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Preface

We would like to present, with great pleasure, the inaugural volume-5, Issue-12, December 2019, of a scholarly journal, *International Journal of Environmental & Agriculture Research*. This journal is part of the AD Publications series *in the field of Environmental & Agriculture Research Development*, and is devoted to the gamut of Environmental & Agriculture issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Environmental & Agriculture as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Environmental & Agriculture community, addressing researchers and practitioners in below areas

Environmental Research:

Environmental science and regulation, Ecotoxicology, Environmental health issues, Atmosphere and climate, Terrestric ecosystems, Aquatic ecosystems, Energy and environment, Marine research, Biodiversity, Pharmaceuticals in the environment, Genetically modified organisms, Biotechnology, Risk assessment, Environment society, Agricultural engineering, Animal science, Agronomy, including plant science, theoretical production ecology, horticulture, plant, breeding, plant fertilization, soil science and all field related to Environmental Research.

Agriculture Research:

Agriculture, Biological engineering, including genetic engineering, microbiology, Environmental impacts of agriculture, forestry, Food science, Husbandry, Irrigation and water management, Land use, Waste management and all fields related to Agriculture.

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with *IJOEAR*. We are certain that this issue will be followed by many others, reporting new developments in the Environment and Agriculture Research Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOEAR* readers and will stimulate further research into the vibrant area of Environmental & Agriculture Research.

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Vegetable crops or Olericulture: Crops utilized fresh or whole (wholefood crop, no or limited processing, i.e., fresh cut salad); (Lettuce, Cabbage, Carrots, Potatoes, Tomatoes, Herbs, etc.)	Tree Fruit crops: apples, oranges, stone fruit (i.e., peaches, plums, cherries)
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Ecological-edaphic and Socio-economic drivers of on-farm tree farming enterprises in Wakiso District, Central Uganda

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***Abstract*—** *The biophysical-edaphic and socio-economic factors do equally influence the on-farm tree farming in the smallholder farming systems. Naturally, neither of the factors do act in isolation, but they are interrelated. The study was carried out in Nsangi sub-county, Wakiso District, 2018. Using the stratified random sampling method based on landholding sizes, a sample of size of sixty households were selected and interviewed. The objectives of the study were to examine the influence of the bio-physical, edaphic and socio-cultural-economic factors onto the performance of the on-farm tree farming enterprise, and to evaluate the farmer's participation in on-farm tree farming activities. The results showed that both ecological-edaphic and socio-cultural-economic factors influence the performance of the tree volume, tree species diversity and tree stand density/ha. There is a negative correlation between size of landholding and farmer's interaction with the on-farm tree farming enterprises. Judging from the results of this study, there is a need for a policy review aimed at devising appropriate socio-cultural-economic and ecological-edaphic practices that promote on-farm tree farming programmes.*

Keywords*— *On-farm tree farming enterprise, ecological-edaphic, socio-cultural-economic factors.

I. INTRODUCTION

Uganda has got approximately 14,900 km^2 of gazetted forest reserves of which some 7,500 km^2 (4%) is savannah woodland and forest plantation, 5,900 km^2 (3%) is tropical high forest and 1,500 k^2 (1%) montane catchment forest (Uganda Forest Department, 1951; Banana and Gombya-Ssembajjwe, 2000). Conversion of natural forests into agricultural land became a serious problem in Uganda in 1970's of which 12% of forested land had been affected by this agricultural encroachment (Banana and Gombya-Ssembajjwe, 2000).

About 53% of forestland within Uganda's forest reserves remains essentially undisturbed (MWLE, 2001a). Deforestation was particularly severe between 1970 and 1985 when government control over forests deteriorated. A high population growth rate, conversion of forest land to agricultural uses as well as break down in law and order have been the major causes for deforestation in Uganda (MWLE, 2002b).

These forests are an essential foundation for the country’s current and future livelihood and growth. Sustainable management of these forests, however, poses great challenges given that the population is heavily dependent on them for timber, agriculture, and energy production (Buyinza and Nabalegwa, 2007). Forests and woodlands covered approximately 45% of the total land area of Uganda in 1898. At present, forest cover has been reduced to approximately 4.9 million hectares or about 20% of the total land area (MWLE, 2002b). About 30% of the tropical high forests are degraded and the degradation trend continues. Without effective institutions to limit and regulate harvesting levels and management practices, forest resources can be over-harvested and even irreversibly destroyed, as is the case in “open access” forests (Galabuzi et. al., 2014).

Many contemporary on-farm tree management policies in both developed and developing countries are therefore seeking to shift control of tree resources to the community level in an attempt to improve management of local tree resources. Empowering local communities to monitor and enforce tree management rules significantly lowers monitoring costs and improves effectiveness because, according to Galabuzi et. al., 2014, when compared to central government institutions, local institutional arrangements are considered better at providing, *inter alia*, rules related to access, harvesting, and management; a forum that can respond to conflict quickly and cheaply; and monitoring and sanctioning methods that are efficient.

The goal of this study was to examine the biophysical-edaphic and socio-cultural-economic factors that influence the potential of the on-farm tree farming practices.

The specific objectives were to (a) identify the relationship that exists between the socio-cultural-economic condition of the farmer with the potential of the on-farm tree farming enterprises, (b) to discover the relationship between the size of landholding and farmer's interaction (work-time) with the on-farm tree enterprises.

The research hypothesis were (1) the biophysical-edaphic and socio-cultural-economic factors influence the performance of the on-farm tree enterprises as indicated by tree volume (m^3), tree species diversity index and tree stand density / ha; (2). The farmer's interaction (work-time) with the on-farm tree enterprises depends on the size of landholding and total number of livestock held.

1.1 Description of the study area

Nsangi Sub-county is located in Wakiso District, South West Uganda. It lies between latitude 0^o13^oN and 0^o20^o N and longitude 32^o24^oE and 32^o33^oE. It covers a surface area of 107 km^2, supports a population of 44,117 people with an average population density of 412 inhabitants per km^2. The area is found within the Lake Victoria basin characterized by a relatively favorable climate i.e reliable rainfall amounting to 1000 mm annually, bi-modal type of rainfall with peak falls in March to May and October to November, has a mean annual maximum temperature of 26^0c and annual minimum temperature of 17^0c.

The area has under undifferentiated gneiss including elements of Pre-cambrian partly granitized and metamorphosed formations. Geologically, the area follows under the Buganda-Toro systems comprised of agilities, phyillites and schist with basal quartzite and amphibolites. It is characterized by flat-topped mesa like hills, which show considerable uniformity of elevation. Like other areas in southwestern Uganda, Nsangi sub-county has got dissected slopes of 1260 meters and at a much higher altitude of 1290 meters associated with many ridges.

The dominant soil type is sandy loams (ferrallitic soils) which represent almost the final stage in tropical weathering. From field observations, the soils of most ridges are ferrallitic, shallow soils ranging from course to stony and bare rock (skeletal soils) or rock out-crops on hill slopes with lateritic soils at the top of hills. The valleys are filled with deeply leached and weathered lateritic soils. The rest of the low land is covered by clay loams, which support agriculture in the area.

The dominant vegetation is savannah mosaic, which covers elephant grass (*pennisetum perpurem*) with isolated forest and savannah trees, which are remnants of a previous forest cover and cultivation demonstrating its intermediate and mixed character. However, today with the increasing population, the vegetation has been cleared for other intensive land use practices such as grazing, brick making, and excavation of stones and extension of land for cultivation and settlement.

II. MATERIALS AND METHODS

The data was obtained from a household survey conducted in July 2018. The primary data was collected using direct measurements, observations, conducting interviews and group discussions with the local people. Secondary data was got from District Forest Support Services and National Forestry Authority. The 60 sample respondents were chosen using the stratified random sampling technique based on the size of land (ha) owned. There strata were formed, namely, Strata I: (< 0.5 ha), Strata II (0.6 - 1 ha), and Strata III (> 1.0 ha). The dependent variables included tree volume (Y_1), tree species - diversity index (Y_2), total time spent working in on-farm tree enterprise (Y_3), and tree stand - density / ha (Y_4) whereas the independent variables were: slope length (X_I), soil erodibility (X_2), slope steepness (X_3), total size of landholding (X_4), age of head of family (X_5), education level of head of family (X_6), social - economic status of head of family (X_7), total family size (X_8), farming experience of head of family (X_9), intensity of extension services (X_{10}), livestock owned (X_{11}), fuel wood consumption / day (X_{12}), and dummy variable (V_I).

2.1 Data analysis

The multiple linear regression and correlation model was used in data analysis. The model involved computation of correlation coefficient (r); multiple regression analysis (T-test); analysis of variance (F-test); coefficient determinant (R^2); and regression coefficient (SE-B)

This model was chosen basing on the fact that the on-farm tree management enterprise potential is influenced by many interacting but different physical, edaphic and socio-economic environmental factors. Using the technique of "dummy variables", several qualitative factors such as intensity of extension services were included in the regression.

The multiple linear regression model was used to assess the collective or individual contribution of two or more independent variables towards the dependent variable:

$$Y_1 = B_0 + B_1X_1 + B_2X_2 \ldots .. + B_nX_n + e.$$

Where: Y_1 = predicted value; B_0 = Y – intercept (constant), B_1 = partial regression coefficient of X1, X_1 = independent (explanatory or predictor) variable, E = error (external factor).

The analysis of multiple correction coefficients was intended to identify the strength of the relationship between the dependent and independent variables. The hypothesis were tested and decisions taken basing on the 95% ($\alpha = 0.05$) degree of confidence. According to Sutrisno (1989), hypothesis can be analysed through a series of statistical stages, in order to identify relationship between dependent and independent variables, multiple correlation coefficient (r) is necessary in predicting the effect of the independent onto the dependent variable. The standards to consider in decision-making were: $0.500 < r > 0.700$ proper for prediction, $0.250 < r > 0.500$ doubtable for prediction and $0.000 < r > 0.250$ practically not good for prediction

III. RESULTS AND DISCUSSION

Basing on the tree volume, tree species diversity index, and tree stand density, the potential of the on-farm tree management enterprise is greatly determined by the physical, edaphic and socio-cultural-economic characteristics of the farmer. The purpose of this study was to examine the physical and edaphic factors that affect the performance of the on-farm tree farming. The physical factors studied included slope length, slope steepness and soil erodibility.

Many socio-economic and cultural factors do influence the adaptation and management of trees in the farming systems of the local farmers. Naturally, these factors do not act in isolation but they are interelated with other institutional factors.

The varied topography of Nsangi sub-county results in wide variations in the soil types and fertility, microclimate and vegetation over short distances. These diversified agro-ecological-edaphic, landscape, morphology, lithology, and topographical conditions have given rise to a diversity of tree species. The tree species diversity index (Y_2) is strongly influenced by local physical and edaphic factors such as slope length, slope steepness and soil erodibility as shown by the coefficient determination ($r^2 = 0.41466$) 41% of the variations in the tree diversity index. There is a strong positive relationship between slope length ($rX_1Y_2 = 0.508$), soil erodibility ($rX_2Y_2 = 0.487$) with the tree species diversity index (Y_1) as illustrated in the mathematical regression model:

$$Y_2 = 2.569016 + 416744X_1 + 410436X_2$$

Of the three physical factors, the slope length (X_1) shows the greatest influence over tree species index whereas slope steepness (X_3) has the least influence. Therefore, using the backward regression method, only slope length and soil erodibility are important towards tree species index. The slope length shows the biggest relationship ($r = 0.5077$), hence can reliably be used for the prediction of the future condition of tree species index. The soil erodibility gives doubtable results with very small relationship ($r = 0.0520$) which practically should not be used for predictions of the potential of the on-farm tree enterprise.

There is a strong positive relationship between tree species diversity index (Y_1) and slope length ($rX_1Y_2 = 0.5077^{**}$), soil erodibility ($rX_2Y_2 = 0.4865^{**}$) at confidence interval $\alpha = 0.001$, this implies that highly eroded soils are planted with different tree species and long slopes have got more diversity of tree species. The successful establishment and growth on-farm tree enterprise depend largely on correct choice of species, soil working methods, silvi-cultural practices and management techniques suited to the different species and site conditions.

There was a weak relationship between slope steepness and tree species diversity index ($rX_3Y_2 = 0.052$), this was because the area is generally of uniform steepness with minor differences which did not significantly affect the species diversity. However, under normal conditions the steeper the slope the more the diversity of tree species planted.

Direct observation revealed that diversity of tree species largely depended on the size of the landholding. Households owning large pieces of land had a big tree species diversity index compared to those with smaller plots of land. It was deduced that owing to marked differences in rooting habits, physiological requirements, growth pattern and life cycle, the physical (slope length and steepness) and edaphic (soil erodibility) factors do influence the performance of the on-farm tree enterprise.

The hypothesis which states that the local physical and edaphic factors influence tree species diversity index is therefore accepted.

The socio-economic condition of the household determines the tree species diversity index in the on-farm tree enterprise. The household demand for fuelwood poses the greatest influence on tree species diversity index. There is a positive relationship between tree species diversity and fuelwood consumption ($rX_{12}y_2 = 0.535$). The big families that require large quantities of fuelwood planted a variety of tree species to meet their needs and objectives. Some trees species are planted for economic motives whereas others for soil conservation purposes and also for cultural advantages.

The size of landholding affects the tree species diversity index ($rX_4Y_2 = 0.0504$), whereby households with big plots of land plant a variety of tree species to serve their ecological-edaphic, economic and social requirements. There is a negative relationship between the level of formal education and intensity of extension services with tree species diversity ($rV_1Y_2 = -0.2287$), this means that the farmers have not responded positively to advise given by extension field workers, this is true because the farmers are poor and fear to undertake risks of investing in expensive, exotic tree species instead continue with the traditional farming methods long used by their grandparents.

