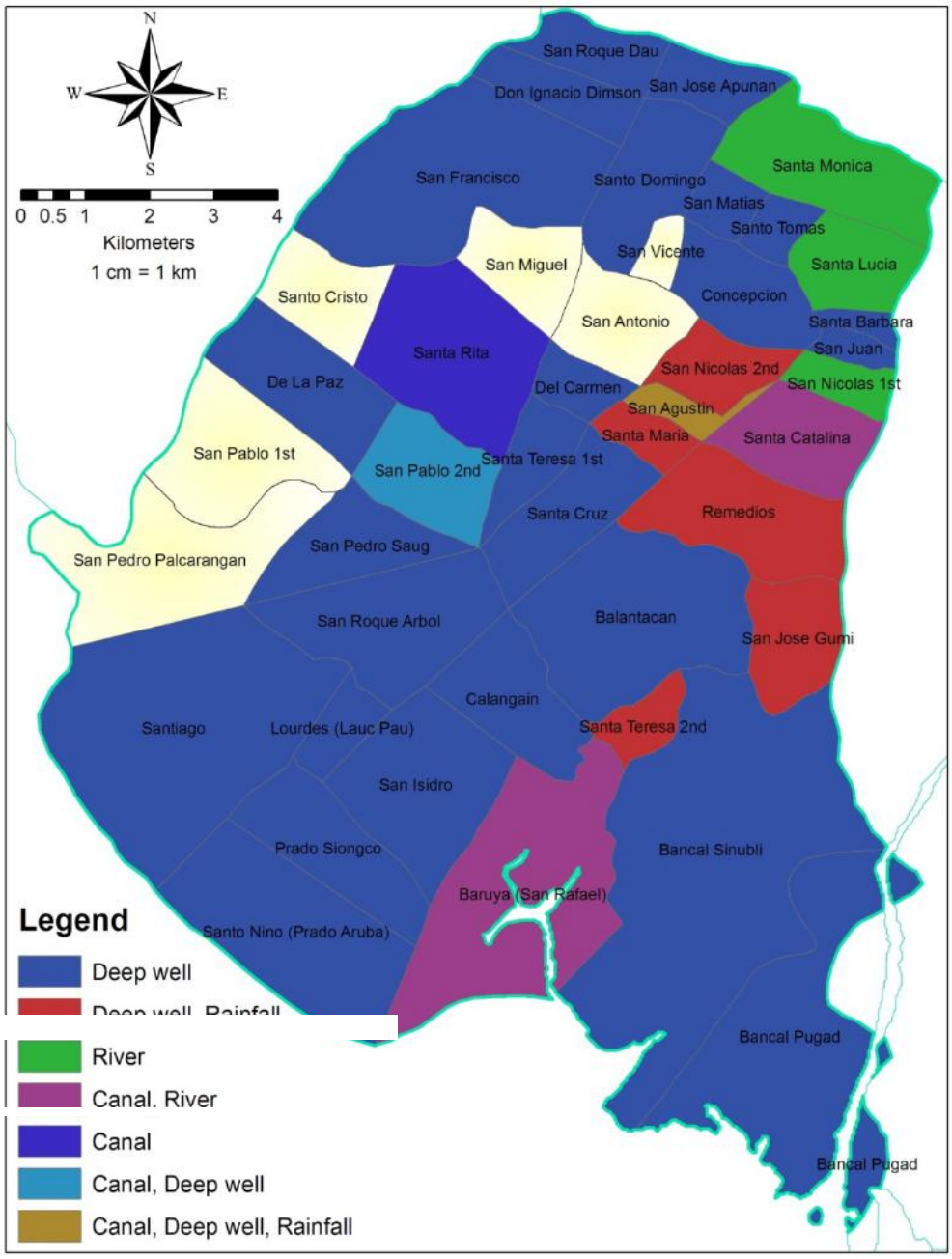

Figure 4: Sources of water in tilapia pond

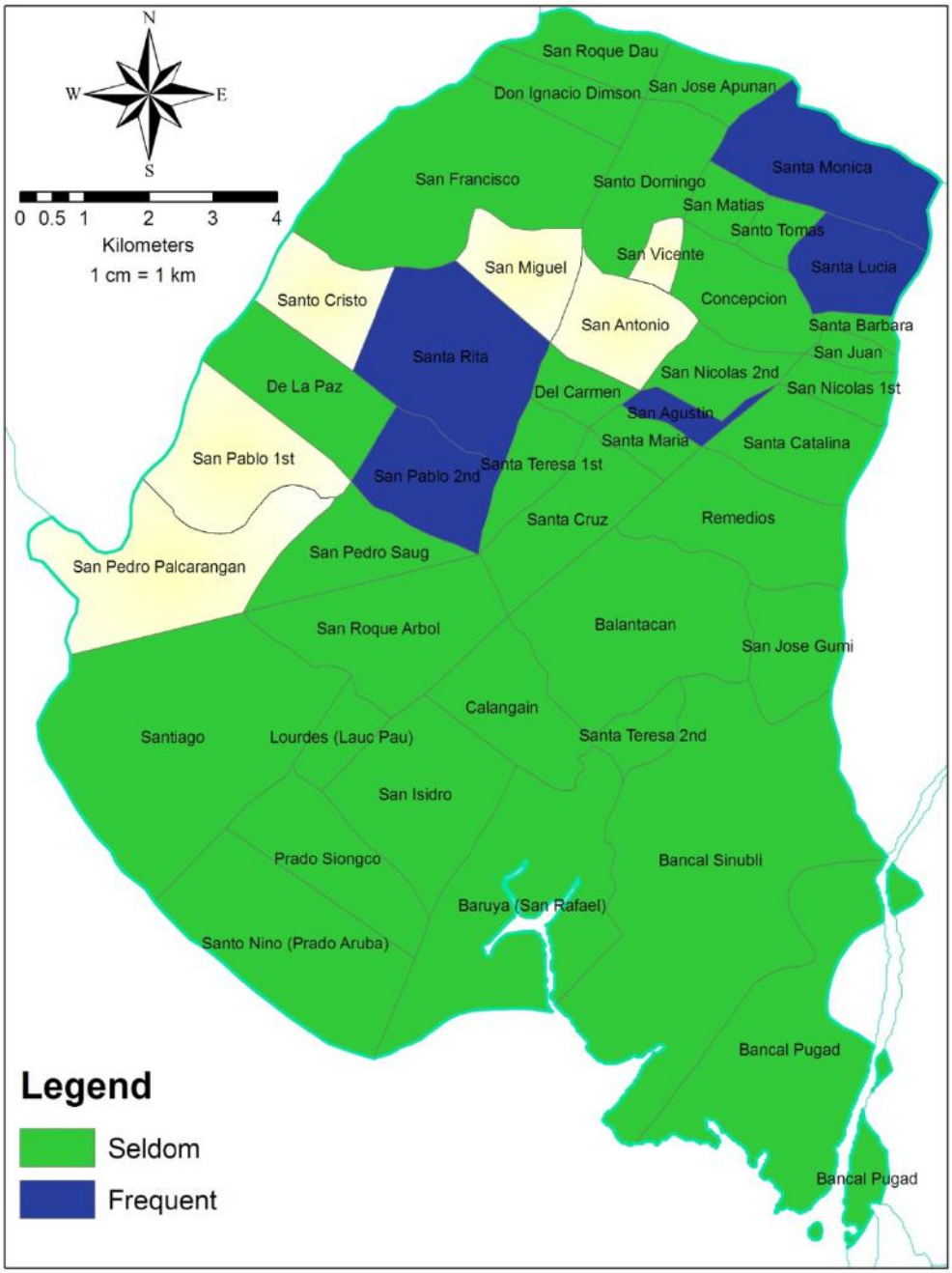

Figure 5: Water exchange in tilapia ponds

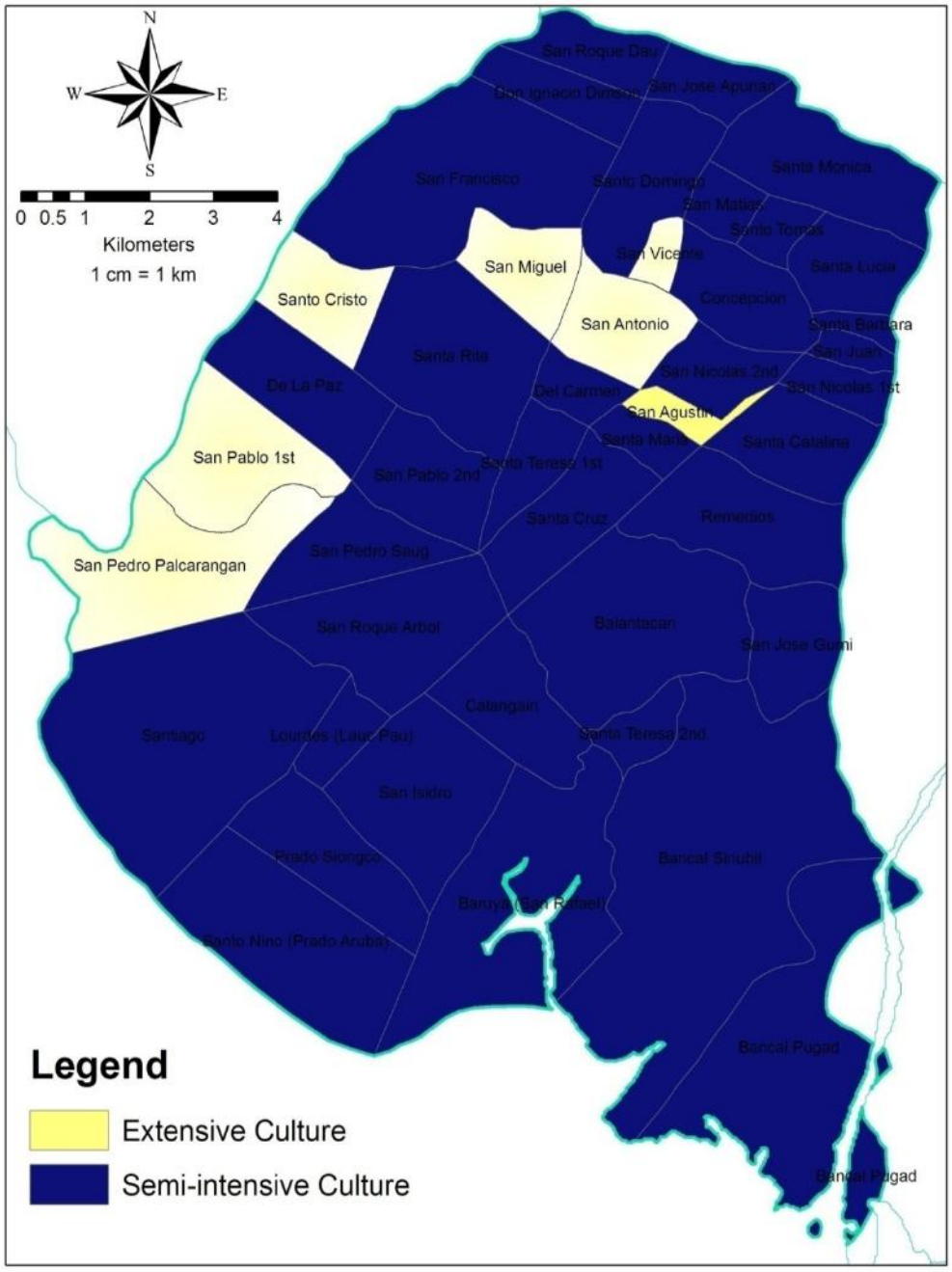

Figure 6: Level of stocking density

