



**FACULTY OF SCIENCE AND EDUCATION
DEPARTMENT OF BIOLOGY**

**ASSESSMENT OF THE PHYSICO-CHEMICAL AND BIOCHEMICAL STATUS OF
SELECTED PONDS WITH EMPHASIS ON IMPROVING CONDITIONS FOR FISH REARING
IN NAGONGERA TOWN COUNCIL, TORORO DISTRICT.**

BY

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BU/UP/2021/1663**

**A RESEARCH REPORT SUBMITTED TO THE DEPARTMENT OF BIOLOGY FACULTY OF
SCIENCE AND EDUCATION IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE
AWARD OF BACHELORS DEGREE IN SCIENCE AND EDUCATION OF BUSITEMA
UNIVERSITY**

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DECLARATION

I hereby declare that this is my original work and that it has not been submitted to any institution of higher learning for an academic award.

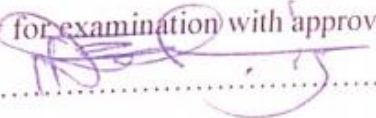
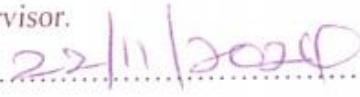
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APPROVAL

This work has been submitted to the Department of Biology, Faculty of Science and Education, Busitema University for examination with approval of my supervisor.

Signature.......... Date..........

DR. HANNINGTON OCHIENG.

DEDICATION

I dedicate this research on assessment of the physical-chemical and bio-chemical status of ponds to improve fish rearing to my dear Father Balaba Lawrence and Mother Kabugho Betty who sponsored the research financially to its completion and therefore played a vital role in this study aimed at improving fish rearing. I also dedicate the research to my dear uncle Rev Br Balaba Laurent, Aunt Balaba Leah and my siblings Bwambale Melchizedek, Biira Philomena and Masereka Bennedict who have always played an advisory role in my studies. Lastly, this dedication goes to fish farmers in agongera town council who were very cooperative to me in this research and have endeavored to take on the mantle of producing fish for communities at low prices to fight low food production and famine. Together we can find more remedies and strategies of improving fish rearing conditions for us to have healthy fish for consumptions within our homes and small pieces of land we have. I also dedicate this research to future scientists who are to build on our research and discover more remedies in improving fish conditions in ponds. Even an area not endowed with natural resources like rivers and lakes can have high and good quality fish produce if fish rearing conditions in ponds are improved and farmers and sensitized and educated about good pond managerial strategies that maintain the physical-chemical and bio-chemical status of ponds to optimal levels

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I would like to thank the almighty God who has enabled me to come to the completion of my course. All the hardships I went through he was just letting me through ably until I am within the vicinity of graduation and long-awaited career. THANK YOU, GOD!

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Lastly, I acknowledge my parents' efforts in financially funding the research project, without their support and encouragement; this would not have come to success and completion. Thank you so much and may God shower you with blessings.

ABSTRACT.

Ponds are water resources that provide food in form of fish in both rural and urban places all over the world, countries that lack natural water resources like lakes and rivers for fish rearing such as Singapore utilize and rely on ponds for fish production. Many fish farmers worldwide lack adequate knowledge on fish pond management and this leads to low production in the pond. There is limited research study in ponds hence poor managerial skills and need for urgent interventions by governments and non-governmental organizations such as WHO to calm the situation. There is need for technological advancement in fish pond management monitoring strategies for the physical-chemical and bio-chemical status to improve fish rearing conditions. In Africa there is much low technological use in pond management strategies to ensure pond status is kept ideal for fish rearing e.g. the use of sensor networks to monitor physical and biochemical pond status in Uganda fish rearing is a lucrative venture currently though more sensitization and education of farmers about fish farming is very low hence farmers lack adequate skills in pond management to rear good quality fish. In Nagongera, ponds support a dynamic and rapidly growing population of people with income and food in form of fish. Tororo district in particular Nagongera has no major lake that can provide adequate fish supply apart from importing from outside the district, from a few rivers and ponds. Ponds suffer anthropogenic disturbances for example, poor fishing methods e.g. poisoning whose impact on the integrity of the pond systems is a subject of concern farmers in Nagongera also face challenges of floods which sweep their fish away and destroy the ponds, lack of adequate labor, lack of a variety of fish species, thieves who fish without permission. Maintenance of biochemical and physical chemical parameters confers good fish living conditions conditions that is to say temperature, pH, turbidity, nutrient loading i.e., phosphates. These can be used to assess the biological status of the ponds at both local and global level with an intention of discovering the effect of the variations in the parameters on fish rearing to improve its quality. In this research selected water parameters were measured and used to assess pond water quality and predict the fish living conditions. Using the set optimal level the, the results measured were compared and conclusions made

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ABBREVIATIONS

BOD – Stands for Biological Oxygen Demand

WHO – Stands for World Health Organization

NWSC – Stands for National Water and Sewerage Cooperation

NEMA – Stands for National Environmental Management Authority

EC – Electrolytic Conductivity of the water.

DO – Stands for Dissolved oxygen

TDS – Stands for Total Dissolved Solids

CHAPTER ONE

1.0 Introduction.

The study investigated the Assessment of the Physico-chemical and Bio-chemical status of the selected ponds with emphasis on improving conditions for fish rearing in Nagongera Sub-county, Tororo District. In this chapter the following were discussed; background to the study, problem statement, research objectives, the research questions, the scope of the study, significance to the study, definitions of the terms, and conceptual framework.

1.1 Background to the Study.

Ponds are a source of economic wealth supporting dynamically growing populations in the world if well managed by providing proper fish conditions.(Manoj & Padhy, 2015) e.g. maintaining pond parameters. There are about 500m ponds and lakes in the world contributing much to the people's livelihood(Van Dam, Kipkemboi, Mazvimavi, & Irvine, 2014) by providing food in form of fish job opportunities and improving overall peoples standards economically. Countries like Singapore that lack enough water resources utilize ponds maximumly to sustain themselves with what other countries are gifted with within the water natural resources(Pauly, 1989). Singapore has only four water sources and lacks natural water sources like lakes and therefore to have fish they need to import or construct and utilize ponds(Kog, 2001). The water sources they have are water catchments, imported water, desalinated water and NEWater (high grade reclaimed water). Canada is the world's country with the highest number of fish ponds contributing to her economy greatly and this is managed by using both local and technological means to maintain the pond water status biochemically and physical chemically(Waite et al., 2014). In Nagongera fish rearing is at a low scale due to low profits and losses associated with fish farming in ponds and a few farmers practice it in fear of risks of low productivity. However, these farmers lack enough managerial skills especially in maintaining water quality to provide favorable fish rearing conditions e.g. maintaining pond water parameters like P^h , temperature, DO, EC, and BOD that can help to curb down the situation. For increased productivity of fish, ponds require maintained optimal levels of physical-chemical and biochemical parameters such as P^h , electrolytic conductivity, dissolved oxygen, biochemical oxygen demand and temperature (Bhatnagar & Devi, 2013). However, due to limited research delved into remedies both local and technological that can help in mitigating significant deviations in pond parameters from optimal levels, farmers have failed to maintain the optimal levels hence affecting fish conditions for rearing and therefore low fish productivity (Bhatnagar & Devi, 2013). There is also limited education and sensitization about best fish rearing practices that can prevent significant deviations of pond parameter values from optimal levels and therefore a larger percentage of