The physical and edaphic factors do not have significant influence towards the tree volume (m^3) or actual standing stock. This is because the area is generally homogeneous with a standard deviation of only 2.6%, slope steepness ranges from 15 - 24% hence slope steepness does not have an significant influence towards tree volume. The three factors explain only 0.6% of the total variation in tree volume (m^3). The remaining 99.4% is because of factors other than those examined in this study. The sizes of the household and total landholdings are the two socio-economic factors that affect the tree volume (m^3) as illustrated by the linear model: $Y_1 = 5.384 + 0.841X_8$

The positive relationship between total number of household members and tree volume ($rX_8Y_1 = 0.362$) suggests that big families have got big labour force to plant and manage big tree volumes. The tree volume also depends on the size of the total land owned whereby farmers who own bigger plots of land tend to plant extensive area with trees. However, it was observed that tree volume also depend on edaphic and biological factors such as soil fertility. Tree density per hectare is greatly influenced by physical factors (slope length and soil erodibility) as shown by the mathematical model: $Y_4 = -363.1432 + 0.3986X_2 + 0.4235X_1$

There is strong positive correlation relationship between slope length and tree stand density / ha ($rX_IY_4 = 0.506^{**}$), this implies that that the longer the slope length, the more close (densely populated) are the tree stands planted with the aim of protecting the soil against erosional agents that cause surface run-off. The positive relationship between soil erodibility and tree stand density ($rX_2y_I = 0.484^{**}$) means that the soils that are highly susceptible to erosion are planted with very close tree stands to add on the resistance capacity of the soil against erosion. It was observed that the demand for fuelwood by a given family shows the greatest influence towards the tree stand density / ha as given in the mathematical model:

$$Y_4 = 545.42 + 0.549X_{I2}$$

There is a positive relationship between tree stand density and fuelwood consumption ($rX_{I2}y_4 = 0.5397$). Households with high fuelwood try to satisfy their needs by making optimal utilization of the land resource by planting trees very close to each other. There is a negative relationship between total size of landholding owned and the total time of work in the on-farm tree enterprise, $rX_4Y_3 = - 0.6207$. The mathematical model showing the relationship is expressed as follows: $Y_3 = 385.323 - 196.579X_4$

The linear model a result suggests that farmers with big agricultural landholding interact less frequently with the on-farm tree enterprise; this is because their requirements such as fodder for livestock and fuelwood are fulfilled from their private landholdings. For purposes of comparison, farmers with less agricultural land spend more time searching for their tree products in the neighboring on-farm tree enterprise which forms a big proportion of total work-time. Households categorized under Stratum 1 (0.0 - 0.5 ha) is 32%, Strata II (0.5 - 1.0 ha) 25%, and strata III (> 1.0 ha) 22% of their total work time in on-farm tree enterprise looking for the tree requirements such as fodder, fuelwood and several other non-timber tree products. The farmer's interaction with the on-farm tree enterprise can be identified basing on the time allocation (work-time) in the on-farm tree enterprise. The activities carried out in the on-farm tree enterprises of Nsangi Sub-county are mainly informal activities such as collecting grass for livestock, gathering fuelwood for their subsistence. The two variables determine 38% ($R^2 = 0.382$) of the total work-time which implying that the two variables strongly influence the variations in the' total time of work in the on-farm tree enterprise for the 4 months of study. The estimated multiple regression equation: $Y_3 = 355.972 - 0.594843X_4 + 0.150083X_{1I}$

The estimating regression equation shows that total land owned determine the total time spent working in the on-farm tree enterprise.

Hypothesis 2 which states that farmer's interaction (work-time) with the on-farm tree farming activities depends on the size of landholding is accepted.

IV. CONCLUSION

The performance of the on-farm tree farming enterprise suggests that ecological-edaphic factors affect the survival and growth of plantation species while socio-economic factors affect the nature and extent of participation, however, ecological-edaphic factors have profound effects during the establishment stages, while community participation is significant on the protection level. Specifically, soil erodibility and slop length are some of the ecological-edaphic factors that significantly affect establishment of the plantations. Of the socio-cultural-economic factors, the major ones that significantly affect the success are demand for fuelwood, size and size of family landholding have the biggest influence on tree volume (m^3). Furthermore, knowledge and understanding about the program were crucial; however, community involvement in the project's identification, inception, planning, and organizational stages was achieved, bringing about favorable results during the implementation phase.

V. RECOMMENDATIONS

The on-farm tree farming practice should be encouraged through the provision of incentives and opportunities to the local people. Similarly, the District Local Forest Services and National Forestry Authority (NFA) should play an advisory role towards the development of no directive and participatory approaches in on-farm tree farming enterprise. The on-farm tree farming program should be revised to emphasis the contribution of the local people's participation in the design, the maintenance, and the utilization of the tree resource.

There is a need for a well-organized, consistent and continuous effort towards alleviating poverty through programs such Plan for Modernization of Agriculture (PMA), Universal Primary Education (UPE), Local Government Development Grant Programme (LGDGP), and National Agricultural Advisory Services (NAADS).

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Farmers Profits: Can the Standard Weights and Measures Help?

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Abstract*—In Ghana, rural people, mostly farmers, experience food insecurity. In bargaining with marketers, farmers tend to lose profits. The use of traditional weights and measures led to inefficient transactions. These difficulties have negatively affected farmers' productivity, calories intake, and international competitiveness. This research investigates how standard weights and measures can secure farmers' profits at local markets. Using a random selection of 312 farmers for the questionnaire survey at two markets, we examine the impact of current pricing methods on farmers' profits and advantages of standard weights and measures for farmers. The results show that price decision-making was based on three primary methods: (1) traditional weights and measures, (2) negotiation with individual marketers, and (3) negotiation with market queens. Markets queens and traditional measures negatively influenced farmers' profits. Farmers' perceptions showed that standard weights and measures would not only increase their profits at local markets but also enhance their international competitiveness.*

***Keywords*— Ghana, food security, local market, weights and measures.**

I. INTRODUCTION

The number of people who suffer from food insecurity in Ghana has increased from 1.2 million in 2009 to 2.1 million in 2016 (FAO, 2017). Rural communities suffer the most. According to a World Food Programme report (WFPR, 2016), about 15.5% of people in Ghana's Brong Ahafo Region, which is mainly rural, are food insecure. Of what Brong Ahafo residents eat 36% comes from their own farms and58% from local markets (WFPR, 2016). This means that local markets play important roles in ensuring rural farmer's food security.

Farmers in the Brong Ahafo Region face many difficulties to optimize their sales benefits at the market. Our earlier study (Antwi and Matsui, 2018) found that traders' ad hoc bargaining exploited the majority of farmers in this Region. Crop and vegetable prices were often determined by traditional weights and measures that traders preferred. Adejobi (2011) similarly found that traditional weights and measures at local markets created price inefficiencies. As a result, farmers who come to sell their products at market tend to distrust the market's pricing system (Pool et al., 2003).

This paper examines the extent to which standard weights and measures rather than traditional ones can secure profits for farmers in Ghana so that the country can reduce the number of its food insecure people in the future. In order to achieve the objective, we try to identify (1) current pricing practices at minor and major local markets, (2) effects of these practices on farmers' profits, (3) determinants of farmers' profits, and (4) farmers' perceptions about using standard weights and measures. In the following discussion, we first describe the significance of our study area. We then explain our methodology and discuss the results of our filed study and questionnaire surveys.

II. LITERATURE REVIEW

USAID (2013), noted that local markets in Africa are known for lower quality products due to lack of grading and packaging standards. Standardisation system helps farmers to identify quality levels by grade and package. In so doing, consumers are better informed about products at the local markets. Researchers showed that a standardized pricing at market ensures the efficient distribution of food to consumers, create employment opportunities for more farmers, provide competitive advantage in regional exports and increase farmer's profit margins (Adejobi et al., 2011; International Labour Organization, 2014).

The dominance of marketers at market over price determination has discouraged the participation of women and youths in agriculture (Feed the Future, 2017). Instead many tend to choose other trade options in developed countries despite the availability of government incentives that promote farming. Farmers in African countries, mostly smallholders, cover their production cost from the sales profit they obtain from selling their products. Therefore, securing optimal profits is critical for them to sustainably commercialize farming (Dolan and Humphrey, 2000).

In Ghana, local markets lack transparency (Lyon, 2003; Ortiz et al., 2010 and Yiridoe, 2005). Antwi and Matsui (2018) found that food prices at local markets were determined by the interplay of bargaining power and ad hoc weights/measures between farmers and marketers. The valuation of a fair return for farmers has resulted partly in price fluctuations and low profits. Other researchers found that price fluctuation at local markets posed challenges in the supply chain (Saurav and Neeraj, 2015). To solve such problems, trade associations headed by so-called “market queens” or market leaders were established in the 1970s to introduce some form of standards in price-fixing. However, these market queens upheld ad hoc traditional market transactions in a way that benefited their interests (Lyon, 2003; Ortiz et al., 2010). More recently, however, the Ghanaian government introduced the standard weights and measures partly to override the power of market queens and their intermediate partners. However, the effectiveness of this new policy is not yet observed at daily transaction practices at Ghana’s local markets (Antwi and Matsui, 2018; Yiridoe, 2005). So, the fundamental question is whether or not smallholder farmers in food insecure areas of Ghana and elsewhere can increase their profits from adopting standardized weights and measures. We found very little study on this question in our literature review.

III. METHODOLOGY

3.1 Study area

The survey was conducted in the Brong Ahafo Region. This region is known as the “food basket” of Ghana because most residents are farmers who raise important cash crops like cocoa, cashew, fruit trees, maize, rice, yam, and other vegetables (SADA, 2016). Using purposive sampling, two markets were selected from two municipalities: Berekum Market and Techiman Market.

Berekum Municipality is located in the north-western part of the Region. According to the Ghana population census of 2010, the municipality had a population of 129,628. The Ghana Statistical Service projected that the municipality population would reach 156,349 by the end of 2019, a 17% increase. More than half of the populations (129,628) were economically active and involved in agriculture, mostly growing tomato, plantain, maize, eggplant, pepper, okra, cassava, rice, and yam. Most farmers (83.5%) were literate (Ghana Statistical Service, 2012). Berekum Market operates on Thursdays when marketers and farmers within the boundary of Berekum Municipality and outside meet. Also, as this market is close to Cote D'Ivoire, Cote D’Ivoire buyers often come for acquiring tomato, garden-egg, pepper, plantain, cassava, maize, and many other farm products.

Techiman Municipality is situated in the central part of the Brong Ahafo Region with a population of 147,788, of which about 74.2% were economically active. About 46.2% was involved in agriculture, mostly cultivating tomato, eggplant, pepper, cabbage, okra, maize, and yam. About 74.2% of the residents in this municipality were literate (Ghana Statistical Service, 2012). Techiman Market is one of the largest markets in Ghana and operates three days a week (Monday to Wednesday). Monday and Tuesday are for wholesale crops, while Wednesday is for both wholesale and retail transactions. This market attracts people from other West African countries like Mali, Burkina Faso, Nigeria, and Niger as well as Ghana’s big cities like Accra and Kumasi.

These two municipality markets are important to rural farmers. Berekum Municipality Market is operated by those who live in Berekum and neighboring towns, while Techiman Municipality Market, an urban market, brings different tribes to trade. Traditionally Techiman Market is located on one of the major trading routes between the northern and southern boundaries of Ghana. It was the primary center for trading bulk foodstuffs such as yams, grains, and vegetables from north Ghana to urban markets in Accra, Kumasi, Takoradi, and CapeCoast.

3.2 Data collection and Analysis

The data collection for this research was primarily based on a semi-structured questionnaire to gather responses from farmers at the two markets. Our survey attempted to understand farmers’ perceptions about the benefits of traditional pricing and the prospects of having standard weights and measures (Lyon, 2000). It was conducted in the period between August and October 2018. In total, we collected valid responses from 312 farmers (165 from Berekum and 147 from Techiman). The response rate was 98%. Before conducting this survey, eight skilled enumerators were briefed to administer the questionnaire. The study was supervised with the collaboration of municipal information officers (MIS) in Berekum and Techiman. In the same period, we conducted in-person interviews with ten farmers, each from the two municipalities to seek their understanding of the questionnaire and personal experiences on the current pricing methods. We also undertook pre-survey observations at the two markets to familiarize ourselves with the area and observe how they transacted businesses.

The survey focused on three sets of questions: (1) socio-demographic characteristics of the respondents, (2) farmers' current pricing practices and their profits, (3) farmers' perceptions about standard weights and measures, including their motivating factors.

We assessed the performance of six current price-setting methods on farmers' profits at market and factors influencing the use of standard weights and measures by using multiple regression analyses. The coefficient was identified to measure the strength of the relationship between variables. P-value (typically ≤ 0.05 and > 0.05) was used to determine the significance of the results and whether to accept or reject the null hypothesis.

IV. RESULTS AND DISCUSSION

4.1 Socio-demographic characteristics of the respondents

The first part of our survey asked the respondents about their age, education, gender, work experience, family size and farm size. These are important to identify relevant factors for our multiple regression analyses. The result shows that about 67% of our respondents were men (Table 1). Here it is important to note that in general men in Ghana dominate commercial farming activities. Regarding education, 63% of the respondents had formal training up to tertiary level, and 37% had no formal education. The majority (84%) were married with an average family size of six persons. Regarding age, the average age of the respondents was 42 years old with a minimum age at 22 years old and a maximum at 71 years old. This indicates an aging issue among local farmers. This tendency is similar in other parts of the country (Feed the Future, 2017; Okoffo et al, 2016). Our respondents had an average farm size of nine acres, and 14 years of trading experience at local market.

TABLE 1
SOCIO-DEMOGRAPHIC CHARACTERISTICS OF FARMERS AT BEREKUM AND TECHIMAN MARKETS

Characteristics	% Response			
Sex	Male	Female		
	67.1	32.1		
Education	None	Primary/JSS	Senior/Form 4	Tertiary
	36.5	45.2	16.6	1.6
Marital Status	Married	Single	Divorced	Widow
	84.9	7.4	4.8	2.9
	Descriptive Statistics			
	Min	Max	Mean	Standard Deviation
Age	22	71	42	8.9
Work Experience	1	50	14	8.3
Family size	1	15	6	3.1
Farm Size (acre)	0.5	40	9	13.6

4.2 Current pricing practices at Berekum and Techiman markets

To better understand current pricing practices among farmers at the two markets, we asked the respondents to select the methods they had used to set prices with multiple choices. Based on information we collected from local market authorities and our own field observation at these two markets, we listed six choices (Table 2). One of the options, which is unique in Ghana, is to negotiate with a market queen. According to Aguda (2009), market queens no longer influenced pricing at Ghana's markets, but our earlier study found otherwise (Antwi and Matsui, 2018). So, we wanted to know how this traditional practice persisted. Other options we listed included negotiation with individual buyers, the use of ad hoc traditional measures (e.g., *olonka* as a unit that uses different sizes of empty cans as containers for vegetables like tomatoes), the use of standardized weights and measures, and negotiation with market and farmers' associations.

