THE IMPACT OF RICE CULTIVATION ON THE WETLAND ECOSYSTEM.

A CASE STUDY OF NALIOBA WETLAND, BANDA SUB-COUNTY,

NAMAYINGO DISTRICT.

BY

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BEM/34070/112/DU

A DISSERTATION SUBMITTED TO THE SCHOOL OF ENGINEERING & APPLIED SCIENCES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A BACHELORS DEGREE IN ENVIRONMENTAL SCIENCE OF KAMPALA INTERNATIONAL UNIVERSITY.

SEPTEMBER, 2014.
DECLARATION

I, Otieno Moses, do affirm that this dissertation was produced as a result of my own efforts and to the best of my knowledge it has never been presented for the award of a Bachelors degree or any other qualification in this institution or any other institution of higher learning.

Student’s name: Otieno Moses

Signature: .....................................................

Date: 16/09/2014
APPROVAL

This is to acknowledge that this work entitled "The impact of rice cultivation on the wetland ecosystem. A case study of Nalioba wetland, Banda sub-county, Namalyango district" has been done under my supervision and has been approved for submission to the School of Engineering & Applied Sciences of Kampala International University.

Name of supervisor: Emmanuel Innocent

Signature: 

Date: 16th 09-2014
DEDICATION

This research is dedicated to my beloved parents Mr. Maaga Michael Mugunda and Mrs. Ajiambo Josephine, my brothers Oraga Joseph, Onyango Sylus, sisters Aoko Millicent, Anyango Clemetina and also my Uncle Wanzama Michael.
ACKNOWLEDGEMENT

A multitude of thanks and appreciation goes to the Almighty God for the precious life and wisdom. I wish to extend my sincere gratitude and thanks to my parents for their tremendous support, guidance and encouragement that enabled me to accomplish this course.

Distinguished tanks to my supervisor Mr. Eniru Emmanuel Innocent who sacrificed his time guiding me during the whole research process and in a special way I wish to thank my lecturers in the department of Biological and Environmental Sciences.

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More appreciation to the District Environmental Officer Mr. Busogwa Alex for the commendable support given during data collection.
ABSTRACT

Rice, which is a new crop in Uganda, was introduced on a large scale in the 1960's as a wetland based crop. The continued use of upland fields for farming has also resulted in loss of soil fertility due to erosion and over use. The rapid population growth and high demand for rice in Uganda, much pressure has been put on wetlands to increase production which has led to their degradation. The objectives of the study were to; establish the factors influencing rice cultivation in Nalioba wetland, determine the effects of rice cultivation activities to the wetland and identify the measures put in place to manage the wetland during rice cultivation. Both qualitative and quantitative designs were used therefore the study was descriptive in nature. A total of 70 respondents were chosen as the sample size. Simple random sampling method was used to get the 60 respondents and purposive sampling was also used to get the 10 key informants. The study concluded that the greatest factors encouraging rice cultivation in Nalioba wetland are good water supply and the availability of fertile soils while the most common rice cultivation practice carried out in Nalioba wetland is leveling or puddling. The majority of respondents get higher yields of rice between 16-25 bags each bag of 60kgs and they sell each kilogram of their rice at Ugx 2,500/=. The most common adverse effect of rice cultivation in Nalioba wetland is low or decreasing crop yields and sensitization is the greatest approach used to manage Nalioba wetland. The study recommended that farmers should obtain new planting varieties each season, introduction of high yielding varieties of other crops, sustainable use of wetlands is through a better understanding of their traditional uses, restrictions and by-laws must be placed, emphasize more grass root sensitization, increase proper funding from NEMA in conjunction with MOFPED to aid more research on how to rehabilitate degraded wetlands should be carried out.
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>DNRO</td>
<td>District Natural Resources Officer</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agricultural Organization of the United Nations</td>
</tr>
<tr>
<td>FAOSTAT</td>
<td>Food and Agricultural Organization of the United Nations Statistics</td>
</tr>
<tr>
<td>Kgs</td>
<td>Kilogram (s)</td>
</tr>
<tr>
<td>MAAIF</td>
<td>Ministry of Agriculture Animal Industries and Fisheries</td>
</tr>
<tr>
<td>MOFPED</td>
<td>Ministry of Finance Planning and Economic Development</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Environment Management Authority</td>
</tr>
<tr>
<td>U.S/USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>UBOS</td>
<td>Uganda Bureau of Statistics</td>
</tr>
<tr>
<td>Ugx</td>
<td>Ugandan shillings</td>
</tr>
<tr>
<td>USDA</td>
<td>United States Department of Agriculture</td>
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<tr>
<td>WID</td>
<td>Wetlands Inspection Division</td>
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<tr>
<td>WRI</td>
<td>World Resources Institute</td>
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CHAPTER ONE

1.1 Introduction and background of the study

Wetlands cover approximately 26,600 km² of Uganda’s total area of 241,500 km², including water bodies. With coverage of 11% of the total land area, wetland resources represent one of the country’s vital ecological and economic natural resources. Unfortunately, their importance is almost exclusively associated with their direct consumptive use values such as crop cultivation, human settlement and extraction of useful materials (Kaggwa et al., 2009). It is estimated that in Uganda, approximately 5 million people depend directly on wetlands for their water supply needs, valued at US$25.0 million per year and in eastern Uganda about 20% of wetlands have been converted to cultivation of largely paddy rice (Kaggwa et al., 2009).

There have been plenty of debates on the origins of the domesticated rice, however, genetic evidence published in the Proceedings of the National Academy of Sciences of the United States of America (PNAS) shows that all forms of Asian rice, both indica and japonica, spring from a single domestication that occurred 8,200-13,500 years ago in China of the wild rice Oryza rufipogon (Molina et al., 2011). A 2012 study published in Nature, through a map of rice genome variation, indicated that the domestication of rice occurred in the Pearl River valley region of China based on the genetic evidence. From East Asia, rice was spread to South and Southeast Asia (Huang et al., 2012). Before this research, the commonly accepted view, based on archaeological evidence, is that rice was first domesticated in the region of the Yangtze River valley in China (Vaughan, Lu and Tomooka, 2008).

Rice is the staple food of over half the world’s population. It is the predominant world’s dietary energy (20%) source for 17 countries in Asia and the Pacific, 9 countries in North and South America and 8 countries in Africa while wheat supplies 19% and maize 5% (FAO, 2004).

As of 2009 world food consumption of rice was 531.6 million metric tons of paddy equivalent (354,603 of milled equivalent), while the far largest consumers were China consuming 156.3 million metric tons of paddy equivalent (29.4% of the world consumption) and India consuming 123.5 million metric tons of paddy equivalent (23.3% of the world consumption). Between 1961 and 2002, per capita consumption of rice increased by 40% (FAO, 2012). Rice is the most important crop in Asia. In Cambodia, for example, 90% of the total agricultural area is used for
rice production (Puckridge, 2004). U.S. rice consumption has risen sharply over the past 25 years because of commercial applications such as beer production (USDA, 2008) with almost one in five adult Americans now report eating at least half a serving of white or brown rice per day (Iowa State University, 2005).

African rice has been cultivated for 3500 years. Between 1500 and 800 BC, *Oryza glaberrima* propagated from its original centre, the Niger River delta, and extended to Senegal. Its cultivation even declined in favour of the Asian species, which was introduced to East Africa early in the common era and spread westward (Maddox, 2006) and African rice helped Africa conquer its famine of 1203 (National Research Council, 1996).