about 85 farmers lack managerial skills of maintaining pond water parameters (Nhan et al., 2007) and knowledge about how important it is to maintain optimal levels of the water parameters in fish rearing in the lane of increasing productivity (Makori, Abuom, Kapiyo, Anyona, & Dida, 2017). However, much as accessibility to technological remedies may be cumbersome, maintenance of the optimal ranges of physical-chemical and biochemical parameters is inevitable in improving fish rearing conditions to increase productivity. In Nagongera floods at times occur around the area during rainy seasons which polluted water find its way into farmers ponds and gears changes in pond parameters. The rearing methods and skills to maintain ponds like feeding regimes, cleanliness of the ponds may impact on pond parameters(Pearson, Mara, Mills, & Smallman, 1987). dust and fumes from vehicles along the roads close to the ponds, the runoffs from the crop gardens around may bring about changes to the ponds distorting the biochemical and physicochemical status of the ponds like biochemical oxygen demand, pH lowering and rising EC and BOD (Wadleigh, 1968). These runoffs may carry with them fertilizers and pesticides from gardens to the ponds and many other pollutants and during heavy rains and ponds receive these waters that cause changes in pond parameters affecting the fish conditions and in the long run poor harvest of fish or even suffocation and death. Fish require a clean water system for their survival which water is supplied with enough oxygen, with neutral pH and minimal nutrient content and minimal dissolved solutes(Van Wyk & Scarpa, 1999). This contributes to quality fish production if all pond parameters are maintained at a recommended level that enables fish survival. Concern over the deteriorating quality of water resources including ponds has resulted into interventions and researches to delve into how water quality in ponds can be maintained e.g. local remedies for maintaining optimal levels of pond water parameters(Holzer, 2012) like temperature ph., EC and BOD and technological means to improve fish rearing conditions in the Ponds not only play a role in fish production but are also habitats for ecologically paramount organisms such as vertebrates, insects, Macrophytes, Planktons and Mollusks (Gopal, 2020). Concerns have been raised to ensure proper rearing conditions for fish and increase pond productivity. A few studies have been done to delve into the issue to overcome the problem of poor water quality in ponds and remedies are being started including technological remedies so as to improve fish living conditions(Pond, 2005)

1.2 Problem statement

The physico-chemical and bio-chemical status of ponds are at a risk due to the various anthropogenic activities (Goshtasbi, Atazadeh, Fathi, & Movafeghi, 2022) like poor feeding practices for fish, poor agriculture practices such as, poor fishing methods like poisoning, use of excessive fertilizers and pesticides near ponds that find their way in ponds through heavy rains and these cause algae blooms which can then affect light penetration to aquatic organisms and then undergo decomposition processes

utilizing the dissolved oxygen and hence lower oxygen levels for aquatic organisms which can kill fish or potentially lead to decline in their overall ecological health and biochemical status of the ponds (Jana & Sarkar, 2005). Despite the ponds' significance as a vital habitat for many aquatic organisms and its contributions to the economy i.e. fish production, limited research has been conducted to assess and understand maintenance of the biochemical and physical chemical status of the ponds (Gafny, Goren, & Gasith, 2000) and there is need to use technologies in mitigating the situation and all other possible remedies e.g. local remedies like fish feeding regimes and pond sanitation to maintain optimal levels (Jerez-Cepa et al., 2021). Consequently, there is urgent need for immediate intervention in checking for the pond's status physico-chemically and biochemically. This research therefore focuses on remedies for the maintenance of physical-chemical and biochemical parameters of ponds within optimal ranges and how they directly impact the water quality and its biological and physiological integrity by identifying the potential stressors, mitigation strategies and evaluating their impact on the ponds ecological balance. There is limited investigation in deviations and maintenance pond water parameter to improve fish rearing conditions, mitigate habitat degradation on pond ecosystems and fish rearing viability (Makori et al., 2017). Potential for utilizing emerging technologies and innovative solutions e.g. sensor networks and bioremediations techniques to monitor and develop remedies that can improve the pond conditions have not been explored into adequately (Elumalai, S et al, 2023). Such research will be essential to develop local remedies and strategies and management plans that will ensure maintenance of pond water parameters within the optimal level ranges and ensure long term sustainability and improving these crucial water bodies for fish rearing by the local communities.

1.3 Research objectives

1.3.1 General Objective

To assess the physico-chemical and bio-chemical status of the selected fish ponds in Nagongera town council, Tororo district using selected physical chemical and biochemical parameters

1.3.2 Specific Objectives

1. To assess the water quality of selected fish ponds through measurements of P^H , temperature, dissolved oxygen and BOD in Nagongera town council.
2. To find out how the farming activities carried out by fish farmers in and around the selected ponds in Nagongera town council, Tororo district.
3. To suggest the management strategies that can be adopted to improve the pond water quality in selected ponds in Nagongera town council.

1.4 Research questions

1. Are the values of the selected water parameters different from the expected normal values of selected fish ponds in Nagongera town council, Tororo district?
2. How have the farming activities carried out in and around the selected fish ponds in Nagongera town council have affected fish farming?
3. Which management strategies can be adopted to improve the pond quality in the selected ponds in Nagongera town council?

1.5 Justification of the study

The research study was focused on assessing physicochemical and biochemical status of ponds to improve fish living conditions and better the fish rearing practices which positively impact on environmental conservation, enhance fish quality and production, enhance economic growth and development, promote sustainable aquaculture practices, make known the optimized rearing conditions and indirectly impact on policy and regulation review.

There is ultimately little research that has been carried out so far in ponds despite their profound contribution to the economy and this justifies the reason for limited management skills of ponds by farmers for example, poor feeding regimes and also little knowledge about maintaining the optimal levels of pond parameters for quality fish harvest and this research study will therefore be focused on assessing and improving the physicochemical and biochemical status of ponds to improve fish living conditions through educating the farmers about better fish rearing and practices such as feeding regimes, monitoring water colour, removing the feeding that may rot and affect water quality and this will impact positively on environmental conservation, enhance fish quality and production, enhance economic growth and development, promote sustainable aquaculture practices and provide management strategies that can help to obtain the optimal levels of the fish parameters

1.6 Scope of the study

The research was carried out in Nagongera town council.