The result shows about 96% of our respondents arbitrarily used varying sizes of traditional weights and measures. In our fieldwork, we observed that farmers in Berekum mainly used black buckets and baskets with different sizes for bulk trade or wholesale. For retail sales, they used calibrated tins or *olonkas*. At Techiman Market, people from northern Ghana used calabash and "koko bowls" in trading grains while those from south used buckets and baskets for vegetables and fish. About 62% of the respondents at Techiman Market negotiated with market queens and leaders of market associations while 68% dealt with individual marketers. These are the practices farmers complained about marketer's unfair pricing practices.

In response to our question about the past use of standard weights and measures at the markets, about 81% of the respondents were negative. However, the respondents generally believed that standards would make pricing practices fairer. Additionally, we interviewed farmers who traded cashew and cocoa at Techiman Market. They said they used standard weights and measures to keep track of their production and benefits at the end of the harvesting season. From the results we found that some farmers (39%) benefited from farmers' associations, especially at Techiman. These associations negotiate with market queens for member farmers. They also help the farmer's loan from banks and other financial institutions.

TABLE 2
FARMERS PRICING PRACTICES AT LOCAL MARKET

Pricing Method	Yes		No	
Negotiated with market queens	194	62%	118	38%
Negotiated with individual marketers	211	68%	101	32%
Used traditional weights and measures	299	96%	13	4%
Used standard weights and measures	58	19%	254	81%
Market associations	78	25%	234	75%
Farmers' association	122	39%	190	61%

4.3 The effects of traditional price setting on farmers

We then asked the respondents to indicate their level of agreement and disagreement with five provided statements about pricing practices. The results show that 67% of the respondents did not think that they would obtain a fair price for their products at local markets (Table 3). Similarly, 68% felt cheated at markets in the process of pricing their products. The respondents attributed this problem to the influence of marketers, market queens and a lack of standard weights and measures. Although negotiations allow farmers and marketers to decide on prices, farmers are sometimes forced to accept marketers' offers. Regarding unfairness at the market for farmers, 68% of our respondents said their profits did not increase by using traditional weights and measures.

TABLE 3
FARMER'S PERCEPTIONS ABOUT CURRENT PRICING

	Percentage of the respondents				
	Strongly Agree	Agree	Not sure	Disagree	Strongly disagree
Do you receive a fair price?	26	3	4	0	67
Do traditional weights optimize profits?	3	16	9	3	68
Has profit margin increased in last 5-10 years?	11	29	33	23	4
Is price negotiation beneficial?	20	20	7	18	36
Do price cheating occur?	68	0	0	0	32

4.4 Significance of current pricing on farmers' profits at local market

To understand the extent to which the current ad hoc pricing practices affected farmer's profits, we tried to find the relationship between farmer's profits and pricing practices through regression analyses (Table 4). Among the six methods of pricing we asked the respondents to identify, negotiations with market queens had the most significant P-value of 1.1E-11 and a coefficient of 0.298. This reiterates our earlier finding that market queens still have a strong influence on pricing activities at Berekum and Techiman markets despite the national policy to abolish their roles in the 1980s.

The multiple regression analysis result for the other pricing methods (negotiation with individual traders, traditional measures and markets associations) were significant at a P-value of 4.05E-8, 0.50 and 1.9E-5 respectively (Table 4). However, coefficient values for traditional measures and market associations were -0.128 and -0.048, a sign of negative relationship. These results indicate that the minimal usage of traditional measures and market associations' support can increase farmer's profits and help them make better price-decisions. Replacing ad hoc measures with standardized ones can minimize the influence of market queens. Institutional support rather than individual efforts ends to promote transparency and trust at local market.

TABLE 4
REGRESSION RESULT OF PROFIT DETERMINANTS

Factors	Profit	Negot. Queen	Negot. Individual	Traditional Measure	Standard Measure	Market Ass.	Farmer Ass.
Profit	.	.000	.000	.050	.000	.000	.000
Negotiate Queens	1.16E-11	.	.000	.270	.000	.000	.000
Negotiate Individuals	4.05E-8	.000	.	.011	.000	.000	.000
Traditional weights	.050	.270	.011	.	.031	.007	.036
Standard weights	4.1E-5	.000	.000	.031	.	.000	.000
Markets Associations	1.9E-5	.000	.000	.007	.000	.	.000
Farmer Association	2.6E-10	.000	.000	.036	.000	.000	.

4.5 Farmers' perceptions about standard weights and measures

Having these results, we tried to understand farmers' perceptions about the use of standard weights and measures. We asked farmers to answer the extent to which they agreed or disagreed with four possible results from the use of these standards (Table 5). We found that about 89% of the respondents strongly agreed that the use of standards could improve their profits. More than half (60%) of the respondents perceived that standard weights and measures would motivate them to increase their production. Also, almost all the respondents strongly agreed or agreed that standard weights and measures would better inform marketers and consumers about their products (Table 5). Lastly, about 69% of our respondents strongly agreed or agreed that the use of standard weights measures would help compete with the supermarket and international trade.

TABLE 5
FARMERS' PERCEPTIONS ABOUT THE BENEFITS FROM USING STANDARDS

	Percentage of respondents				
	Strongly Agree	Agree	Not sure	Disagree	Strongly disagree
Standards would improve my profit	89	0	0	0	11
They better inform about products	50	31	16	3	0
They help compete with supermarkets	46	23	20	7	4
They encourage to increase production	60	0	0	0	40

4.6 Factors influencing the use of standard weights and measures

Ghana has formulated a policy that imposes the use of standard weights and measures at all local markets. As this policy is not yet fully implemented, we tried to identify factors that can influence the implementation. In particular, we tried to find out how our respondent's age, education, farm size, and experience can influence the level of policy implementation. The multiple regression analysis results showed that farm size, age, education, and farming experience were significant at a P-value of 5% ($p<0.05$). However, the coefficient values for education and experience showed negative. This indicates that inadequate training and information on the use of standard weights and measures may affect farmer's usage and price decision-making (Table 6).

TABLE 6
REGRESSION ANALYSIS OF FACTORS INFLUENCING STANDARD WEIGHT AND MEASURE

Factors	Standard weight	Age	Education	Experience	Farm size
Standard weight	.	.021	.183	.361	.000
Age	.021	.	.423	.043	.000
Education	.183	.423	.	0.05E-3	.050
Experience	.361	.043	0.05E-3	.	.001
Farm size	1.67E-17	0.04E-4	.050	.001	.

V. CONCLUSION

Inefficient and opaque transaction practices at Ghana's local markets directly or indirectly affect the current rise in food secure people in rural Ghana. Market queens continue to influence the pricing system. This led to the loss of farmers' profits and limited farmers' purchasing ability. Also, traditional market price negotiations led to the loss of farmers' profits. Farmers were well-aware of these conditions as about 67% of our respondents found that they did not receive a fair price for their products, and 68% felt cheated in negotiation. They did emphasize the importance of having standard weights and measures to decide on prices. These farmers appear to be ready to adopt standard weights and measures as they believed that these standards would better inform marketers and consumers about products, allowing them to better compete with supermarkets and international markets. The respondents also believed that these standards would incentivize further production, potentially revitalizing aging agricultural sector. For the Ghanaian government to successfully implement its market standardization policy it needs to better inform farmers and marketers about benefits standard weights and measures can bring.

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Potential Impact Assessment of Agricultural Practices on Water Quality in Nyanza District; A Case Study of Bishya Wetland

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Abstract— *A challenge of linking agricultural sector with water quality in order to combat water pollution remains worrying for the Government of Rwanda. The general objective of the study was to assess the potential impacts of agricultural practices on water quality in NYANZA District. Specifically, the study assessed agricultural practices in Bishya wetland, analyzed the level of water pollution in Bishya wetland, and demonstrated the correlation between agricultural practices and water quality from Bishya wetland. Data were obtained through questionnaires, observation, and laboratory analysis of water samples taken twice per month in six sampling points of bishya dam situated in bishya wetland starting from 4th March 2019 up to 20th August 2019. The Linear Regression Model using SPSS statistics with 95% confidence interval was used to demonstrate the correlation between agricultural inputs and water quality data for all selected physico-chemical parameters. Findings revealed that agricultural practices in Bishya wetland and surrounding areas are characterized by the presence of different crops, ineffective anti-erosions, absence of wetland margins, ineffective drainage of wetland, use of organic manures and chemical fertilizers, as well as the presence of different types of rocks and soils. Findings revealed also that all parameters have not manifested pollution, but some of them did according to Rwanda Standard Board guidelines. In sampling point1, the parameters that presented pollution were nitrites (r=0.047), phosphates(r=0.384), iron (r=0.11), and manganese(r=0.018); in sampling point2, were nitrites(r =0.010), iron (r=0.059), and chemical oxygen demand(r=0.012); in sampling point 3, were pH (r=0.048), nitrites(r =0.086), and phosphates (r=0.329); in sampling point 4, were nitrites (r =0.123), iron(r=0.182), and manganese (r=0.051); in sampling point 5,were turbidity (r=0.080), nitrites (r=0.095), phosphates(r=0.188),iron(r=0.093), manganese(r=0.051), and chemical oxygen demand(r=0.017), and in sampling point 6, the parameters that presented pollution were nitrites(r=0.046), phosphates(r=0.277), iron(r=0.106), and manganese(r=0.190). Finally, findings revealed that agricultural practices in Bishya wetland and surrounding areas, have contributed to the pollution of water quality of Bishya dam through substances of organic manures, chemical fertilizers and pesticides, crop residues, and soil sediments that are transported into the dam by erosion. The study concluded that an effort to create anti-erosions in all areas surrounding wetland, respectful of buffer zones, improving vegetation covers, creating water management bodies at cells level, increasing awareness of population about ecosystem functions, and capturing rain water from houses may effectively contribute to water quality in Bishya wetland.*

Keywords— Agricultural practices, water quality, water pollution, and Bishya wetland.

I. INTRODUCTION

Water is a key natural resource, which is very important to all ecosystems on the earth surface (UNESCO, 2006). It is a fundamental element for all forms of life for various purposes such as agriculture, drinking, cleaning, and as shelter for aquatic organisms (Ninhoskinson, 2011). Water covers 70% of the Earth's surface, yet 40% of the world's peoples experience water shortage (Mmbando J. et al, 2007). Access to clean and safe water is a basic necessity of human life, and one of the most important global issues (Larsen, 1997). According to WHO, quoted by Mmbando J. et al (2007), 1.4 billion people, equivalent to 20% of the world's population, do not have access to clean and safe water. It is mainly the poorer Less Economically Developed Countries (LEDCs) who have least access. This lack of access is a major barrier to a country's development (Mmbando J. et al, 2007). No single measure would do more to reduce disease and saves lives in the developing world than bringing safe water to all (Koffi Annan, 2000). One of the main reasons for the shortage of water is that 97.5% of the water that covers the Earth is saltwater, whilst just 2.5 % is fresh water.

In Africa, up to 90% of freshwater is used in agriculture. The WHO, quoted by Mmbando J. et al (2007), it is estimated that 17% more freshwater will be needed simply to grow enough food to cope with the estimated increase in population. Rapid population growth has put pressure on the world's resources and affected quality of life. Half of all the populations in LEDCs still do not have safe water to drink. Contaminated water is responsible for the cause and spread of 80% of the world's disease including cholera, typhoid and dysentery (WHO, 2006). Waterborne diseases kill 25000 people daily, and about 14 million children under five-year old die each year from illness and hunger (Mmbando J. et al, 2007).

Although human beings benefit a lot from water, they are among the main causes of water pollution through poor management of agricultural practices (US-EPA, 1994). These include excessive use of fertilizers for increasing production, traditional irrigation practices, use of pesticides and herbicides and poorly managed animal farming operations (EPA, 2009). The rapid population growth in LEDCs has resulted in environmental degradation and remarkable reduction in cultivable land. Agricultural smallholders dominate the scarce land available and the smaller the land, the more likely the landholder to live in poverty (IDA, 2008). Water management in degraded environment and in a very limited cultivable land is considered as a big challenge for the much-needed expansion of basic services including water services, which cannot be expanded at the desired quality and quantity; thus the need for a new approach to improving water provision in such degraded environment and limited cultivable land (Schreinemachers, 2012).

In Rwanda, the Government has adopted some policies like enhancing irrigation practices, use of fertilizers, expanding the cropland area, increasing use of lime and organic manures, all aim at increasing agricultural productivity and eliminating poverty among citizens (Nahayo et al, 2016). Besides, the Government of Rwanda adopted the National Water Services Strategy through which the Government is committed to fast tracking affordable and sustainable access to safe water in the settlements of both rural and urban areas. This is achievable through defining national standards for low-cost technologies and increasing number of public or communal outlets under formal water service provision (WASAC, 2018). However, these practices adopted for increasing agricultural production have resulted in water quality deterioration through hurrying soil erosion and release of phosphorus, nitrogen and other chemical substances from agrochemicals applied, which in round, cause water pollution and high levels of eutrophication in wetlands and some lakes (REMA, 2009).

Agricultural inputs have been identified as one of the leading sources of water pollution in Rwanda, especially in wetlands (REMA, 2009).The worsening of fresh water quality can be directly observed through water utilities in a country. For instance, the amount spent on acquiring chemicals to treat water constitutes a huge part of any water utility's expenditure. The Rwandan Water Utility (WASAC) spends millions of Rwandan Francs on water treatment chemicals where in 2017/2018 an amount of 96 million Rwandan Francs have been spent for the purification of water in NYANZA town alone (WASAC, 2018). The amount spent on chemicals rises with the deterioration of raw water quality and this in turn makes water expensive, as the water utilities are forced to adjust water prices to recover costs. Some researches related to agricultural policies, crop production have been conducted in Rwanda; however, a challenge of linking these sectors with water quality in order to combat water pollution remains.

II. MATERIALS AND METHODS

2.1 Description of the study area

Bishya wetland is located between Busasamana, Rwabicuma and Mukingo Sectors of Nyanza district in the Southern Province of Rwanda. It is situated on the plateau agro-ecological zone of Rwanda at approximately 19500 m, covers an area of 17km^2. The annual range of rainfall in Bishya Wetland is 1200 mm–1400 mm (Nyanza District report, 2018).