The British colonial government started large-scale drainage of wetlands throughout Uganda in the 1930s. Conversion continued until Uganda gained independence in 1962 after which drainage continued at a reduced rate (Puhalla, 2009). Rice, which is a new crop in Uganda, was introduced on a large scale in the 1960's as a wetland based crop (Aryamanya, 2011), however, rice production in Uganda had been conducted mainly in a few irrigation schemes in Eastern regions where rice production had been introduced by the Chinese in the 1970s (Kijima, 2012). Beginning from the Kibimba Irrigation Scheme, in Eastern Uganda, rice has now spread as a major crop in that region to cover a number of wetlands. The clearing of wetlands for rice has resulted in the loss of biodiversity and a number of wetland functions (Aryamanya, 2011). In Uganda, rice production has increased rapidly in the past 10 years while the yield has been stagnant thus Uganda is one of the few countries in SSA (Sub Saharan Africa) in which domestic rice production has been increasing and where imports of rice have declined recently (Kijima, 2012).

In the 1980s, pressure on wetlands mounted in both rural and urban areas. The communities that access these wetlands use them for agriculture, extraction of various raw materials and fishing. Consequently, a significant amount of encroachment on wetlands has occurred. By 2000, 64% of the total seasonal wetlands in Iganga and 68% in Pallisa had been converted for rice cultivation. In Kabale district, the originally permanent wetlands such as Nyamuliro located in Muko Sub-county had been completely reclaimed for Irish potatoes growing (Aryamanya, 2011).
1.2 Problem statement

Paddy rice cultivation in Uganda has been carried out in wetlands for a long time. However due to rapid population growth and high demand for rice in Uganda, much pressure has been put on wetlands to increase production which has led to their degradation. The continued use of upland fields for farming has also resulted in loss of soil fertility due to erosion and over use. The high urban market demand for food irish potatoes and rice, has pushed many farmers to increase production in their wetland fields (Puhalla, 2009). In relation to Nalioba wetland, large parts have been put to rice cultivation where traditional open channel irrigation is used to supply water to rice fields. This has led to reduction in the water quality and quantity in Nalioba wetland, loss of vegetation and other animal species, loss of soil fertility, sedimentation and drying up of the wetland periphery. Only a few wetland management measures are being implemented such as arresting those who use illegal fishing gears in the wetland like small-sized nets, and by-laws which are mostly ignored by the farmers. This study therefore attempted to assess the impacts of rice cultivation on the wetland ecosystem and therefore coming up with flexible measures of implementation of the management strategies since less is known by most scholars, environment management agencies and politicians about of the status of this wetland amidst persistent rice cultivation.

1.3 Objectives

1.3.1 General objective

To assess the impact of rice cultivation on the wetland ecosystem in Nalioba wetland, Banda sub-county, Namayingo district.

1.3.2 Specific objectives

The specific objectives of the study were;

i) To establish the factors influencing rice cultivation in the wetlands.

ii) To determine the effects of rice cultivation activities to the wetland

iii) To identify the measures put in place to conserve the wetland during rice cultivation.
1.4 Research questions

i) What are the factors influencing rice cultivation in Nalioba wetland?

ii) How does rice cultivation affect Nalioba wetland?

iii) Which measures have been put in place to manage Nalioba wetland during rice cultivation?

1.5 Scope of the study

The study focused on establishing the factors influencing rice cultivation in Nalioba wetland, determining the effects of rice cultivation activities to the wetland and identifying the measures put in place to manage the wetland during rice cultivation. The study was carried out in Nalioba wetland Banda Sub County, Namayingo District and it was for a period of three months March-July, 2014.

1.6 Significance of the study

To academicians, the study will provide information that is useful to students in future especially those who will carry out research on rice cultivation in the various wetlands.

The study will also avail information to the District Environmental Officer (DEO) and environmental organizations in the District on the impact of rice cultivation on the wetlands of the district and also make them to conduct multiple studies on how to reduce the various causes of wetland encroachment by the local people especially poverty.

This study will provide a guideline on the formulation of by-laws regarding better management of the wetland especially where other means of management might seem fruitless but also encourage the local authorities to seek better ways of implementing the less successful methods of wetland conservation in the area.

1.7 Definition of key terms

Wetlands are shallow seasonally or permanently water logged or flooded areas, which normally support both hydrophytic (water tolerant) vegetation and animals.

Impact refers to the power that something has on a situation.
CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction
This chapter focuses on reviewing existing related literature on the factors influencing rice cultivation in the wetlands, determining how rice cultivation affects wetland management, and identifying the measures put in place to manage the wetland during rice cultivation.

2.1 Factors influencing rice cultivation in the wetlands
Wetlands management in Uganda has greatly changed depending on the regime in power. Before national independence, the Gibb Study (1954) advised draining the wetlands for agricultural purposes. This influential study persuaded the Obote and Amin administrations to encourage Ugandans to convert wetlands by issuing leases to tycoons who claimed the land for large-scale cattle grazing and agriculture. These leases disenfranchised the poor peasants who were denied access to the wetlands (Sophie, 2007).

Most of the paddy rice in Uganda is produced in the eastern districts of the country especially Bugiri, Butaleja and Pallisa (Oonyu, 2011) and several factors have been responsible for the rising trends in rice production. Firstly, in the 1970s, the Government encouraged paddy production through the establishment of commercial farms in the country and these farms served as important demonstration gardens, which were not only responsible for providing technical advice, but also generated interest among farmers in the surrounding areas. Secondly, shortage of land in the densely populated districts of Eastern Uganda forced people to cultivate rice and other crops in wetlands. Thirdly, rapid urbanization and the current decline in the production of food crops such as millet, cassava and bananas, have caused an increase in the demand for rice. Lastly, rice is now an important source of income for rural households (Oonyu, 2011).

In the recent past, rice acreage has greatly expanded because of the increased demand in urban areas, the changing food habits and, the decline in the production of traditional food crops, particularly bananas, cassava and finger millet (MAAIF, 2008; MOFPED, 2009).
In many countries in Sub-Saharan Africa (SSA), the consumption of rice has been increasing far more rapidly than domestic rice production due to rapid population growth and urbanization in the region. When the price of rice surged in 2007 and 2008, food insecurity among the poor became more serious therefore since rice is a major cereal crop that can improve food productivity in SSA (Sub Saharan Africa), policies to enhance rice production are urgently needed not only for food security but also for income generation (Kijima, 2012).

The continued use of upland fields for farming has resulted in loss of soil fertility due to erosion and over use. An increase in the urban market demand for food produced in the wetlands, particularly Irish potatoes and rice, has pushed many farmers to increase production in their wetland fields (Puhalla, 2009).

The needs of agriculture for flat, fertile land with a ready supply of water mean that wetlands are often a potentially valuable agricultural resource. In arid and semiarid regions with seasonal rainfall patterns the capacity of wetlands to retain moisture for long periods, sometimes throughout the year and even during droughts, means that they are of particular importance for small-scale agriculture, both cultivation and grazing (McCartney et al., 2010).

Approximately 1 million people live within the Niger delta in Mali with livelihoods largely supported by fishing, livestock breeding and cultivation. Within the delta, rice, millet, maize, and wheat are cultivated in the rich floodplain soils. Farming varies from basic subsistence to larger, irrigated projects. Yields for non-irrigated crops grown on the floodplain are highly dependent on flood levels. For the years 1987 to 2003 rice production varied from 10,600 to 115,700 tonnes per year (ty⁻¹) however, the non-irrigated rice grown on the floodplains of the Inner Niger Delta fluctuates between 40,000 and 200,000 ty⁻¹ with yields in the order of 380-1,500 kg ha⁻¹ (Zwarts et al., 2005). In recent years, upstream dams and irrigation schemes have affected both the magnitude and timing of the annual flood and it has been estimated that average annual rice production has been reduced by a total of 15% (13,200 tonnes) as a consequence of these changes (McCartney et al., 2010).
McCartney et al., (2010) stated that several large-scale irrigation schemes were established within Lake Chilwa wetland in Malawi in the 1970s growing high-yielding varieties of rice and as a result, production from these constitutes 50% of all the rice grown in Malawi.