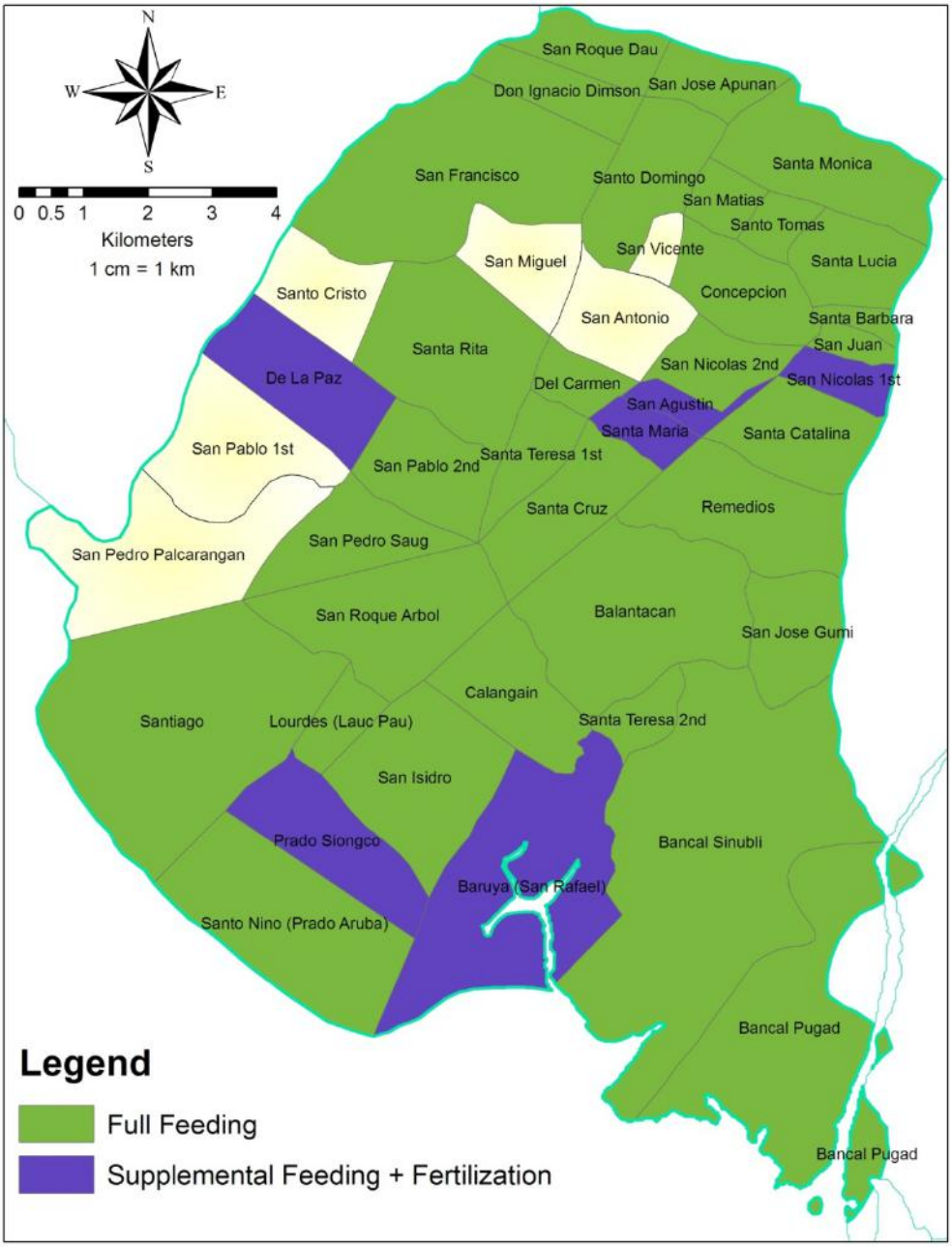

Figure 7: Level of feeding

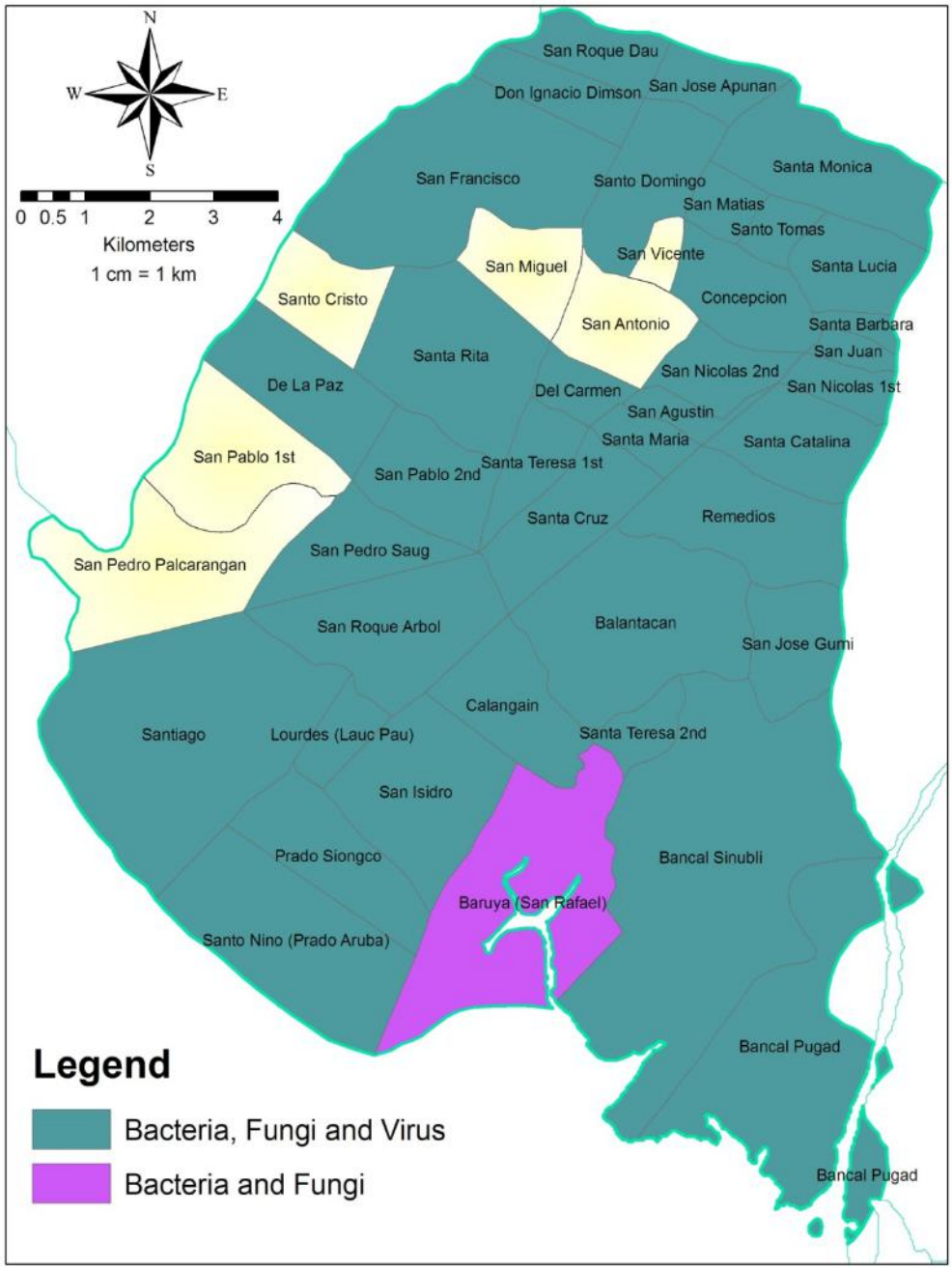

Figure 8: Biological agents of disease

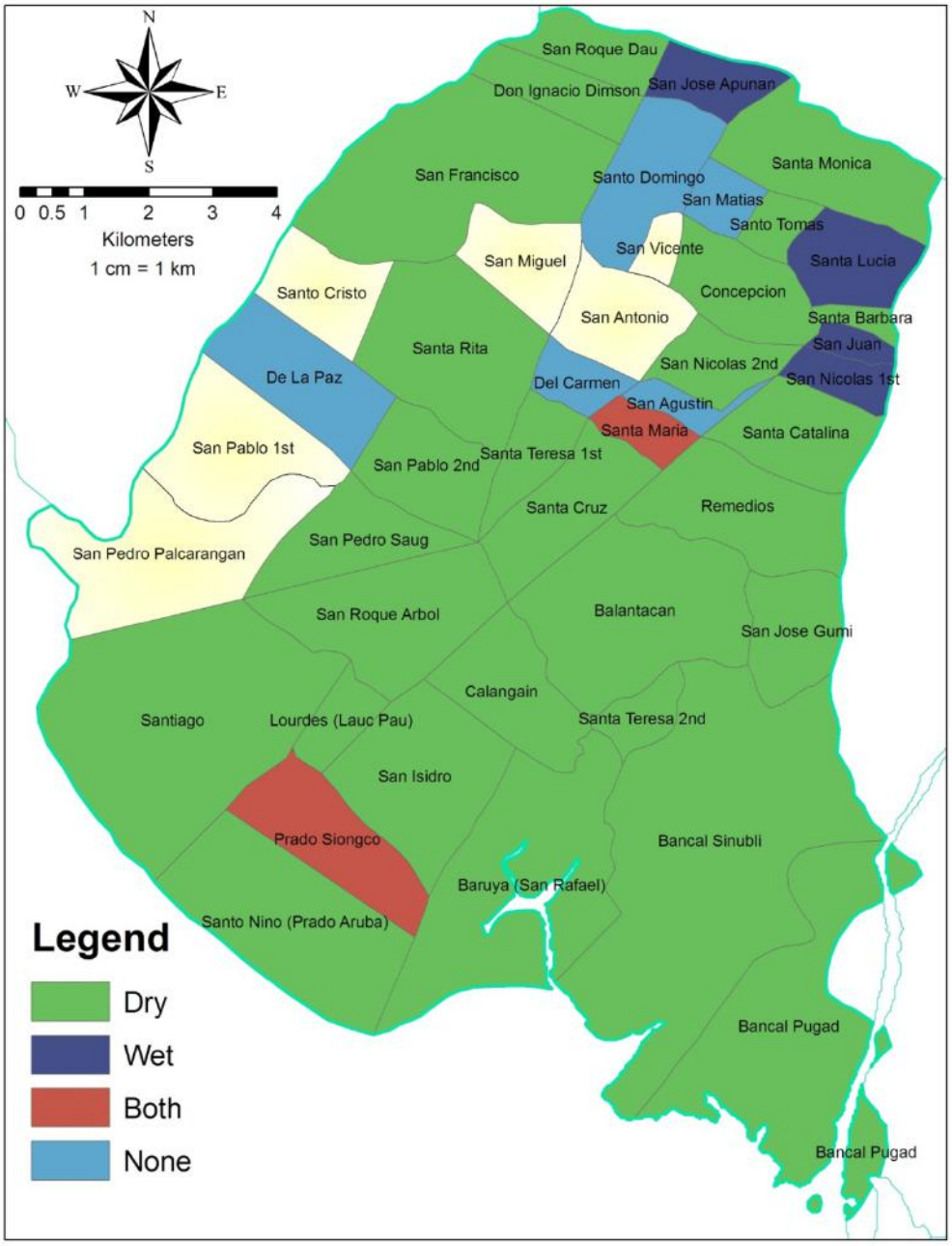

Figure 9: Fish disease outbreak

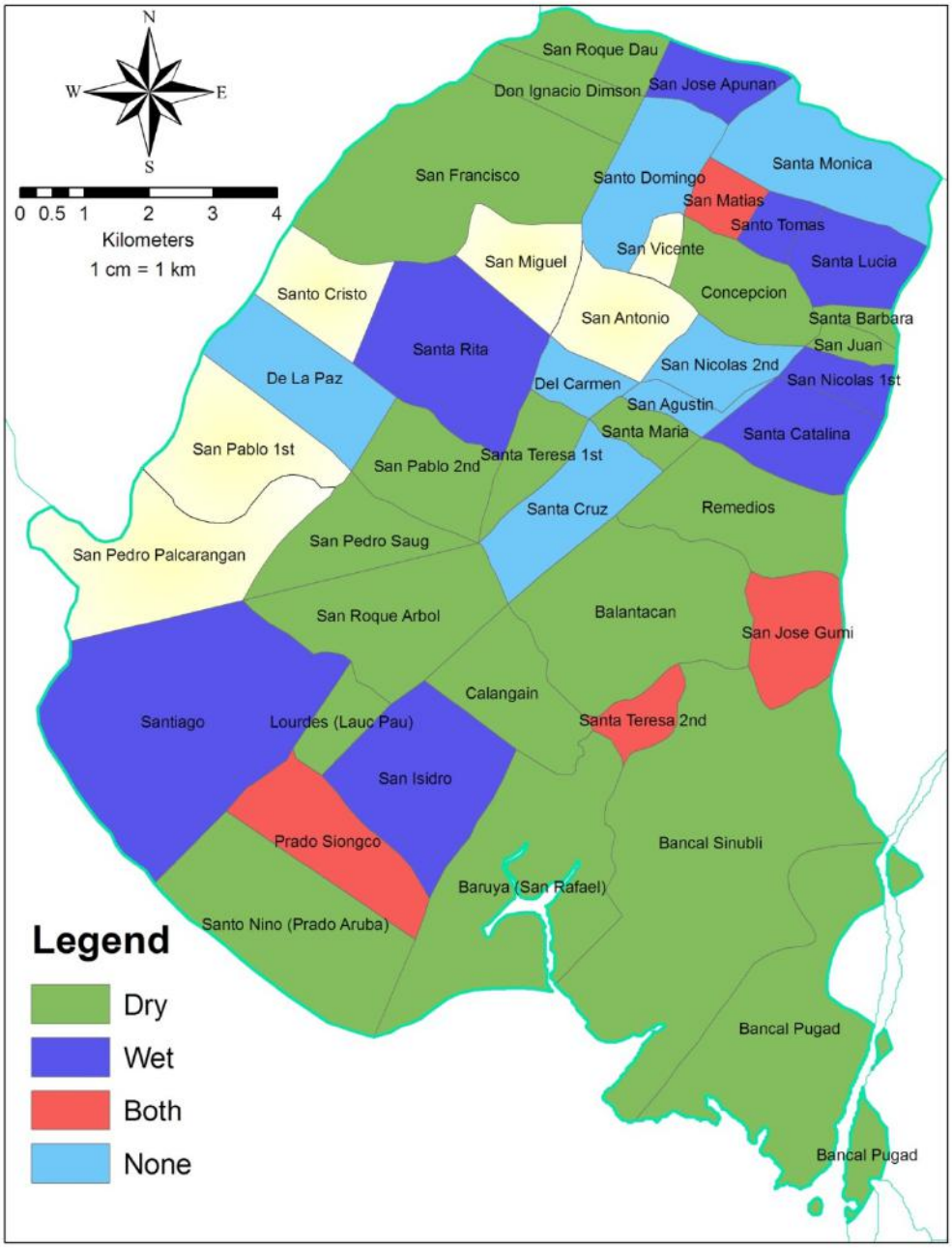