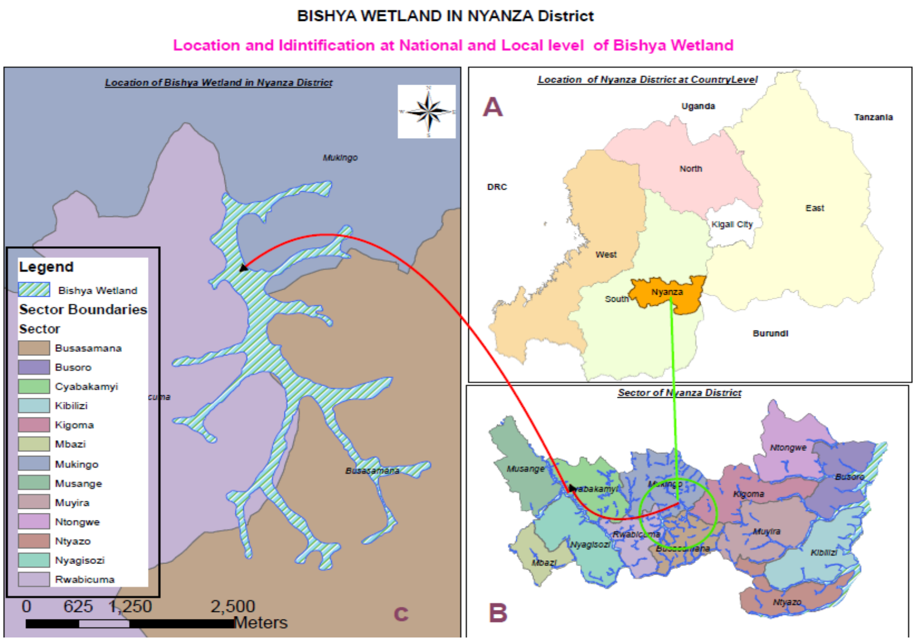

FIGURE 1: Bishya wetland

Bishya wetland has been exploited in an unorganized way for a long time where people cultivated different crops such as sweet potatoes, maize, beans, sorghum, etc. Since 2015, this wetland was divided into two parts: one part (downstream) was constructed in valley dam and the second part (upstream) is used for agricultural activities and sericulture (Nyanza District report, 2018).

2.2 Research design

A research design is considered as a master plan specifying the accurate methods and procedures for collecting and analyzing the required information. Hence, this study used qualitative and quantitative methods. In regard to qualitative method, the researcher distributed questionnaires to farmer cooperatives operating in Bishya wetland and surrounding areas. Furthermore, the researcher's own observation was needed for supplementary information. In terms of quantitative method, the researcher has selected six sampling points in bishya dam basing on different entrances of different streams passing through the areas characterized by different agricultural plantations (maize for sampling point1 and 2, mulberry for sampling point3, vegetables for sampling point4, cassava and sweet potatoes for sampling point5, and the dam intake in water supply for the sampling point6). Furthermore, a Linear Regression Model using SPSS statistics with 95% confidence interval was used to analyze the correlation between agricultural inputs and water quality from Bishya dam.

2.3 Study population

The population, under this study, was composed of all farmer cooperatives performing agricultural activities in Bishya wetland and surrounding areas, which the total number is five cooperatives, namely NGIRANKUGIRE and SHINGISUKA cooperatives, both maize farming, TURENGERABANA cooperative, vegetable growers, TURWANYINZARA cooperative, sweet potatoes and cassava farming, and HEworks Rwanda Silk Ltd, mulberry cultivation.

2.4 Source of data

The study involved the use of primary data and secondary data. Primary data were collected through questionnaires, observation, and laboratory tests of raw water from Bishya dam. Secondary data from books and official reports

2.4.1 Questionnaire

The closed and open-ended questions were given to five representatives of five different farmer cooperatives performing their agricultural activities in Bishya wetland and surrounding areas. In general, the survey was designed to know the characteristics of agricultural practices in Bishya wetland, and basing on these characteristics to assess their potential impact on the water quality from Bishya dam.

2.4.2 Observation

The author did his own observation on field for different times, in dry and rainy seasons of 2019, in order to ensure himself the agricultural features in Bishya wetland and surrounding areas.

2.4.3 Laboratory tests of water from Bishya dam

2.4.3.1 Water sampling

The water samples were collected twice per month from Bishya dam for a period of six months starting from 4th March 2019 up to 20th August 2019. Subsequently, twelve sampling campaigns were conducted during that period for the six sampling points in the dam. Samples were collected and stored in 500ml plastic bottles. The plastic bottles were washed and rinsed with distilled water before use. Samples were put in a cooler box for preservation during transportation to the laboratory for analysis. Then, samples were kept in a fridge at 4^{o}c to avoid any external contamination while preparing the laboratory equipment and reagents to be used in testing of different selected physico-chemical parameters.

2.4.3.2 Laboratory analysis

Water samples from the Bishya Dam were collected and analyzed in Laboratory of WASAC at MPANGA water treatment plant. Samples were analyzed using standards procedures for testing water and wastewater (APHA, 2005). The physico-chemical parameters analyzed in this research were pH, turbidity, nitrites, nitrates, ammonia nitrogen, phosphates, iron, manganese, and chemical oxygen demand.

2.4.4 Data analysis procedure

The collected data was processed, analyzed and managed using editing, tabulation, and graphics in order to provide clear and understandable data. Furthermore, Linear Regression model with 95% confidence interval was used to establish potential correlation between agricultural inputs and water quality parameters. Hence the results from laboratory and had positive correlation with agricultural inputs were compared to the Rwanda Standards Board (RSB) guidelines for natural fresh water in order to analyze the level of water pollution from agricultural practices in Bishya wetland.

III. RESULTS AND DISCUSSIONS

3.1 Assessment of agricultural practices in Bishya wetland and surrounding areas

3.1.1 The opinions of respondents

In terms of agricultural production, all respondents (100%) have insisted on mulberry, maize, vegetables, sweet potatoes, banana plantation, and cassava as the main agricultural production performed in Bishya wetland and surrounding areas. This situation shows that agricultural production, in Bishya wetland, are varied crops necessitating various fertilizers and pesticides to grow.

Regarding the cooperative farm size and grown crop, NGIRANKUGIRE and SHINGISUKA grow maize on respectively 76ha (25.7%) and 59ha (20.0%), TURENGERABANA grows vegetables on 52ha (17.6%), TURWANYINZARA grows sweet potatoes and cassava on 51ha (17.2%), and HEworks Rwanda Silk Ltd that grows mulberry at 57ha (19.3% of the total exploited land). This situation shows that Bishya dam’s surrounding land is sufficiently exploited, and accommodates various crops that necessarily require various fertilizers and pesticides to grow up and to produce more.

Regarding the frequency of using fertilizers and pesticides in cooperative farms, the majority of respondents (80%) confirmed that they regularly use fertilizers and pesticides in their farms, while only 20% highlighted that the use of fertilizers and pesticides in their farms is done sometimes. None of cooperatives denied the use agricultural inputs. Those who irregularly use agricultural inputs are farmer cooperative that grows sweet potatoes and cassava. This situation confirms that agricultural practices in Bishya wetland and surrounding areas are characterized by the use of different fertilizers and pesticides.

Regarding the types of fertilizers and pesticides usually used in farm crops of Bishya wetland and surrounding areas, the majority of respondents (80%) regularly use organic manure as fertilizers; 60% of respondents frequently use NPK17*17*17, DAP, Urea, and insecticide composed of Cypermethrin 40% and Profenofos 40%), and fungicide; 60%of respondents repeatedly use chlorpyrifos-ethyl, 40% of respondents often use thiram and benomyl as pesticides, while only 20% of respondents regularly use NPK20*10*10 and lime as agricultural input. This situation confirms that agricultural practices in Bishya wetland and surrounding areas are characterized by the use of different chemical fertilizers, organic manures and pesticides as agricultural inputs.

In terms of quantity of fertilizers and pesticides used in farming crops in every season, NGIRANKUGIRE cooperative, which grows maize, uses NPK (19,000kgs), organic manure (380,000kgs), and Chlorpyrifos-ethyl (76kgs); SHINGISUKA cooperative, which also grows maize uses NPK (14,750kgs), organic manures (295,000kgs), and Chlorpyrifos-ethyl (59kgs); TURENGERABANA cooperative, which grows vegetables, uses organic manures (260,000kgs), Urea (4160 kgs), DAP (5,200 kgs), Fungicide (52 kgs), and insecticide (52kgs); TURWANYINZARA cooperative, which grows cassava and sweet potatoes, uses organic manures (357,000 kgs); and HEworks Rwanda Silk Ltd, which grows mulberry, uses NPK20*10*10 (24,510kgs)

For the question to know if farmer cooperatives have received any agriculture input aid within season B of 2019, the majority of farmer cooperatives (80%) have received agricultural inputs; while only 20% did not received. This was confirmed by Agronomist of Nyanza District during the interview conducted to him, where he said that farmer cooperatives are given priority in provision of agricultural input aids known as NKUNGANIRE program, basing on priority crops (A farmer pays 25% and Government pays 75% of the total prices of agricultural inputs). This situation shows that, basically, farmers have advantages from joining farmer cooperatives. The situation highlights also that farmer cooperatives apply all necessary quantity of chemical fertilizers and pesticides according to the requirements of MINAGRI since they get these agricultural inputs under the form of aids from the Government of Rwanda.

3.1.2 The author’s own observation

During our own observation on field for different times, in dry and rainy seasons of 2019, we realized that agricultural features in Bishya wetland and surrounding areas, are mainly composed of ineffective anti-erosions, existence of different types of rocks and soils, the misuse of organic manures and chemical fertilizers, absence of vegetation covers, absence of wetland margins, and ineffective drainage of wetland. This weak management of Bishya wetland remains a major challenge, despite the efforts made by the Government of Rwanda at improving wetlands management over the years.The following figures highlight ineffective management of Bishya wetland

FIGURE 2: Crop farming activities

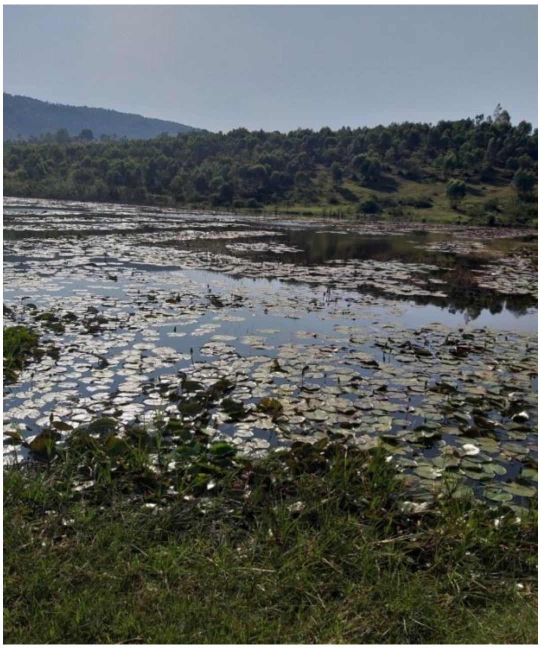

FIGURE 3: The concentration level of water hyacinth

3.2 Laboratory tests of water samples

3.2.1 The sampling points

Six water-sampling points were selected basing on different entrances of different streams passing through the areas characterized by different agricultural plantations namely mulberry, maize, vegetables, cassava and sweet potatoes. Therefore, two points were selected to represent the upstream of the Bishya dam where two streams from the farms owned by NGIRANKUGIRE and SHINGISUKA cooperatives that grow maize fall in the dam (P1, P2). Other two points, P3 and P4, were chosen basing on entrances of different streams passing through mulberry and vegetable plantations owned by HEworks Rwanda Silk Ltd and TURENGERABANA cooperative respectively. The sampling point P5 was selected basing on entrance of stream passing through the plantation of sweet potatoes and cassava owned by TURWANYINZARA cooperative. Finally, the sampling point P6 is the dam intake for water supply systems in NYANZA District. Pictorial location of the sampling points within the Bishya dam (Figure 4).

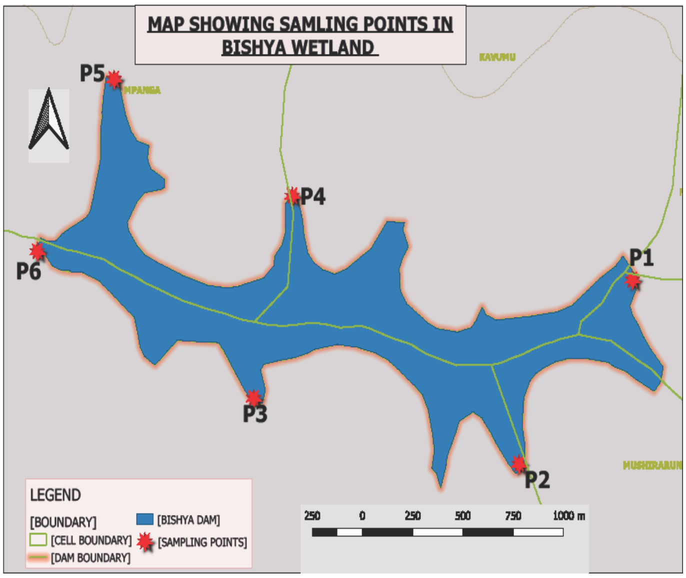

FIGURE 4: Sampling points within the Bishya dam

3.2.2 Presentation of the results of physico-chemical parameters from laboratory tests.

This section presents findings from laboratory analysis and then presents the graphical analysis of data. In order to interpret and be able to draw suitable conclusions on our research the linear regression model has been conducted. From the 4th March2019 up to the 20th August 2019, water samples from Bishya Dam have been taken and brought to laboratory for the analysis. Below we present the average values and standard deviation of different physico-chemical parameters for each sampling point.

TABLE 1
AVERAGE VALUES OF DIFFERENT PHYSICO-CHEMICAL PARAMETERS FOR EACH SAMPLING POINT

Sampling points	P1	P2	P3	P4	P5	P6	RSB standards
	N=12	N=12	N=12	N=12	N=12	N=12	
PH	6.06±0.22	6.04±0.35	5.25±0.24	5.65±0.54	5. 84±0.45	5.73±0.29	**5.5-9.5**
Turbidity(NTU)	74.85±14.28	80.78±29.8	114±50.56	58.33±22.46	49.17±13.05	51. 9±27.8	**25**
Nitrites (mg\L)	1.15±0.11	1.09±0.11	1.12±0.08	1.18±0.07	1.21±0.05	1.15±0.05	**0.9**
Nitrates (mg\L)	3.79±0.50	3.88±0.52	3.74±0.47	3.50±0.59	3.18±0.17	3.78±0.46	**45**
Ammonia Nitrogen (mg\L)	0.36±0.14	0.38±0.18	0.40±0.10	0.27±0.06	0.24±0.08	0.28±0.08	**0.5**
Phosphate (mg\L)	2.49±0.16	2.35±0.12	2.35±0.13	2.38±0.18	2.33±0.12	2.50±0.13	**2.2**
Iron (mg\L)	2.64±0.34	5.60±0.52	5.23±0.50	2. 80±0.26	2.41±0.47	2.37±0.49	**0.3**
Manganese (mg\L)	0.14±0.04	0.64±0.25	0.78±0.34	0.26±0.03	0.26±0.03	0.21±0.03	**0.1**
COD(mg\L)	46.50±10.24	58.41±10.4	52.3±10.4	53.4±12.8	51.00±8.22	49.00±8.53	**50**

Water quality parameters described in the Table 1 have been selected on basis of some aquatic plants that can be an indicator of a water rich in some chemical substances present in the dam such as water hyacinths and also basing on fertilizers and pesticides that are used in agricultural activities in this area. Moreover, the table indicates the average values and standard deviation of the physico-chemical parameters for each sampling point in Bishya dam. It also indicates the RSB standards to compare with these average values and then to demonstrate the level of pollution.