Paddy cultivators have also taken advantage of this flood regime with deepwater rice and recession rice being cultivated in the floodplains around the Tonle Sap Great Lake area in Cambodia. Therefore, fishing and farming are both closely associated with this wetland system. During the wet season many households engage primarily in cultivating rain-fed rice, while some subsistence fishing is carried out in the paddy fields. During the dry season the villagers cultivate recession rice in the floodplain area of the Tonle Sap and graze their livestock (McCartney et al., 2010; Matsui et al., 2006; Senaratna, Smith and Nguyen-Khoa, 2008a).

2.2 Effects of rice cultivation activities to the wetland
Although wetland agriculture can bring significant benefits in terms of food security, health and income, ill-considered development often results in wetland degradation, deleterious environmental impacts and harmful consequences to peoples’ livelihoods. Impacts on wetlands can be derived from human activities that occur within wetlands and, because of the interconnectedness of the hydrological cycle, also from activities that take place within the wider catchment. Through removal of water or by alteration of natural flow, chemical, and sediment regimes, human exploitation of both surface water and groundwater resources can have major detrimental consequences for wetland ecosystems (McCartney et al., 2010).

Some obvious impacts of wetland destruction include increased frequency of flooding, destruction of habitats, associated biodiversity and ecological processes. Adverse local climate modification is characterized by prolonged drought. This has largely contributed to a 2 metre drop in the water level of the Nile River and Lake Victoria (Kaggwa et al., 2009).

Damming of rivers, withdrawal of river water and groundwater abstraction have all resulted in the desiccation of many wetlands. Pollution from the use of fertilizers and pesticides has adversely impacted natural biota (including fish) and undermined the ecological character of many wetlands. It is estimated that more than 50% of some wetland types in North America, Europe, Australia and New Zealand have been lost, largely as a consequence of human activities.
directly related to agriculture. In contrast, it has been estimated that by 1985, 27% of wetlands in Asia (that is, about 80 Mha-Mega hectares) and 2% of wetlands in Africa (about 3 Mha) had been drained for intensive agriculture (McCartney et al., 2010).

The impact of rice cultivation on wetlands depends on wetland type, the intensity of drainage and agronomic practices including the use of fertilizers. Excessive use of fertilizers will cause eutrophication and adversely affect the ability of the wetland to maintain and improve water quality. Drainage for agriculture is particularly harmful to seasonal wetlands. It has been reported that 60% of the seasonal wetlands in Pallisa and Iganga districts have been lost as a result of this practice. In Butaleja district, over 80% of the rice is cultivated in the Doho Wetland (Oonyu, 2011).

Wetland destruction ultimately releases carbon to the atmosphere. Although the major cause for increasing carbon dioxide (CO₂) levels in the atmosphere is burning of fossil fuel, wetland destruction poses a potential threat for accelerating this greenhouse effect. Undisturbed wetlands often function as active sinks of carbon, although they also emit the greenhouse gas (GHG) methane in substantial quantities (Mitra, Wassmann & Vlek, 2005).

Rice cultivation on wetland rice fields is thought to be responsible for 1.5% of the anthropogenic methane emissions (WRI, 2005). Rice requires slightly more water to produce than other grains. Rice production uses almost a third of Earth’s fresh water. Long-term flooding of rice fields cuts the soil off from atmospheric oxygen and causes anaerobic fermentation of organic matter in the soil. Methane production from rice cultivation contributes approximately 1.5% of anthropogenic greenhouse gases (Neue, 1993). There are some changes in climate such as unreliable rainfall patterns and excessive heat due to long periods of drought as a result of wetland use and conversion due to increased population (Iyango et al., 2012).

Oonyu (2011) stated that rice yields have continued to decline for all categories of farmers and this decline is sharpest among farmers in Nambaale parish (NWF). Farmers in the DRS (Doho Rice Scheme) and the NWF (Nambaale Wetland) reported that before 1980, rice production levels were high with yields of between 25 to 30 bags per acre or 1,500 to 1,800 kg/acre. Rice
growing spread to Nambaale parish from the DRS after 1980, but since then, there has been a steady decline in rice production levels and incomes.

Rice pests are any organisms or microbes with the potential to reduce the yield or value of the rice crop or of rice seeds (Jahn et al., 2007). Rice pests include weeds, pathogens, insects, nematode, rodents, and birds. A variety of factors can contribute to pest outbreaks, including climatic factors, improper irrigation, the overuse of insecticides and high rates of nitrogen fertilizer application (Jahn, Almazan and Pacia, 2005). Weather conditions also contribute to pest outbreaks. For example, rice gall midge and army worm outbreaks tend to follow periods of high rainfall early in the wet season, while thrips outbreaks are associated with drought (Douangboupha et al., 2006).

Declining yields may either force farmers to continuously cultivate the crop, leaving little room for the soil to recover lost nutrients or to expand acreage in an attempt to increase yields. However continuous cultivation in wetlands has been reported as a major factor that predisposes wetlands to destruction and even loss (Oonyu, 2001; Oonyu, 2011). There are also reports of the rising infestation of such rice pests as leaf rollers, rice bugs, leafhoppers and caterpillars, and the incidence of Rice blast caused by the fungus *Pyricularia grisea* (Cooke) (Oonyu, 2011).

Agriculture in and around wetlands can lead to conflict between farmers and other wetland users. The most frequent impact of the development of wetland agriculture is losses in subsistence agriculture, which are offset by gains in market-orientated agriculture, where the latter is often associated with a monoculture and intensive water use. Hence, agricultural intensification in wetlands often results in groups of people reliant on subsistence agriculture losing out, with a negative feedback cycle occurring where productivity losses lead to further expansion and transformation of wetland areas (McCartney et al., 2010).

The contribution of rice growing to household incomes has therefore sharply declined due primarily to the declining soil fertility levels, farmers’ inability to control water use, use of low yielding varieties, and poor farming practices, thereby creating a possibility of adversely impact on the Doho Wetlands in Butaleja district. Declining yields imply that rice growing in the area, is
becoming less profitable than in the past. In fact, the costs of production in many instances are equal to or more than the rice earnings, particularly for farmers outside the Scheme (Oonyu, 2011).

2.3 Measures put in place to ensure proper the wetland management during rice cultivation

A part from rice cultivation and some reclamation, active wetland management is a new concept in Uganda, and little is known about which activities are possible and desirable in wetlands (Iyango et al., 2012). However, the government has pioneered several interventions to counter wetland degradation, including public awareness and research, and the establishment of relevant policies, legislation and institutional frameworks for sustainable management of wetland resources (Kaggwa et al., 2009).

According to Aryamanya (2011), the Government of Uganda (GoU) in 2001 started the process of physical restoration of critical wetlands in the country working closely with the local leaders and communities and by 2011, ten (10) wetlands had been restored for example Nakaiba wetland in Masaka municipality Masaka district, Kinawataka wetland in Kampala and Wakiso districts whose main importance for both the former and latter is tertiary treatment of wastewater from Masaka municipality and Kampala Capital City respectively.

Trends in wetlands ownership has shifted from communal property resources before the 1990s to private property ownership through the Government policy of 1972 and then recently reverting back to communal property through the Wetlands Policy of 1995, National Environment Statute of 1995 and Constitution of the Republic of Uganda of 1995. This is a positive development as far as the need for wetland management planning is concerned considering that today population has increased, tastes have changed, ecosystem resilience has reduced and there is use of and therefore increased pressure on wetland resources, However, the current legal provisions on wetland ownership are not enough to ensure their sustainable utilization (Iyango et al., 2012).