Nagongera town council is bordered by four other sub-counties which include; Molo sub-county in the South-East, Mukuju sub-county, Morukatipe sub-county and Akadot sub-county.

1.7 Significance to the study

The study is of significance to the following stakeholders: The local government of Tororo district, vocational schools/ Institutions, Fish farmers and researchers; as it makes makes known better management strategies for fish ponds and maintenance of selected physical chemical and biochemical parameters in their specific fields and how they cause improved productivity.

1.8 Definitions of the terms

Ponds are water resources that provide food in form of fish in both rural and urban places all over the world.

Physico-chemical status of a pond simply means indicators of water quality such as P^H , temperature, dissolved oxygen and salinity.

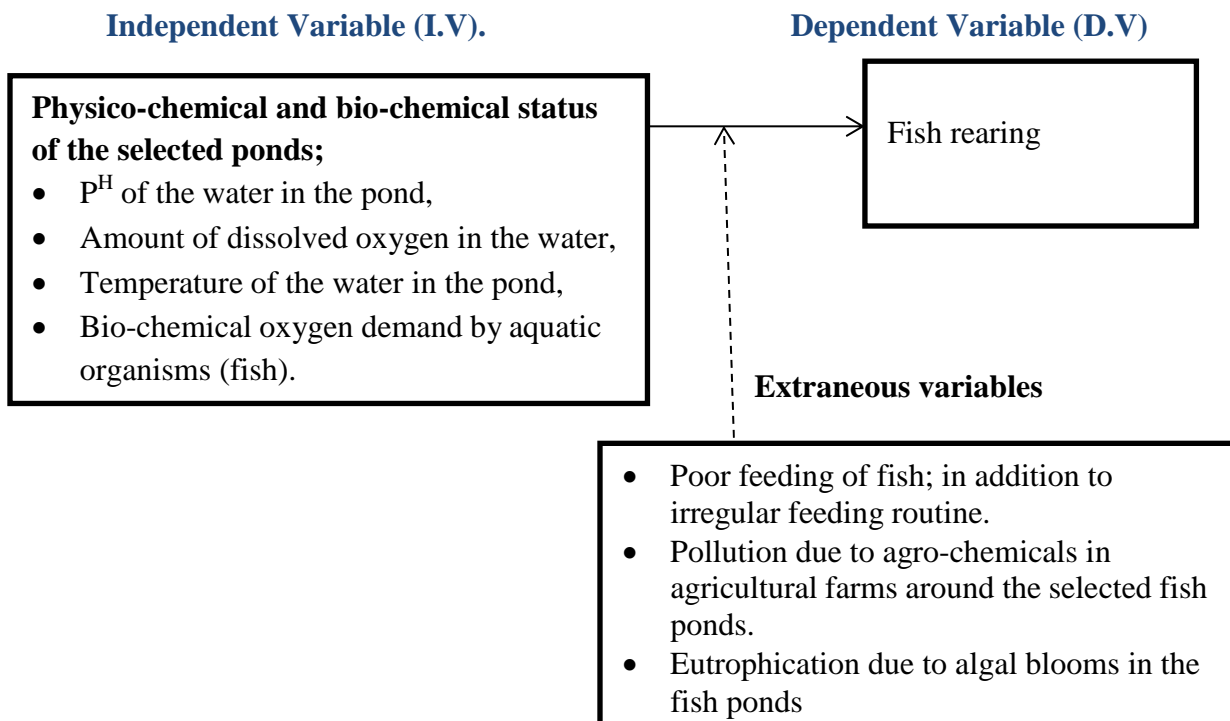
Bio-chemical status of a pond refers to the study carried out to understand the current status of use of chemicals and antibiotics in fish health management in fresh water aquaculture activities.

1.9 Conceptual framework.

In this Conceptual Framework, the relationship between variables is illustrated. Physico-chemical and bio-chemical status of selected fish ponds such as the P^H of the water, amount of dissolved oxygen, temperature of water in the pond and bio-chemical oxygen demand by aquatic organisms, is taken as independent variable; and Fish rearing being dependent variable; which only becomes successful if good management practices are carried out in the selected ponds, P^H and temperature of water are favorable and amount of dissolved oxygen in the water is adequate.

Physico-chemical and bio-chemical status of the selected fish ponds may favour fish rearing from the study area if sustainable agriculture is carried out to avoid pollution in the ponds, algae is removed on regular basis which may bring about algal blooms causing eutrophication in the fish ponds.

Conceptual framework illustrating the relationship between variables



Source: Primary data 2024.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction.

This chapter reviews the literature describing the pond water quality through measurements of the physico-chemical and bio-chemical status of the water using different parameters, farming activities carried out by fish farmers within the ponds and the management strategies that can be adopted to improve pond quality and fish quality from the selected ponds of Nagongera town council, Tororo District.

2.1 Pond water quality through measurements of its physico-chemical and bio-chemical status.

Water quality is an important aspect in fish quality and several key parameters were identified and each studied in isolation and its impact on aquatic life examined. The parameters are physical, chemical and biological. After acquiring various types of pollutants which affect water quality, several professionals have reported the issues of water bodies (lentic and lotic) (physical, chemical, biological). water characteristics in which all living organisms operate optimally have acceptable limitations and within these parameters, rapid decline or increase has negative consequences for essential physiological health of the aquatic organism (Jerez-Cepa, I., & Ruiz-Jarabo, I. 2021). Fish are cultured in ponds (lentic waters) in majority of countries but regrettably many fish farmers are not aware of the need of water quality standards in aquaculture and if properly guided they acquire high productivity at low input. There are several parameters that have been used to determine water quality i.e. temperature, transparency, turbidity, water color, carbon dioxide, pH, alkalinity, hardness, ammonia, primary productivity, biochemical oxygen demand (BOD) and plankton population. All these can't be underestimated in maintaining a proper aquatic environment for fish

2.1.1 Temperature of the water from the selected ponds

The degree of coldness or hotness of the body of the aquatic organism whether in or out of water is known as temperature (Boyd, C. E., & Boyd, C. E.2020); Fish body temperature changes with changing environmental factors. The optimum temperature is estimated between 26^oto 30^oc but however the temperatures vary with the organism species.