Figure 10: Fish kill outbreak

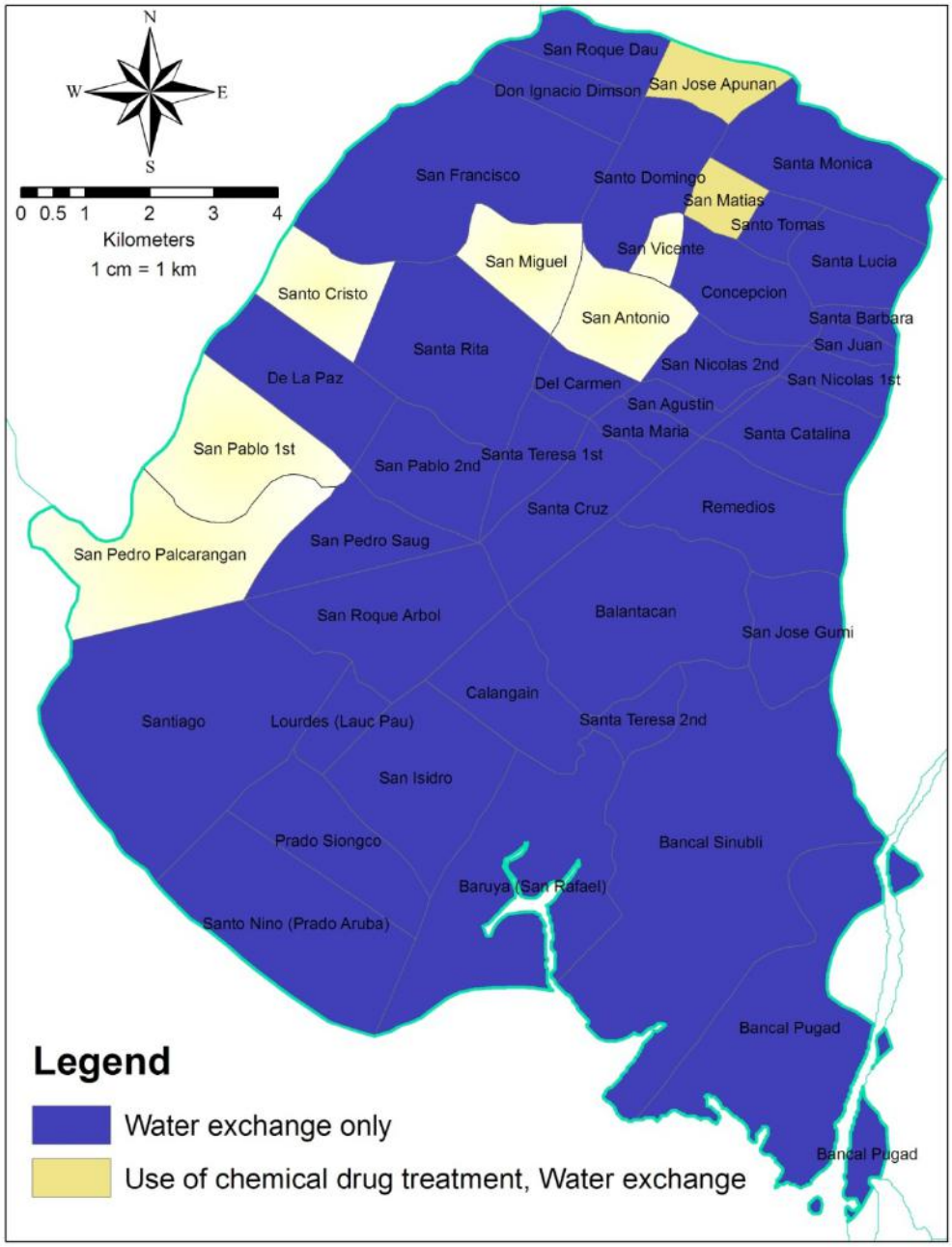

Figure 11: Preventive control for fish disease and fish kill outbreaks

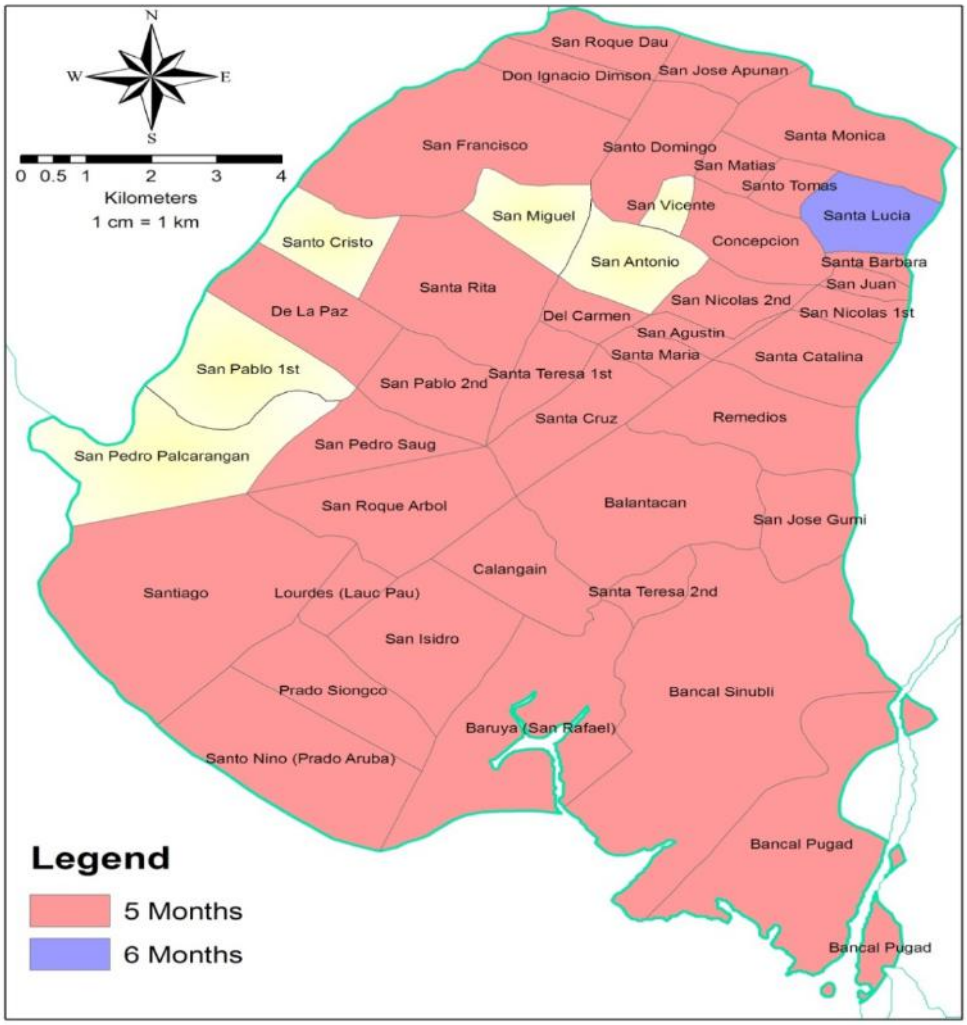

Figure 12: Duration of tilapia grow-out culture

RECOMMENDATIONS

Based on the information gathered, the following points were recommended for a sustainable and profitable tilapia production in Lubao, Pampanga: (1) Grow-out ponds with recurrent fish disease and fish kill outbreaks should fallow their land; (2) Practice frequent water exchange as it does not only eliminates bacterial disease agents but also lessens nitrogenous waste in the water, thus, reducing environmental stress which is the main cause of fish kill; (3) If planning to incorporate chemical drug treatment in the water, always consider the cost-efficiency ratio; (4) Direct stocking at size #10 is highly recommended as it offers significantly higher yield according to Bolivar *et al*. (2004) [18]; and (5) An alternative feeding regime is also advised. Consistent with Bolivar *et al*. (2006) [19],

alternate feeding can reduce the production cost of feed consumption by half without compromising the growth of the cultured tilapia, therefore, lowering feed conversion ratio and almost doubling the profit.