When President Museveni came to power in 1986, he placed a ban on large-scale wetland until the National Wetlands Program was developed in 1989. The Museveni administration has continued to support wetland management and conservation in Uganda, and has become a
signatory to the Ramsar wetlands convention which led to the formation of the Uganda’s National Wetlands Policy for the Conservation and Management of Wetland Resources in 1995 (Sophie, 2007).

The Poverty Eradication Action Plan (PEAP) recognizes wetlands as one of the natural resources that play a vital role in creating economic, social and environmental benefits for the people of Uganda. PEAP also emphasizes that Uganda’s economic growth and its sustainability will depend on how well the components of the environment and natural resources are managed and used. In particular, the PEAP highlights the need for improved wetland management for the provision of a wide range of associated products and ecological functions (Kaggwa et al., 2009).

One of the major ways to develop policies and guidelines for sustainable use of wetlands is through a better understanding of their traditional uses. This is because traditional management systems are based on indigenous knowledge and practices passed on from generation to generation. These ideas are the ones that need to be promoted and applied during wetland management planning, as there is consequently a need to test a variety of potential use options for wetlands. Studies conducted in Busia and Rakai districts, revealed that in the 1940s cultivation in wetlands, sand mining and use of papyrus, ranked lowest, while the traditional use of wetlands for water, hunting, grazing and fishing ranked highest Iyango et al., (2012).

Although the Wetlands Inspection Division (WID) has produced guidelines for small- holder paddy rice cultivation in seasonal wetlands (WID, 2001; Oonyu, 2011), these are unfamiliar to the majority of farmers in the area. For instance, it is recommended that 2 to 5 years of rice production should be alternated with 2 to 3 years of fallow. A major impediment to fallowing is the growing pressure on land by the rapidly rising population. It is important that farmers implement recommended agronomic practices for rice cultivation in wetlands (Oonyu, 2011).

Iyango et al., (2012) observed that traditional uses were sustainable under low population densities and had regulatory systems, a situation which changed in the 1990s with cultivation, papyrus use and sand mining ranking highest, while hunting steadily declined. There are some changes in climate as a result of wetland use and conversion due to increased population. The study suggested that indigenous knowledge provides the best management options to the
continued use of wetlands especially those that provide at least one known essential good, service, or attribute where alternatives are not practically or economically viable.

Wetlands provide ecosystem goods and services vitally important to humans. Land managers and policymakers working to conserve wetlands require regularly updated information on the statuses of wetlands across the landscape using Synthetic Aperture Radar (SAR) and Landsat’s optical/infrared sensors. However, wetlands are challenging to map remotely with high accuracy and consistency. Synthetic aperture radar technology is attractive for mapping and monitoring wetlands remotely. These sensors provide their own energy source to detect features on the Earth’s surface and therefore are not limited to sunlight hours for collecting land-cover data. SAR systems operate at wavelengths in the microwave portion of the electromagnetic spectrum that can penetrate cloud cover and, to varying degrees, vegetation canopies. These systems are well suited to detect moisture in the landscape because water’s high dielectric constant increases the radar reflectivity of the land surface (Alisa et al., 2014).

There are numerous wetland management tools in Uganda whose aim is to sustain the biophysical and socioeconomic values of wetlands for present and future generations which include legal tools like the constitution, statutes and acts, and institutions like the Wetland Inspection Division (Kabenge & Mfitumukiza, 2012; NatureUganda, 2013). However wise and sustainable use of wetland resources has not been achieved due to lack of harmony between the policies and their implementation in wetland management. The responsible institutions lack operation strength, with limited political will and financial support to effectively enforce environmental law (NatureUganda, 2013). Furthermore, there is limited information to support wetland conservation efforts (Kabenge & Mfitumukiza, 2012).
CHAPTER THREE
RESEARCH MATERIALS AND METHODS

3.0 Introduction
This chapter presents the materials and methods that will be used to aid proper data collection including the description of the study area, research design, sampling designs, data collection methods, data analysis and ethical considerations.

3.1. Description of the study area
Namayingo District Local Government is located in the South Eastern part of Uganda. It is bordered by Busia to the East, Bugiri to the North West and Mayuge to the West, Uganda/Kenya South East and Tanzania in the South. The District is 216km away from the Capital City (Kampala) through Bugiri District headquarters. Nalioba wetland is found Banda sub-county. Nalioba wetland is a seasonal wetland, which is usually flooded with water in the rainy season and dries in the dry season. Its geographical coordinates are 60, 1000E, 0028000N at an altitude of 3750ft.

In 2002, the national census put the population of the district at approximately 175,000 while in 2012 the population was approximately 232,300. The major economic activities are commercial and subsistence agriculture, commercial fishing and small scale businesses.

3.3. Research design
Both qualitative and quantitative designs were used therefore the study was descriptive in nature. Qualitative design was used through the questionnaires and interview guides while recording the responses and the quantitative design was also used to reveal the numerical form of data in form of frequencies and percentages.

3.3 Sampling design
The target population was basically the farmers that engage in rice cultivation, a few agricultural extension officers, environmental officers and the local leaders.

A total of 70 respondents were chosen as the sample size comprising of 15 people from each of the two (2) surrounding villages of Lutoro and Nangera, and also two (2) trading centres near the
the wetland namely; Sidanda and Lugala which was totaling to 60 respondents. Eight (8) local leaders hence three (2) chosen from the two villages and two trading centres respectively. Also one (1) environmental officer and one (1) agricultural officer were included in the sample.

Simple random sampling method was used to get the 60 respondents whereby every member who does agriculture in or near wetlands had a non-zero probability to be chosen into the sample. Purposive sampling was also used to select the local leaders, agricultural officers and environmental officer given the fact that they could be having more knowledge and experience regarding rice cultivation past and emerging issues including wetland management.

3.4 Data sources and research instruments

3.4.1 Data sources
Data was collected from both primary and secondary sources. Primary data was got from questionnaires and observations while secondary data was got from newspapers, reports, journals and text books.

3.4.2 Research instruments
Questionnaires
Self-administered questionnaire were used whereby the respondents were required to read the questions and later on fill in the answers by themselves. The questions were both open and closed-ended. However, it is important to note that some of the respondents were not able to read and write. Therefore, I and the research assistant had to administer the questionnaires by interviewing the respondents and recording their responses.

Observation:
This was used to clearly see the general occurrence of rice cultivation and some wetland management practices in Nalioba wetland while carefully recording any relevant issues noticed.
3.5 Data analysis
Data was systematically organized in a manner that facilitated statistical analysis. For both qualitative and quantitative analysis, descriptive statistics was used to describe, organize and summarize the data in the form of pie-charts, frequency distribution tables and percentages.

3.6 Validity and Reliability
The researcher carried out a pre-test of the questionnaire before using it in the field and it was cross-examined for approval by the expert who in this case was my supervisor to ensure that the information generated was appropriate and consistent.

Validity means that it is true that the instrument measures what it is supposed to measure and that the data collected should accurately represent the respondent’s opinions based on experience and knowledge.

Therefore, the Content Validity Index (CVI) was used to test for validity.

Formula: \[ CVI = \frac{\text{Number of items declared valid}}{\text{Total number of items}} \]

\[ = \frac{68}{80} = 0.9 \]

According to Amin (2005), for the instrument to be accepted, the average index should be 0.7 or above. Hence the instrument was accepted because it had an average index of 0.9 as its Content Validity Index.

3.7 Ethical considerations
This involved getting permission from the university (Dean of School of Engineering & Applied Sciences) to conduct the research henceforth submitting to the local leaders in the study area for their consent, this helped to avoid hostility by the respondents after viewing the researcher as a stranger.