In brackish water ponds the tropical shrimps, *penaeus aztecus*, *p. merguensis*, *p.mondon*, *p. indicus*, *p.japonius* and *p.duorarum* in Nigeria were cultured. While the optimal temperatures for these shrimps would differ generally range of 26^o to 30^o c and this is considered optimum temperature for growth in terms of maximum yield. The temperatures also vary within the stratifications of the ponds. The

temperatures increase gradually from the lowest stratum the hypolimnion to thermocline the middle stratum and the epilimnion the surface stratum. When the temperatures are extremely high on a sunny day the fish can run to the lower stratum to lower their body temperatures.

2.1.2 P^H of the water from the selected ponds

The optimum P^H for fish is between the range of 6.5 to 8.5; research by (Ghorbani, A., King, J. J., & Larijani, M.2022), emphasizing factors affecting pond P^H like geology, land use and additions of chemicals from agricultural activities. (Yu, Q., Xie, J et al.2020).

In normal conditions, the P^H favorable to any aquatic organisms is between 6.5 to 9.0 (Yu, Q., Xie, J et al.2020). A fish's natural P^H level is 7.4; so it is better to manage your ponds as close to this level as possible. Fish can tolerate slight fluctuations in the acidity or alkalinity of water. However, only down to about 6.8 and up to 8.6 (Wurts & Durborow, 1992).

2.1.3 Amount of dissolved oxygen in the selected ponds

Whenever Dissolved Oxygen (DO) levels fall below 3 to 4 ppm, oxygen stress will occur. Lack of adequate dissolved oxygen is the leading cause of fish mortality (Mallya, 2007). Normal oxygen content in a healthy pond ranges from 5 to 10 ppm.

Dissolved oxygen levels of less than 3ppm, warm water and levels less than 5ppm and cold water causes fish mortality (Sallenave, 2019). Fish exposed to lethal levels of dissolved oxygen over a prolonged period of time will be chronically stressed, stop eating and be more susceptible to disease.

The maximum amount of dissolved oxygen that can held by water is 18.0mg/L and the minimum oxygen that can prevail in water is 6.0mg/L (Padden & Gloyna, 1971). Whenever DO levels fall below 3 to 4 ppm, oxygen stress will occur.

2.1.4 Biochemical oxygen demand (BOD)

Environmental health guidelines recommend that in natural ecosystems, a BOD level below 2 to 3milligrams per liter (mg/L) is considered favorable for aquatic organisms and maintaining water quality. High BOD levels indicate high organic pollution which can deplete oxygen levels and harm aquatic organisms.

United States Environmental Protection Agency (EPA) set maximum allowable BOD levels for different water bodies based on their designated use such as drinking water, recreational activities, aquatic habitats for example, EPA set BOD for aquatic habitats as 5mg/L or less. The Global Aquaculture Alliance adopted an initial BOD₅ limit of 50mg/L with a target limit of 30mg/L.

2.1.5 Total Dissolved Solids (TDS)

TDS being a measure of dissolved combined contents of organic and inorganic substances present in a liquid in molecular, ionized or in micro-granular suspended form, research provides that the primary sources of TDS in receiving waters are Agricultural run-off and residential (urban) run-off, clay-rich mountain waters, leaching of soil contamination and point source water pollution discharge from industrial or sewage treatment plants (Goshtasbi, Atazadeh, Fathi & Movafeghi, 2022); which supply the common constituents such as sodium, calcium, phosphates, nitrates, potassium and chlorides into the fish ponds during the run-off.

More exotic and harmful elements of TDS are pesticides arising from surface run-off. Certain naturally occurring total dissolved solids arise from the weathering and dissolution of rocks and soils (Bibak et al.2012). The United States has established a secondary water quality standard of 500mg/l to provide for palatability of water for home use and aquaculture use.

In the case of hydroponics and aquaculture, TDS is often monitored in order to create a water quality environment favourable for organisms' productivity (Raoa et al, 2015). For fresh water oysters, trouts and other high value seafood, highest productivity and economic returns are achieved by mimicking TDS and P^H of each native environment especially the ponds and lakes where fish live in (Wetzel, R.G, 2001).

2.1.6 Electrolytic conductivity (EC)

Studies by researchers such as Smith et al., Boanu, N. Y., Dadson et al.2022, have shown that fresh water fish species thrive in the waters in the ranges of electrolytic conductivity of 100-500 micro-Siemens per centimeter as an optimum range for most fish species. High levels may indicate pollution by excessive mineral content while low levels may lead to inadequate ion availability. The ranges differ in the different fish species e.g. brackish fish water ponds optimum ranges of EC are 1000-5000 micro-Siemens per centimeter (Severa et al.2023). Saltwater fish can survive in optimum ranges of 30000-50000 micro-Siemens in the studies by marine biologists such as Jones (Suhaili et al.2023). Increased level can affect viscosity of the water hence the mobility of fish and also can affect the overall turbidity of the waters hence clarity and light penetration.

Biological indicators are direct measures for the health of flora and fauna in the water way. Commonly used bio indicators in the fresh water include various measures of micro invertebrates or fish diversity, benthic algal growth and benthic oxygen demand. Algae are considered as very good biological indicators of water quality due their rapid response to accumulation of pollutants, they are still paramount biological organisms for water purification because they absorb organic and inorganic pollutants from water such

as heavy metals and radioactive substances (Bibak et al.2012). Zooplanktons are a vital food source for fish and also play a role as biological indicators and help to evaluate the level of water pollution. Research made by (Archambault et al 1982) concluded that the benthos must be considered when assessing the impact of pollution. Microorganisms such as bacteria, fungi, nematodes are highly sensitive to environmental changes and thus used as bio indicators. Microbial biomass, actinomycetes, lichens as well as earthworm, nematodes, termites, and ants' populations can act as bio indicators on account of their important role in nutrient cycling, specific soil fertility and soil conservation (Raoa et al, 2015).

2.2 Farming activities carried out by fish farmers within and around the selected ponds.

Removing weeds such as algae from the water; this is intended to prevent death of fish in the pond.

Over growth of algae cause algae blooms which can then affect light penetration to aquatic organisms and then undergo decomposition processes utilizing the dissolved oxygen and hence lower oxygen levels for aquatic organisms which can kill fish or potentially lead to decline in their overall ecological health and biochemical status of the ponds(Jana & Sarkar, 2005).

Clearing the bushes around the fish ponds; there is need to use technologies in mitigating the situation and all other possible remedies for example, local remedies like fish feeding regimes and pond sanitation (clearing areas around the pond)to maintain optimal levels (Jerez-Cepa et al., 2021).

Feeding of fish; various anthropogenic activities like poor feeding practices for fish, bad agriculture practices e.g. poor fishing methods like poisoning, use of excessive fertilizers and pesticides near ponds that find their way in ponds through heavy rains (Goshtasbi, Atazadeh, Fathi, & Movafeghi, 2022).

