BIOFUEL PRODUCTION AND FOOD AVAILABILITY IN MERU DISTRICT, ARUSHA TANZANIA

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ABSTRACT

Jatropha cultivation for biofuel production in Tanzania started in 2006 and the process has kept on increasing. In Meru District it has continued through inter-cropping system, which can lead to food insecurity due to its competition with food crops in its growth requirements. A cross sectional research design was adopted in this study to examine how jatropha production as biofuel raw material influences food availability in the District. Overall, 232 male and 58 female farmers were involved. Wards Agricultural Officers and District Agricultural and Nutrition Officers were also involved. Data was analyzed using SPSS version 20. Household food security status was assessed using questions obtained from Household Food Insecurity Access Scale (HFIAS). Results show that: Food secure access was 16%, mildly food insecure access was 35%, moderately food insecure access was 46% and severely food insecure access was 3%. This means that communities were food insecure since only 16% were able to access food all the time. Jatropha cultivation was done in small scale whereby 2% of agricultural land was used for cultivation and 98% of agricultural land was for other crops. No biofuel production was done in the District since the responsible company for production was closed. We reject the null hypothesis that the production of jatropha as raw material for biofuel production will unlikely lead to food insecurity since there is reduction of number of bags of maize harvested in post jatropha production, the jatropha production did not generate income to 95% of the farmers since there was no market for the seeds and made farmers to abandon their plants even though the plants already occupy 2% of the agricultural land. So jatropha cultivation affects food availability, other factors which affect food availability are food price, government subsidies, rainfall, business, labour, distance to the market and land.

DECLARATION

I Neema Mwakasege, do hereby declare to the senate of Sokoine University of Agriculture, that this dissertation is my own original work done within the period of registration and that has neither been submitted nor being concurrently submitted for degree award in any other institution.

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The above declaration is confirmed by

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DEDICATION

This work is dedicated to my beloved parents, my father, late Mr John Mwakasege and my mother Mrs N. Mwakasege, for laying the foundation of my education and shaping me the way I am today. I also dedicate the work to my family, Steven Mugisha Hauli (my husband) and my sons, Sethi S. Hauli and Josiah S. Hauli, for being patient and unfailing support while undertaking this study.

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LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

CO_2	Carbon dioxide
FAO	Food and Agriculture Organization of the United Nations
Fig.	Figure
GTZ	German Technical Cooperation Agency
HFIAS	Household Food Insecurity Access Scale
KLM	Koninklijke Luchtvaart Maatschappij (Royal Dutch Airlines)
MoAFC	Ministry of Agriculture, Food and Cooperatives
NBS	National Bureau of Statistics
Pb	Lead
SMART	Standardized Monitoring and Assessment of Relief and Transitions
SO_2	Sulphur dioxide
SPSS	Statistical Package for Social Sciences
SVO	Straight Vegetable Oils
TaTEDO	Traditional Energy and Development Organization
TZS	Tanzanian Shilling
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
IFPRI	International Food Policy Research Institute
URT	United Republic of Tanzania
TMA	Tanzania Meteorological Agency
WHO	World Health Organization
WFP	World Food Programme
WFS	World Summit on Food Security

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Food security is a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life (FAO, 2003). Food insecurity is defined as uncertain access by people at all times, to adequate food for an active and healthy lifestyle (FAO, 2003).

Food insecurity leads to chronic and often widespread hunger amongst people. According to FAO (2008), human can respond to chronic hunger and malnutrition by decreasing body size, known in medical terms as stunting or stunted growth. This process starts in *utero* if the mother is malnourished and continues through approximately to the third year of life. Food insecurity leads to higher infant and child mortality, but at rates far lower than during famines (FAO, 2008).

The WHO, (2001) stated three pillar determinants of food security which are access, availability and utilization. The Food and Agriculture Organization (FAO, 2006) added a fourth pillar on top of these, stability of the three pillars. The Food and Agriculture Organisation expounds the pillars as accessibility referring to the ability to produce one's own food or buy it; availability as relating to supply of food through production, distribution and exchange; utilization as the ability of an individual to metabolize the food and stability as ability to obtain the food over the time (FAO, 2006). Food availability is still a problem in areas where food production does not meet population needs, thus raising the question does our planet have the capacity to feed the growing millions whose consumption habits are on the rise? Utilization consists of food quality from a nutritional,

sanitary, sensory and socio-cultural point of view. Food security integrates the notion of food safety. The fourth pillar incorporates issues of price stability and securing incomes for vulnerable populations (FAO, 2009).

Food production is determined by a variety of factors including land ownership and use; soil management; crop selection, breeding, and management; livestock breeding and management as well as harvesting. Crop production can be impacted by changes in rainfall and temperatures. The use of land, water, and energy to grow food often competes with other uses and tend to affect food production. Land used for agriculture can be used for urbanization or lost to desertification, salinization and soil erosion due to unsustainable agricultural practices (FAO, 2003). In order for people to produce food crops, they need land and production tools. In the recent past, much of the arable land has been turned into production of non-food crops and even some food crops have been turned into non - food uses such as production of biofuels.

Biofuel are energy carriers derived from the conversion of biomass to provide sustainable inputs for heat, power and transport applications (GTZ, 2005). It is a type of energy derived from renewable plant and animal materials, including ethanol, which is often made from corn in the United States, sugarcane in Brazil and biodiesel (vegetable oils and liquid animal fats) and Green diesel (derived from algae and other plant sources). In Tanzania, jatropha seeds are used for production of biofuels.

1.2 Problem Statement

Jatropha cultivation for biofuel production in Tanzania started in 2006 (Action Aid, 2010) and has kept on increasing. According to Shuma (2010), jatropha is grown in various places including Arusha, Coast, Dodoma, Kilimanjaro, Manyara, Lindi, Tanga, Singida,

Rukwa and Mbeya regions. People in Meru District, Arusha Region cultivate jatropha by inter cropping system whereby jatropha trees are mixed with food crops (Shuma, 2010). This process may lead to food insecurity since the area for cultivation of food crops is reduced by planting jatropha. Similarly, the returns from jatropha are often low as it takes about four years to harvest them. (it is only 31 – 37% of the oil in jatropha which is extracted) (Scott, 2009; Sulle and Nelson 2009).

Biofuel production is likely to compete for inputs with food production. The main inputs for Jatropha production are land, labor, water and fertilizer. Competition for inputs places an upward pressure on food prices, even if the raw material is a non-food crop like jatropha (Sulle and Nelson 2009). By increasing price for food crops; and thus only few people will be able to buy food crops for their own consumption and may escalate into food insecurity.

Biofuel development places a lot of pressure on smallholders and the rural poor farmers, since biofuel expansion tends to generate new pressure on land tenure arrangements, leading to alienation of certain members of the households especially women or even certain communities. Poor households may be compelled to sell their land in order to meet the increasing demands for the biofuel sector of raw material production. This has happened to some degree in Mkuranga District in Coastal Region (Scott, 2009). This may also happen in Meru as biofuel production expands.