The respondents were equally assured of confidentiality of their views or responses on sensitive information.
3.8 Limitations to the study

The researcher met several obstacles, which may in one way or the other affect the findings of the research and they included the following;

- Based on high rates of poverty, most respondents expected to be given money after filling the questionnaires, which could have affected the quality of the responses they gave especially those who did not turn up on the first few days of the exercise.
- The entire process of data collection was too expensive in terms of transport, facilitating the research assistant and purchasing the scholastic materials.
- Further, based on the recent past occurrences such as arrests of fishermen with undersized nets, the respondents warned me not to take any photographs which would serve as evidence against them.
- A majority of the respondents were not willing to give necessary information over fears that the government wants to evict them from the wetland.
CHAPTER FOUR
PRESENTATION, INTERPRETATION AND ANALYSIS OF DATA

4.0 Introduction
This chapter focuses on the presentation, analysis, interpretation and discussion of data to make it useful and easy to understand regarding rice cultivation and wetland management in Nalioba wetland, Namayingo district.

4.1 Demographic data of the respondents

Table 1: Demographic data of the respondents (N=70)

<table>
<thead>
<tr>
<th>Characteristic of the respondents</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>33</td>
<td>47</td>
</tr>
<tr>
<td>Female</td>
<td>37</td>
<td>53</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16-25</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>26-35</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>36-45</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>46-55</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>55years above</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
<tr>
<td>Religion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catholic</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>Protestant</td>
<td>19</td>
<td>27</td>
</tr>
<tr>
<td>Moslems</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>----------</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Others</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marital Status</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Married</td>
<td>44</td>
<td>63</td>
</tr>
<tr>
<td>Single</td>
<td>21</td>
<td>30</td>
</tr>
<tr>
<td>Widowed</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education level</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>O-level</td>
<td>30</td>
<td>43</td>
</tr>
<tr>
<td>A-level</td>
<td>22</td>
<td>31</td>
</tr>
<tr>
<td>Tertiary</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occupation</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Peasant</td>
<td>53</td>
<td>76</td>
</tr>
<tr>
<td>Formal</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Businessperson</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Primary data, 2014.

Table 1 shows that there were more females (53%) than males (47%) because it is mostly the females who engage in most rice cultivation activities like leveling, planting, weeding,
harvesting and storage in the wetland as compared to the males who in most occasions participate in digging/ploughing the wetland, harvesting, storage and sale of the rice. The respondents in age group 26-35 (37%) were the highest implying that there are many youth who are unemployed hence depend entirely on the wetland for rice cultivation as a means of raising income while the lowest were those in the age group 55 years and above (7%) referred to as elders who only do less rice cultivation and mostly engage in advisory and supervisory services to the youth when carrying out rice growing in the wetland. In terms of religion, it was found that the respondents who are Catholics were the majority (36%) while the category of others (17%) were the least comprised of Seventh Day Adventist, Pentecostal Christians and other Born again Christians belonging to various religious denominations. The married respondents were the majority with 63% while widowed were the least at 7% implying that those who are married depend on the wetland for rice cultivation to provide their family’s basic needs ranging from such as food, clothing, and medical care to raising income for their educating their children in schools. However, the widowed carry out rice growing activities in limited rates but mostly it is through their children but in most occasions after some time they end up getting married to the deceased’s brothers to continue the family lineage and expansion. Most of the respondents were those who had acquired an Ordinary level (O-level) of education at 43% but could not afford money to further their studies so end up becoming typical rice cultivators and automatically get married to have a closer partner to help in most rice farming activities while those at tertiary or university level were the least with 6%. There were more peasants (76%) while those in formal employment or civil servants were the least with 4%, and this means that it is mostly the peasants who carry out rice cultivation in the wetlands because of poverty hence use the wetland as a source of their income.
4.2 Factors influencing rice cultivation in Nalioba wetland

4.2.1 Wetland has occupied vast land

Table 2: Wetland has occupied vast land

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>45</td>
<td>64</td>
</tr>
<tr>
<td>No</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: primary data, 2014.

Table 2 shows that most of the respondents (64%) agree that the wetland has occupied vast land that could be used for other activities like construction and growing of other crops that do not require plenty of water while the least number of respondents (36%) said that wetlands deserve to be where they are located hence the wetland has not encroached on their land.

4.2.2 Wetland is important

Table 3: Is Nalioba wetland important to you?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>55</td>
<td>79</td>
</tr>
<tr>
<td>No</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: primary data, 2014.

Table 3 shows that majority of the respondents (79%) accepted that the wetland is very important to them as it provides them with fertile soils and plenty of water for rice cultivation while the least number of respondents (21%) said that they were not getting any direct value from the wetland hence the wetland is not important to them simply because they did not have plots within the wetland for carrying out rice cultivation.
4.2.3 Factors encouraging rice cultivation in Nalioba wetland

Table 4: Factors encouraging rice cultivation in Nalioba wetland

<table>
<thead>
<tr>
<th>Factor favouring rice cultivation</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High population growth</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Fertile soils</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>Raw materials and other products</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Poverty</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>Good water supply</td>
<td>20</td>
<td>29</td>
</tr>
<tr>
<td>Open access</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Primary data, 2014.

Table 4 shows that the greatest factors encouraging rice cultivation in Nalioba wetland are good water supply (29%) and the availability of fertile soils (29%) because both of them give higher rice yields. Kijima (2012) also observed that the average rice plot size is less than 0.4 hectares. The average yield is 2.5 tons per hectare, which is higher than the average rice yield in SSA. This high yield is, however, only achieved in Butaleja and Kamuli districts. In other districts, the average yield is less than 2 tons per hectare. These yield differences across districts may be explained by differences in the cultivation practices applied. The continued use of upland fields for farming has resulted in loss of soil fertility due to erosion and over use. An increase in the urban market demand for food produced in the wetlands, particularly Irish potatoes and rice, has pushed many farmers to increase production in their wetland fields (Puhalla, 2009). In addition, the needs of agriculture for flat, fertile land with a ready supply of water mean that wetlands are often a potentially valuable agricultural resource (McCartney *et al.*, 2010).

These were followed by poverty (15%) meaning that most of the respondents look at the wetland as an option and source of wealth in terms of rice cultivation which offers them high yields and higher income because of the high selling price per kilogram as shown in table 6 and 7 below respectively and as a result, most of the respondents are able to pay school fees for their children.
High population growth (13%) with each family having more than six children has also led to high land fragmentation rates leaving many with little or no land to cultivate hence resort to the wetland to carry out rice growing for survival. However, this is also encouraged by the fact that wetlands are open access (13%) hence belong to everyone and no one owns making even Nalioba more prone to encroachment by rice cultivators to acquire plots of land which they later on assign to themselves on a permanent basis, others even go to the extent of hiring out the plots of land within the wetland to those who do not have. These findings agree with Oonyu (2011) who observed that shortage of land in the densely populated districts of Eastern Uganda has forced people to cultivate rice and other crops in wetlands. Rapid urbanization and the current decline in the production of food crops such as millet, cassava and bananas, have caused an increase in the demand for rice. Kijima (2012) also noted that in many countries in Sub-Saharan Africa (SSA), the consumption of rice has been increasing far more rapidly than domestic rice production due to rapid population growth and urbanization in the region.

The availability of raw materials and other products (1%) such as papyrus (Cyperus papyrus L.), which form extensive single species stands (Oonyu, 2011), is the least factor encouraging rice cultivation in Nalioba wetland because these raw materials are in small quantities and do not support the greater portion of the population.