Harvesting of fish from the ponds; with good management, as described in the preceding sections, the fish should be ready to be harvested within six to nine months after stocking. By this time, tilapia is expected to have reached a size of approximately 250-300 g and catfish a size of 250-500 g, depending on their size at stocking, the density at which they were stocked, and water temperatures during the growing period (Charles Ngugi, 2007).

2.3 Management strategies that can be adopted to improve pond quality and fish quality.

Routine feeding of fish; Fish can be allowed to feed anytime they want to feed until they are satisfied (that is, adlib feeding) or given to feed at specific time intervals (MAAIF, 2020). This is revealed in the juveniles where fish are fed in live feeds both in extensive and in intensive systems.

Provision of nutritious feeds to fish; feeds prepared for other animals, such as chick mash e.t.c.

Although these are not specifically formulated for fish, they can increase fish growth and will also

supplement your use of organic fertilizers to enrich the pond. Examples of mixes that are easily prepared and economical to use include: Mixture of 76% rice bran and 24% fish meal; and Mixture of dried freshwater shrimp (*Caradina* spp.) and maize bran, sometimes with some silverfish meal added (Charles Ngugi, 2007).

Provision of male hormone to the fingerlinings; Male tilapia are known to grow almost twice as fast as females. It is therefore preferable to stock only males (monosex culture) to achieve the fastest growth and reach market size in the shortest possible period of time, resulting in more protein and profit for the farmer (Charles Ngugi, 2007). All-male populations can be produced by hormonal sex reversal. In this technique, special training to prepare hormone-containing feeds and to administer these feeds on a precise schedule during the first few weeks after hatching is highly required.

Maintaining water quality in the pond; Tilapia grows best in waters with a temperature range of 20 to 30°C. They can grow up to 500 g in eight months if breeding is controlled and food supply is adequate. The hygiene in the pond kept in standard conditions (Jerez-Cepa et al., 2021); and the water P^H maintained at arrange between 6.5 to 8.5.

CHAPTER THREE

METHODOLOGY

3.0 Introduction.

This chapter concentrates on explaining the data that was collected, describing the Area of Study, and the population in which the samples were chosen. It also explains the research instruments, procedures in data collection, and procedures in data presentation and analysis.

In this study, the assessment of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing in Nagongera town council, Tororo district was explained in details.

3.1 Research design.

This Study was designed to employ both qualitative and quantitative methods of data collection which include; Research question (Questionnaire), Sampling techniques, Experimental method, Analytical method, Descriptive approach, and Review.

Questionnaire approach mainly was used so as to obtain satisfactory data concerning the assessment of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing in Nagongera Sub-county, Tororo district.

Sampling method similarly was used to confirm the data that was collected and obtained confidential data from the Respondents.

Other approaches such as descriptive, analytical and review were also used to ensure the quality of data collected before it was used. The research design was also conducted following three main phases; Conceptual phase, narrative phase and finally, Interpretive phase.

3.2 Study area.

The research was conducted in Nagongera town council, Tororo District where the assessment of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing was studied.

Nagongera town council is bordered by four other sub-counties which include; Molo sub-county in the South-East, Mukuju sub-county, Morukatipe sub-county and Akadot sub-county.

3.3 Study population.

This study specifically was conducted among community farmers who were selected from Nagongera town council and other important respondents were selected from other parts of Tororo district like the instructor.

The study sample includes the category of people from whom data was collected, their gender, experience and the number of people (respondents) will be interviewed. This will be done as illustrated in the table 1 below;

arch, 08 respondents who include; Fish farmers, Agriculture instructors and the District Fisheries Officer.

Research Tools and Equipment



3.4 Data collection methods.

Data was collected using Questionnaires, Interview guides and by observation.

3.5 Sampling Techniques.

Using sampling techniques such as random sampling technique, fish farmers were chosen randomly from Nagongera town council; there was a total of 8 respondents, according to this research.

Successful data collection was achieved by using systematic random sampling method for which a list of fish farmers was obtained. The L.C.1 representative helped to make the process very easy by providing some relevant information.

3.6 Data collection procedure

Data collection procedure involves; General policy decisions, objectives of data collection, Indicators and data variables, Data collection strategies, data collection methods, Data management, Planning and implementation and System appraisal. The parameters were measured by dipping the sensor of the measurement tools into the pond waters and readings taken and recorded. For BOD, samples of water were collected in bottles and taken to the biology laboratory for measurement.

3.7 Data analysis.

The data that was collected from the respondents was verified, compiled, coded and summarized before being analyzed using the Statistical Package for Social Sciences (SPSS) Windows Software Version 16.0. Both quantitative and qualitative methods of data analysis were used.

For quantitative data, descriptive and inferential statistics were applied. In descriptive statistics, frequencies, percentages, and mean were calculated.

In inferential statistics, the t-test method was used to determine whether there had been any significant difference in fish rearing before assessment of Physico-chemical and Bio-chemical status of the fish pond and after the ways of improvements have been adopted.

The criterion to be used for the t-test was that the findings of the study were considered significantly different if the d-value was to be less than 0.05. Mathematically represented as; $d \leq 0.05$.

3.8 Ethical Consideration.

The study was purely carried out from the selected area with high level of respect for the respondents. Systematic approaches such as Questionnaires were used and was not designed to obtain data which could irritate the community where the study was conducted from.

The questions contained in the questionnaire were very clear, precise to the educational level of the respondents and were specifically beneficial to both the researcher and the respondents involved.

In this research, the research questions were created aware of the assessment on the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing in the study area. Some considerations while conducting research were:

Permission from the people whom the study involves during research was sought

The research was done not do anything that would cause physical or emotional harm to other opinions/ subjects.

Objectivity versus subjectivity in research was another important consideration.

This research took no advantage of easy-to-access groups of people (such as children at a day care) simply because they are easy to access. to choose subjects based on what mostly benefit the research.

3.9 Limitations and delimitations

However much this research was successful, it faced a lot of challenges which are summarized as below; One of the limitations is financial hazards. Moving from place to place, Village to village, all required finances. This problem may limit the normal progress of the research. In addition, finances were required in the purchase of basic needs such as food and drinks during field study in order to conduct assessment of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing.

The other is insufficient equipment. These may include the computer system that will be used for type-setting of the research findings and their analysis.

Environmental conditions are also looked at as one of the challenges that the researcher faced in the field. Too much temperatures alternating with too much rain in other days limited movement

Lastly, the poor road network also limited the research activities. Movement towards the ponds from the main road was difficult.

CHAPTER FOUR

PRESENTATION, INTERPRETATION AND ANALYSIS OF RESEARCH FINDINGS

4.1 Introduction

In this chapter, findings aimed at producing a detailed analysis of the assessment of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing in Nagongera town council, Tororo district are discussed.