1.3 Justification

Tanzania like many other countries with potential to produce biofuels is food insecure since food security statistics from *Household Budget Survey 2010* show that, out of 20 regions of Tanzania, 12 regions had highest prevalence of food insecurity. Studies

conducted to assess the impact of biofuel production on food security in Tanzania (Action Aid, 2010; Sulle and Nelson 2009) show that biofuels initiatives in Tanzania are largely characterized by acquisition of large tracts of land by external investors and using it to plant jatropha and other crops for fuel production. Hitherto limited systematic information on the impact of jatropha production by small scale farmers on food security have been documented (Scott, 2009). This study aims at examining the production of biofuel and its influence on food availability in Meru District in Arusha Region.

1.4 Research Objectives

1.4.1 General objective

To examine how production of jatropha as a biofuel raw material influences food availability in Meru District.

1.4.2 Specific objectives

i. To assess jatropha production in Meru District
ii. To assess food security status in Meru District
iii. To identify factors influencing food availability at the household and at the district levels

1.5 Research Hypothesis

The productions of jatropha as raw material for biofuel production will unlikely lead to food insecurity in Meru District.

1.5.1 The conceptual frameworks of hypothesis

Figure 1 presents the conceptual framework showing hypothetical relationships of the study objectives. It is assumed that jatropha production will unlikely lead to food

insecurity since it will increase household income therefore raising food security status at the household level and the district level. The household may use the income for purchasing food, therefore attaining food availability at the family level. Household income may also be used to finance access to social services for example education and health services, resulting to livelihood security.

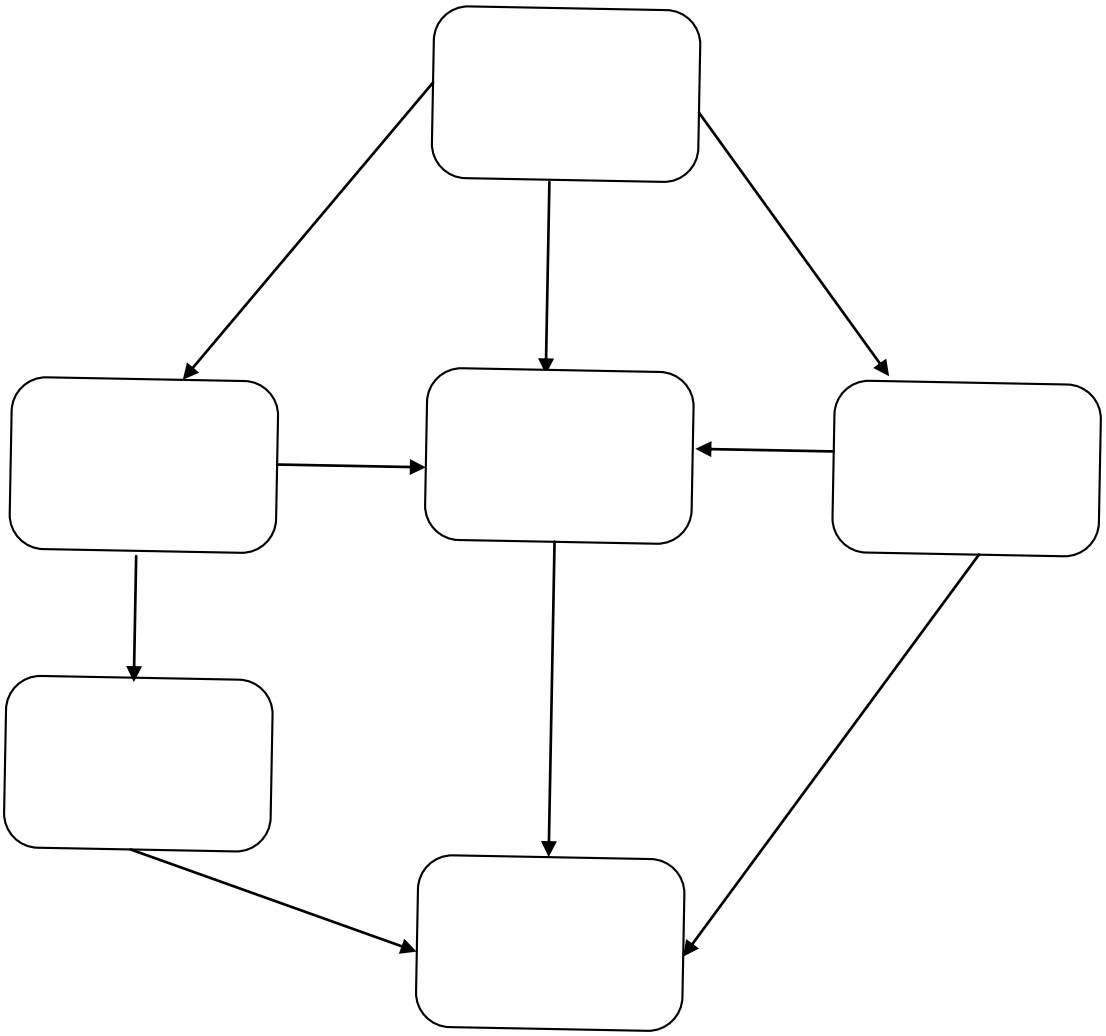

Figure 1: Jatropha production; conceptual framework

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Biofuel Production

The use of petroleum products in diverse sectors of the economy is linked to the emission of pollutants such as lead (Pb), sulphur dioxide (SO_2), and carbon dioxide (CO_2), which in turn raise environmental concerns. Unpredicted rising prices of fossil fuels at the world market have created not only political and social problems but also insecurity and uncertainty in all sectors that entirely depend on them. In the view of this, production and use of biofuels is considered to be the best option to address these challenges (Ejigu, 2008).

According to Oxfam (2008), the shift to production of biofuel will not be a solution to any of the current global crisis but rather may contribute to other crisis such as food insecurity, displacement of communities and degradation of natural resources such as land, forestry, water and biodiversity. Other countries, including Ghana and Ethiopia have already experienced with these problems (Oxfam, 2008).

In Ghana for example, it is reported that a corporation illegally seized 38 000 hectares of land for production of raw materials for biofuels production (Oxfam, 2008). In this country, production has created social tension within community members (Oxfam, 2008). Similarly, in Ethiopia, 10 000 hectares of land were cleared, out of which 86 percent was part of Elephant Haven Company for feedstock plantations to produce raw materials for biofuel production (UNCTAD, 2008).

The biofuel industry in Tanzania is still at its infancy stage as most biofuel projects started in 2006. The government of Tanzania is on the forefront encouraging the production of biofuels as a strategy to reduce green house gas emissions in the light of climate change, diversification of energy sources, creation of employment, improvement of energy security and enhancing rural development (Action Aid, 2009).

2.2 Jatropha Production

The Jatropha plant known as *Jatrophacurcus Linnaeus* is an oil plant which can be used for production of biofuel. Jatropha plant is a small tree or large shrub which can reach a height of up to 5 m. The life span is more than 50 years (Hennemann, 2013). The plant has potential in combating greenhouse effects, it helps to stop local soil erosion, creates additional income for the rural poor and provides a major source of energy both locally and internationally (Hincha, 2013).