CONCLUSION

The study was able to determine the following information: (1) Most of the tilapia farmers in Lubao, Pampanga were operating a medium-scale fishpond at semi-intensive stocking density. The fishponds were sun dried and limed first before stocking size #22 tilapia fingerlings wherein FaST was the most preferred strain. Most of the operators were using deep well as water source. The fish were fully fed using commercial feeds and duration of culture usually lasted for 5 months; (2) Most of the farms experienced fish disease and fish kill as being associated to bacteria, fungi and virus. Factors such as extreme environmental condition, unsafe source of water and poor water quality in ponds contributed to the occurrence of the problems; and (3) The operators were receiving limited technical support from the government or private agencies with respect on the occurrence of fish diseases and fish kills.

ACKNOWLEDGEMENT

The authors expressed their profound gratitude to the Department of Science and Technology (DOST), Dr. Emmanuel Vera Cruz, Mr. Roberto Miguel Sayco, Mr. Joel Sumeldan, Mr. Allan Botch Valdez, Mr. Mar Macasiray and Mr. Rodolfo Atayde for making this study possible.

LITERATURE CITED

[1] Sorgeloos, P. 2010. Resources, technologies and services for future aquaculture: A needs assessment for sustainable development. Retrieved on January 5, 2014 from http://www.fao.org/docrep/015/i2734e/i2734e.pdf.

[2] Fessehaye, Y. 2006. Natural mating of Nile tilapia (*Oreochromis niloticus* L.).Implications for reproductive success in breeding and cannibalism. Wageninngen UR. pp. 150.

[3] http://www.bfar.da.gov.ph/pages/Programs/prog-getexeltilapia.html.

[4] http://archives.pia.gov.ph/?m=12&fi=p051027.htm&no=54.

[5] Asian Development Bank. 2005. An evaluation of small-scale freshwater rural aquaculture development for poverty reduction. Asian

Development Bank. Metro Manila, Philippines. 164 p.

[6] Sumeldan, J.D., E.M. Vera Cruz, A.T. Reyes, R.M.V. Sayco, A.B.D. Valdez, R. Macasiray, M. Macasiray, M.A.M. Ventura, G.G. Garcia, A. Espino and M. Cinense. 2013. Profiling of tilapia grow-out aquaculture in Minalin, Pampanga based on management practices. Paper presented during the 45th Annual National Convention on Marine and Freshwater Sciences at the Legend Hotel, Puerto Princesa City, Palawan on October 16-18, 2013.

[7] Sarig, S. 1968. Possibilities of prophylaxis and control of ectoparasities under condition of intensive warm water fish culture. Bull. Off. Epiz., 69(9-10):1577-1590.

[8] Dujin, C.V.F. 1973. Diseases of Fishes. 3rd edition. Life Books, London. 215 p.

[9] Kugel, B., R.W. Hoffman and A. Fries. 1990. Effect of low pH on the chorion of rainbow trout and brown trout. J. Fish Biology, 37: 301-310.

[10] Schroder, W. 2006.GIS, geostatistics, metadata banking, and tree-based models for data analysis and mapping in environmental monitoring and epidemiology. Int. J. Med. Microbiol., 296 (Suppl 40): 23-36.

[11] Maguire, D.J., M. F. Goodchild and D.W. Rhind (eds.). 1991. Geographical information systems: Principles and application, Vol. 2. Retrieved on January 5, 2014from http://books.google.com.ph.

[12] Stead, S.M., G. Burnell and P. Goulletquer. 2002. Aquaculture and its role in integrated coastal zone management. Aquac. Int., 10:447–468.

[13] Tongco, A.F. 2011.Developing a GIS for rural villages in the Philippines. Retrieved on January 5, 2014 from http://dge.upd.edu.ph/philgeos2013/files/Full_Paper_PhilGEOS2013_Tenorio-and-Gonzalez.pdf.

[14] http://en.wikipedia.org/wiki/Lubao,_Pampanga.

[15] www.zamboanga.com/z/index.php?title=Lubao,_Pampanga,_Philippines

[16] Esteban, K.B and A.T. Reyes. 2014. Bacterial distribution of pond-reared Nile tilapia (*Oreochromis niloticus* L.) in Minalin, Pampanga using geographic information system.

College of Fisheries, Central Luzon State University, Science City of Muñoz, Nueva Ecija.

[17] Gascon, C.G. and A.T. Reyes 2014. Bacterial load and composition of river tributaries in Minalin, Pampanga. College of Fisheries, Central Luzon State University, Science City of Muñoz, Nueva Ecija.

[18] Bolivar R.B., E.B.T. Jimenez, J.R.A. Sugue and C.L. Brown. 2004. Effect of stocking sizes on the yield and survival of Nile tilapia (*Oreochromis niloticus* L.) on-grown in ponds. Retrieved on March 16, 2015 from https://ag.arizona.edu/azaqua/ista/ISTA8/FinalPapers/PDF/32%20BOLIVAR%20paper.pdf.

[19] Bolivar R.B., E.B.T. Jimenez and C.L. Brown. 2006. Alternate-day feeding strategy for Nile tilapia grow-out in the Philippines: Marginal cost revenue analyses. Retrieved on March 16, 2015 from http://www.tandfonline.com/doi/full/10.1577/A05 012.1#preview