Original Research Article

Nexus between agricultural land use seasonal dynamics and rural household food security in Kilombero Wetland, Morogoro Region, Tanzania

Abstract

It is recognized that wetlands have great potential for enhancing agricultural activities due to their prolonged periods of water availability and good fertile soils making great expansion and intensification of agricultural production enhancing household food security in rural areas hence, communities have been relying on those wetlands for their livelihoods in different ways. It is from this interdependence that this study was proposed to examine the seasonal patterns of agriculture in the wetland and their implications on food security in three villages, Njage, Mngeta and Mkangawalo in the Kilombero wetland. The study employed mixed method approach whereby household questionnaires,-key informant interviews, focus group discussions, field observations, wealth ranking and documentary review were used to collect primary and secondary data. Purposive and simple random sampling techniques were used to obtain 150 respondents. Content analysis was used to analyze qualitative data while descriptive statistics were used to analyze quantitative data. Chi-square test was used to test the statistical significances of the differences between wetland and upland yields as well as size of wetland plots cultivated among socio-economic groups. The findings revealed that wetland users were the average wealthy (42.7%) and poor farmers (40.7%) who depended on the wetland for their survival. Crop production in Kilombero wetland was low as farmers practiced mono-cropping of rice and maize in both dry and wet seasons depending on rain-fed agriculture. Very few wealthy (8.7%) practiced dry season farming. The small size of the wetland plots cultivated, inadequate use of agro-inputs and over dependence on subsistence led to low crop production. Consequently, farmers experienced seasonal food shortages and food insecurity, particularly among the poor and very poor households. The study concludes that, despite its agricultural potential, Kilombero wetland had not contributed much to improve the food security status of the poor and very poor households, only the well-off and average wealthy were benefiting from the wetland. It is recommended that Kilombero district authorities should ensure that village governments allocate adequate land for both the poor and very poor farmers to enable them increase crop production. The agricultural extension officials of Kilombero district should build capacity to farmers on the importance of intensive agriculture, use of improved seeds and use of a variety of cropping methods in order to improve their produce.

Key Words; Kilombero wetland, Household Food Security, Land use, Seasonal agriculture patterns

1. Introduction

Agriculture in wetlands involve subsistence production where families produce food to meet their own needs; small-scale or artisanal production where farmers produce additional goods in relatively small quantities which they could sale; and commercial production of large quantities

of agricultural goods basically in monoculture settings for widespread distribution and sale (Ramsar, 2014). Agricultural production could be rain-fed or irrigated especially for paddy production (Ramsar, 2014; Kadigi, 2003; McCartney *et al*., 2010). Irrigation agriculture has been used by many farmers as a strategy for promoting crop production in wetlands. For instance, wetland farmers in Oromiya wetlands who practiced irrigation had better food availability than those who did not (Degefa, 2002). Accordingly, those irrigation users did not lose crops through drought because of better use of irrigation and inputs.

Wetlands are very important in supporting lives, human health as well as the natural environment. They provide services that are crucial in improving peoples' livelihoods and the ecologically sensitive and adaptive systems (Turyahabwe *et al.*, 2013). Most of the rural communities in Sub-Saharan Africa (SSA) have had their lives improved through the services provided by wetlands (Bergkamp *et al.*, 2000). In many parts of the world, agriculture is rooted in wetlands. In the temperate zones, for example, about three quarters of the wetlands had been used for agricultural systems and more than 1.6 million km² of wetlands had been drained prior to 1985 (L'vovich *et al.*, 1990). For instance, over a million people subsisted on about 2,248km² wetland area of Lake Chilwa wetland (Jamu *et al*., 2005). Wetlands are crucial to life-support functions, human health and the natural environment. They are estimated to cover about 570 million ha (approximately 5.7 million km²), which is roughly about 6% of the earth's land surface (Ramsar Convention Secretariat, 2013; WWF, 2004). Therefore, wetlands as the new frontiers for agriculture (Wood *et al.*, 2013) have become the most valuable agricultural resources that provide food in both wet and dry seasons.

The presence of water and fertile and alluvial soils supports cultivation of different crops in wetlands. The main crops grown in most of the African wetlands are sweet potatoes, sorghum, maize, rice, sugarcane, wheat, millet, beans, fruits and vegetables like onions, cabbage tomatoes, peppers and lettuce (Emerton, 2005; Zwarts *et al*., 2005; Puhalla, 2009; Pedro *et al*., 2014). In the wetlands of Niger, rice, millet, maize and wheat were the wet season crops grown in the wetland (Zwarts et al., 2005; Pedro et al., 2014). Vegetables were being grown in the dry season whereby crops were sown in the emerging soil as the water in wetlands receded (Schuyt and Brander, 2004; Pedro *et al.*, 2014).

Studies that have been conducted in different parts of the developing countries have reported that farmers were the main users of wetlands to meet their food demands (Najafi, 2003; Flintan,

2003; WWF, 2009; Mombo *et al.*, 2012; Wood *et al.*, 2013). These wetland users differed in terms of gender, age and socio-economic status all of which determined which people could have access to wetlands (Geheb and Adebe, 2003; Msofe, 2012). This implies that, not all individuals in a society have access to wetlands and their resources. Smallholder farmers depends on wetlands for crop cultivation, as well as grazing and watering of their livestock while other users include large scale farmers and large companies, which have invested in the wetlands. Wood *et al.* (2013) classified wetland users into higher wetland users, that is households using the wetlands mainly for cultivation from soon after the rainy season to the onset of the next rainy season; the middle and lower wetland users who can use the wetland during the wet season only.

In most of the Tanzanian wetlands, various crops are being grown for both food and cash income. For instance, maize, sorghum and rice were mainly grown in Bahi wetlands (Majule, 2009) while maize, beans, cowpeas, lima beans, gram, sunflower and tomatoes were the main crops grown in Lake Jipe wetland (Mahonge, 2010). In the Msimbazi valley wetlands, leafy vegetables (amaranth, spinach, Chinese cabbage, eggplants and okra), cereals like rice paddy, maize, bananas, tubers as well as fruits were grown (Palela, 2000). In the Kilombero valley wetlands, rice, banana, maize, sugarcane, and mushrooms, cassava, sesame, sweet potatoes and pigeon peas are grown (Mombo *et al.*, 2011; Balama *et al.*, 2013).

Cultivation in the wetlands in Tanzania has a considerable contribution to household cash income. For instance, wetland farmers in Bumbwisudi wetland in Zanzibar earned an average annual income of $3,312 for the better-off farmers, $2,239 for the average wealthy and $698 for the poor farmers (McCartney and van Koopen, 2004). Kilombero wetland is one of the largest wetlands in Tanzania with an area of 7,967 km². The wetland is largely drained by Kilombero River, which floods annually over the small swamps and pools scattered throughout the length of the wetland (Crafter, 1993; Mombo et al., 2011). The wetland forms an important source of livelihoods for communities especially those adjacent to it. In Kilombero valley wetlands, wetland farmers earned an average annual income of $910, $44 and $230 among the better-off, average wealthy and the poor farmers, respectively (*ibid*). Such incomes had improved farmers' livelihoods and wellbeing including food depending on their socio-economic status.

Tanzania has about 43 million *ha* of land suitable for agricultural production, but only 6.3 million *ha* are under agricultural production, out of which 0.45 million *ha* are under wetland cultivation (Kalinga and Shayo, 1998). Despite its contribution to GDP, agriculture has been experiencing crop failure due to drought among other factors which resonated with an unsatisfactory level of food security (URT, 2005). The trend of food production has remained low, thus failing to meet household and national requirements (Karatu *et al.,* 2011).