4.2 Demographic Characteristics of the Study population.

Socio-economic and demographic characteristics of the study population are summarized as below. These characteristics include Genda, occupation and the educational level of the respondents.

4.3 Pond water quality through measurements of its physico-chemical and bio-chemical status

Water quality is an important aspect in fish quality and several key parameters are identified; each studied and analyzed in isolation and its impact on aquatic life examined.

4.3.1 Temperature of the water from the selected pond

According to the research carried out, the temperature of between 24.8⁰c and 26.9⁰c favor fish farming. This was put forward after the first and the second sampling on different selected fish ponds as evidenced in table 4 and table 5 below;

Table 5: Shows the results of the first sampling

Parameter		Pond 1			Pond 2			Pond 3		
Temperature, Temp (°C)		25.9	25.8	25.9	25.0	24.8	24.9	25.4	25.5	25.0
pH		6.9	6.5	6.6	8.2	7.7	8.0	7.1	7.3	7.5
Dissolved oxygen, DO, (mg/L)		3.35	3.31	3.22	5.12	4.98	5.00	4.00	3.95	3.65
Biochemical oxygen demand, BOD	DAY 1	5.0	4.9	5.4	3.6	3.5	3.8	4.6	4.2	4.4
	DAY 5	2.8	2.9	2.8	2.7	2.6	2.8	3.1	3.1	2.5
Electrical conductivity, EC, (µs/cm)		199.2	211	139	143	136	185	188	178	202
Total Dissolved Solids, TDS (mg/L)		499	489	500	502	501	498	504	458	565

Source: Primary data 2024

Table 6: Shows the results of the second sampling

Parameter		Pond 1			Pond 2			Pond 3		
Temperature, Temp (°C)		26.9	26.8	26.8	26.0	25.8	26.1	26.5	26.1	26.5
pH		6.5	6.9	7.1	8.7	7.8	8.8	8.3	8.6	8.4
Dissolved oxygen, DO, (mg/L)		3.69	3.77	3.91	4.84	4.89	4.88	3.98	4.12	4.06
Biochemical oxygen demand, BOD	DAY 1	5.1	4.9	5.2	3.9	4.0	3.8	4.7	4.6	4.9
	DAY 5	2.6	3.1	2.7	3.4	3.4	3.2	3.4	3.6	3.6
Electrical conductivity, EC, (µs/cm)		238	229	228	188	191	194	200.8	199.3	200.3
Total Dissolved Solids, TDS (mg/L)		488	499	500	509	503	501	489	498	504

Source: Primary data 2024

4.3.2 P^H of the water from the selected pond

Basing on the research findings in table 4 and 5 above, the P^H of the pond water was found to fluctuate between weakly acidic and weakly alkaline. This means that much of the time, pond water were at a neutral P^H of 7.0 which favors the survival of aquatic life.

Then the mean value of the P^H for the second sample was calculated as below;

$$PH = \frac{psn+psn+psn}{3} = \frac{6.5+6.9+7.1}{3} = 6.8$$

Where; psn is the PH of 2nd sample from either pond 1, 2 or 3

4.3.3 Amount of dissolved oxygen in the selected ponds

According to the first sampling, dissolved oxygen amount was seen fluctuating between 3.00 and 5.00 mg/l of the pond water. This revealed that there were some conditions in the pond which at times deplete oxygen from the water causing fluctuations. Due to adoption of good management practices like regular removing of water weeds such as algae, proper harvesting of fish using environmental free methods and proper disposal of wastes and chemicals, the dissolved oxygen level/ amount was seen increasing in the second sampling shown in table 5 above.

Then the mean value of Dissolved Oxygen was calculated as below;

$$DO = \frac{DSi+DSi+DSi}{3} = \frac{3.35+3.31+3.22}{3} = 3.29$$

Where; DSi is the dissolved oxygen of first sample from either ponds 1, 2 or 3

4.3.4 Biochemical Oxygen Demand (BOD) of the selected ponds

Basing on the results of the two samples in table 4 and 5 above, the BOD for aquatic organisms kept varying between day 1 and day 5 in the two samples. Each pond had its own varying demand by organisms living within. This shows that the BOD of organisms in any ecological niche depends on the conditions of the pond and their body capacity/ size. From the results and mean calculated below BOD is above the expected value depicting more oxygen supply required for decomposition of organic content. This can also depict a lot of pollution by organic matter in the selected ponds and hence low oxygen available for fish in the water.

Then the mean value BOD of organisms in the water was calculated as;

$$\text{BOD} = \frac{\text{BSi} + \text{BSi} + \text{BSi}}{3} = \frac{5.0 + 4.9 + 5.4}{3} = 5.1$$

Where BSi is the biochemical oxygen demand of the first sample from either ponds 1,2 or 3

4.3.5 Electrolytic Conductivity (EC)

Basing on the research findings, the EC of water in the pond was found to vary between 136 $\mu\text{s}/\text{cm}$ and 238 $\mu\text{s}/\text{cm}$. Each pond was found to have unique EC but within the range favouring fish rearing.

Considering the results in table 4 and 5, high levels were found indicating pollution by excessive mineral and ion content in the ponds that does not favour proper fish rearing.

Then the value of EC of the water in the pond(s) was calculated as;

$$\text{EC} = \frac{\text{ESi} + \text{ESi} + \text{ESi}}{3} = \frac{199.2 + 211 + 139}{3} = 183.1 \mu\text{s}/\text{cm}$$

Where Esi is the electrolytic conductance of the first sample from either ponds 1,2 or 3

4.3.6 Total Dissolved Solids (TDS)

According to the results in table 4 and 5, the TDS of the pond water from the study area are in line with the standards for aquatic life as put forward by United States quality standards. This was found favouring fish rearing. About 70% of the fish farmers had the pond water with TDS level of 498 which was nearest to 500 mg/L indicating a moderate level to optimal values.

Then the TDS of the water of the first sample were calculated as below;

$$\text{TDS} = \frac{\text{TSi} + \text{TSi} + \text{TSi}}{3} = \frac{499 + 489 + 500}{3} = 496 \text{ mg/L}$$

Where; Tsi is the total dissolved solids of the i^{th} sample from either ponds 1,2 or 3

4.4 Farming activities carried out by fish farmers within the selected ponds

According research findings, fish feeding was the main activity carried out from the selected pond and accounted to 55%, this was followed by clearing of bushes around the ponds with 16.7%, then 23.3% harvesting, while 05% removing of water weeds in the ponds. Basing on the data provided by the respondents, these activities were carried out depending on the need of the pond only not daily; a part from feeding of fish which was a daily routine.