3.2.2.1 Results from PH laboratory test

The pH is an important parameter in water as it can indicate whether organisms or substances can exist in water for any value of the pH. Figure 5 illustrates the average values of pH in six sampling points.

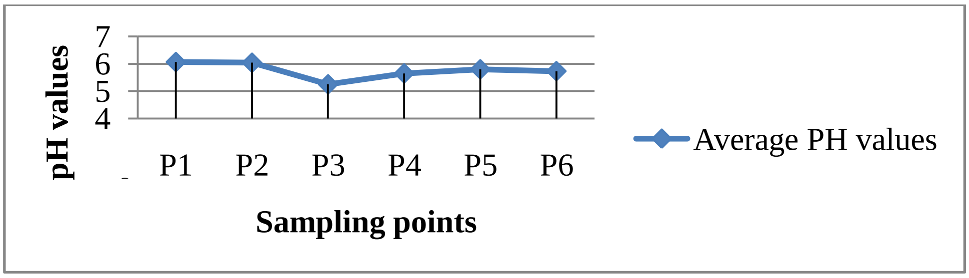

FIGURE 5: Average pH values according to sampling points in Bishya dam

This graph indicates that the pH in sampling point 3 was more acidic than other sampling points with average pH value of 5.25 overtaking the minimum limit of 5.5 recognized by RSB. The lower pH means that the water can provoke redness and irritation of eyes for the people during the usage and also can cause corrosion of metal pipes of the water supplying systems (Ombaka,2013).The acidic behavior of water in bishya dam especially in P3 could be due to dissolved carbon dioxide and organic acids derived from the decayed matter which then eventually fall into the water body. The sampling points P1, P2, P4, P5, and P6 were less acidic with means pH values of 6.06, 6.04, 5.65, 5.84, and 5.73, respectively and these values fall in acceptable limits of RSB.

3.2.2.2 Results from Turbidity laboratory test

The average values of water parameters from laboratory results as presented in table1showed that turbidity is high in all sampling points ranging from 49.17NTU to 114 NTU. These average turbidity values overtake accepted limits of RSB that is fixed at 25NTU.

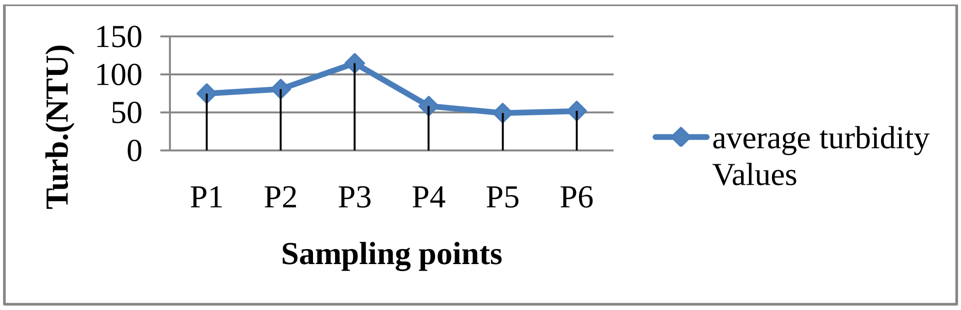

FIGURE 6. Average turbidity values according to sampling points in Bishya dam

From the above graph, it is observable that in sampling point P3 located in the area of mulberry plantation the turbidity level was very high comparing to other sampling points though all of them present the level overtaking the accepted limits of RSB. This situation means that in all sampling points, suspended particles, the presence of organic and colloidal materials from agricultural runoff and soil sediments contribute towards high turbidity values, especially in rainy season according to Thirupathaiah, 2012. Turbidity can give shelter for microorganisms and pathogens in water and also Turbidity of water has an impact on other parameters such as color and even chemical parameters which affect water quality (Ombaka, 2013)

3.2.2.3 Results from Nitrites laboratory test

Nitrites are among substances that have been analyzed in this research since we noticed that they have an impact on the pollution of water in Bishya dam. The laboratory tests for Nitrites have shown that average concentration of nitrites varies from 1.09 mg/l to 1.21mg/l. These all mean values are above the RSB guideline, which is 0.9mg/l.

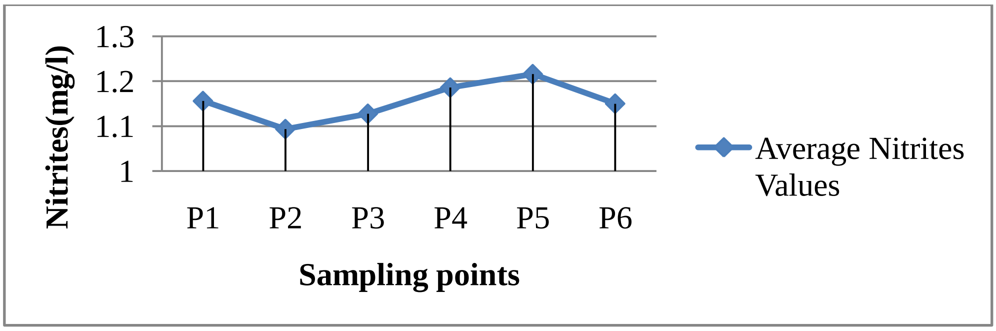

FIGURE 7: Average of nitrites concentration according to sampling points in Bishya dam

The above graph shows that the average nitrites levels was high in sampling point P5 comparatively to other points, though all sampling points present the mean values overtaking the accepted limit of RSB. This situation showed that activities performed in P5 produce substances containing high quantity of nitrites comparing to other points. Considering detailed results from each sampling points in different seasons, it was observable that nitrite concentration increased in the dry season than in rainy season in all sampling points. This situation proves the theory that when the volume reduces the concentration increases. In dry season, the rain is reduced and there is a too much evaporation, which finally results in the reduction of volume of water in the dam and increase of concentration of chemical substances in general.

3.2.2.4 Results from Nitrates laboratory test

Nitrates have been selected among parameters to be analyzed as they can contribute in water pollution of the dam since they are much more abundant in intensive agricultural runoff. From the laboratory tests nitrates have shown that the average concentration of nitrates varies from 3.18 mg/l to 3.88mg/l in all sampling points. However all mean concentration levels were within the RSB standards of 45mg/l.

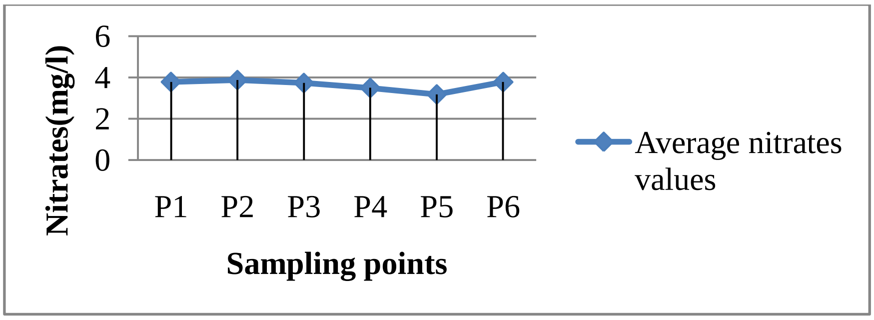

FIGURE 8: Average of nitrate concentration according to sampling points in Bishya dam

From the above graph it is noticed that concentration of nitrates didn't vary too much, since the difference in average values is not high. The sampling point P5 presents a less concentration level of 3.18 mg/l; this point is traceable on the side of sweet potatoes and cassava plantations.

3.2.2.5 Results from Ammonia nitrogen laboratory test

The ammonia nitrogen in water body comes from different sources but in our research, we focused the ammonia nitrogen which comes from fertilizers that are used in the area of our research. In this area, it is known that runoff that enters Bishya dam contains ammonia nitrogen that can have a negative impact on water quality.

Laboratory results have shown an average concentration level of ammonia nitrogen swinging between 0.24mg/l and 0.49mg/l for all sampling points. These all average values were within the limits accepted by RSB of 0.5 mg/l.

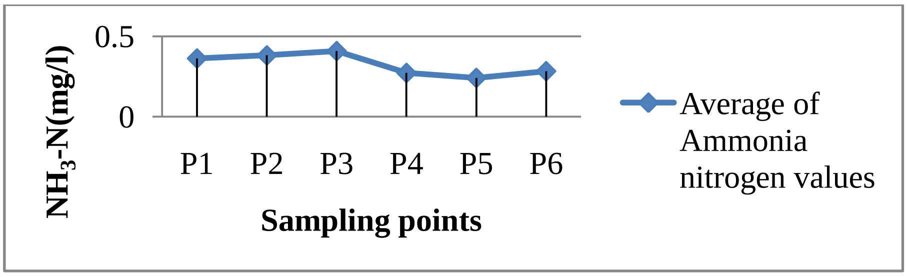

FIGURE 9: Average of ammonia nitrogen values according to sampling points in Bishya dam

The graph indicates that the concentration of ammonia nitrogen was on high in sampling point 3, which located on the side of mulberry plantation. Even if laboratory tests for ammonia nitrogen (NH_3-N) shown that the mean values did not overtake RSB guideline which is 0.5mg/l, the trend situation was not negligible in all sampling points. Moreover, the results indicated that Bishya dam had some quantities of organic matters in it, and provoke the water to have a bad smell (indication of water quality deterioration).

3.2.2.6 Results from Phosphates laboratory test

As other parameters analyzed in this research, phosphates from agricultural runoff contribute to the deterioration of water quality in the dam. Laboratory tests for phosphates have shown phosphates concentration level varying between 2.33 mg/l and 3.50 mg/l in all sampling points. These average values present pollution cases in Bishya dam since they are all above accepted limit of RSB which is 2.2 mg/l.

These average values present pollution cases in Bishya dam since they are all above accepted limit of RSB which is 2.2 mg/l.

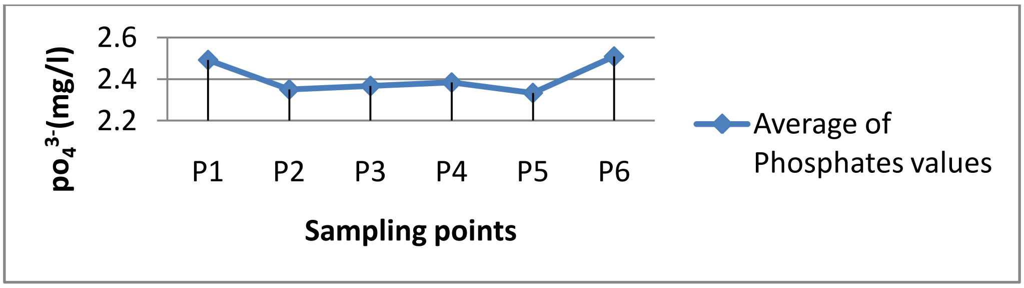

FIGURE 10: Average of phosphate concentration according to sampling points in Bishya dam

The analysis from the graph shows that there is high concentration levels in P1 and P6 corresponding to 2.49mg/l and 2.50mg/l respectively, comparatively to other points. This means that in sampling point1 and 6, the dam accommodates a large quantity of substances containing phosphates ions than others.

3.2.2.7 Results from Iron laboratory test

Laboratory tests for iron have shown that the concentration level of iron in Bishya dam varies between 2.37mg/l and 5.60mg/l in all sampling points. These average values are highly surpassed the limits accepted by RSB that stands at 0.3 mg/l.

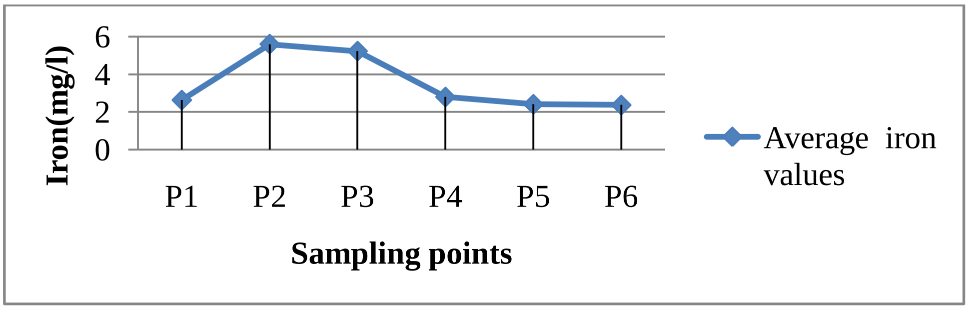

FIGURE 11: Average of iron concentration according to sampling points in Bishya dam

From the graph above, the concentration of iron is higher in sampling points P2 and P3 situated near the plantation of maize and Mulberry respectively.

3.2.2.8 Results from Manganese laboratory test

Laboratory tests for manganese have shown that the concentration level of manganese in Bishya dam varies from 0.14 mg/l to 0.78mg/l in all sampling points. These average values exceeded the limit of RSB standing at 0.1 mg/l.

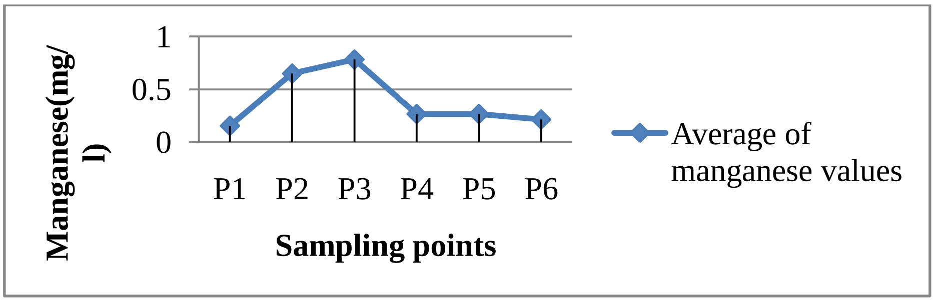

FIGURE 12: Average of manganese concentration according to sampling points in Bishya dam

The graph indicates that the concentration of manganese is increasing in P2 and P3 situated in the areas of Maize and mulberry plantation respectively. This situation means that Bishya dam accommodates the sediments of manganese that are highly soluble in water and their concentration manifest itself during the dry season than rainy season.