Jatropha cultivation in Tanzania is done under large scale plantation and small scale farming (Action Aid, 2009). Large-scale cultivation of jatropha in Tanzania involves taking up large tracts of land from communities. This leads to several social impacts to the community in that particular area intended for biofuels investment. Such impacts involve displacement of people, loss of property and creation of pressure on land resources and other social tensions, which have negative impacts on food security

Cultivation of jatropha in small-scale farming is done by small-scale farmers who cultivate jatropha on their small farms as hedge or intercropping with other crops on the same farm (Shuma, 2010). Small-scale farmers in Meru District apply the same system of cultivation. Such kind of cultivation adopted by the small-scale farmers in this District was

emphasized by the Dilligent Company Tanzania Limited which was the main buyer of raw materials of biofuel production (Shuma, 2010).

The Diligent Company Tanzania Limited was a biofuel production company that was registered in 2005, its activities were to purchase jatropha seeds through collection centers and to promote planting jatropha using an out growers model. The easiest way to convince farmers to grow extra Jatropha was done by buying all Jatropha seeds already available and after sufficient trust between the company and the community was gained, field officers trained the local community to plant additional Jatropha. The company was using the jatropha seeds to produce fuel, which was used by Dutch carrier, KLM in a green fuel test flight in 2009. Collection centers were established in areas with many Jatropha trees. The centers were shops, farmhouse or a rented space, and consisted of a 'main' collector who was often well known in the area, usually the village Chairperson or elder (Shuma, 2010).

Diligent Company provided farmers with jatropha seeds on contractual basis. The company provided seeds to farmers for planting while obligating them to sell the seed harvested to the company. The contract stated an absolute minimum guaranteed price of 100 TZS, which Diligent Company would pay for a minimum of 10 years. The price could increase depending on the oil price and transport expenses. Diligent Company was declared bankrupt in 2012 and Eco Carbone Tanzania took over the activities in the early beginning of 2013 after Diligent Tanzania went into voluntary liquidation. After two years of working, in February 2014, the Eco Carbone Tanzania also ceased to work. Then farmers who signed 10-years contract with Diligent Tanzania Limited were lamenting over the company's demise and their grown plants, as they had no market to sell their seeds. At the same time, they had lost land and energy for jatropha cultivation, which was then

uneconomic worth crop. The communities were food insecure because of reduced land which was taken by jatropha plants, which then reduced the number of bags of maize harvested.

Plate 1: a) Young jatropha plant, b) jatropha flower, c) jatropha seed

2.3 Food Security

2.3.1 The concept of food security

Food security exists when all people at all times have physical and economic access to sufficient, safe, and nutritious food to meet dietary needs and food preference for an active and health life (USAID, 1992). This definition is widely accepted and it is in this respect taken to embrace three specific aims: ensure production and adequate food supplies, maximizing stability in the growth of supplies, and securing access to the available supplies (FAO, 1995). According to LCD (1997), a country and people are food secure when their food system operates efficiently and in such a way that there would be no fear that there will be no enough to eat. In this view, food security will be achieved when the poor and the vulnerable groups of people particularly women, children and those living in marginal areas; have secured access to the food they need.

2.3.2 Pillars of food security

The WHO states that there are three pillars that determine food security: food availability, food access, and food use (WHO, 2013). The FAO adds a fourth pillar: the stability of the first three dimensions of food security over time (FAO, 2006). In 2009, the World Summit on Food Security stated that the "four pillars of food security are availability, access, utilization, and stability".

2.3.2.1 Food availability

The first pillar of food security is availability. In the WFS definition it refers to the term "sufficient". It is defined by WFP as "The amount of food that is present in a country or area through all forms of domestic production, imports, food stocks and food aid" (WFP, 2009).

2.3.2.2 Food access

WFP, defines the food access as "A household's ability to acquire adequate amount of food regularly through a combination of purchases, barter, borrowings, food assistance or gifts". (WFP, 2009). There are three elements in the access to food: physical, financial and socio-cultural. The physical aspect is provided by a situation where food is being produced in the concerned country or area. The economic aspect of the access to food is a situation where by a food commodities are available where people need it and households have the financial ability to regularly acquire adequate amounts of food to meet their requirements. Finally, the last element of the access to food, as per the WFS definition, is the "social" or socio-cultural access to food. This refers to the food commodities be available, physically near to the consumer that may have the required resources to acquire them but that there may be socio-cultural barriers limiting the access to food, in particular to some groups of the population for gender or social reasons.

2.3.2.3 Food utilization

The third pillar of food security is food utilization. In the WFS definition it refers to "safe and nutritious food which meets their dietary needs". It is not sufficient that food be available and accessible to households to ensure that people will have a "safe and nutritious" diet. A number of elements intervene here such as: the selection of food commodities, their conservation and preparation as well as the absorption of nutrients. Food has to be of good quality and safe. It should not be taken for granted that all people, even in so called traditional societies, know how to best utilise food commodities, not to mention the fact that dietary habits are changing very quickly, including in so called traditional societies. This is even more true for displaced persons and refugees and people victim of a shock that may have modified the commodities value chains (Conte *et al*, 2002) Food utilization is also related to clean water, sanitation and health care. This dimension, thus, not only refers to nutrition but also to other elements that are related to the use, the conservation, the processing and the preparation of the food commodities. It shows, however, how closely nutrition is linked to food security and therefore confirms that it is a useless repetition to speak about food security and nutrition as there could not be any food security without proper nutrition (Proietti, 2009).

2.3.2.4 Food stability

The fourth pillar of food security is stability. In the WFS definition it refers to: "at all times". This stability applies in the first instance to the previously mentioned three pillars of food security. Food security is "a situation" that does not have to occur a moment, a day or a season only but on a permanent basis with sustainability.

Thus food security equal to food availability, food access, food utilization and food stability as figure 2 shows:

Figure 2: Pillars of Food Security

2.3.3 Food security at regional level

The concept of food security, however, takes a different dimension at different levels. At the regional level, food security is equated to national and regional food balances (IFPRI, 1994). Nevertheless, food balances is now considered as an inadequate criterion for food security since availability may not guarantee access due to poor distribution or lack of purchasing power. Food security is therefore, defined by a combination of criteria that are not mutually exclusive such as the balance between availability and need; the absence of famine or temporary food insecurity; seasonal or chronic under nutrition; micro nutrient deficiency, especially of iron, iodine, and vitamin A; and nutrient depleting illnesses such as malaria, diarrhea, and internal parasites (IFPRI, 1994).

2.3.4 Food security at household level

At the household level, food security can be defined as the ability of the family of securing enough food to ensure adequate dietary intake for all of its members (FAO, 1983). At this level, food security is equated with sufficiency of household food entitlement, which, is whether food production resources, income availability for the purchase of food (through employment), and gift or assistance is sufficient to meet aggregate needs of all of the household members. In the urban areas, household food security largely depends on the level of income earned by the family. In this case, achieving food security is largely determined by the assumption of minimum nutritional need, particularly energy (FAO, 1983).