4.2.4 Rice cultivation practices in the wetland

Table 5: Rice cultivation practices in the wetland

<table>
<thead>
<tr>
<th>Rice cultivation practices</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transplanting</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Constructing bunds/canals</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Levelling/puddling</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>Using new planting material each season</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>Use of artificial fertilizers</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Broadcasting</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Control of pests and diseases</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: primary data, 2014.
According to table 5 above it is important to note that if these practices are well practiced, they can sustain the wetland or degrade if poorly used. The most common rice cultivation practice carried out in Nalioba wetland is leveling or puddling (26%) and this involves soils structure deliberately destroyed and the soil dispersed by plowing and harrowing the soil in a flooded or saturated state hence frequent cultivation of the wetland and also heaping soil on the lower parts to prevent washing away of the seeds if broadcasted and easy water retaining capacity to aid proper rice growth. Tado (2010) also found out that leveling facilitates water and golden apple snail management, helps suppress weed growth, and maximizes efficiency of fertilizer in the field therefore proper leveling of the field solves more than 50% of the problems in rice production such as the alteration of the soil texture and structure leading to the leaching of the soil nutrients and also through leveling, plenty of vegetation is lost.

This was followed by broadcasting (19%) whereby the respondents just sow the rice after ploughing the wetland and allow it to grow given the favourable conditions of plenty water and fertile soils. Using new planting material each season (14%) and control of pests and diseases (14%) are carried out to aid good rice growth to acquire high yields while at the same time controlling the pests and diseases of the previous rice. However, some respondents said that they use pesticides on rare occasions especially when the rice is attacked by strange pests and sometimes birds as well when the other methods like use of scarecrows fail.

Constructing bunds/canals (11%) and this is a form of a dyke, levee or wall constructed to either retain water or divert when the need arises hence it is necessary because of aiding proper drainage and irrigation after leveling (Tado, 2010). The findings in this study are also in agreement with that of Kijima (2012) who observed that although applying proper cultivation practices such as constructing bunds, leveling, and transplanting is considered to be critical in yield enhancement, especially for lowland rice cultivation, such cultivation practices are rarely adopted by the sample households in the districts of Butaleja, Kumi, Lira and Dokolo given the percentages above and the fear of some framers to using them due to their labour-intensive nature.
Nwite et al., (2014) also found out that depending on the soil texture, tillage may induce a gain or loss in soil permeability which may affect rice yield through better retention of surface water. During wet tillage (puddling) and compaction in rice field soils decreases water permeability by decreasing the volume of transmission pores. In addition, in soils with less than 70 percent sand, puddling as well as compaction are equally effective in decreasing water percolation to satisfactory levels for growing a good crop of rice. However, in soils having greater than 70 percent sand, compaction rather than puddling is effective in decreasing water permeability.

Transplanting (9%) involves fragmenting the wetland into smaller plots which are easily managed as nurseries and well watered to allow good growth of the rice before transplanting into the main garden within the wetland. This is often done with constructing drainage channels to make watering very easy.

Use of artificial fertilizers (7%) is the least done activity or practice but can only apply in the rice fields that the yields have dropped drastically from each harvest season due to loss of soil fertility. However, the high cost implication of the fertilizers has prevented many people from using them.

### 4.2.5 Yields of the rice per acre

Table 6: Yields of the rice

<table>
<thead>
<tr>
<th>Yield (bags)/acre</th>
<th>Yields in kgs</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-15</td>
<td>300-900</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>16-25</td>
<td>960-1500</td>
<td>18</td>
<td>40</td>
</tr>
<tr>
<td>26-35</td>
<td>1560-2100</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>36-45</td>
<td>2160-2700</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>46-55</td>
<td>2760-3300</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>56 and above</td>
<td>3360&gt;</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Source: Primary data, 2014.
Table 6 shows that the majority of respondents (40%) get higher yields of rice between 16-25 bags or sacks/acre each containing 60kgs from the wetland than from any other crop in the area and this encourages them to over cultivate in an effort to acquire higher yields and income than in the previous seasons. The least group of respondents (7%) were those that get 55 bags and above/acre and they said that this was attributed to vast rice fields in the wetland, good rice planting, new planting materials, fertile soils, early weeding and pest management. Their high yield is what is encouraging most of the people as well to over cultivate rice in the wetland.

4.2.6 Cost of rice per kg

Table 7: Cost of rice per kg

<table>
<thead>
<tr>
<th>Cost (Ugx)</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,500</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>1,600</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>1,800</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>2,500</td>
<td>25</td>
<td>36</td>
</tr>
<tr>
<td>2,800</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: primary data, 2014.

Table 7 shows that the majority of the respondents (36%) sell each kilogram of their rice at Ugandan shillings (Ugx) 2,500/= which earns them Ugx. 150,000/= from a sack of 60kgs while the least respondents (13%) sell their rice per kilogram at Ugx. 1,500/= earning them Ugx. 90,000/= . This former price of rice has been earmarked for encouraging encroachment and over cultivation of rice in Nalioba wetland because most people aim at getting higher yields and income to cater for their family needs.
4.2.7 Quantity of land owned by the respondents

Table 8: Quantity of land owned by the respondents

<table>
<thead>
<tr>
<th>Quantity of land (acres)</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>1</td>
<td>30</td>
<td>43</td>
</tr>
<tr>
<td>1.5</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>2.5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>3 and above</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: primary data, 2014.

According to table 8 above, a majority of the respondents (43%) own only one (1) acre of land. It was followed by those who own 0.5 acres (20%) which is in relation to Kijima (2012) findings who also observed that the average rice plot size is less than 0.4 hectares which is equivalent to 1 acre hence most people own less than 1 acre in most parts of SSA (Sub-Saharan Africa). The least number of respondents (4%) were those that owned more than 3 acres of land. This means that most of the people have only fragmented plots of land which is far too less to meet the demands of their large families such as land for crop cultivation and construction hence they opt for more plots or land in the wetland for further crop production especially rice.

4.2.8 Other crops grown in the wetland

Table 9: Other crops grown in the wetland

<table>
<thead>
<tr>
<th>Crops</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>26</td>
<td>37</td>
</tr>
<tr>
<td>Green vegetables</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>Beans</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>Sweet potatoes</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: primary data, 2014.
Table 9 shows that the maize (37%) is the second most cultivated crop in Nalioba wetland but does not offer high yields as compared to rice while the least grown crop in the wetland is sugarcane (7%).

4.2.9 Other activities carried out in the wetland

Table 10: Other activities carried out in the wetland

<table>
<thead>
<tr>
<th>Activities</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle grazing</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Brick making</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Fishing</td>
<td>39</td>
<td>56</td>
</tr>
<tr>
<td>Papyrus harvesting</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: primary data, 2014.

Table 10 shows that the second most dominant activity in the wetland is fishing (56%) using local equipment such as spears, hooks and baits, baskets and a few fishing nets while the least done activity in the wetland is cattle grazing (10%) since if many cattle are grazed, they will end up eating people’s crops especially rice and maize, and also the low quantity of land available does not favour animal rearing even in the surrounding communities. These findings are in agreement with McCartney et al., (2010); Matsui et al., (2006); Senaratna, Smith and Nguyen-Khoa (2008a) who stated that fishing and farming are both closely associated with the wetland ecosystem in that during the wet season many households engage primarily in cultivating rainfed rice, while some subsistence fishing is carried out in the paddy fields. During the dry season the villagers cultivate recession rice in the floodplain area of the Tonle Sap in Cambodia and graze their livestock.
4.3 How rice cultivation affects wetland management

4.3.1 Knowledge on the effects of rice cultivation practices to Nalioba wetland

Table 11: Knowledge on the effects of rice cultivation practices to Nalioba wetland?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>32</td>
<td>46</td>
</tr>
<tr>
<td>No</td>
<td>38</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: primary data, 2014.