3.2.2.9 Results from Chemical Oxygen Demand laboratory test

Laboratory tests for chemical oxygen demand have demonstrated that COD concentration ranged between 46.50 mg/l to 58.41 mg/l in all sampling points. The sampling points P2, P3, P4, and P5 present the average results that are above the limit of RSB (respectively 58.41 mg/l, 52.3 mg/l, 53.4mg/l, and 51.08mg/l); other points P1 and P6 (46.50 mg/l and 49.0 0mg/l respectively), represent average results accepted by RSB guideline which is 50mg/l.

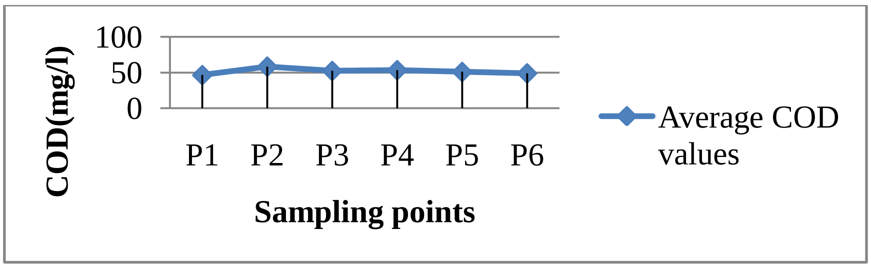

FIGURE 14: Average of chemical oxygen demand concentration according to sampling points

From graph analysis, the COD concentration is high in P2 comparatively to other sampling points. This sampling point P2 is nearing the maize plantation. The high concentration level of COD in Bishya dam makes it polluted. COD is an indicator of organic pollution, which is caused by the inflow of agrochemicals, livestock, and industrial waste that contains elevated levels of organic pollutants.

3.3 Correlation between agricultural practices and water quality from Bishya dam

3.3.1 Demonstration of coefficient of correlation using Linear Regression Model

In order to demonstrate the correlation between agricultural inputs and water quality from Bishya dam, a Linear Regression Model using SPSS statistics with confidence interval of 95% was adopted (Table 2).

TABLE 2
COEFFICIENT OF CORRELATION BETWEEN AGRICULTURAL INPUTS AND WATER QUALITY FROM BISHYA DAM

Sampling sites	P1 N=12	P2 N=12	P3 N=12	P4 N= 12	P5 N=12	P6 N= 12
Coefficient of correlation(r)	r	r	r	r	r	r
PH	-0.25	0.066	0.048	0.300	0.266	-0.109
Turbidity(NTU)	-0.027	-0.132	-0.028	-0.084	0.080	-0.011
Nitrites (mg\L)	0.047	0.010	0.086	0.123	0.095	0.049
Nitrates (mg\L)	0.033	0.064	0.077	0.080	-0.060	0.046
Ammonia Nitrogen (mg\L)	-0.044	0.109	-0.027	-0.047	-0.003	0.134
Phosphate (mg\L)	0.384	-.0536	0.329	-0.312	0.188	0.277
Iron (mg\L)	0.11	0.059	-0.060	0.182	0.093	0.106
Manganese (mg\L)	0.018	-0.077	-0.046	0.051	0.051	0.190
Chemical Oxygen(mg\L)	-0.063	0.012	-0.059	-0.143	0.017	0.106

3.3.2 Correlation between agricultural inputs and water pollution from Bishya dam

The relationship between agricultural practices and water quality from Bishya dam was demonstrated trough Linear Regression Model using SPSS with confidence interval of 95% considering both data from agricultural inputs used by farmers in their respective farm crops as summarized in Table 3, and laboratory results of water samples as indicated in Table 1.

TABLE 3
SUMMARY OF FINDINGS OF AGRICULTURAL ACTIVITIES IN BISHYA WETLAND AND SURROUNDING AREAS

Cooperative	Farm size (Ha)	Crops	Direction towards sampling points	Agricultural inputs	Quantity (kg)
NGIRANKUGIRE	76	Maize	P1	NPK 17*17*17	19000
				Organic manure	380000
				Chlorpyrifos-ethyl	76
SHINGISUKA	59	Maize	P2	NPK 17*17*17	14750
				Organic manure	295000
				Chlorpyrifos-ethyl	59
TURENGERABANA	52	Vegetables	P4	Organic manure	260000
				Urea	4160
				DAP	5200
				Fungicide	52
				Insecticide	52
TURWANYINZARA	51	Sweet potatoes, cassava	P5	Organic manure	357000
HEworks Rwanda Silk Ltd	57	Mulberry	P3	NPK20*10*10	24510

In previous subsection 3.3.1, we have demonstrated the coefficient of correlation between agricultural inputs and water quality from Bishya dam; however all parameters that showed positive relationship were not indicating pollution basing on RSB standards. Therefore, in this section, we highlight the relationship between agricultural inputs and water quality with emphasis on water quality parameters presenting pollution levels comparing to limits set up by Rwanda Standards Board.

The Linear Regression Model results showed that agricultural activities had positive relationship with nitrites (r=0.047), Phosphates (r=0.384), Iron (r=0.11), and Manganese (r=0.018) in sampling point P1. This situation highlights pollution of water in sampling point P1, which is attributed to extensive use of different fertilizers and pesticides in maize farm crop owned by NGIRANKUGIRE Cooperative where there is stream passing through to fall into the bishya dam.

Results indicated also that agricultural activities had positive relationship with nitrites (r =0.010), Iron (r=0.059), and COD (r=0.012) in sampling point P2. This situation highlights pollution of water in sampling point P2, which is attributed also to the use of different fertilizers and pesticides falling into the dam by small stream passing through maize farm crop owned by SHINGISUKA cooperative.

Moreover, results showed that agricultural activities had positive relationship with pH (r=0.048), nitrites (r=0.086), and phosphates (r=0.329) in sampling point P3. This situation highlights water pollution in sampling point P3 attributed to the use of different fertilizers and pesticides reaching into the dam from the stream passing through the mulberry plantations grown by HEworks Rwanda Silk Ltd.

Furthermore, results revealed that agricultural activities had positive correlation with nitrites (r =0.123), iron (r=0.182), and Manganese (r=0.051) in sampling point P4. This situation highlights water pollution in sampling point P4, which is attributed to the use of different fertilizers and pesticides from the farm of vegetables grown by TURENGERABANA cooperative. Considering also the presence of different types of rocks in surrounding lands, Bishya dam accommodates the most abundant sediments from agricultural activities containing iron and manganese that are highly soluble in water and contribute to dam pollution. It also highlights that absence of anti-erosion and ineffective drainage of Bishya wetland contribute to degradation of water quality though excessive level of iron and manganese concentration.

In addition, results from Linear Regression Model showed that agricultural activities had positive relationship with Turbidity (r=0.080), nitrites (r=0.095), Phosphates (r=0.188), iron (r=0.093), manganese (r=0.051), and chemical oxygen demand (r=0.017) in sampling point P5. The situation highlights water pollution in sampling point P5, which is attributed to the use of different fertilizers and pesticides from the farms of cassava and sweet potatoes grown by TURWANYINZARA farming cooperative in its surrounding. Basing on agricultural features of Bishya wetland surrounding areas characterized by absence of anti-erosion and buffer zone, ineffective wetland drainage, and absence of vegetation cover, Bishya dam accommodates the most abundant sediments transported by soil erosion.

Finally, results highlighted that agricultural activities had positive relationship with nitrites (r =0.046), Phosphates (r=0.277), Iron (r=0.106), and Manganese (r=0.190) in sampling point P6. The situation highlights water pollution in the Bishya dam intake (sampling point P6) for water supply systems in NYANZA District. This water pollution comes from the use of different fertilizers and pesticides from different streams falling into the dam from different directions of Maize, mulberry, vegetables, sweet potatoes and cassava farm crops, owned by farmer cooperatives namely NGIRANKUGIRE, SHINGISUKA, TURENGERABANA, TURWANYINZARA, and HEworks Rwanda Silk Ltd. Also the absence of anti-erosion, wetland bank, vegetation cover, and ineffective drainage of wetland, Bishya dam accommodates different dissolved minerals transported by erosion.

IV. CONCLUSION

Agricultural practices in Bishya wetland and surrounding cropland areas characterized by availability of different crops, ineffective drainage, absence of anti-erosion structures, weak management of wetland margins, absence of vegetation covers, use of organic manures, chemical fertilizers and pesticides, and presence of different types of rocks and soils have influenced water quality in Bishya wetland in all sampling points of Bishya dam as the agricultural inputs were positively correlated with water quality parameters. However, the positive relationship does not mean that all selected parameters have manifested pollution, but some of them did according to RSB guidelines. The parameters that presented pollution were nitrites (r=0.047), Phosphates (r=0.384), Iron (r=0.11), and Manganese (r=0.018) in sampling point P1; in sampling point 2, they were nitrites (r=0.010), Iron (r=0.059), and COD (r=0.012); in sampling point 3, they were pH (r=0.048), nitrites (r=0.086), and phosphates (r=0.329); in sampling point 4, they were nitrites (r=0.123), iron (r=0.182), and Manganese (r=0.051); in sampling point5, Turbidity (r=0.080), nitrites (r=0.095), Phosphates (r=0.188), iron (r=0.093), manganese (r=0.051), and chemical oxygen demand (r=0.017); and in sampling point6, parameters that presented pollution were nitrites (r =0.046), Phosphates (r=0.277), Iron (r=0.106), and Manganese (r=0.190). For sustainable wetland management the researcher suggested the following:

- ✓ To create effective anti-erosions in all areas surrounding Bishya wetland
- ✓ To sensitize people using croplands surrounding Bishya wetland to fully respect the minimum of wetland margins (buffer zone) according to the law on wetland protection applicable in Rwanda,
- ✓ To consider the importance of ecological values of wetlands while developing policies for economic development.
- ✓ To introduce mass education in order to make the population understand well the importance of wetland ecosystem functions.
- ✓ To set up water management bodies at cells level
- ✓ The agricultural policy should not only be focused on the increase in production but also the future use of the wetland.
- ✓ Increase awareness in environmental protection and sustainable management of water resources for farmers in bishya wetland.
- ✓ To capture rain water from their houses in order to avoid erosion.
- ✓ Respect the laws governing the use of wetland in Rwanda.

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Abundance Plankton and Analysis Stomach Content and Trophic Level in Makassar Strait at East Season

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Abstract— *The research aims to know the condition of environmental parameters both from biological factors and physical factors of the Makassar Strait during the East season. The usability of the research ie can be to build and simulate dynamic models of fisheries systems. Data Collection has been carried since May 2019 to November 2019. Data collection on environmental parameters (temperature, salinity, pH, dissolved oxygen, flow velocity) and nutrients (nitrates and phosphates), phytoplankton and zooplankton abundance, , and gastric contents analysis were carried out, Method for analysing was used analysis of variance (ANOVA) to compare environmental parameters, nutrients and abundance of plankton between the three districts observed. The relationship between the abundance of plankton with environmental parameters was analyzed by using multiple linear regression analysis. Determination of trophic level is based on analysis of gastric contents using the TrophLab 2K program. Results of analysis of variance (ANOVA) between observation stations grouped in 6 months of observation showed that salinity was significantly different between locations and months of observation, temperature and pH were significantly different between months but did not differ according to location of observation, whereas DO levels did not show differences either between locations. The results of identification of phytoplankton types obtained during this research were dominated by diatoms. The type of zooplankton obtained is generally dominated by copepods. The result of gastric surgery is 10 dominant and economically valuable fish's species belonging to planktivor, omnivor and carnivor fish, and based on ecosystems including pelagic and demersal fish.*

Keywords— Abundance Plankton, phitoplankton, zooplankton, gastric contents, Makassar Strait.

I. INTRODUCTION

1.1 Background

Geographically and ecologically, the Makassar Strait is a waters where is located between two seas (the sea of Sulawesi and Jawa) and flanked by two lands (Kalimantan and Sulawesi). Moreover, Makassar Strait have abundant natural resources such as mining minerals that has an impact on progress in the economic, mining and transportation sectors for Indonesia and local governments (Kunarso, 2011).

The Makassar Strait with its strategic location is one of a regional area which has quite high diversity of water resources (Susetiono, 2013), therefore it becomes the target of foreign fishermen to catch underwater biodiversity around the location. Accordingly, the potential of the natural wealth possessed by the Makassar Strait must continue to be pursued to be beneficial for life. An expedition or research is a way that can be done to realize these goals.

Information derived from environmental factors from physical factors as well as biological factors is something that is beneficial to the life of organisms in waters and fisheries activities. Deputy of Earth Sciences LIPI, Dr. Iskandar Zulkarnain revealed that the sea waters throughout the year are crossed by a mass of sea water from the Pacific Ocean to the Indian Ocean, part of the global ocean current circulation. This ocean current is an important element for determining the nutrient cycle and the food chain in the sea globally is also influenced by the mass of cold, nutrient-rich sea water, and raised to the surface together with the upwelling process (increasing of sea water mass). Keulartz and Zwart (2004) stated that environmental degradation in the waters of the Makassar Strait led to an erosion process that resulted in sedimentation along the Mahakam watershed and finally an accumulation of sediment in the estuary and coastal areas of the Mahakam delta coast, East Kalimantan. Based on the case of the phenomenon described above, the researchers tried to conduct a research related to the fertility of the Makassar Strait, both in terms of the aquatic environment and in terms of the organisms that live in the vicinity.

II. RESEARCH METHODS

This research has been conducted from May to October 2019. Data collection on environmental parameters was executed in the coastal waters of Pinrang, Barru and Bantaeng Districts; Measurements of environmental parameters (temperature, salinity, pH, DO and current velocity) were measured by insitu.