According to URT (2003), food security at the household level is defined as the ability of the household to acquire food either through production, purchases, transfers or exchange that are adequate in quantity and quality to fulfill the nutritional needs of all members of the household. It is therefore concerned with intra-household microeconomics, which describes the use of food in the household and the influencing factors such as culture, beliefs, practices and food preparation. Thus, for the household to achieve food security it must have the means to produce (land, production tools and inputs) or the ability to purchase (job and income) the food that the households need, and the time and knowledge to ensure that the nutritional needs of the family members are met.

Food security at an individual level is often not considered, and if it is considered at that level, it refers to nutritional security that also calls for consideration of the healthy status of individuals (IFPRI, 1994).

2.5 Determinants of Household Food Security

Food security is affected by all factors related to the availability of food, access to food and risk related either to availability or access to food. In this respect, the factors associated with food production such as availability of land, access to credit, availability of qualified labour force and agricultural practices do affect the food security situation. Similarly, the factors, which affect stability of the available food such as storage and processing, social sustainability and sustainable environment, can play crucial roles on food security. Also important are the conditions determining food access, which include physical, social and economic accessibility (Hubbard, 1995). Furthermore, macro and micro economic policies are known to have impact on household food security (Ehui *et al,* 2002).

CHAPTER THREE

3.0 METHODOLOGY

3.1 Study Area

The study was conducted in Meru District, Arusha Region, Tanzania. Meru was formaly known as Arumeru (Fig. 1). Meru District is located at an elevation of 1,609 meters above mean sea level; it lies between 3°19'60" S and 36°45'0" E. The District is bordered to the north and west by Monduli District, to the east by Kilimanjaro Region and to the south by Arusha District. The District is divided into 17 wards and has a population of about 268 144 people whereby 131 264 are males and 136 880 are females with a mean household size of 4.3 according to NBS, (2012). The District is estimated to have 214 515 people engaged in agricultural activities (80%) (URT, 2003).

The Meru, Maasai and Waarusha tribes mainly occupied the area. Most of them are small-scale land holders who are subsistence farmers of food crops as well as coffee, Some are employed in several factories such as Brewery, Fiberboard plants and pharmaceuticals. Mererani ward, which is also located in the District, is the sole source of the gem-quality mineral called Tanzanite.

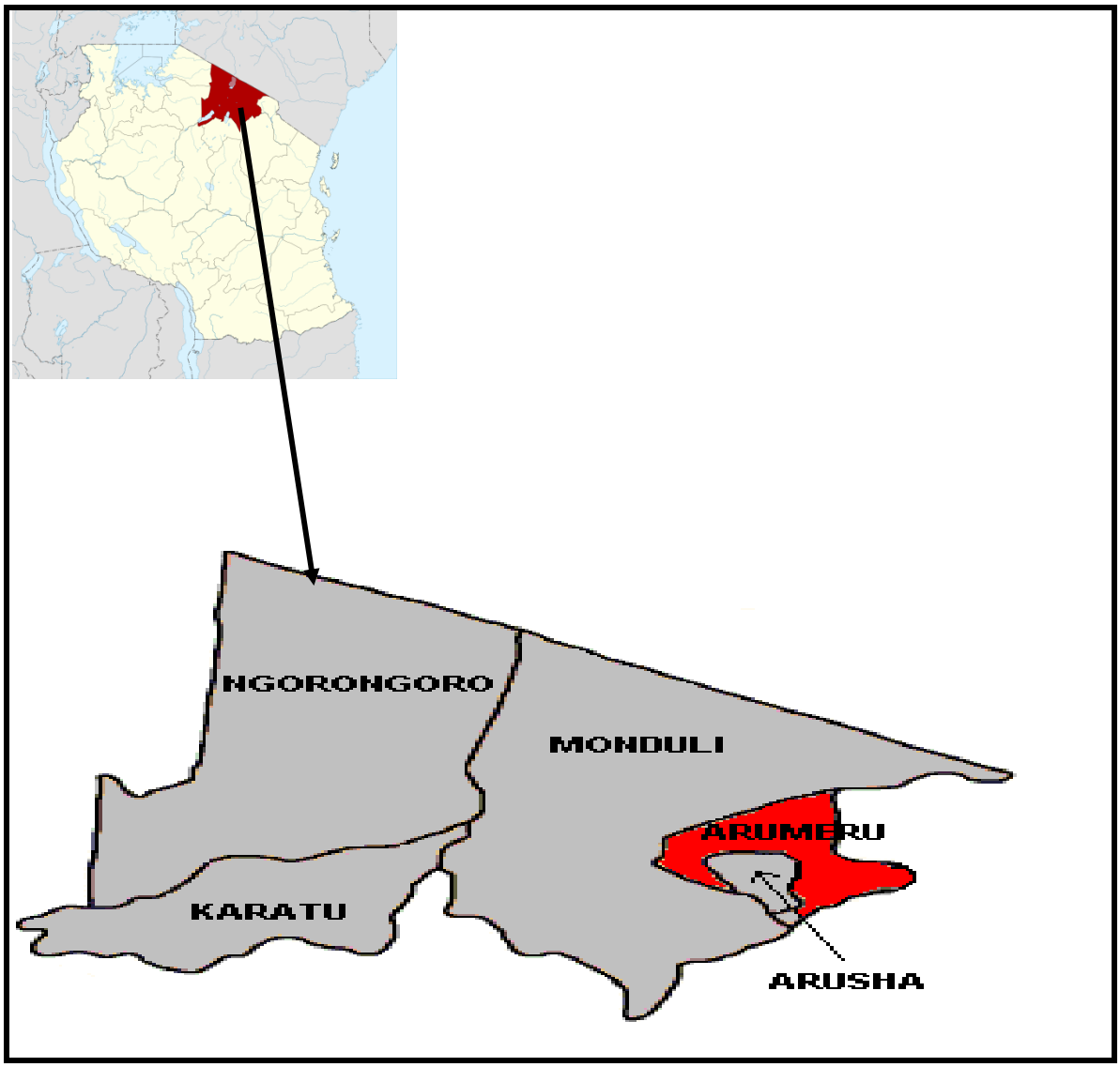

Figure 3: Geographical boundary of Arumeru (Meru District) showing the study area

Source: UNCTAD (2008)

3.2 Study Design

The study employed a cross - sectional research design which allows data collection to be conducted once. Data collected at various levels: household, community and district levels. This involved various techniques ranging from face-to face interviews to focus group discussions and key informants discussions.

3.3 Sampling Frame and Unit

Sampling frame consisted of the Meru District Administrative Officers, mainly the District Agricultural Officer, the District Nutrition Officer and the Ward Agricultural Officers of Leguruki, Kingóri and Maji ya Chai Wards. Other groups were small - scale farmers engaged in jatropha cultivation from three wards which were Leguruki, Kingóri and Maji ya Chai. Furthermore, other targeted respondents were the Diligent Company employees. However, employees of this company could not be involved as they were not around because the company went bankrupt in 2012.