Agriculture supports the livelihoods of many people especially in developing countries through both food production and income generation. Because many people depend on rain-fed agriculture, food production, in some cases does not meet food demands of the rural communities. Wetlands contribute to addressing food insecurity for they provide vital nutrients for crop farming and ensure water availability useful for irrigation during the dry season. They are also used for income generation; for example, they provide clay for pottery, raw materials for reed and palm mats as well as baskets and they support beehives and cultivation of crops (Turyahabwe *et al.,* 2013). Kilombero wetland, being amongst the largest seasonal wetland in East Africa which has attracted a number of large scale investors with a lot of nutrients suitable for crop cultivation, should thus contribute to reversing the trend of food insecurity in the country. Although intensification of agriculture has been employed in wetlands as a measure to meet the food demands, the trends of food production show either stagnation and or decline, hence food insecurity (Becker, 2017).

Kilombero District, for example, has been experiencing unstable food availability due to changes in food production triggered by changes in seasonality of rainfall (Mfugale, 2010). Food shortages still echo among households and some places have even been receiving food relief. Unfortunately seasonal dynamics of agricultural land use in the wetland and how these can contribute to household food production are not well covered due to inadequate information. Studies have been conducted in Kilombero wetland but none of them has ever linked the seasonal dynamics of agricultural land uses means how the main agricultural activities were being practiced by the wetland farmers in the different seasons and their implications to household food security of local community. It is from this argument that this study was undertaken to examining the seasonal patterns of agricultural land use in the wetland and their implications on food security. This article aimed at answering the following research questions;

i. What were the seasonal patterns of agricultural land uses dynamics along Kilombero wetland ecosystem?
ii. What was the contribution of Kilombero wetlands to rural household food security in the Kilombero wetland ecosystem?

1.1 Theoretical Framework

This study was guided by the Food Entitlement Decline (FED) Approach which was developed by Amartya Sen on his influential book titled 'poverty and Famine' (1981) decisively shifted the focus of famine analysis from supply side to the demand side. The entitlement food theory focuses more on possession of wealth materials which can be exchanged for food or can be used to get food through other means, access to food. It concentrates on individual's entitlement to commodity bundles, such as food and views starvation as result from failure to entitlement to a bundle, rather than the availability of food (Devereux and Maxwell, 2003). According to Sen (1981:2) all legal sources of food are production-based entitlement, trade-base entitlement, own-labour entitlement and inheritance and transfer entitlement. The main argument of this theory is that, mere presence of food in the economy or in the market does not entitle/guarantee a person to consume it and thus starvation can set in without any obvious aggregate available fall (Getachew, 1995).

Some of the catastrophic famines have occurred without food availability decline. For example, the Bengal famine of 1943, the Ethiopian famine of 1973 and 1984, and the Bangladesh famine of 1974 occurred due to lack of entitlement rather than due to lack of availability short fall (Fasil, 2005). Among many positive features of the FED approach is: - First it has emphasized upon demand rather than supply. Second, it allows vulnerable groups to be identified like smallholder farmers. Finally, it suggests more appropriate policy intervention (Devereux and Maxwell, 2003). Although this approach has the above mentioned strength upon, it has also its own limitations. Generally, food security signifies the combination of the availability, accessibility, stability and food utilization because enough food must be available (produced) and households must have the capabilities to acquire it (accessibility) (Degafa, 2002). Therefore, the entitlement food theory was used in this study to explore the usefulness of agricultural land use seasonal dynamics to rural household food production in Kilombero

wetland ecosystems as one of the basic farming systems performed by smallholder farmers in responding to food insecurity in Kilombero district.

2. MATERIALS AND METHODS

2.1 The Study Area

The study was carried out between March to May 2022, in Kilombero district, morogoro region. The study was conducted in Kilombero wetland ecosystems. The choice of the wetland was because it is one of the most productive wetlands in Tanzania, also is under Ramsar site convention, which means it is protected for ecological purpose, yet it experiences agricultural expansion and intensification. It was for that reason that this study was done in Kilombero wetland. Kilombero wetland is surrounded by 19 wards and 81 registered villages. Mchombe ward which has six villages was selected for this study because it experienced more agricultural expansion and intensification than other wards. Out of the six villages, three villages namely, Mngeta, Njage and Mkangawalo were purposively selected because of the agricultural expansion and intensification that was taking place. The villages were also selected on the basis of easy accessibility because of the presence of the railway line and the main road that make the villages accessible throughout the year. The villages are also located adjacent to and or within the Ramsar site and depend on the wetland for agriculture to sustain their food demands.

This study was conducted in Mngeta, Mkangawalo and Njage villages in the Kilombero wetland (Figure 1). The wetland lies in Kilombero and Ulanga districts within Morogoro Region between latitudes 08ºand 16º in the South, and longitudes 36º 04´ and 36º 41´ East (Hetzel *et al.*, 2008). It covers an area of about 596,908 ha (Munishi *et al*., 2012). The main economic activity in the study area is agriculture, the major crops being rice, maize, bananas, sesame, cassava, tomatoes and leafy vegetables. Other activities like livestock keeping, petty business and brick making are undertaken as sources of household income.

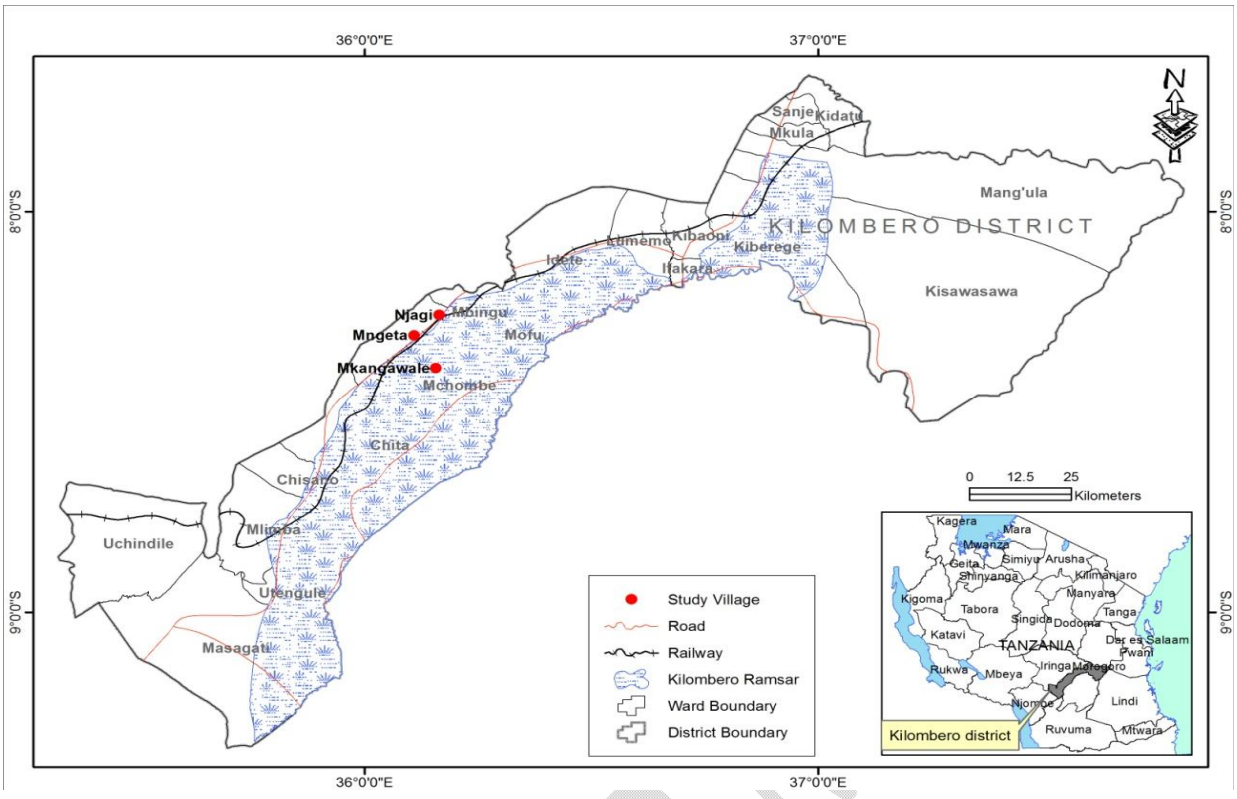

Figure 1: Location of the Study Villages and Kilombero wetland in Kilombero District
Source: IRA GIS Lab, (2022).