Table7: Shows farming activities carried out in the selected ponds

Farming activity	Frequency	Percentage (%)
Removing of weed in the pond	3	5.0
Clearing of bushes around the pond	10	16.7
Feeding of fish	33	55.0
Harvesting of mature fish	14	23.3
Total	60	100

Source: Primary data 2024

The above results in table 7, evidence that the technical team was engaged in harvesting of fish and as well feeding of the fish.

4.5 Management strategies that can be adopted to improve fish quality

Management of the pond to improve fish quality involves regular feeding of fish, provision of nutritious feeds, provision of fingerlings with male hormone to enable them grow very big and changing of water to increase the amount of dissolved oxygen in the water; as illustrated in table 8 below;

Table 8: Shows the management practices carried out in the selected fish ponds

Management practice carried out in the pond	Frequency	Percentage (%)
Regular feeding of fish	22	55
Provision of nutritious feeds to fish	12	30
Provision of hormones(bought while packed) testosterone	4	10
Changing of water in the pond.	2	05
Total	40	100

Source: Primary data 2024

According to table 8 above, 85% of the management of the pond was related to feeds; which is evidence that there was improvement in fish quality and pond quality as a whole. The leading management practice was feeding of fish at regular intervals which accounted to 55%, the nutrients in the rations given to fish

were equally important and stood at 30%, the 10% of the activities carried out was stimulating turning of fingerlings to male fish by giving them male hormone. This was to make the fish attain the biggest size possible according to the information provided by the experts. Changing of the water in the pond was done at 05% if suspected pollution to have occurred.

CHAPTER FIVE

DISCUSSION, SUMMARY OF FINDINGS AND CONCLUSIONS

5.1 Introduction.

This chapter presents the discussion, summary of the findings, conclusions and recommendations of the assessment of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing in Nagongera town council, Tororo district.

5.2 Discussion.

The research focused on the assessment of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing, the conditions which may be water quality in terms of P^H , Dissolve Oxygen and Biochemical Oxygen Demand by fish.

The literature looked at how increased productivity of fish in ponds can be achieved; but the research carried out affirmed that it required maintenance of optimal levels of physico-chemical and biochemical parameters such as P^H , electrolytic conductivity, dissolved oxygen, biochemical oxygen demand and temperature (Bhatnagar & Devi, 2013).

The research also revealed that many of the management practices such as routine feeding of fish, provision of nutritive feeds to fish, provision of male hormone to fingerlings for atleast one month, and changing of pond water in case of suspected pollution, when carried out can as well improve the quality of fish produced in the selected ponds of Nagongera town council.

In addition to the above, institution training Agriculture both at secondary level and tertiary level give a lot of theoretical approaches with limited practices. This made management of the ponds very difficult as many personnel qualified to rear fish but having limited skills of management. The research carried out encouraged that people should attain industrial training on particular programs (DIT) such as fish rearing strategies.

5.3 Summary of the findings.

The study established various assessments of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing and the major one was pond water quality where several key parameters were identified and each studied in isolation in order to ascertain its impacts on aquatic life. The temperature of between 24.8⁰c and 26.9⁰c was said to favour fish farming; the neutral P^H of 7.0 and the amount of dissolved oxygen of between 3.00 to 5.00 mg/l, also favoured the survival of aquatic life. Other parameters included Biochemical Oxygen Demand of the

pond and Electrolytic conductivity of pond water which also gave the basis on how aquatic life should be managed if pond productivity is to be maintained at higher levels.

Other respondents forwarded that the productivity of fish rearing depends on the activities carried out within and around the pond. According to the research findings, fish feeding was the main activity carried out from the selected pond and accounted to 65%, this was followed by clearing of bushes around the ponds with 10%, then 20% harvesting, while 05% removing of water weeds in the ponds. All these activities contributed to high production of good quality fish from the selected ponds.

In addition to the activities carried out in the ponds, management strategies also contributed a lot to productivity of the selected ponds in that, 85% of the management of the pond was related to feeds; which is evidence that there was improvement in fish quality and pond quality as a whole. The leading management practice was feeding of fish at regular intervals which accounted to 55%, the nutrients in the rations given to fish were equally important and stood at 30%, the 10% of the activities carried out was stimulating turning of fingerlings to male fish by giving them male hormone. This was to make the fish attain the biggest size possible according to the information provided by the experts. Changing of the water in the pond was done at 05% if suspected pollution to have occurred.

However, it is clear that the Physico-chemical and Bio-chemical Status of the selected fish Ponds can be modified by the activities carried out within and around the pond(s); and fish quality can as well be improved by improving conditions for fish rearing such as routine feeding, improving the nutrient content in the feed rations, formulating fresh feed rations and improving the size by mixing their feed with male hormone (Testosterone). The mismanagement of the fish ponds has concern on skilling many young especially the less privileged (girl-children). Therefore, challenges concerning fish rearing and management of fish ponds have been spelt out and sustainable approaches have been put forward so as to improve on fish rearing in Nagongera town council, Tororo District.

5.4 Conclusions.

In Nangogera the biochemical and physico-chemical status of ponds is at stake because the selected parameter values are deviant from the expected normal values of these parameters and hence impacts on the fish productivity of the ponds. Therefore there is need to adopt the management strategies discussed in this report to maintain the ponds biochemical and physical chemical status to improve the fish rearing conditions such as good feeding regimes.

5.4 Recommendations.

Basing on the results of the study, the youth and the community as a whole are therefore, encouraged to have a collective effort in improving fish rearing as one of the sectors which improve family nutrition and income. In order to address the situation, the study recommends the following measures, which range from the household to regional and national levels:

(i) The government should establish strategies to empower the local authorities, schools and other key stakeholders with capacity, knowledge and skills needed to boost up fish rearing in Nagongera town council. The farmers should also adopt the discussed management strategies to maintain the biochemical and physical chemical pond status for improved fish rearing conditions.

(ii) Efforts should be made by various Actors such as directors of different schools; both secondary and the tertiary institutions to modify the curriculum enabling acquisition of vocational skills by all children (both boy and girl-children) and this will boost up job market, nutrition and family income.

(iii) The government and all actors involved should execute comprehensive strategies and strengthen the acquisition of fish rearing skills for school dropout, women and men especially the less privileged to ensure productivity in Nagongera town council.

(iv) Further technical studies are recommended to find out more scientific facts concerning fish rearing in ponds and how management strategies carried out in the fish pond empower an individual to become a specialist in order to increase employment opportunities and family lifestyle of the people of Nagongera and beyond.

Furthermore, I recommend Busitema University to encourage more learners to carry research which is instrumental in problem solving; like for this case study, assessments of the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing.

Areas for future research

The following topics were identified for future research;

- (i) Effects of fish farming in the community.
- (ii) Girl-child involvement in sustainable fish farming
- (iii) Contributions of fish farming to environmental sustainability.