3.4 Sample Size

The MoAFC (2010) approximated that, seventeen percent of the Tanzania population in Meru District are engaged in agricultural activities. This was equivalent to 209 152 of the population in Meru District according to the 2012 Tanzania census (NBS, 2012). So the required sample was obtained by using the method adopted by SMART (2012) that was calculated as per following formulae:

$$\text{Sample Size} = \frac{[(\text{Z - score})^2 - \text{Std Dev}*(1-\text{Std Dev})]}{(\text{Margin of error})^2}$$

Whereas;

Z- Score is 1.96 as 95% confidence level takes a 0.5 standard deviation.

A margin of error (confidence interval of ± 0.05)

Hence, the calculation was as follows

$$\frac{[(1.96)^2 \times 0.78 \times 0.22]}{(0.05)^2}$$

= 263 farmers represented an appropriate sample size to meet statistical value. However, 290 were recruited to take into consideration of attrition.

3.5 Sampling Technique

Sampling for primary data collection adopted a number of steps and procedures to ensure a representative sample of the Meru District. Diligent Tanzania Company was purposively selected because it was an active company in the production, promotion and usage of vegetable oil, mainly Jatropha oil (Agri Hub Tanzania, 2014). In addition, purposive sampling was done to obtain respondents in the district (the District Administrative Officers) because of their specific duties. The selected respondents were the Nutrition Officers, the District Agriculture Officer and the Ward Agriculture Officers from respective selected wards.

Simple random sampling for wards in Meru District was done to have three representative wards (Leguruki, Kingóri and Maji ya Chai). Wards were selected by lottery method followed by listing method that was done to get ten villages from the three wards. The selected ten villages were Ngurdoto, Maji ya Chai, Imbaseni, Nkoasenga, Chichitoni, Leguruki, Miririni, Malula, Nsenyonyi and Kingóri, Lastly, the small-scale farmers were randomly selected by listing in each village involved

3.6 Data Collection

Data collection was achieved through key informants' interviews and the use of the structured questionnaire to interview small-scale farmers (Appendix 1 and 2).

3.6.1 Key informants interviews

District's Administrative Officers participated in this part of the study. Key informant interviews were guided by an interview schedule, which included biofuel production in Meru District, food security especially availability and factors influencing food availability in the District. Through the prepared interview schedule, key informants had to identify factors influencing food availability at the household and District levels.

3.6.2 Face to face interviews

For each village, jatropha small-scale farmers were interviewed face to face. A sample size of 290 farmers taken from ten villages was used. The farmers were asked to give information on farm productivity and jatropha plantation, family income before and after jatropha cultivation, number of bags of staple food harvested before and after jatropha cultivation. An assessment of food security status was done by using questions obtained from Household Food Insecurity Access Scale (HFIAS) and other questions were added in order to get information about factors influencing food availability in the district.

3.7 Data Analysis

The collected data was entered into statistical program (Statistical Package for Social Sciences - version 20 (SPSS, Inc, Chicago, IL, USA) for analysis to explore frequencies for categorical variables including assessment of jatropha production. Inferential statistics such as Chi-square test was done to test the level of significance among variables. All the statistical confidence levels were tested at 95% significant level ($P \leq 0.05$). Questions on food security status were coded and analyzed by grouping them into four categories according to Household Food Insecurity Access Scale (HFIAS). The four categories were; food secure, when answers of all nine questions scored 0 to 1. Mildly food insecure access status when answers of all nine questions scored 5 to 8. Moderately food insecure access

status when answers of all nine questions scored 8 to 12 and severely food insecure access status when answers of all nine questions scored 13 to 27.

The codes were 0 for no, rarely and yes 1, sometimes 2 and often 3. The higher the score household scored the more food insecurity (access) indication, the lower the score the less food insecurity (access) at household. Maximum score is 27 and minimum score is 0.

CHAPTER FOUR

4.0 RESULTS

4.1 Respondent Characteristics

4.1.1 Age and sex of respondents

A total of 290 respondents were involved in this study, among them 80% were males and 20% were females. The mean age of the respondents was 51 years and 61% of the respondents were in the age category between 43-60 years. About 51% of the subjects in this aged category (43 – 60 years) were males and only 10% were females (Fig. 4). About 34% were aged between 61- 82 years (Fig. 4).

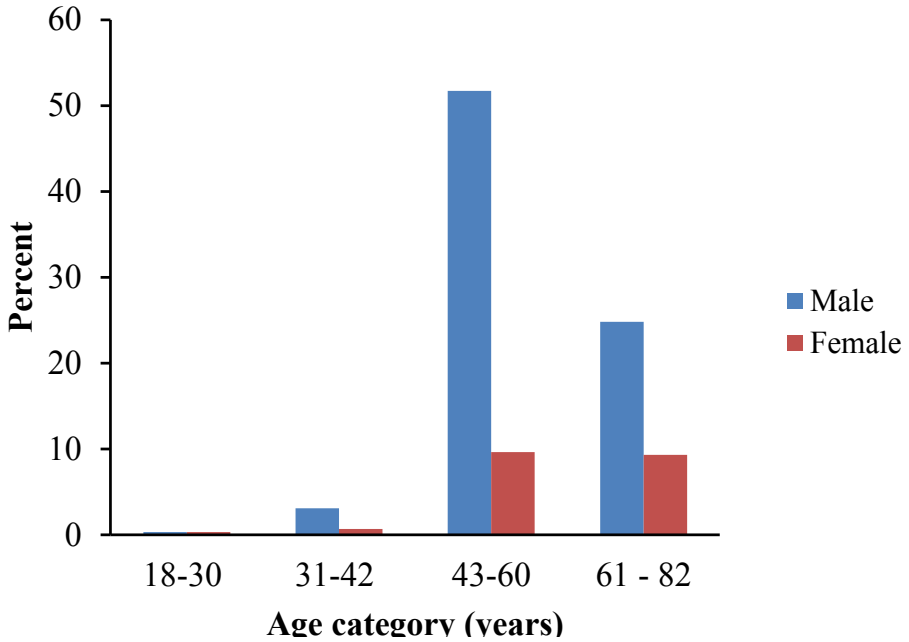

Figure 4: Age and sex of the respondents

4.1.2 Marital status of the respondents

More than three quarters (85%) of the respondents were married. The least proportion were either single (2%), widow/widower (11%) or divorced (2%) (Fig. 5). Among the married respondents, 76% and 9% were males and females, respectively. The percent of the divorced respondents was equal (1%) in both male and female (Fig. 5)