The wetland lies in Kilombero and Ulanga districts within Morogoro Region between latitudes 08ºand 16º in the South, and longitudes 36º 04´ and 36º 41´ East (Hetzel *et al.*, 2008). It covers an area of about 596,908 ha (Munishi *et al.*, 2012). The climate of Kilombero is sub-humid tropical climate with two rain seasons namely, the short rain and the long rain seasons (Hetzel et al., 2008). The short rains are in October, November and December while the long rains are in March, April and May (URT, 2020). The average annual rainfall ranges between 800 and 1600mm while temperature averages between 26ºC to 32ºC (ibid). The annual dry season is experienced from June to October (Hetzel *et al.*, 2008). Kilombero wetland lies between Udzungwa Mountains and the Mahenge escarpment. It has an elevation ranging from 210 to 250m above sea level, and it is the largest low altitude inland fresh water wetland in the world (Munishi *et al.*, 2012). The many rivers draining the wetland make it also the largest seasonal freshwater lowland floodplain in East Africa and thus attractive for livelihood diversification including agriculture. The study villages are drained by such rivers as Kimbi, Mngeta, Mchombe and Njagi.

2.2 Research Approaches

The article adopted a mixed methodological approach based on a combination of both qualitative and quantitative research approaches which formed the basis for data collection and analysis with a case study research design. Major sampling procedures were random sampling procedure was applied to obtain the sample households from each village. Purposive sampling was used in the selection of the study area. Thereafter, key informants, particularly agricultural officers, village leaders and elders were purposively involved in the study due to their potentiality to the research theme. The sampling frame for this study included all households, which used Kilombero wetland for agriculture to sustain their living. The researcher selected a sample that represented these households in Mngeta, Mkangawalo and Njage villages. The focus group members and key informants were purposively selected based on their occupation (agriculture) and having relevant knowledge of the wetland. This study used a household as a sampling unit of analysis. A sample of 150 heads of household was selected for the study, and these were involved in a household survey.

This study used 10% of the households in Mkangawalo, Njage and Mngeta villages with a total of 1504 households of agro-wetland users to determine the sample size. According to Babbie (1983:191), "a sample size of 10% to 12.5% of the entire population is a good representative sample for social science research". Ten percent of a sample population in a study area was also sufficiently representative for statistical analysis purposes (ibid). The researcher used a simple formula to determine the sample size. The formula was;

$$n = \frac{10}{100} x\, N$$

Whereby, *N* is the total number of farming households in a village and *n* is a sample size. The procedure used to determine the sample size for each village was done as shown below.

$$n = \frac{10}{100} x\, N$$

$$n = \frac{10}{100} x\, 412$$

$$\boldsymbol{n = 41.2 \text{ households}}$$

These 41 households were a 10% of 412 farming households in Mkangawalo village. The same procedure was repeated for Mngeta and Njage villages. This study also used fifteen (15) key informants who included 12 heads of household one from each socio-economic group in each village and three (3) agricultural extension officers, who were purposively selected. The researcher also used three focus groups each composed of six farmers were chosen to participate

in focus group discussion. In each village 10% of households were drawn, which gave a total of 150 households as sample size (Table 1).

Table 1: Sample size in the study villages

Villages	Farming households	Sample size	% of the total
Mkangawalo	412	41	27.3
Mngeta	323	32	21.3
Njage	769	77	51.3
Total	**1504**	**150**	**100**

Source: Field data, 2022

2.3 Data Collection Methods

The study used both primary and secondary data sources. Secondary data was collected from reading different published and unpublished literature, obtained from different sources of information. The sources comprised of papers published online by scientific and reputable journals, books, and unpublished documents from local government offices. Also, visits were made to the Ministry of Agriculture, Ministry of natural resources and tourism. Primary data was collected through a household survey, in-depth interviews, focus group discussions (FDGs), and field observation.

A household survey was used to collect quantitative data from heads of household using a semi-structured questionnaire, which had both open-ended and close-ended questions. Heads of household in each village were requested to provide information to the researcher by filling in the questionnaires. This method was used to collect information on demographic characteristics of smallholder farmers, farmers' ownership of land, cropping systems, and the potentials of Kilombero wetland on food production. In-depth interview with key informants was used to collect qualitative data. The key informants comprised 15 people who were knowledgeable about the study theme. This study also used fifteen (15) key informants who included 12 heads of household one from each socio-economic group in each village and three (3) agricultural extension officers, who were purposively selected. Also, the District Agricultural Officer, ward executive officers, ward agricultural officers, village executive officers and village elders from the study villages.

This method was used to collect information on land uses, types of crops grown under different cropping systems, status of food production. The information was recorded using a tape recorder and a notebook. Moreover, focus group discussions (FGDs) were also used to collect qualitative data. The focus groups consisted of 6 participants per group. A checklist with guiding questions was used as a tool for the FGDs. One group was formed in each village comprising of smallholder farmers: of men and women, youths and elders. Furthermore, physical observation was done in the field to capture and verify issues rose during FGDs and in-depth interviews, such as wetland users and their socio-economic status, crop yields, types of crops grown under different cropping systems, seasonal patterns in the wetland and the importance of Kilombero wetland to food production. Generally, in-depth interviews and FGDs were conducted in all study villages aiming to capture qualitative information but also to complement quantitative information from the household survey. Resource mapping whereby, the focus group members in each village drew a map of the wetland surrounding their villages and showed farm and non-farm activities as well as the crops grown in wet and dry seasons of the year and wealth ranking used to classify and characterize wetland users into socio-economic groups. Wealth ranking provides an opportunity to utilize local perception and criteria of wealth to categorize households in a given community into different socio economic groups (Mung'ong'o, 1995; Liwenga, 2003). The reason of using wealth ranking is that, local people know themselves better than the researcher (Liwenga, 2003).

2.4 Data Analysis

Qualitative data from key informants, interviews and FGDs were analysed through content analysis and presented through descriptive statements and direct quotations. Quantitative data collected from the household survey was coded, processed and analysed using the Statistical Package for Social Sciences (SPSS IBM, version 23) which simplified the description and presentation of the study findings as well as making patterns and trends analysis. Chi-square test was used to test the statistical significances of the differences between wetland and upland yields as well as size of wetland plots cultivated among socio-economic groups. Results for quantitative data were presented by using figures and tables.

3. Results and Discussion

3.1 Seasonal Agriculture Patterns in the Wetlands

3.1.1 The major economic activities conducted in the study area

The respondents were engaged in various economic activities to support their livelihoods, however, differed among the socio-economic groups and from one village to another. Agriculture was the main economic activity for the very poor and poor farmers. The average wealthy and well-off depended more on non-farm activities, mainly petty business and rice milling. These included agriculture, rice milling, petty business, local beer brewing, brick making, fishing as well as masonry (Figure: 2). About 42.7% of the respondents practiced agriculture only while 57.3% engaged also in non-farm activities in addition to agriculture.

Table 2: Economic activities per socio-economic group

Activity	Very poor		Poor		Average wealthy		Well-off		Total	Percent
	F	%	F	%	F	%	F	%	F	%
Agriculture only	27	18.0	27	18.0	9	6.0	1	0.7	64	42.7
Rice milling	-	-	-	-	6	4.0	7	4.6	13	8.7
Petty business	-	-	2	1.3	22	14.6	5	3.3	29	19.3
Local beer brewing	8	5.3	10	6.6	2	1.3	-	-	20	13.3
Brick making	-	-	5	3.3	6	4.0	-	-	11	7.3
Fishing	2	1.3	3	2.0	1	0.7	-	-	6	4.0
Masonry	-	-	1	0.7	6	4.0	-	-	7	4.7
Total	**37**	**26.3**	**48**	**31.9**	**52**	**34.6**	**13**	**8.6**	**150**	**100**

Source: Field data, 2022

This study was interested to find out how the main agricultural activities were being practiced by the wetland farmers in the different seasons and their implications to food production. The focus was mainly on crop cultivation and livestock grazing.