Table 11 shows that the majority of the respondents (54%) are not aware about the adverse effects of rice cultivation practices to Nalioba wetland while the least (46%) had knowledge about such effects except that they could not stop the activities on the wetland because they do not have an alternative piece of land to carry out large scale rice farming.

4.3.2 Adverse effects of rice cultivation practices to Nalioba wetland.

Table 12: The adverse effects of rice cultivation practices to Nalioba wetland

<table>
<thead>
<tr>
<th>Adverse effects</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreasing water levels</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Decreasing crop yields</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Unreliable rainfall patterns</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Loss of aquatic life (flora and fauna)</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Habitat destruction</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Rice pests &amp; diseases</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Eutrophication</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Reduced subsistence farming</td>
<td>10</td>
<td>14</td>
</tr>
</tbody>
</table>
Table 12 shows that the greatest adverse effect of rice cultivation in Nalioba wetland is low or decreasing crop yields (23%) and this is because of over cultivation which occasionally leads to loss of soil nutrients henceforth loss of soil fertility. These respondents (23%) said that they never fallow their land because of limited land in the area, so they have to make the best use of the wetland plots that they possess. However, Oonyu (2011) findings indicated that when the yields of rice are declining, this either forces farmers to continuously cultivate the crop, leaving little room for the soil to recover lost nutrients or to expand acreage in an attempt to increase yields hence continuous cultivation in wetlands has been reported as a major factor that predisposes wetlands to destruction and even loss. In addition, the findings in this study concur with Oonyu (2011) who observed that in spite of rice’s growing importance as both a food and cash crop, its production in Doho Wetlands in Butaleja district has continued to lag behind demand because the yields from farmers’ fields have remained low, rarely exceeding 800 kg/acre as compared to yields in excess of 2000 kg/acre obtained in experimental trials.

This was followed by decreasing water levels (16%) in the wetland due to over cultivation which reduces the water holding capacity of the soils hence high evaporation rates and also the excessive drainage of water into the various rice fields or plots within the wetland.

Reduced subsistence farming (14%) has affected the wetland in such a way that most of the respondents/farmers prefer cultivating the rice for commercial purposes usually in 1 acre or more of the wetland while those who cultivate in less than 1 acre is for subsistence purposes as shown in table 8 above yet at the same time they continue to search or hire plots within the wetland to cultivate more rice. The study findings are concur with McCartney et al., (2010) who emphasized that agriculture in and around wetlands can lead to conflict between farmers and other wetland users and that the most frequent impact of the development of wetland agriculture is losses in subsistence agriculture, which are offset by gains in market-orientated agriculture,
where the latter is often associated with a monoculture and intensive water use. Hence, agricultural intensification in wetlands often results in groups of people reliant on subsistence agriculture losing out, with a negative feedback cycle occurring where productivity losses lead to further expansion and transformation of wetland areas.

Eutrophication (13%) usually occurs due to the excessive application of fertilizers especially NPK (Nitrogen, Phosphorous and Potassium) to increase on the soil fertility yet these fertilizers also increase on aquatic plant life (algae bloom) hence competition for the nutrients, turbidity of the water and also produces bad odour. The respondents apply these fertilizers without seeking permission from the concerned authorities. This is in agreement with McCartney et al., (2010) who observed that pollution from the use of fertilizers and pesticides has adversely impacted natural biota (including fish) and undermined the ecological character of many wetlands. The findings also concur with Oonyu (2011) who found out that excessive use of fertilizers always causes eutrophication and adversely affect the ability of the wetland to maintain and improve water quality.

Loss of aquatic life (flora and fauna) (10%) occurs due to eutrophication, high drainage rates, over cultivation, direct harvesting by man such as papyrus and cutting grass, and also fishing using ordinary equipment and as such, people have to go into the deeper parts of Lake (L.) Victoria to catch fish since it is now rare that one can catch them in Nalioba wetland due to reduced numbers. The findings agree with Oonyu (2011) who stated that drainage for agriculture is particularly harmful to seasonal wetlands hence it was reported that 60% of the seasonal wetlands in Pallisa and Iganga districts have been lost as a result of this practice. In Butaleja district, over 80% of the rice is cultivated in the Doho Wetland.

Unreliable rainfall patterns (7%) have been noticed by the respondents in that in most occasions they the rains come when they are too heavy leading to the flooding (7%) of the area due to lack of aquatic vegetation to reduce the velocity of the water or absorb the water and this is in agreement with Kaggwa et al., (2009) who stated that some obvious impacts of wetland destruction include increased frequency of flooding, destruction of habitats, associated biodiversity and ecological processes. Adverse local climate modification is characterized by prolonged drought and this has largely contributed to a 2metre drop in the water level of the Nile
River and Lake Victoria. In some instances, the rains are too low hence affecting rice growth forcing people to carry out massive drainage to avail water for the rice.

Habitat destruction (6%) has occurred in that most aquatic plants and animals have reduced such as fish, frogs and some birds since their habitats have been converted into rice fields. The birds are constantly being poisoned, hunted or chases away by scarecrows. In addition, the destruction of the habitat has been in form of digging drainage channels, leveling, over cultivation thus altering the soil structure and eutrophication from fertilizers.

The least effect was the invasion by rice pests and diseases (4%) which the respondents said that they happened rarely but would unexpected and would affect the entire rice fields in the wetland if not solved early enough leading to poor yields and at times no yield at all. The findings are related with Jahn et al., (2007) who defined “rice pests” as any organisms or microbes with the potential to reduce the yield or value of the rice crop or of rice seeds. Also Jahn, Almazan and Pacia (2005) who noted that a variety of factors can contribute to pest outbreaks, including climatic factors, improper irrigation, the overuse of insecticides and high rates of nitrogen fertilizer application in the wetlands. Douangboupha et al., (2006) also stated that weather conditions also contribute to pest outbreaks for example, rice gall midge and army worm outbreaks tend to follow periods of high rainfall early in the wet season, while thrips outbreaks are associated with drought.
4.4 Measures put in place to ensure proper wetland management alongside rice cultivation

Table 13: Measures put in place to ensure effective wetland management in Nalioba wetland.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity building</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Community participation</td>
<td>13</td>
<td>19</td>
</tr>
<tr>
<td>By-laws</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>High yielding crop varieties</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Sustainable wetland uses</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Sensitization</td>
<td>28</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Primary data, 2014.

Table 13 shows that sensitization (40%) is the greatest approach used to manage Nalioba wetland in a sense that there is wide spread creation of awareness being conducted in form of announcements in church, local leaders, in market places, partially in schools but mostly through focused group discussions with the farmers in the wetlands. At a slow pace most of the respondents appear to be acknowledging the values of wetlands, rate of degradation as a result of human induced impacts and the need to conserve them for sustainability. Kabenge & Mfitumukiza (2012) also emphasized that more sensitization programs for the public need to be put in place to promote wise use and conservation of wetland resources.

It was however followed by community participation (19%) which is being done though to a lesser extent in the decision-making process of the wetland management which has created some form of sabotage by the local people. However, Iyango et al., (2012) emphasized that more efforts should always be made to engage the various stakeholders in the planning processes as well as introducing access and user rights in a bid to engage resource users in monitoring and evaluating the utilization of wetlands.

Capacity building (8%) has been done through training the District Environment Officer (DEO) of Namyingo District, District Physical planner, District Natural Resources Officer (DNRO),
District Fisheries officer and District forestry officer, NAADS (National Agricultural Advisory Services) coordinators who in turn impart the skills and knowledge to the parish chiefs, local environment committees, local leaders and a few farmers on how to manage the wetland alongside rice production to ensure sustainability.