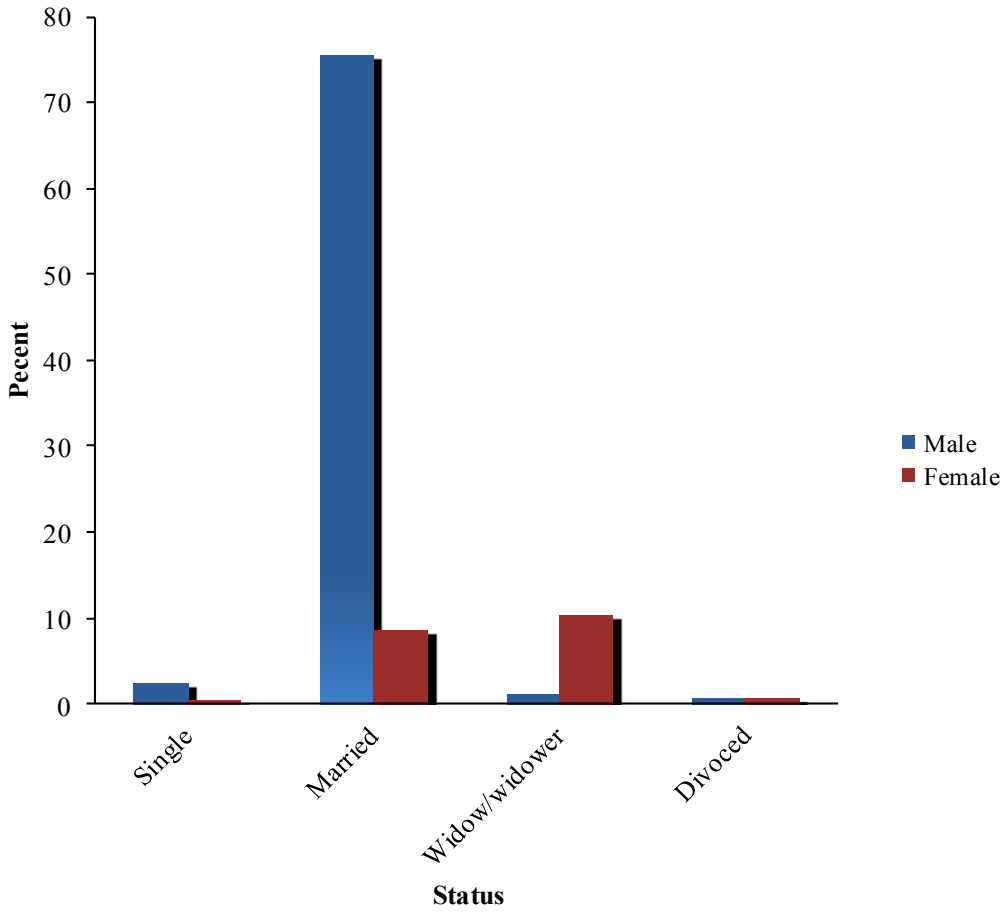

Figure 5: Marital status of respondents

4.1.3 Marital status and age

About 6% and 5% of the widow or widower were aged between 61 – 82 and 43 – 60 years, respectively (Fig. 6).

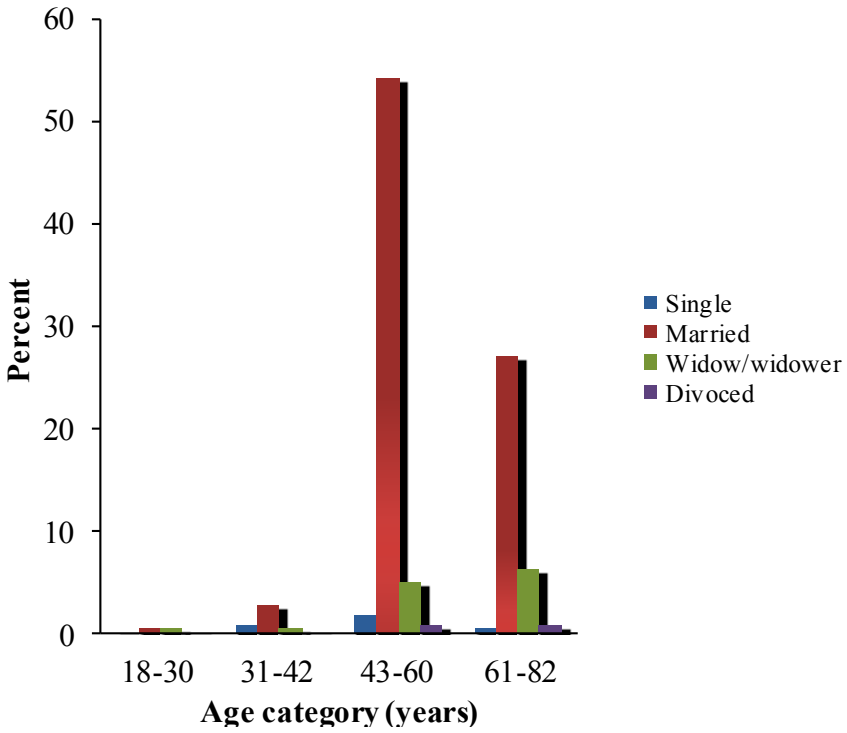

Figure 6: Marital status and age categories of respondents

4.1.4 Education level of respondents

The level of education attained by most of the respondents (81%) was primary school education (class 7), 17% had never attended formal education and 2% had attended adult literacy education program. Only one percent of the respondents had attained secondary school education. Among respondents who had acquired primary school education, 68% were males and 13% were females. About 6% and 11% of the respondents who had never attended formal schooling were females and males, respectively (Fig. 7).