Table 3: **Proportion of wetland farmers in the socio-economic groups**

Wealth group	Households per village						Total	
	Mkangawalo *n = 41*		**Mngeta *n = 32***		**Njage *n = 77***		***n=150***	
	F	%	F	%	F	%	F	%
Very poor	11	7.3	2	1.3	3	2.0	16	10.7
Poor	19	12.7	16	10.7	26	17.3	61	40.7
Average wealth	10	6.7	11	7.3	43	28.7	64	42.7
Well-off	1	0.7	3	2.0	5	3.3	9	6.0
Total	**41**	**27.4**	**32**	**21.3**	**77**	**51.3**	**150**	**100**

Source: Field survey, 2022.

3.2 Land Ownership (access) as household assets

The study revealed that majority of the wetland users (68%) in the study villages owned land in the wetland while 32% did not own the fields they cultivated. Variations in land ownership, however, existed among socio-economic groups (Table 4). Majority of the farmers who owned land were in the average wealthy group followed by the poor group. Very few of the poor (1.3%) owned land. Variations also existed among villages. While majority of wetland users who owned land in Mngeta village were in the poor socio-economic group (11.3%) those in Njage and Mkangawalo were in the average wealthy group. Only very few among the wealthy group owned wetland plots especially in Njage and Mngeta villages. Similarly, only very few among the very poor wealthy category in Mkangawalo owned land in the wetland. The above findings clearly show that the major users of the wetland for agriculture were the poor and the average wealthy households because of the land they owned.

Table 4: Land ownership in the wetland among socio-economic groups

Socio-economic group	Village of respondents							
	Mngeta *n=32*		**Mkangawalo *n=41***		**Njage *n=77***		**Total *n=150***	
	F	%	F	%	F	%	F	%
Very poor	-	-	2	1.3	-	-	2	1.3
Poor	17.0	11.3	10	6.6	33	22.0	60	40.0
Average	13.0	8.6	18	12.0	39	26.0	70	46.6
Well-off	2.0	1.3	11	7.3	5	3.3	18	12.0
Total	**32**	**21.2**	**41**	**27.2**	**77**	**51.3**	**150**	**100**

Source: Field survey, 2022

Land acquisition in the wetland was by different modes, which included inheritance, buying, allocation by the village authorities and clan land (Table 5). Majority of the respondents in all

socio-economic groups except the well-off were given land by the village government. On the contrary, majority of the well-off and some of the average wealthy had bought the wetland plots they owned. Thus the village governments in all the three villages had a major influence on who owned land in the wetland.

Table 5: Modes of Land Acquisition among socio-economic groups

Modes of land acquisition	**Percentage of response per socio-economic group**									
	Very Poor		**Poor**		**Average wealthy**		**Well-off**		**Total**	**%**
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
Inheritance	2	2.7	9	6.0	9	6.0	2	1.3	24	16.0
Buying	-	-	3	2.0	20	13.4	17	11.3	40	26.7
Village authority	8	5.3	28	18.7	29	19.3	3	2.0	68	45.3
Clan land	3	2.0	5	3.3	9	6	1	0.7	18	12.0
Total	**13**	**10**	**45**	**30**	**67**	**44.7**	**23**	**13.5**	**150**	**100**

Source: Field data, 2022

For those respondents who did not own land in the wetland they accessed it through hiring (29.3%), borrowing (2%) and sharing with the land owners (0.7%). Majority of those who hired land for cultivation were the average wealthy (31.1%) and the poor (27.3%). The well-off who hired land were 26.3%. The very poor farmers (25%) borrowed land while 1.4% of the average wealth shared land with the owners.

3.3 Seasonal Patterns of Agriculture in Wetlands uses

This study was interested to find out how the main agricultural activities were being practiced by the wetland farmers in the different seasons and their implications to food production. The focus was mainly on crop cultivation. Respondents were asked about the reasons for opting for wetland cultivation. Majority of the respondents (54.7%) especially the average wealthy and the well-off, mentioned the presence of fertile soil and moisture and or water availability as the main reasons. These allowed them to grow commercial crops like rice, the major crop for 94.7% of the respondents. For the very poor and the poor groups, the decision to cultivate in the wetland was due to crop failure in the upland plots due to drought and eviction from the reserve areas in the uplands. This was confirmed by one of the key informants who said;

> *"My crops have dried in the upland due to poor rains…. No water for irrigation. The area I used to grow crops is now a reserve area… But in this wetland I can*

grow crops although in a small plot but I am sure I can get only food" (Key informant from Mngeta village, 2021 Pers. com).

Most of the respondents depended on rain-fed agriculture. They grew their wetland crops in December (the period of short rains) and January-February (period of intermediate rains) (Table 6). Rice, the major crop in the study area was particularly grown by the majority during this period. Only 4% who could cultivate in both wet and dry season were growing rice between May and July. Majority of the farmers (54%) were also growing maize in December while about 16% were growing it between May and July.

Table 6: Seasonal Calendar of growing crops

	December	**Jan-Feb**	**May-July**
Wetland crops	**%**	**%**	**%**
Rice	51.3	40	4.0
Maize	54.0	2.6	16.0
Sesame	4.7	2.0	-
Bananas	4.7		-
Cassava	4.0	2	-
Leafy vegetables	-	-	3.3
Upland crops			
Rice	4.0	-	-
Maize	30.0	-	12.6
Bananas	5.3	-	0.7
Sesame	1.3	-	0.7
Cassava	-	-	2.0

Source: Field data, 2022

Irrigation agriculture was practiced in the dry season in order to cope with drought though very few respondents (8.7%), mainly the average wealthy and the well-off farmers practiced it. When asked as to why they practiced irrigation agriculture, 6.7% said they irrigated because of prolonged drought, 1.3% needed to increase yields for sale while 0.7% irrigated their fields to increase yields for food. About 4.7% of the respondents irrigated their farms from January to March before the start of the long rains, 2.7% around June to August while 0.7% irrigated from October to December when the short rains did not come on time. These findings implied that only 8.7% of the respondents were able to grow crops throughout the year. Therefore, extension of the irrigation services in the study area could increase food production and thus availability among the households. This is supported by Degefa (2002) who reported that irrigation agriculture practiced in Oromiya wetlands had provided wetland farmers with better food availability and they did not lose crops through drought because of better use of irrigation.

The study examined the common cropping methods practiced in the wetland. It was observed that mixed cropping, rotational cropping, inter-cropping and mono-cropping were commonly practiced. These methods, however, varied according to seasons (Figure 2).

For example, majority of the respondents (70.7%) practiced mono-cropping in the wet season and 54.7% in the dry season. Rotational cropping and intercropping were mainly practiced in the dry season and rarely in the wet season. About 14.7% intercropped maize, cassava and bananas and very few respondents practiced rotational cropping of mainly maize and cassava. Mixed cropping of mainly maize and leafy vegetables was practiced by 18% of the farmers during the dry season and 19.3% during the wet season.