Chapter (v) however, summarizes pond water quality in consideration of the key parameters such as temperature, P^H of the pond water, amount of dissolved oxygen and Biochemical Oxygen Demand of the aquatic organisms, farming activities carried out within the selected ponds and the management strategies selected to improve fish quality in the selected fish ponds; forwards the nature and the quality of research finding and provides précised conclusion summarizing the whole research.

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APPENDICES

Appendix A

(i) Questionnaire for Fish farmers.

I am **Mumbere Michael**, a student of Busitema University pursuing Bachelor of Science with Education. As it is a requirement from higher Institutions of learning for every student undertaking higher education to carry out a research study, I am therefore, carrying out a study to assess the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing in Nagongera town council, Tororo district.

You have been chosen as one of the respondents to provide the information by filling in the designed Questionnaire provided below.

I therefore, request you to be very free while providing required information. For whatever information you give, will be kept **confidential**.

Instructions

- Choose the right alternative provided for part 1 and tick appropriately on the box.
- **Do not** write your **name** anywhere on this Questionnaire.

PART 1

Personal Information

1. The respondent's information on;

(i) Gender; Male Female

(ii) Marital status; Married Single Divorced

(iii) Size of household; Two people More than two people

PART 2.1

Pond water Quality through measurements if its Physico-chemical and Bio-chemical status.

For each Statement in this part, please **tick** appropriately on the box



1 If you **Strongly Agree**

2 If you **Agree**

3 If you are **NOT SURE**

4 If you **Disagree**

5 If you **Strongly Disagree**

The following are the major physico-chemical and bio-chemical parameters which are used in assessments of pond water quality in the selected ponds of Nagongera town council;

Statements on Pond water quality		1	2	3	4	5
(i)	Temperature range of water between 24.8 ⁰ c to 26 ⁰ c in the pond favour fish rearing.					
(ii)	Fish grow well in pond water with a P ^H range of between 6.5 to 8.0; basing on the research results.					
(iii)	Amount of Dissolved Oxygen in pond water should be between 3.22 to 5.12 mg/l, for fish to grow well.					
(iv)	Aquatic organisms such as fish arrange of between 2.6 to 5.0 biochemical oxygen demand in their bodies.					

PART 2.2

Farming Activities carried out within the selected fish ponds

In this section the researcher wishes to collect information on the various farming activities farmers carry out within and around the fish ponds that could have contributed to high productivity of fish from the selected ponds.



For each Statement in this part, please **tick** appropriately in the box

1 if the statement is “**True**”

2 if the statement is “**False**”

3 if “**Not Sure**” of the statement

Farming Activities carried out within the selected fish ponds		1	2	3
(i)	Removing the water weeds in the pond preventing over-growth which may lead to algal blooms.			
(ii)	Clearing the bushes around the pond so as to destroy hiding places for fish predators which may reduce fish population.			
(iii)	Feeding of fish to ensure their growth reaching maturity.			
(iv)	Harvesting of mature fish using environmental free (sustainable) approaches.			

“Thank you for your Time and Cooperation.”

(ii) Questionnaire for Agriculture Instructors.

I am **Mumbere Michael**, a student of Busitema University pursuing Bachelor of Science with Education. As it is a requirement from higher Institutions of learning for every student undertaking higher education to carry out a research study, I am therefore, carrying out a study to assess the Physico-chemical and Bio-chemical Status of the selected fish Ponds with emphasis on improving conditions for fish rearing in Nagongera town council, Tororo district.

You have been chosen as one of the respondents to provide the information by filling in the designed Questionnaire provided below.

I therefore, request you to be very free while providing required information. For whatever information you give, will be kept **confidential**.

Instructions

- Choose the right alternative provided for part 1 and tick appropriately on the box.
- **Do not** write your **name** anywhere on this Questionnaire.

PART 1

Personal Information

1. The respondent's information on;

(i) **Gender;** Male Female

(ii) **Marital status;** Married Single Divorced

(iii) **Educational level;** Master's degree PhD

PART 2.1

Pond water Quality through measurements if its Physico-chemical and Bio-chemical status.

For each Statement in this part, please **tick** appropriately on the box

1 If you **Strongly Agree**

2 If you **Agree**

3 If you are **NOT SURE**

4 If you **Disagree**

5 If you **Strongly Disagree**

The following are the major physico-chemical and bio-chemical parameters which are used in assessments of pond water quality in the selected ponds of Nagongera town council;

Statements on Pond water quality		1	2	3	4	5
(i)	Temperature range of water between 24.8 ⁰ c to 26 ⁰ c in the pond favour fish rearing.					
(ii)	Fish grow well in pond water with a P ^H range of between 6.5 to 8.0; basing on the research results.					
(iii)	Amount of Dissolved Oxygen in pond water should be between 3.22 to 5.12 mg/l, for fish to grow well.					
(iv)	Aquatic organisms such as fish arrange of between 2.6 to 5.0 biochemical oxygen demand in their bodies.					

PART 2.2

Farming Activities carried out within the selected fish ponds

In this section the researcher wishes to collect information on the various farming activities farmers carry out within and around the fish ponds that could have contributed to high productivity of fish from the selected ponds.



For each Statement in this part, please tick appropriately in the box

1 if the statement is “**True**”

2 if the statement is “**False**”

3 if “**Not Sure**” of the statement

Farming Activities carried out within the selected fish ponds		1	2	3
(i)	Removing the water weeds in the pond preventing over-growth which may lead to algal blooms.			
(ii)	Clearing the bushes around the pond so as to destroy hiding places for fish predators which may reduce fish population.			
(iii)	Feeding of fish to ensure their growth reaching maturity.			
(iv)	Harvesting of mature fish using environmental free (sustainable) approaches.			

PART 2.3

Management Strategies that can be adopted to improve the fish quality

In this section the researcher wishes to collect information on the Management Strategies that can be adopted to improve the fish quality from the selected ponds of Nagongera town council.

For each Statement in this part, please tick appropriately in the box



1 if the statement is “**Correct**”

2 if the statement is “**Incorrect**”

3 if “**Not Sure**” of the statement

Management Strategies that can be adopted to improve fish quality		1	2	3
(i)	Regular feed of fish following routine operation to ensure rapid growth of fish in the pond.			
(ii)	Provision of nutritious feeds to fish to boost their growth rate; reaching maturity in time.			
(iii)	Provision of male hormone in their feeds to make fish attain large sizes; and grow very fast reaching maturity in time.			
(iv)	Maintaining water quality in terms of hygiene, P ^H , temperature and electrolytic conductivity in order to ensure enough oxygen dissolved in the water, thus proper fish growth in the pond			

“Thank you for your Time and Cooperation.”