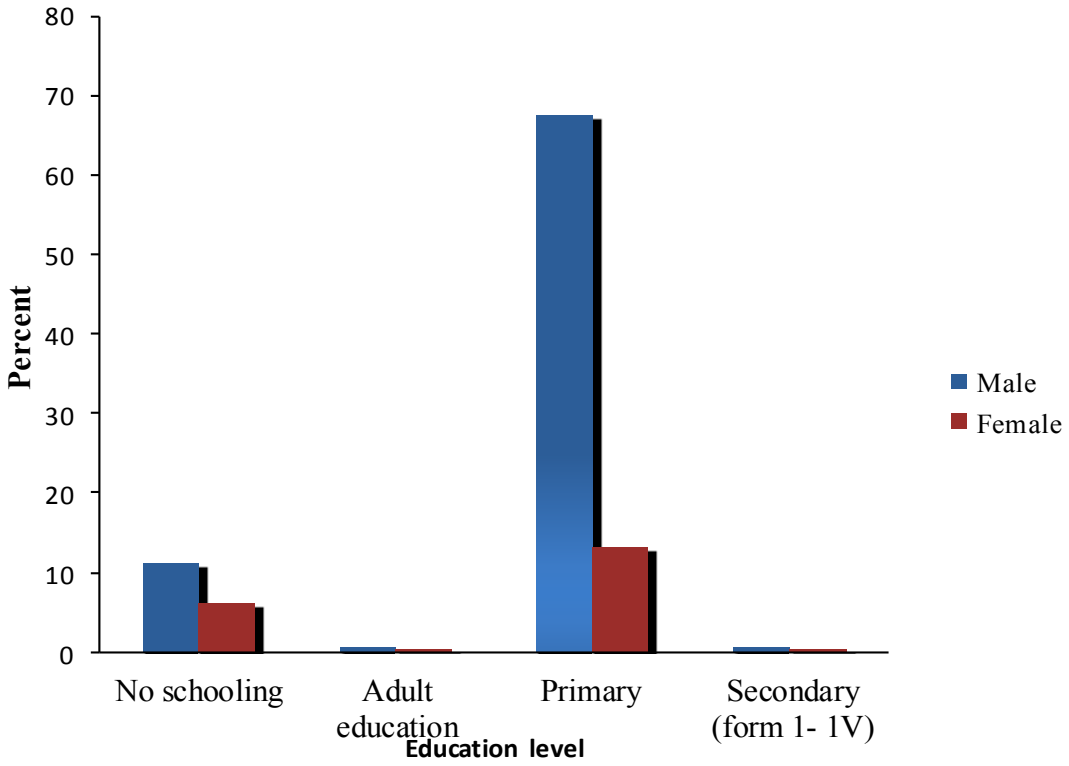

Figure 7: Education level of respondents in terms of sex

4.1.5 Types of houses of the respondents

Eighty six percent (86%) of the respondents live in houses built using concrete bricks and roofed with iron sheets. Ten percent of the respondents were living in houses whose walls constructed with mud wall and iron sheets roofing. Other respondents lived in simple mud wall houses with thatched roofing and some were in houses with walls constructed by wood and mud and thatched roofing (Fig. 8).

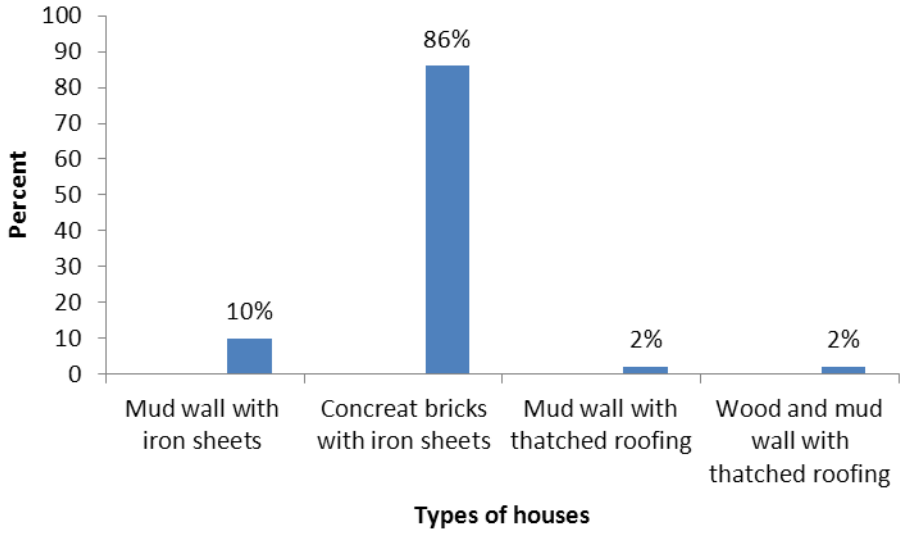

Figure 8: Housing of respondents

4.2. Jatropha Production

4.2.1 General agricultural land and land under Jatropha cultivation

The mean agricultural land per households in the study area was 3.6 acres. The Kingóri Ward had an average of 4.58 acres per household followed by Leguruki Ward, 3.26 acres per household (Table 1). About 0.4 acres was planted with jatropha in Kingóri ward and 0.16 acres was planted with jatropha in Leguruki ward. The mean land planted with jatropha was 0.2 acres (Table 1).

Table 1: Land area under Jatropha cultivation

Ward	Mean land under agriculture per household (Acres)	Mean land under jatropha per household (Acres)
King'ori	4.58	0.37
Leguruki	3.26	0.16
Maji ya Chai	2.98	0.07
Mean land (Acre)	**3.6**	**0.2**

4.2.2 Purpose of Jatropha production

The purpose of jatropha cultivation was for fencing (100%), soap making (72%), energy generation (23%) and land rehabilitation (23%) (Fig. 9).

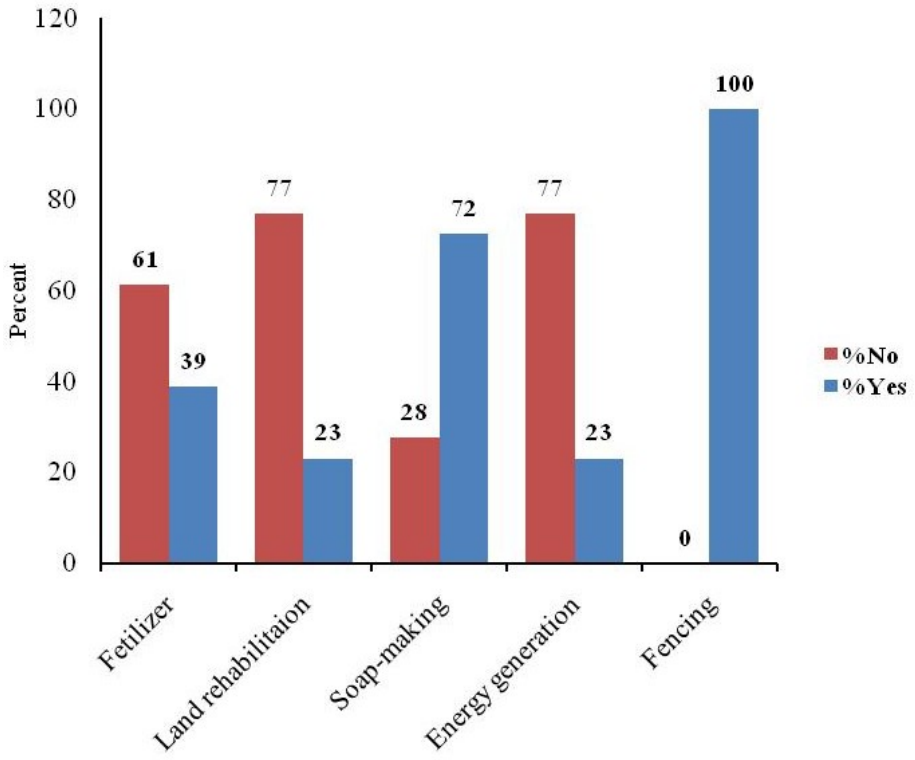

Figure 9: Purpose of Jatropha cultivation

4.2.3 Income generated from Jatropha production

Ninety five percent (95%) of the farmers were not earning income from jatropha seed selling. Only two percent of the farmers earned below 10 000 TZS per year and 3% of the farmers earned between 11 000 – 21 000 TZS per year.

4.2.4 Performances of the main staple food in pre and post Jatropha production

There was slight significant difference in maize harvest between pre-jatropha cultivation and post-jatropha cultivation (P<0.05). The percentage of the households' who harvested between 24 – 29 bags of maize had dropped by one percent before jatropha production to

zero percent after jatropha production. The number of those who harvested bags sacks of maize had also declined from 4% to 3% (Table 2).