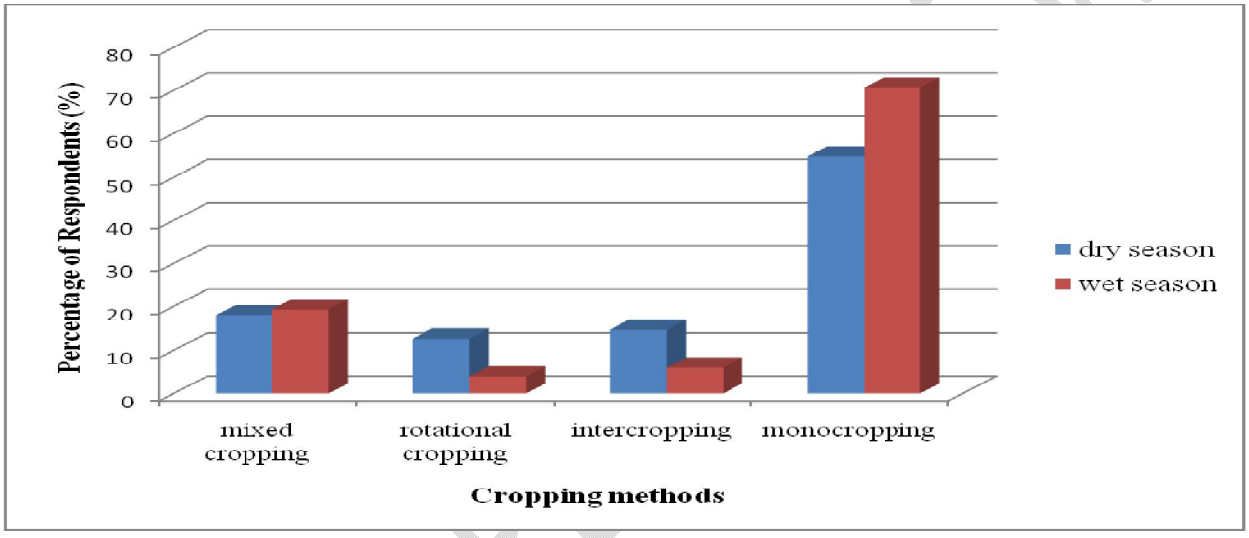

Figure 2: **Cropping methods practiced in the wetland**

The rotation of cereals, leafy vegetables, roots, fruits and leguminous plants improved nitrogen compounds and physical properties of the soil, reduced soil erosion, suppressed weeds, insects and diseases and thus increased yields of rotated crops (Rizvi, 1992; Mukwada, 2000; Mahonge, 2010). This method could therefore benefit farmers in Kilombero wetland if widely practiced. Unfortunately only very few respondents in the study area practiced rotational cropping. In Lake Jipe wetland, farmers practiced inter-cropping due to land shortages that limited the practice of mono-cropping (Mahonge, 2010). This was contrary to the practice in the study area where farmers had small plots but practiced mono-cropping. According to Tumbo (2012), mixed cropping was being widely used in Simiyu wetlands with the expectations that when one crop failed, another crop could survive due to differences in crop cycles, rooting depth and water requirements. In Kilombero wetland, however, this was true for only 18% and 19.3% of the respondents who practiced mixed cropping during the dry and wet seasons, respectively.

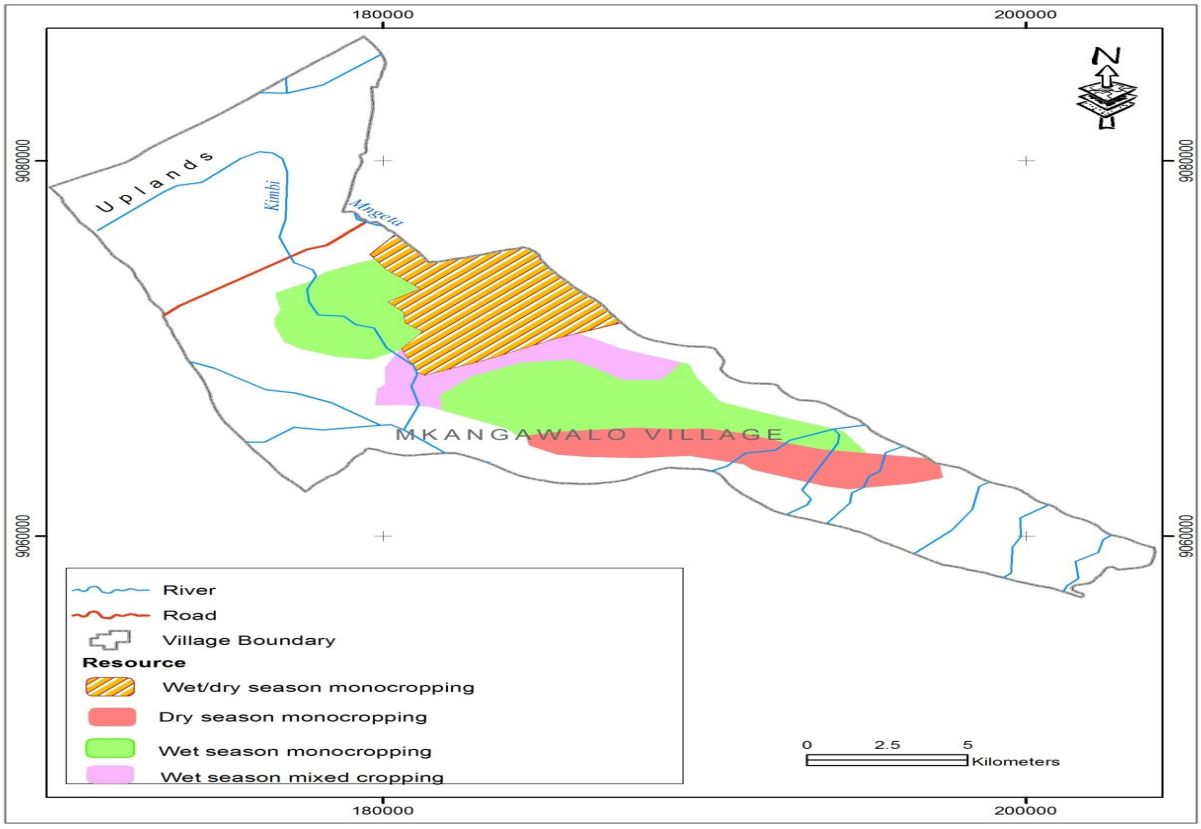

Figure 3: Seasonal Patterns of cropping in the wetland in Mkangawalo village
Source: GIS lab. IRA, 2022

Similarly, mono-cropping covered a very large area in Njage village compared to mixed and intercropping (Figure 3). Dry season mixed cropping was observed in areas where irrigation was practiced while inter-cropping was seen to cover a very small area. Rice was grown as a single crop while maize and sesame were mixed in different portions in the same field. In some cases cassava and bananas were seen being intercropped. Basing on (Figure 4) below shows the seasonal patterns of cropping in Mngeta village. Again Mono-cropping, mixed cropping and inter-cropping were the main patterns observed in the village. Wet season mono-cropping covered a large area compared to the other patterns. Rice was grown as a single crop while sesame and maize were mixed in the same field.

From the above findings it is evident that most of the farmers were growing crops in the wet season only when there was plenty of water and depended mostly on mono-cropping of rice, maize and or sesame. This has had implications on food security because of inadequate food varieties. This is contrary to other wetlands where intensification and a combination of varieties of cropping methods had improved food production.