The fourth measure is the formulation and implementation of by-laws (16%) even at the local levels that prohibit certain activities to be carried out in the wetland and for those accepted regarding rice cultivation should be done in the agreed format such as fallowing after every 2-3 years of cultivation and limiting the use of chemical fertilizers, among others. This is supported by Iyango et al., (2012) observation that enforcement of laws must be done at all levels to ensure effective wetland management.

High yielding varieties (10%) of rice and other crops should be done introduced to the community so that the pressure put on the wetlands for rice production is reduced. This is in agreement with Oonyu (2011); MAAIF (2008) who encouraged the adoption of the following rice varieties; NERICA 4 popularly known as Upland rice, NARIC 3 which is not only high yielding, producing yields of 1,250 to 1,500 kg/acre but also early maturing (90 to 110 days) has been developed by local breeders. Normally, local varieties take more than 120 days to mature with yields hardly about 800 kg/acre. In addition, NARIC 3 which has an attractive aroma, is less susceptible to birds, and yields heavier grains.

Sustainable wetland use practices (7%) like fish farming in ponds is in agreement with Kabenge & Mfitumukiza (2012) findings because it can replace arable farming but on a minimal scale usually with the approval of NEMA through the DEO. This is reducing the impacts of over cultivation and application of chemical fertilizers, excessive drainage and loss of animal and fish species in the wetland.
CHAPTER FIVE
CONCLUSIONS & RECOMMENDATIONS

5.0 Introduction
This chapter presents the conclusions and recommendations that have been made from this study.

5.1 Conclusions
The following conclusions were drawn from the study;

The greatest factors encouraging rice cultivation in Nalioba wetland are good water supply (29%) and the availability of fertile soils (29%) while the least factor is the availability of raw materials and other products (1%). The most common rice cultivation practice carried out in Nalioba wetland is leveling or puddling (26%) while the least is the use of artificial fertilizers (7%). The majority of respondents (40%) get higher yields of rice between 16-25 bags or sacks/acre each containing 60kgs from the wetland than from any other crop while the least group (7%) were those that get 55 bags and above/acre. Majority of the respondents (36%) sell each kilogram of their rice at Ugx 2,500/= which earns them Ugx. 150,000/= from a sack of 60kgs while the least price was Ugx. 1,500/= for 1kg in a 60kgs bag earning them Ugx. 90,000/=.

The greatest adverse effect of rice cultivation in Nalioba wetland is low or decreasing crop yields (23%) while the least adverse effect was the invasion by rice pests and diseases (4%).

Sensitization (40%) is the greatest approach used to manage Nalioba wetland while the least was the use of sustainable wetland use practices (7%).

5.2 Recommendations
The study recommended the following;

NEMA and MAAIF should make it a priority for the farmers to obtain new planting varieties each season if they are to get high yields of paddy rice from the wetland and this must be done alongside fallowing period of 2-3 years is necessary after rice cultivation for 2-5 years in the wetland so as to allow the soils to regain the nutrients. In addition, Oonyu (2012) stressed that in order to continue enjoying the benefits of these high yielding varieties, farmers must ensure good
agronomic practices including maintaining soil fertility levels, control of pests and diseases, and use of new planting material each season. Others include constructing bunds and transplanting.

High yielding varieties of other crops should be introduced to reduce the pressure placed on the wetlands by MAAIF through conducting research which can be planted on the uplands with the available conditions.

Sustainable use of wetlands is through a better understanding of their traditional uses. This is because traditional management systems are based on indigenous knowledge and practices passed on from generation to generation. These ideas are the ones that need to be promoted and applied during wetland management planning, as there is consequently a need to test a variety of potential use options for wetlands (Iyango et al., 2012).

Restrictions and by-laws must be placed by the district council, community representatives, DNRO and the DEO such as on the type of animals to be hunted for example animals representing totems for particular clans, such as lungfish. In addition, hunters can be banned from killing pregnant animals, fishermen from trapping immature fish even the papyrus harvesters.

Although the Wetlands Inspection Division (WID) has produced guidelines for small-holder paddy rice cultivation in seasonal wetlands, these are unfamiliar to the majority of farmers therefore more grassroot sensitization should be done in various forms such as village drama, printing and distributing leaflets or brochures in the local language, announcements in churches, markets and where necessary through suspension of the rice cultivation activities to raise curiosity of the farmers through the Police and local leaders hence calling for a round table discussion.

Lastly, all these recommendations can only be possible if there is proper funding from NEMA in conjunction with MOFPED hence the budgetary allocations to NEMA and the local governments should be adjusted to suit wetland management and aid more research on how to rehabilitate degraded wetlands should be carried out.
REFERENCES


Food and Agricultural Organization of the United Nations (2004). "Rice is Life".


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Appendices

Appendix I: Questionnaire

I am Otieno Moses a student of Kampala International University pursuing a Bachelor of Science in Environmental Management and currently carrying out research on “The impact of rice cultivation on the wetland ecosystem. A case study of Nalioba wetland, Banda sub-county, Namayingo District.” I kindly request you to be part of this study by answering all the questions in this questionnaire. This research is only for academic purposes and the information you provide shall be treated with strict confidentiality.

Instructions:

- Please tick ✔ the most correct answer provided in the boxes below or fill in the spaces given.

SECTION A: Demographic data of the respondents

1. Age ............................................................
2. Sex .................................................................
3. Religion ......................................................
4. Marital Status ...............................................  
5. Education level ............................................
6. Occupation ..................................................

SECTION B: Factors influencing rice cultivation in this wetland

7. Has this wetland occupied valuable space that would be used for other activities?
   Yes □ No □  
   Give reasons for your answer .................................................................
.................................................................................................................
.................................................................................................................
.................................................................................................................
.................................................................................................................
.................................................................................................................

8. Is this wetland important to you?
   Yes □ No □
Give reasons for your answer........................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................

9. What rice cultivation activities do you carry out in this wetland?
   a) Leveling □   b) constructing bunds □
   c) control of pests and diseases □   d) new planting material each season □

   Any other, please specify ........................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................

10. Why do you grow only rice in this wetland?
   a) Fertile soils □   b) More profitable □
   c) No perennial cash crops □   d) Plenty water □

   Any other, please specify ........................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................

11. Does the rice offer you higher yield than the other crops?
   a) Yes □   b) No □

12. Give the quantities in terms of bags (each 100kgs) of your harvest in No.14 above
   a) 80 bags □   b) 50 bags □
   c) 20 bags □   d) Less than 5 bags □

   Any other, please mention ........................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................
........................................................................................................................................................................................................

13. What is the cost of your rice after harvesting?
   a) 2000 shs/kg □   b) 1500 shs/kg □
c) 2500shs/kg  □  d) 1800shs/kg  □

Any other, please mention

14. What is your income from rice production each harvest period?

15. Which other crops do you grow in this wetland?
   a) Maize  □  b) Vegetables  □
   c) Yams  □  d) Sugarcane  □

Any other, please specify

16. Do you have plenty of land as personal property?
   a) Yes  □  b) No  □

Give reasons for your answer

17. Do you get good yields from crop growth in your land?
   a) Yes  □  b) No  □

18. What other economic activities do you carry out in this wetland?
   a) Fishing  □  b) Cattle grazing  □
   c) Papyrus harvesting  □  d) Brick making  □
23. Are you thinking of stopping rice growing in this wetland very soon?

SECTION D: Measures put in place to ensure proper the wetland management during rice cultivation.

24. What wetland management measures have been put in place alongside rice cultivation?

25. Do you think the measures in No. 23 above are effective in managing this wetland?
   a) Yes ☐ b) No ☐
   Give reasons for your answer

26. What other measures do you suggest to be implemented to ensure proper wetland management?

Thank you very much.