Measurement of nutrient concentration (nitrates and phosphates) is done by taking water samples and then analyzed in a laboratory using a spectrophotometer. At the same time, measurement of in-situ environmental parameters and nutrient sampling were collected by taking plankton abundance data using layered plankton net by filtering as much as 100 liters of water. Samples of plankton were preserved by using 4% lugol of solvent (APHA, 1989). The measurement of environmental parameters, nutrients and plankton was conducted at 3 stations in 3 districts (Pinrang, Barru and Bantaeng), therefore there are 9 stations of total observations with frequency of observations every month for 6 months (May until October).

Observation of gastric contents was accomplished by dissecting the contents of the stomach and recording food items on 10 types of dominant fish caught from 11 districts with a frequency every month (Pauly, 1998). Fish species are classified as planktivor, omnivore, carnivore and high level carnivore, and demersaL fish.

Method for analysing was used analysis of variance (ANOVA) to compare environmental parameters, nutrients and abundance of plankton between the three districts/locations observed (Zar, 1984). The relationship between the abundance of plankton with environmental parameters was analyzed by using multiple linear regression analysis (Kleinbaum, 2010) . Determination of trophic level is based on analysis of gastric contents using the TrophLab 2K program (Pauly, 1998).

III. RESULT AND DISCUSSION

3.1 Environmental Parameters

Measurement of environmental parameters that has been conducted at 9 observation stations in 3 districts or locations (Pinrang, Barru and Bantaeng) every month from May to October 2019 revealed that the range value (minimum-maximum) of each measured environmental parameter namely; the temperature of surface water ranges between 30.0 - 33.0 ^{o}C, salinity (30.0 - 34.0 o/oo), pH (7.0 - 8.5) and dissolved oxygen levels (4.1 - 6.9 ppm). When compared with the results of measurements in 2018, there is a difference of increasing of temperature and salinity values, especially in September and October.

Results of analysis of variance (ANOVA) between observation stations grouped in 6 months of observation showed that salinity was significantly different between locations and months of observation, temperature and pH were significantly different between months but did not differ according to location of observation, whereas DO levels did not show differences either between locations

The results of the mean difference in environmental parameters between locations and months of observation are summarized in Table 1.

TABLE 1
THE RESULT OF THE AVERAGE TEST DIFFERS IN ENVIRONMENTAL PARAMETERS IN EACH LOCATION FOR 6 MONTHS OF OBSERVATION

Environmental Parameter	Location		
	Pinrang	Barru	Bantaeng
Temperature (^{o}C)	31.58 ± 0.75^{a}	31.42 ± 0.75^{a}	31.19 ± 0.52^{a}
Salinity (o/oo)	32.78 ± 1.10^{a}	31.61 ± 0.87^{b}	31.56 ± 0.73^{b}
pH	8.11 ± 0.50^{a}	8.14 ± 0.48^{a}	7.97 ± 0.50^{a}
DO level (ppm)	5.62 ± 0.65^{a}	5.53 ± 0.57^{a}	5.41 ± 0.73^{a}

Note: Different letters in the same line indicate differences in environmental parameters between observations based on the Tukey HSD test (α = 0.05)

Based on the time of observation, the results of the Tukey HSD test (Table 2) show that there is a tendency to increase in temperature and salinity from May to October. The average of temperature and salinity in May differ significantly lower than the average temperature in September and October. The highest average temperature in October was significantly different than the average temperature of the five months preceding it. The pattern of changes in salinity shows trends similar to changes in temperature where the mean salinity is lower in May and June significantly different than the average salinity in September and October.

TABLE 2
AVERAGE AND DIFFERENCE TEST IN ENVIRONMENTAL PARAMETERS BETWEEN MONTHS FROM 3 OBSERVATION LOCATIONS.

Environmental Parameter	Month					
	May	June	July	August	September	October
Temperature (°C)	30.83 ± 0.43 [a]	30.89 ± 0.49 [ab]	31.39 ± 0.55 [ab]	31.39 ± 0.55 [ab]	31.56 ± 0.46 [b]	32.33 ± 0.50 [c]
Salinity (o/oo)	31.00 ± 0.56 [a]	31.39 ± 0.96 [ab]	31.89 ± 0.86 [abc]	32.22 ± 0.97 [bcd]	32.44 ± 1.01 [cd]	32.94 ± 0.81 [d]
pH	7.28 ± 0.36 [a]	8.22 ± 0.51 [b]	8.17 ± 0.35 [b]	8.28 ± 0.26 [b]	8.28 ± 0.26 [b]	8.22 ± 0.26 [b]
DO level (ppm)	5.30 ± 0.51 [a]	5.79 ± 0.68 [a]	5.20 ± 0.79 [a]	5.46 ± 0.68 [a]	5.79 ± 0.58 [a]	5.59 ± 0.50 [a]

Note: Different letters in the same rowmean it different environmental parameters between months of observation based on the Tukey HSD test (α = 0.05)

3.2 Plankton Abundance

The output of plankton counting at 3 locations and 6 months of observation. The results of identification of phytoplankton types obtained during this research were dominated by diatoms. Some types of diatoms that are abundant and have a high frequency of occurrence include *Bacteriastrum, Biddulphia, Chaetoceros, Coscinodiscus, Ditylum, Eucampia, Melosira, Navicula, Nitzschia, Rhizosolenia, Skeletonema, Thalassionema, Thalassiosira, and Thalassiothrix*. The total abundance of phytoplankton obtained ranged from 458 - 4443 cells/liter with a monthly average at 3 locations as shown in Figure 1.

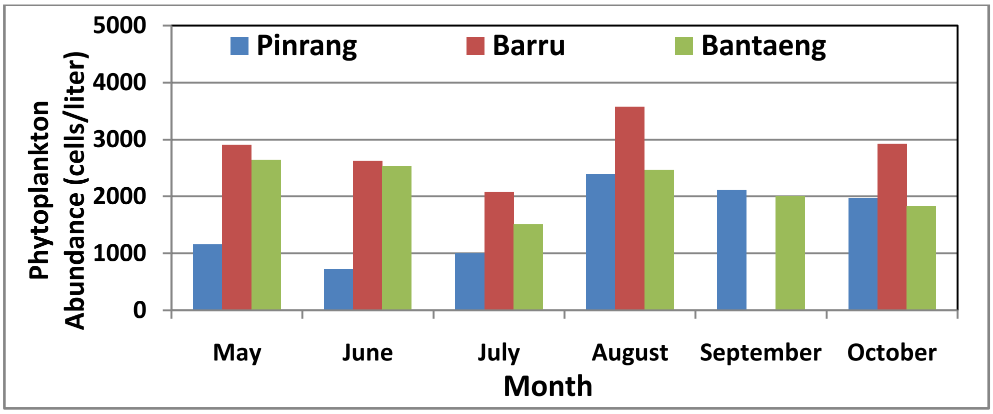

FIGURE 1. Average total abundance of phytoplankton at each location and month of observation

The type of zooplankton obtained is generally dominated by copepods. Some types of copepods that are often found in large quantities include Acartia, Oitona, Tartonus and nauplii and copepod's eggs. The total abundance of zooplankton gained ranged from 531 to 1157 individuals/liter with a monthly average at 3 locations as shown in Figure 2.

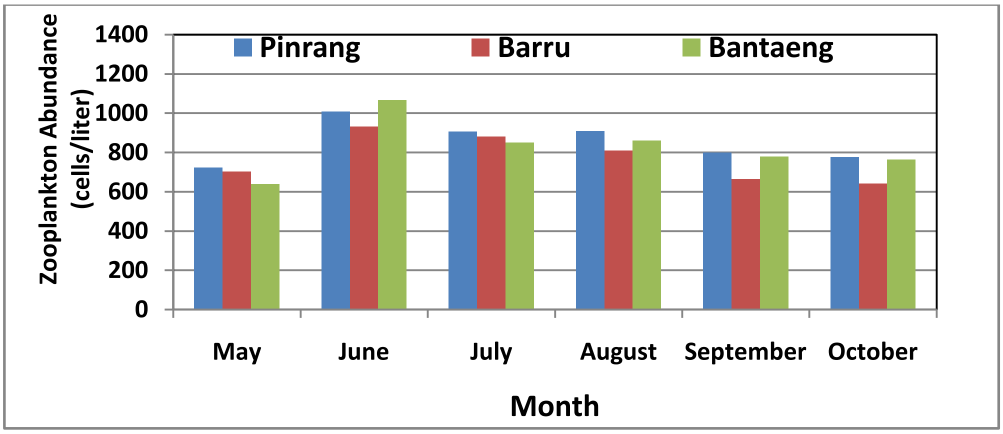

FIGURE 2. Average total abundance of zooplankton at each location and month of observation

The results of analysis of variance (ANOVA) for total abundance of phytoplankton and zooplankton revealed that phytoplankton abundance was significantly different based on location and month of observation according to F test in ANOVA table ($p<0.05$), while total abundance of zooplankton only differed by month of observation but did not differ according to location observation. Mean different test results using Tukey HSD total abundance of phytoplankton and total abundance of zooplankton based on location and month of observation are summarized in Tables 3 and 4.

The average abundance of phytoplankton in Pinrang (1557 ± 729) and Bantaeng (2161 ± 819) cells/liter differed significantly lower than in Barru (2864 ± 930) cells/liter. The average abundance of zooplankton did not indicate differences between the three observation sites.

TABLE 3
AVERAGE AND DIFFERENCE TEST OF PLANKTON AND CHLOROPHYLL-A ABUNDANCE BETWEEN LOCATIONS FOR 6 MONTHS OF OBSERVATION

The Abundance of Plankton	Location		
	Pinrang	Barru	Bantaeng
Abundance of Phytoplankton	1557 ± 729 *a*	2864 ± 930 *b*	2161 ± 819 *a*
Abundance of Zooplankton	852 ± 150 *a*	771 ± 167 *a*	825 ± 144 *a*

Based on the month of observation, it is seen that the average abundance of phytoplankton in August (2810 cells/liter) was significantly different compared to July (1528 cells/liter). The average abundance of zooplankton in June (1001 individuals/liter) was significantly different than the average abundance of zooplankton in May (687 individuals/liter). The difference in average abundance of plankton is caused by changes in nutrient and zooplankton predation to phytoplankton.

TABLE 4
AVERAGE AND DIFFERENCE TEST OF PLANKTON ABUNDANCE AND CHLOROPHYLL-A BETWEEN MONTHS FROM 3 OBSERVATION STATIONS

The Abundance of Plankton	Month					
	May	June	July	August	September	October
Abundance of Phytoplankton	2233 ± 1006 *ab*	1958 ± 1334 *ab*	1528 ± 773 *a*	2810 ± 957 *b*	2399 ± 699 *ab*	2237 ± 698 *ab*
Abundance of Zooplankton	687 ± 91 *a*	1001 ± 149 *c*	878 ± 105 *bc*	859 ± 125 *bc*	746 ± 105 *ab*	727 ± 111 *ab*

Note: Different letters in the same line indicate differences in plankton abundance between months of observation based on the Tukey HSD test (α = 0.05)

3.3 Stomach Content and Trophic Level

The result of gastric surgery is 10 dominant and economically valuable species belonging to planktivor, omnivor and carnivor fish, and based on ecosystems including pelagic and demersal fish. The result of identification for gastric contents is shown in Table 5.

TABLE 5
FOOD ITEMS OF SEVERAL TYPES OF FISH THAT ARE PREDOMINANTLY OBTAINED AND OF IMPORTANT ECONOMIC VALUE

No	Fiashes Species	Food Items
1	*Stolephorus commersoni*	Phytoplankton, zooplankton
2	*Sardinella fimbriata*	Phytoplankton, zooplankton
3	*Leiognathus* sp	Phytoplankton, zooplankton
4	*Decapterus ruselii*	Phytoplankton, zooplankton, zooplankton, crustaceans, small shrimp, fish larvae
5	*Rastrelliger kanaguarta*	Phytoplankton, zooplankton, crustaceans, small shrimp, fish larvae
6	*Selaroides crumenopthalmus*	Zooplankton, crustaceans, small shrimp, fish larvae, cephalopods and nekton, and worms
7	*Katsuwonus pelamis*	Zooplankton, nekton, molluscs, cephalopods, fish, shrimp and squid
8	*Epinephelus coioides*	Zoobenthos, nekton, shrimp and benthic crustaceans, molluscs, squid, small fish and crabs
9	Lutjanus campechanus	Zoobenthos, nekton, shrimp and benthic crustaceans, molluscs, squid, small fish and crabs
10	*Caranx ignobilis*	Zoobenthos, nekton, shrimp and benthic crustaceans, molluscs, squid and small fish

TABLE 6
RANGE AND AVERAGE TROPHIC LEVEL OF 10 FISHES SPECIES THAT ARE PREDOMINANTLY OBTAINED AND HAVE IMPORTANT ECONOMIC VALUE

No	Fishes Species	Trophic Level		
		Minimum	Maximum	Mean
1	*Stolephorus commersoni*	2.29 ± 0.00	3.35 ± 0.46	3.07 ± 0.52
2	*Sardinella fimbriata*	2.53 ± 0.00	3.62 ± 0.50	3.29 ± 0.67
3	*Leiognathus sp*	2.64 ± 0.00	3.68 ± 0.53	3.42 ± 0.42
4	*Decapterus ruselii*	2.86 ± 0.30	4.08 ± 0.67	3.95 ± 0.64
5	*Rastrelliger kanaguarta*	2.96 ± 0.34	4.04 ± 0.70	3.87 ± 0.60
6	*Selaroides crumenopthalmus*	3.40 ± 0.54	4.40 ± 0.87	4.17 ± 0.96
7	*Katsuwonus pelamis*	3.80 ± 0.67	4.61 ± 0.94	4.25 ± 0.89
8	*Epinephelus coioides*	3.93 ± 0.67	4.50 ± 1.10	4.35 ± 0.94
9	*Lutjanus campechanus*	4.03 ± 0.77	4.50 ± 0.97	4.45 ± 0.90
10	*Caranx ignobilis*	4.00 ± 0.64	4.40 ± 0.97	4.25 ± 0.88

The abundance of plankton in waters tends to affect changes in food items for planktivorous fishes. This is related to the nature of planktivorous fishes that eats plankton by filtering it, consequently the candlenut in the intestines of planktivorous fishes with the type of plankton in waters very high correlated. In contrast, omnivorepou fishes more adjust the availability of food items. If the availability of the main food is limited, then it tends to choose other more abundant food items.

Carnivorous fishes have transformations of trophic level according to change and food availability besides competition factors as stated by Binder T.R. et. al, (2011), that one of the causes of migration from fish is due to food.. Based on food items, pelagic carnivorous fishes tend to have gastric contents according to their availability and abundance on the water surface. Carnivorous fishes that live in the bottom show that the contents of the stomach contain many types of fishes and shrimps that live in the benthic system. This evidences that carnivorous fishes use habitat both in the pelagic and demesal areas to find their food.