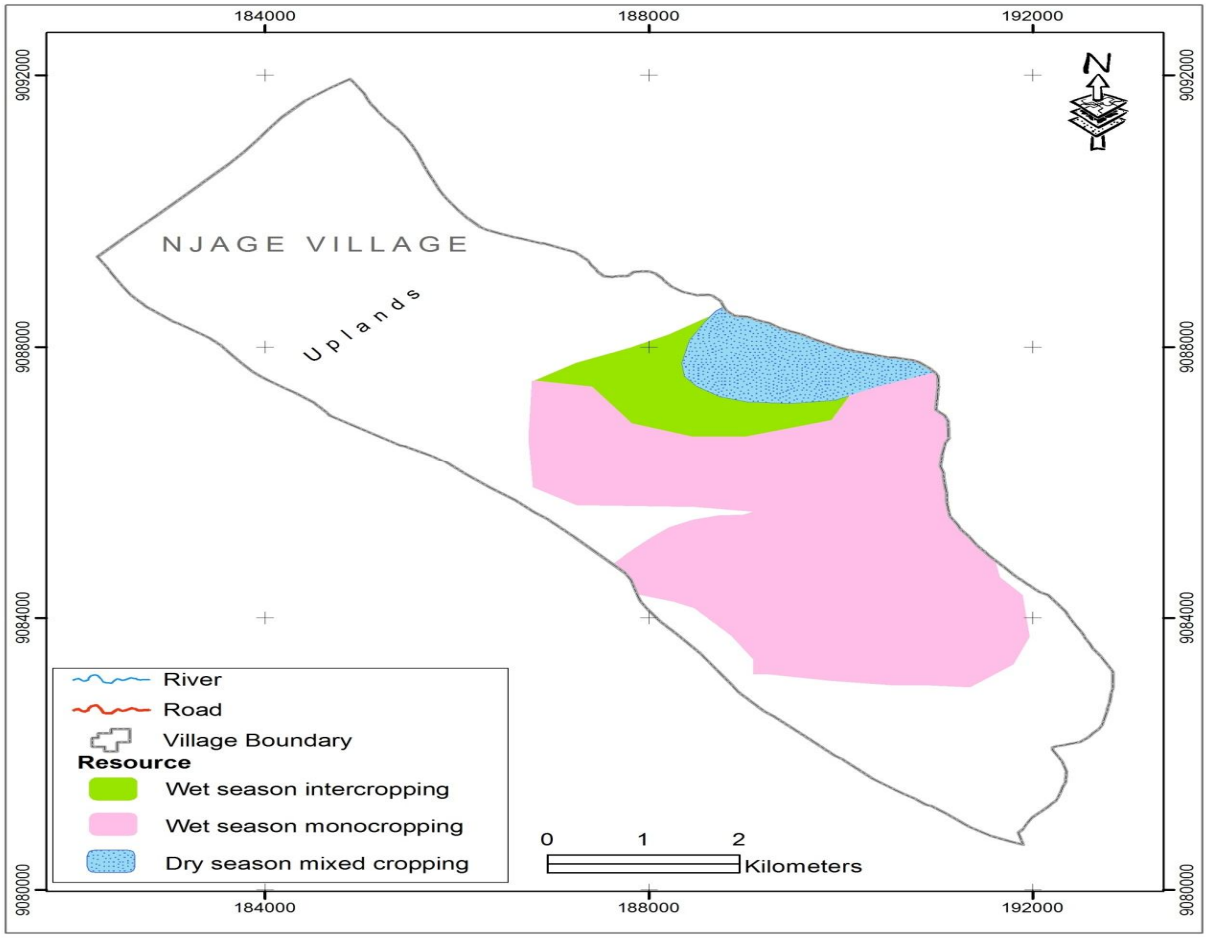

Figure 4: Seasonal Patterns of cropping in the wetland in Njage village
Source: GIS lab. IRA, 2022

Basing on Figure 5 below, shows the seasonal patterns of cropping in Mngeta village composed of Mono-cropping, mixed cropping and inter-cropping were the main patterns observed in the village. Wet season mono-cropping covered a large area compared to the other patterns. Rice was grown as a single crop while sesame and maize were mixed in the same field. From the above findings it is evident that most of the farmers were growing crops in the wet season only when there was plenty of water and depended mostly on mono-cropping of rice, maize and or sesame. This has had implications on food security because of inadequate food varieties. This is contrary to other wetlands where intensification and a combination of varieties of cropping methods had improved food production.

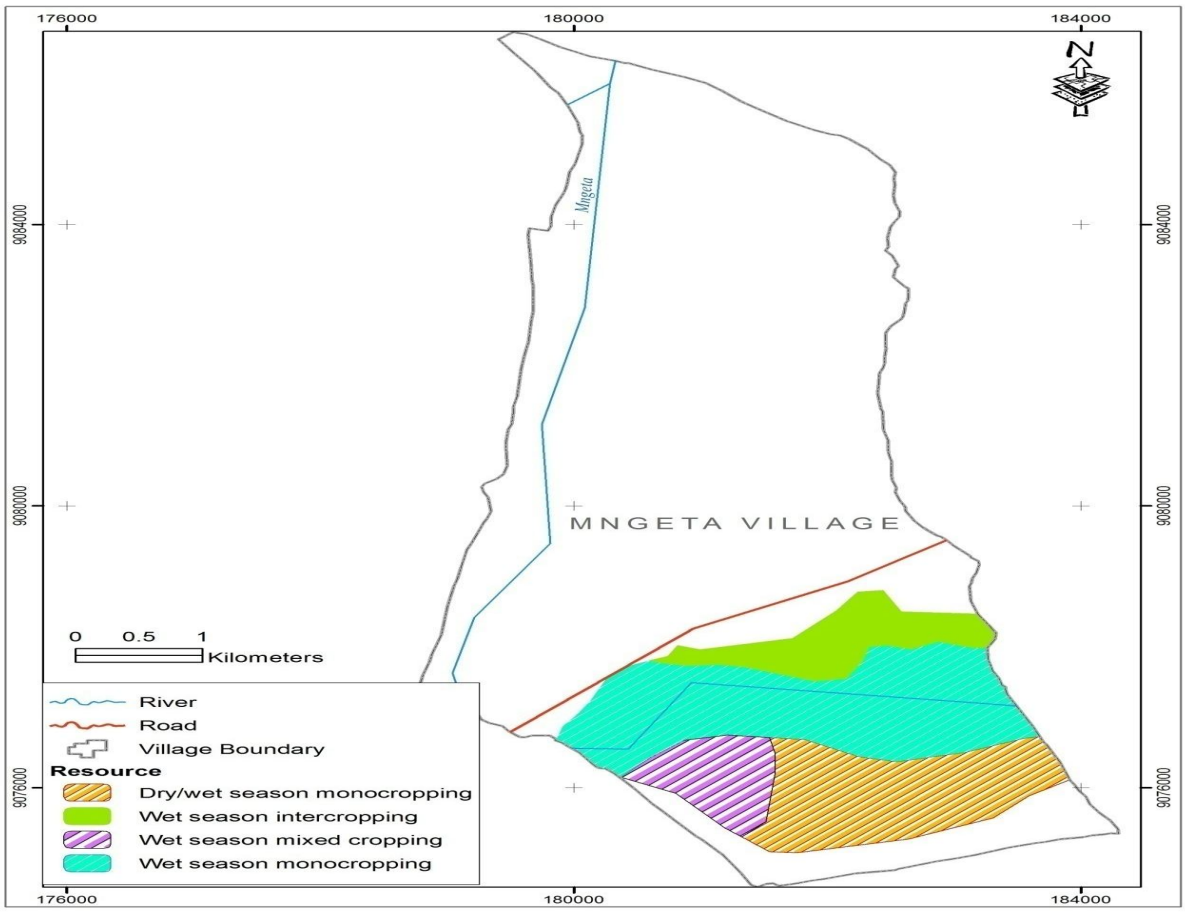

Figure 5: Seasonal Patterns of cropping in the wetland in Mngeta village
Source: GIS lab. IRA, 2022

3.4 Annual Yields of Wetland Crops

Kilombero wetland is very important for both small and large scale agriculture. The wetland supports cultivation of different crops for both commercial and subsistence uses. During the study, it was observed that the annual yields of wetland crops varied depending on the area the crop was being grown. Majority of the respondents had annual rice and maize yields ranging between 1 to 15 bags (Table 7). Only 10.6% produced more than 45 bags of rice and very few produced the same amount of maize. Cassava and sesame were being produced in small quantities by only a few farmers.

The researcher was interested to know whether there was any difference in yields between wetland and upland plots. Forty four percent of the respondents agreed that there was a difference, 24% reported no difference while 32% did not cultivate in the upland. A comparison of crop yields per 0.5 ha was made between the upland and wetland plots. Majority of

respondents (12%) had annual rice yields ranging between 6 to 10 bags from the wetland plots compared to 3.3% who had less than one bag of rice harvested from the upland fields of the same size (Table 7). The yields of other wetland crops were also more than those of the upland crops.

Table 7: Differences in yields (bags per 0.5ha) between wetland and upland crops

Crop type	**Wetland crops**								**Upland crops**					
	<1 bag		1-5 bags		6-10 bags		11-15 bags		<1 bag		1-5 bags		6-10 bags	
	F	%	F	%	F	%	F	%	F	%	F	%	F	%
Rice	1	0.7	1	0.7	18	12.0	6	4.0	5	3.3	2	1.3	-	-
Maize	-	-	37	24.6	20	13.3	3	2.0	21	14.0	23	15.3	5	3.3
Sesame	1	0.7	6	4.0	-	-	-	-	4	2.6	2	1.3	-	-
Total	**2**	**1.4**	**44**	**29.3**	**38**	**25.3**	**9**	**6.0**	**30**	**19.9**	**29**	**17.9**	**5**	**3.3**

Source: Field survey, 2022.

The chi-square test, which was done to test the statistical significance of the differences in yields between wetland and upland crops showed that there was a statistically significant difference in the yields (x^2 *(2, N=150*) = 247.619) (Table 8).

Table 8: Chi-Square Test

	Value	df	A symp. Sig. (2-sided)
Pearson Chi-Square	247.619[a]	12	.000
Likelihood Ratio	167.528	12	.000
Linear-by-Linear Association	103.806	1	.000
N of Valid Cases	150		

Due to more yields being realized in the wetland, some farmers abandoned their upland plots for the wetland plots. During in-depth interview one of the key informants stated:

> *"....There is a lot of water and natural fertility….No need of fertilizer… I have left my plot in the upland so that I can get more yields here. …My family gets food from this small plot." (Key informant in Mngeta village, 2021 Pers. com).*

Bakobi (1993) stated that most of the Tanzanian wetlands were potential for growing various crops such as rice, maize, bananas, sweet potatoes and sugarcanes because of moist and fertile soils. This was also true for Kilombero wetland, which had a potential role in ensuring household food security.

4. Contribution of Kilombero Wetland to Household Food Production (HFP)

Basin on the production results, it is evident that most of the respondents were food insecure. Key indicators of food security/insecurity, most of the key informants mentioned levels of income, number of meals per day and the presence of surplus food. Low income limited poor farmers' access to food through purchases. majority of the wetland users in the study area were the poor and average wealthy groups whose annual income ranged from Tsh 50,000 to 100,000 and 100,000 to 1,000,000/=, respectively. It was observed that the income earned covered a range of needs such as food, school fees, field preparation, hiring plots for cultivation as well as buying farm inputs. Thus it was not enough to purchase adequate food supplies.

About the contribution of Kilombero wetland to household food security, majority of the respondents said that it had increased their crop yields as well as cash income (Table 9). Further scrutiny of the results, however, revealed that the wetland has had little contribution to household food production especially among the very poor farmers. The other groups of farmers, however, were able to increase their yields and food in both dry and wet seasons from wetland cultivation. Some also increased their savings food budget and got varieties of food. Majority of these were in the average wealthy and well-off categories.

The results on (Table 9*)* imply that only the food security and livelihoods of the average wealthy, well-off and a few of the poor farmers were improved by wetland cultivation. The very poor and poor farmers especially those who did not own land generally remained poor and food insecure because even the little income they obtained from selling crops was used to hire plots and at the same time buy food. This is contrary to the rural wetland farmers in Waza Logone floodplain in Cameroon, who had their livelihoods improved on a per capita basis of € 53 per floodplain dependant member (Loth and Acreman, 2004).

Table 9: Contribution of Kilombero Wetland to HFS

Contributions	Very poor		Poor		Average wealthy		Well-off		Total	
	F	%	F	%	F	%	F	%	F	%
Increased cash income	-	-	8	5.3	40	26.7	14	9.3	62	41.3
Savings for food budget	-	-	2	1.3	15	10.0	17	11.3	34	22.7
Increased crop yields	2	1.3	21	14.0	36	24.	11	7.3	70	46.7
Get food varieties	-	-	2	1.3	11	7.3	7	4.7	20	13.3

Provision of food in dry and wet season	-	-	15	10.0	22	14.7	12	8.0	49	32.7

Source: Field data, 2022

Moreover, when asked about the importance of wetland cultivation to HFS majority of the respondents (52.7%) agreed that wetland cultivation was important for food security in the study area. When asked to explain why it was important, majority of the respondents (46%) said the wetland had provided them with markets for their crops and livestock. While 41.3% had their income increased, 24.7% could grow wetland crops in wet and dry seasons while only 18% said the wetland had provided them with pasture/grazing land for their livestock. On the other hand, about 47.3% of the respondents confirmed that the wetland did not have any contribution to household food security. When asked to explain why they said so, they mentioned low income obtained despite cultivating in the wetland and food insecurity among the very poor and poor households. They also said that land allocation favoured the rich and investors and not the poor. This was confirmed by one of the key informants who angrily said;

> *"What food security? There is no food security at all.. I cultivate in the wetland but I'm still poor. They took my farm plots and gave them to KPL. They took my large farm in the wetland and allocated it to rich farmers from town. I and my poor mates will remain food insecure" (Key informant in Mkangawalo village, 2022 pers.com).*

These results further confirm that the wetland had improved the food security of the well-off and average wealthy more than the poor group.

5. Conclusion

To conclude, from the findings of this study it is concluded that majority of the wetland users were the poor and the average wealthy farmers who depended on the wetland for their survival. They had limited assets, including land, income to support their livelihoods. While the very poor farmers did not own land in the wetland, most of the poor farmers owned small plots that they acquired from their clans and through inheritance. The average wealthy and the well-off, however, owned large wetland plots that they acquired through buying and from the village authorities. Thus generally, despite its agricultural potential, Kilombero wetland had not contributed much to improving the food security status and livelihoods of the very poor and poor farmers.

Food insecurity was still rampant among their households; only the well-off and average wealthy farmers seemed to have benefited more from wetland cultivation. These could afford three meals a day and their increased income enabled them to diversify in to off-farm activities which supported them whenever they faced food shortages.

Therefore, Kilombero district authorities should ensure that village governments allocate adequate land for both the poor and very poor farmers to enable them increase crop production. The government should also encourage the wetland farmers to diversify their crops and activities to increase production and earn income that they can use to buy food in cases of food shortages. The agricultural extension officials of Kilombero district should educate farmers on the importance of intensive agriculture, use of improved seeds and use of a variety of cropping methods in order to improve their produce. This calls for more economic diversifications which will ensure more production in the Kilombero wetlands ecosystems.