IV. CONCLUSION

Some conclusions that can be drawn from the results of this research include:

- There are dynamics of environmental parameters that affect plankton productivity and fish growth in the sea.
- Different catch rates for fish at different trophic levels affect population dynamics and the sustainability of fishes resources in the Makassar Strait.
- Planktivorous fishes play an important role in the fishes food chain in the pelagic system. If the population of planktivorous fishes is caught too much, the population of omnivorous and up carnivorous will decrease.

SUGGESTION

To get parameters of environmental dynamics trends, plankton abundance, determination of trophic level structures in the Makassar Strait it is necessary to do the same research for the West Season.

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Effects of Water Deficiency on the Physiology and Yield of Three Maize Genotypes

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Abstract— *Three maize genotypes research experiment was carried out in the experimental farm of University of Debrecen, Hungary. The genotypes were subjected to two different treatments, (irrigated and non-irrigated) where the irrigated was the control experiment. Physiological parameters (SPAD, LAI, HEIGHT) and grain yield (kg ha^{-1}) were measured and statistically computed. From our results, SPAD, LAI and HEIGHT values were significantly affected by water stress in the three studied genotypes. Grain yield was reduced in two of the studied genotypes (S.Y Zephir and S.Y Chorintos). But no significant difference was notice in the KWS 4484 cultivar. LAI was not affected in the second measurement in the S.Y Chorintos genotype and, plant height did not record any difference in the first measurement in the KWS 4484 cultivar. Our results suggest second experiment to specifically look at the critical stage in the genotypes growth where water stress has the severe effect on the studied genotypes.*

Keywords— Maize genotype, water deficiency, Physiology and Yield.

I. INTRODUCTION

Maize (Zea mays L) is an important cereal crop consumed by both human beings and animals all over the world. It is also an important industrial crop which serves as a raw material to produce corn sugar, corn starch, corn syrup and industrial corn oil. (Onwueme IC and Sinha TD, 1991; Ekpeyong TE, 1985; Anochili BC, 1984). Maize crop has more genetic diversity than other cereals and is one of the most cultivated cereal crops worldwide. It is ranked as the third world cereal produced following wheat and rice as reported Food and Agriculture Organization (FOA, 2002).

Water deficit has been recognised as one most single yield reducing factor for crops. Water deficit may occur frequently even in regions characterized by high annual rainfall. Water deficit affect growth and decrease the conversion of radiation into biomass in the maize. (Bohnert and Bressan, 2001; Otegui et al., 1995). Maize is very sensitive to drought two weeks before and two to three weeks after silking (Otegui et al., 1995; Hall et al., 1992). Drought stress is an important environmental factor in the reduction of plants growth and development. Hayat and Ali (2004), stated that, moisture stress is a limiting factor for crop growth in arid and semi-arid regions due to low and uncertainty precipitation. Water deficiency is a critical problem limiting maize growth through its impact on the physiological, morphological and biochemical processes. Water stress in maize crop production affects cell enlargement and thus reduces stem length by inhibiting inter-nodal elongation and also checks the tillering capacity of the maize plant (Ashraf M and Oleary JW, 1996; Chaves MM and Oliveira MM, 2004). According to (Dutt, 2005), Maize cultivars differ in their growth characteristics, yield and yield components and there recommend that growers and breeders must select the most promising combiners in their breeding programmes.

II. MATERIALS AND METHODS

Three maize (Zea mays L) genotypes (KWS4484, S.Y Chorintos and S.Y Zephir) were planted in the experimental station site of University of Debrecen (Latokep) which lies along the number 33 main road, about 15 kilometres from the main township of Debrecen (N. Latitude 47°33’, E. Longitude 21°27’) in the 2018 cropping year. The sowing and harvesting dates for this experiment were 14th April 2018 and 13th September, 2018 respectively. The soil of the experiment site is that of lowland chernozem with deposits of lime formed on loess. It has a medium nitrogen and phosphorus supply with a high content of humus (70-90 cm layer thickness). The average annual precipitation is 565.3mm and the precipitation for the cropping season was 120.7mm as shown in (Figure 1) below.

To study and evaluate the effects of water deficiency on the maize genotypes, two treatments of water was applied with three replications in a complete non-randomise block with each plot having 5 roles. The two treatments were irrigated and non-irrigated where the irrigated treatment was the control experiment, whiles the non-irrigated depended on the natural rainfall. In the control treatment, irrigation was applied three times within the cropping season and the dates and quantity of water supplied is as follows;

June 5th, 2018: 50mm
June 24th, 2018:50mm
July 20th, 2018:25mm.

The chlorophyll content was measured using SPAD-502 plus (Konica Minolta, Japan) at three different stages in the maize growing period (V12, VT and R1). Leaf Area Index (LAI) values were measured using SS1-Sunscan Canopy Analysis System (Delta-T Devices, UK). Plant height was manually measured using a long ruler just before harvest. All measurements were randomly done on 10 plants from each plot from the experimental field.

Statistical analysis of data was done using SPSS version 22 software and an independent sample T-Test was used to compare the means.

The aim for this current experiment was to study the effects of water stress on the chlorophyll parameters, plant height and yield on different maize genotypes under irrigation and non-irrigation conditions.

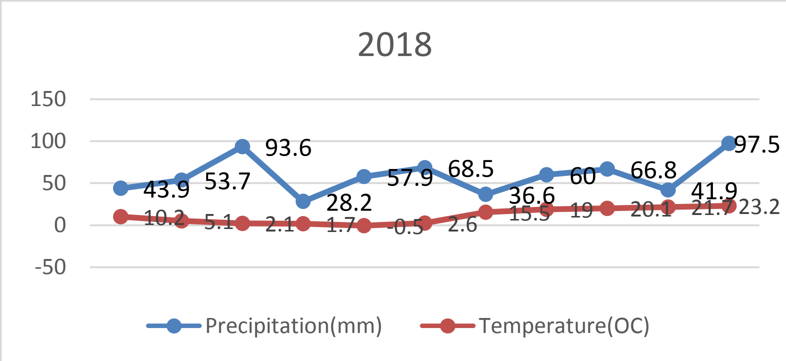

FIGURE 1: Precipitation (mm) and Temperature (^{O}C) data from the experimental site (Debrecen - Latokep)

III. RESULTS AND DISCUSSION

Results from the analysis date from this experiment showed that, chlorophyll (SPAD) content was lower in the non-irrigated treatments in all the three genotypes under study compared to the control experiment (irrigated). The mean difference was significantly noticed at the third measurement (Silking stage (R1)) for the genotype KWS 4484 and S.Y Zephir and at the second measurement (Tassel stage (TV)) for the S.Y Chorintos genotype as recorded in table 1 below. Water deficiency in maize crop production is one of the main factors limiting photosynthetic activities of the plant (Malakouti et al., 2005). Findings of Zobayed et al. (2005) has it that, chlorophyll concentration is an index for evaluation and there, a decrease of its concentration could be considered as non-stomata limiting factor under drought stress conditions. Kuroda et al., 1990 also reported a decrease in chlorophyll content mean value under drought stress condition. The reduction in chlorophyll in the drought stressed treatments could be as a result the proline in the plant tissues which has missed water, since water is needed for by plants for their physiologically and biochemical activities. Plants need a maximum amount of water to maintain their chlorophyll activities (Bohrani and Habili, 1992).

Leaf Area Index (LAI) was lower for the drought stressed maize plants in two genotypes (KWS 4484 and S.Y Zephir) in the first and third measurements respectively compared to the control experiment which had supplementary water applied through irrigation. The genotype S.Y Chorintos was however not affected in all the three measurement dates as shown in the (table1) below. Water stress significantly reduced leaf area index in this research due to reduction in cell division and this may reduce plant turgor pressure and cell expansion, thus resulting in dry mass being contain within a smaller leaf area and increasing the density of leaves (Hsiao, 1973; Rascio et al., 1990).

Means comparison as seen in (table1) below shows an increase in the drought stress resulted in a significant decrease in the leaf area index and this findings coincided with other research finding such as that of (Nouri and Ehsanzadeh, 2007; Saberali et al.,2007; Pandey et al.,2000) all reported significant reduction in maize under drought stress condition. Ritchie, 1987 also reported that, there was difference between irrigated and drought stress at the end of the growing season whereby plants under stress conditions lost the leaf area. The genotype LAI means comparison showed that the KWS 4484 had the highest rate of LAI (3.89) and the S.Y Zephir genotype had the lowest LAI rate (2.51) under the irrigated regime whereas under the drought stress treatment, S.Y Zephir genotype had the highest LAI value rate of (3.40) and KWS 4484 had the lowest mean value rate of (1.86).

TABLE 1
WATER DEFICIENCY EFFECT ON THE PHYSIOLOGICAL PARAMETERS AND YIELD ON THREE MAIZE GENOTYPES

KWS 4484		MEAN	Independent Sample Test t	Independent Sample Test Sig.(2-tailed)	S.Y ZEPHIR		MEAN	Independent Sample Test t	Independent Sample Test Sig.(2-tailed)	S.Y CHORINTOS		MEAN	Independent Sample Test t	Independent Sample Test Sig.(2-tailed)
SPAD 1	IRRIGATED	56.90	.242	.821	**SPAD 1**	IRRIGATED	61.20	-1.851	.138	**SPAD 1**	IRRIGATED	64.80	-.341	.750
	NON-IRRIGATED	57.57				NON-IRRIGATED	59.00				NON-IRRIGATED	64.37		
SPAD 2	IRRIGATED	63.00	1.839	.140	**SPAD 2**	IRRIGATED	65.20	-1.724	.160	**SPAD 2**	IRRIGATED	72.33	-6.682	**.003**
	NON-IRRIGATED	66.77				NON-IRRIGATED	63.40				NON-IRRIGATED	55.67		
SPAD 3	IRRIGATED	76.80	-3.337	**.029**	**SPAD 3**	IRRIGATED	70.93	-6.813	**.002**	**SPAD 3**	IRRIGATED	65.03	-1.279	.270
	NON-IRRIGATED	62.63				NON-IRRIGATED	58.37				NON-IRRIGATED	60.33		
LAI 1	IRRIGATED	2.46	-2.997	**.040**	**LAI 1**	IRRIGATED	2.51	-1.176	.305	**LAI 1**	IRRIGATED	2.71	-1.938	.125
	NON-IRRIGATED	1.87				NON-IRRIGATED	2.21				NON-IRRIGATED	2.07		
LAI 2	IRRIGATED	3.18	-.683	.532	**LAI 2**	IRRIGATED	2.99	1.046	.355	**LAI 2**	IRRIGATED	3.05	-1.880	.133
	NON-IRRIGATED	2.67				NON-IRRIGATED	3.40				NON-IRRIGATED	2.29		
LAI 3	IRRIGATED	3.89	-2.009	.115	**LAI 3**	IRRIGATED	3.86	-3.210	**.033**	**LAI 3**	IRRIGATED	2.92	-.430	.689
	NON-IRRIGATED	2.72				NON-IRRIGATED	2.81				NON-IRRIGATED	2.86		
HEIGHT	IRRIGATED	291.33	-.791	.474	**HEIGHT**	IRRIGATED	352.67	-.3.902	**.018**	**HEIGHT**	IRRIGATED	295.00	-6.547	**.003**
	NON-IRRIGATED	287.33				NON-IRRIGATED	276.00				NON-IRRIGATED	285.00		
YIELD	IRRIGATED	16106.3	1.023	.364	**YIELD**	IRRIGATED	16995.7	2.921	**.043**	**YIELD**	IRRIGATED	26401.0	3.681	**.021**
	NON-IRRIGATED	13232.7				NON-IRRIGATED	10552.0				NON-IRRIGATED	13928.7		

BOLD: is significant at P<0.05

In this experiment, plant height of two maize genotypes (S.Y Zephir and S.Y Chorintos) were significantly affected by water stress as they showed greater mean value compared to the well irrigated genotypes whereas the KWA 4484 genotype was not significantly affected even though the irrigate treatment had a higher mean value (291.33) against the water stress treatment crop (287.33). The difference in plant height in this study is in consistent with the results of Sarvar and Ali, 1999 who studied the impact of drought stress on two maize genotypes and reported plant height reduction in both genotypes. El Neomani et al., 1990 also recorded a drastic decrease in maize plant height under water stress situation and reported that, at the beginning of rapid growth, stress drastically reduces maize height although dry matter production depends on levels of photo-assimilate product. This reduces the amount of photo-assimilate during grain filling in the maize ear. This current study also relates to that of Sionit and Kramer (1977) who recorded no significant difference in in plant height under water stress (Genotype KWS 4484) as observed in (table1). Other researchers whose results are in consistent with this current study included (Pandey et al., 2000; Yazar et al., 2002 and Denmead and Show, 1960).

Maize plant yield was higher for the control experiment (irrigated) compared to the water deficient regime in all the three genotypes studied. Significant difference was recorded for the genotypes S.Y Zephir and S.Y Chrorintos. There was no significant difference in 4484 genotypes although the irrigated treatment had a high value; this value was statistically not significant (Table 1). This study agreed with previous studies which reported maize grain yield reduction under drought stress situation. Chimenti et al. (2002) and Erdem et al. (2006) have both reported grain yield and weight of 1000 grain decreased in with an increase in drought stress. Karam et al. (2007) indicated that, with increasing in drought stress, leaf area index, grain yield and its components were significantly reduced. Environmental stresses in the form of heat intensity and nutrient unavailability to plants because of water deficiency could be a major driver causing plants yield reduction in this study.

IV. CONCLUSION

The effects of water deficiency on the physiological parameter and grain yield on maize cannot be over emphasized as the results in this study showed different reaction by the different maize genotypes used for this experiment. This study confirms that irrigation significantly affect chlorophyll measurement in all the three genotypes. Leaf area index was affected by water stress in KWS 4484 and S.Y Zephir genotypes but S.Y Chrorintos was not affected. Water deficit also significantly affected maize height except KWS 4484 genotype. The effects of this physiological parameters translated to the maize grain yield which resulted in the reduction in yield in all the studied genotypes under the drought stress treatments and was significantly noticed in the S.Y Zephir and S.Y Chrorintos genotypes in this study. This experiment could be repeated to further investigate the critically sensitive stages of this genotype’s growth to water stress for one year of study is not enough to conclude of definite results, although it gives an initial understanding of drought effect on maize genotypes.

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