REFERENCES

Babbie, E.R. *Practice of Social Research*. Wordsworth Publishing Company, Belmont. 2019

Bakobi B.L.M. *Conservation of Wetlands of Tanzania*, in Kamukala G.L &Crafter S.A (1993) *Wetlands of Tanzania*: Proceedings of a Seminar on the Wetlands of Tanzania, Morogoro, Tanzania, 27-29th November 1991. 1993

Balama, C., Augustino, S., Ericksen, S., Makonda, F.S.B. and Amanzi, N. Climate Change Adaptation Strategies by Local Farmers in Kilombero District, *Ethiopian Journal of Environmental Studies and Management*, 6:724-736. 2013

Becker, M. *Wettelands in East Africa*: Reconciling Future Food Production with Environmental Protection, Institute of Crop Science and Resource Conservation (INRES), Berlin. 2017

Bergkamp, G., McCartney, M., Dugan, P., McNeedly, J. and Acreman, M. *Dams. Ecosystem Functions and Environmental Restoration*, Thematic Review 11.1 World Commission on Dams, Cape Town. 2000

Degefa, T. *Household Seasonal Food Insecurity in Oromiya zone Ethiopia*: Causes, Organization of Social Sciences Research in Eastern and Southern Africa, Addis Ababa. 2002

Emerton, L. *Values and Rewards:* Counting and Capturing Ecosystem Water Services for Sustainable Development, IUCN water, Nature and Economics Technical Paper 1, Gland. 2005

Flintan, F. Engendering Eden: Women, Gender and ICDPs in Africa: Lessons Learnt and Experiences Shared, *IIED wildlife and Development Series*, 2(17). 2003

Geheb, K. and Adebe, Y.D. *Wetlands of Ethiopia:* Proceedings of a Seminar on the Resources and Status of Ethiopia's Wetlands, IUCN, Nairobi. 2003

Hassan, H.K. and Munishi, P.K.TContribution of Wetlands to Household Income and Food Security in Nyumba ya Mungu Wetland System, *Tanzania Journal of Forestry and Nature Conservation*. 79(2). 2009

Hertzel M.A.W., Alba S., Frankhauser M., Mayumana I., Lengeler C., Obrist B., Nathan R., Makemba A.M., Mshana C., Alexander Schulze A. and Mashinda H. *Malaria Risk and Access to Prevention and Treatment in the Paddies of the Kilombero valley*, Tanzania. 2008

Jamu, D.M., Chimphamba, J.B, Brumett, R.E. Land Use Patterns in Likangala River Catchment and its Implication for Management of Small Watersheds in Developing Countries, *Geophysics Research*. 7:248. 2005

Kadigi, R.M.J. *Rice Production Economics at the Local and National levels*: The Case of Usangu Plains in Tanzania, Sokoine University of Agriculture, Morogoro. 2003

Kakuru, W., Tindamanyire, T., Mafabi, P. and Lyango, L., *Wetlands*: Wise Use, Smart Plans Meeting the Challenges for Sustainable Wetlands Use. 2013

Kalinga, G.M. and Shayo, E. Tanzania Country Paper: Agriculture in the Tanzania Wetlands, Available on line at: *http://www.fao.org.com* Retrieved on 2nd September, 2015. 1998

Kangalawe, R.Y. and Liwenga, E.T. Livelihoods in the Wetlands of Kilombero Valley in Tanzania: Opportuniies and Challenges to Integrated Water Resources Management, *Physics and Chemistry of the Earth*, 30(11):968-975. 2005

Liwenga E.T. Food Insecurity and Coping Strategies in Semiarid Areas: The Case of Mvumi in Central Tanzania, The Department of Human Geography, Stockholm University, Stockholm, Sweeden. 2003

Loth, P. and Acreman, M.C. The Return of Water: Restoring the Waza Logone Floodplain in Cameroon, IUCN, Gland. 2004

L'vovich, M.I., White, G.F., Belyaev, A.V., Kindler, J., Koronkevic, N.I., Lee, T.R. and Voropaev, G.V. Use and Transformation of Terrestrial Water Systems. The Earth as

Transformed by Human Actions: Global and Regional Changes in the Biosphere over the past, 300:235-252. 1990

Lyimo, J.G. (2005), Changes in Agricultural Land Use and Household Production in Tanzania: A Case of Smallholder farmers in the Usangu Plain. PhD Dissertation, University of Copenhagen.

Mahonge, C.P.I. Co-managing Complex Socio-ecological Systems in Tanzania: The Case of Lake Jipe Wetland, Wageningen Academic Publishers, Netherland. 2010

Majule, A.E. Climate Change Impacts on Livelihoods in Wetland Resources of Bahi District, Central Tanzania, Institute of Resources Assessment (IRA), University of Dar es Salaam. 2009

McCartney, M.P. and van Koopen, B. Sustainable Development and Managemnt of Wetlands. Wetland Contributions to Livelihoods in United Republic of Tanzania. International Water Management Institute, Colombo. 2004

McCartney, M., Rebelo, L., Sellamuttu S.S. and de Silva, S. *Wetlands, Agriculture and Poverty Reduction,* International Water Management Institute (IWMI), Colombo, 137:39. 2010

Msofe, N.K. Dynamics of Land use/cover Changes and its implications to Rural livelihoods and Wetland Resources: A sace of Kilombero Wetlands. A Masters Thesis, University of Dar es Salaam. 2012

Mombo, F., Speelman, S., van Huylenbroeck, G., Hella, J., Pantaleo M. and Moe, S. Ratification of the Ramsar onvention and Sustainable Wetlands Management: Situation Analysis of the Kilombero Valley Wetlands in Tanzania, *Journal of Agricultural Extension and rural Development*, 3(9):153-164. 2011

Mombo, F., Speelman S., Kessy J., Hella J. & van Huylenbroeck G. Determinants of Access Partens to Goods and Services from Wetlands in Tanzania and the Impact on Sustainable Wetland Management, *African Journal of Agricultural Research*, 7(14):5585-5593. 2012

Munishi, P.K.T, Kilungu H.H., Jackson H., and Soka G. Gender Relations in Utilization and Conservation of the Kilombero Floodplains Ramsar Site Wetlands. *Tanzania Journal of Forestry and Nature Conservation,* 81(2). 2012

Najafi, B. An Overview of Current Land Utilization Systems and Their Contribution to Agricultural Productivity. Report of the APO Seminar on Impact of Land Utilization Systems on Agricultural Productivity, Productivity Organization (APO), Iran. 2003

Palela, E. *The impact of Anthropogenic Factors on Wetlands*: The Case of Msimbazi Valley, Dar es Salaam, unpublished M.A. Thesis, University of Dar es Salaam. 2000

Pedro, M.H, Davies, J., and Baena, P.M. *The Governance of Rangelands:* Collective Action for Pastoralism, Routledge, New York. 2014

Puhalla, J.M. Land Use and Agricultural Intensification in Mugandu Wetland, Kabale District, A PhD Dissertation, University of Florida, USA. 2009

Ramsar Convention Secretariat, *Ramsar Concentration Manual*: A guide to the Convention on Wetlands (Ramsar, Iran 1971) 6th Edition, Ramsar Convention Secretariat, Gland. 2013

Ramsar. *Wetlands and Agriculture*: Partners for Growth, Gland, Switzerland. 2014

Schuyt, K. and Brander, L. *The Economic Value of the World's Wetlands*, WWF, Gland. 2004

Tumbo, M. Community vulnerability and Adaptation to the Impacts of Climate Variability and Extremes on Simiyu Wetlands: The Case of Simiyu Wetlands, Lake Victoria, Institute of Resources Assessment, University of Dar es Salaam. 2012

Turyahabwe, N., Kakuru W., Tweheyo M. and Tumusiime M.D. *Contribution* of Wetland Access to Household Food Security in Uganda, Kampala. *Agriculture and Food security*, 2(5). 2013

URT.National Wetlands Strategies, Ministry of Natural Resources and Tourism, Dar es Salaam. 2007

URT.Kilombero District Socio-economic Profile, NLUP and BTC, Ifakara, Morogoro. 2012

Wood, A., Dixon, A. and McCartney, M. *Wetland Management and Sustainable Livelihoods in Africa*, Routledge, London. 2013

WWF.*The Economic Value of the World's Wetlands*, Luke Brander Institute for Environmental Studies, Netherlands. 2014

Yanda, P.Z., Majule A.E. and Mwakaje A.G. *Wetlands Utilization, Poverty Alleviation and Environmental Conservation in Semiarid Areas of Tanzania:* The Case of Singida and Dodoma Regions, A Paper Presented in REPOA 9th Annual Workshop. 2004

Zwart, L., van Benkering, P., Kone, B. and Wymenga, E. (ed). *The Niger, a lifeline*, RICA/IVM/Wetland International/Altenburg and Wymenga ecological Consultants, Veenwounden. 2005