Table 2: Maize harvest pre and post Jatropha production

	Number of Maize bags				
Harvest period	0 – 5	6 - 11	12 - 17	18 - 23	24 - 29
Pre- jatropha cultivation (N =290)	16	63	16	4	1
Post- jatropha cultivation (N=290)	17	64	16	3	0

Chi –square value = 782.321; df = 16; *P* = 0.000

4.2.5 Community knowledge on Jatropha cultivation

Ninety percent of the respondents did not have knowledge on how to cultivate jatropha. Only 2% of the respondents had knowledge on jatropha production (Table 3).

About 79% of the respondents did not know the consequences associated with biofuels production to food security and only 1% knew the consequences associated with biofuels production to food security (Table 3).

Eighty percent of the respondents observed that biofuels production has not raised the family income and only 2% of the respondents observed that the production of jatropha has raised the household income (Table 3).

Table 3: Community knowledge on Jatropha cultivation

Knowledge	Percent responses				
	Strongly disagree	**Disagree**	**Neither agree nor disagree**	**Agree**	**Strongly agree**
Do you have knowledge on how to cultivate jatropha?	4.0	86.0	8.0	1.0	1.0
Do you know the consequence of biofuels production to food security?	5.0	74.0	21.0	0.0	0.0
Has biofuels production raised your family income?	4.0	76.0	18.0	2.0	0.0

4.3 Food Security Status

4.3.1 The status of food security at the household level

Three percent of the respondents were severely food insecure (scored 13 to 27), 46% of the respondents had moderate food insecurity (scored 9 to 12). About 35% were mildly food insecure status (scored 5 to 8) and 16% of the respondents were food secured (scored 0 to 1).

Level of education of household head had significant ($P < 0.05$) influence on food security status. The highest food security status was attained in households whose household head had primary education level (Fig. 10).

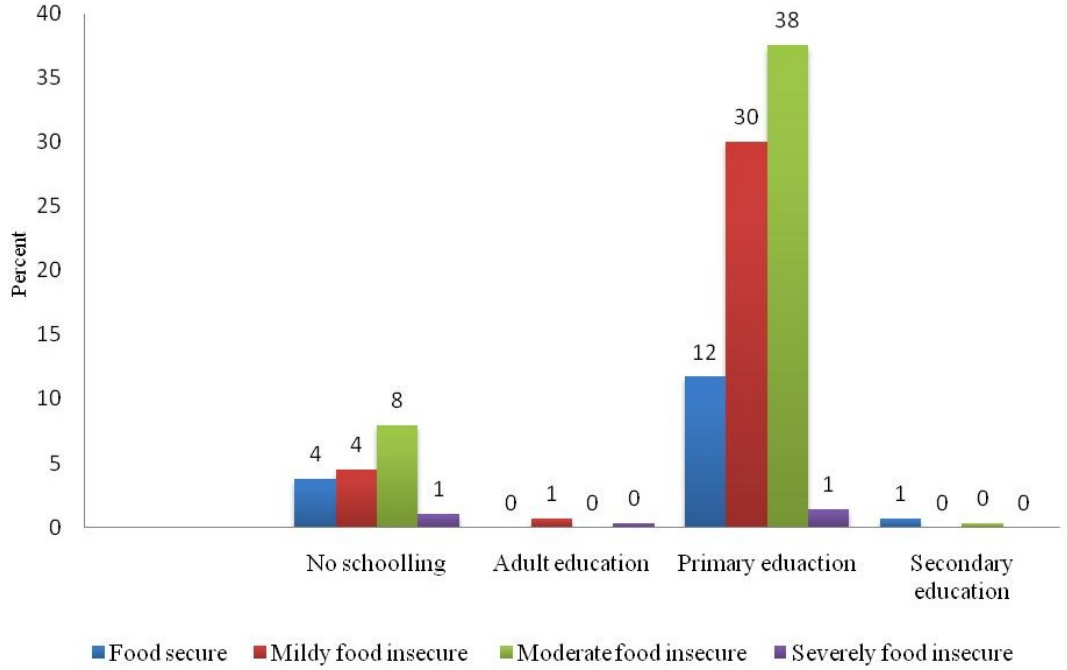

Figure 10: Household Food security status and education level

4.3.2 Household food security and farmland cultivated under agriculture

Household food security correlated with farmland under agriculture, it showed that households that had severely food insecurity had agricultural area of less than 2 acres (Table 4).

Table 4: Household food security and farmland cultivated under agriculture

Status	**Total size of farmland under agriculture (Acre)**				
	0-2 (n=147)	3-5 (n=138)	6-9 (n=4)	10-13 (n=1)	Total (n=290)
Food secure	36	11	0	0	47
Mildly food insecure	31	67	3	1	102
Moderate food insecure	74	59	0	0	133
Severely food insecure	6	1	1	0	8

Chi-square value = 44.549; df = 9; *P* = 0.000

4.3.3 Household food security status and income generated from jatropha

Food security status among households that generated different income from the selling of jatropha seeds was significantly different ($P < 0.05$). About 20% of the households with severely food insecure earned between 1 000 – 10 000 TZS (Fig. 11).

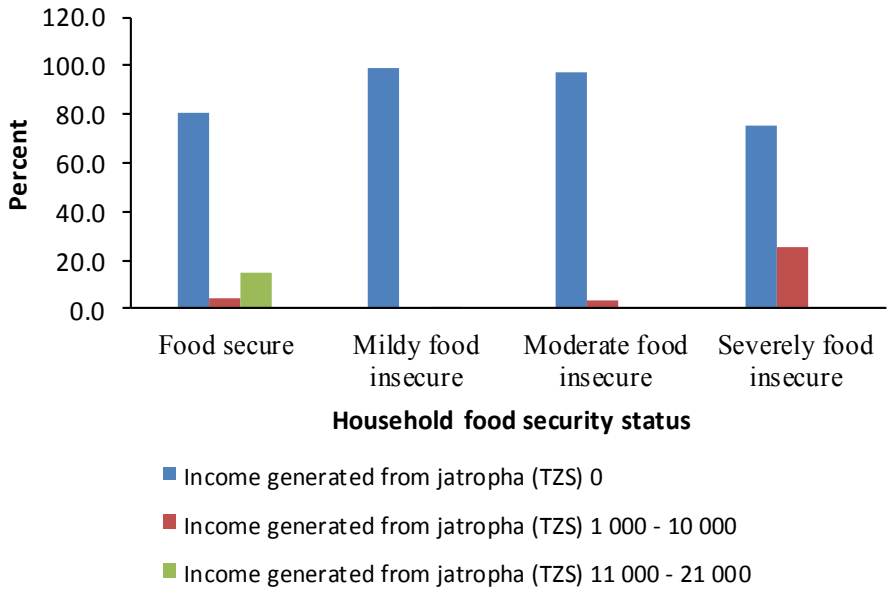

Figure 11: Household food security status and income generated from jatropha seed selling in 2014

4.4 Factors Influencing Food Availability in Meru District

There were seven factors identified determining the availability of food in the District and at household level. Whereby 93% of the households cited Food price at the market as a factor determining food availability at household and district levels Government subsidies (78%) and rainfall availability (77%) were addition factors that were identified by the respondents (Fig. 12).

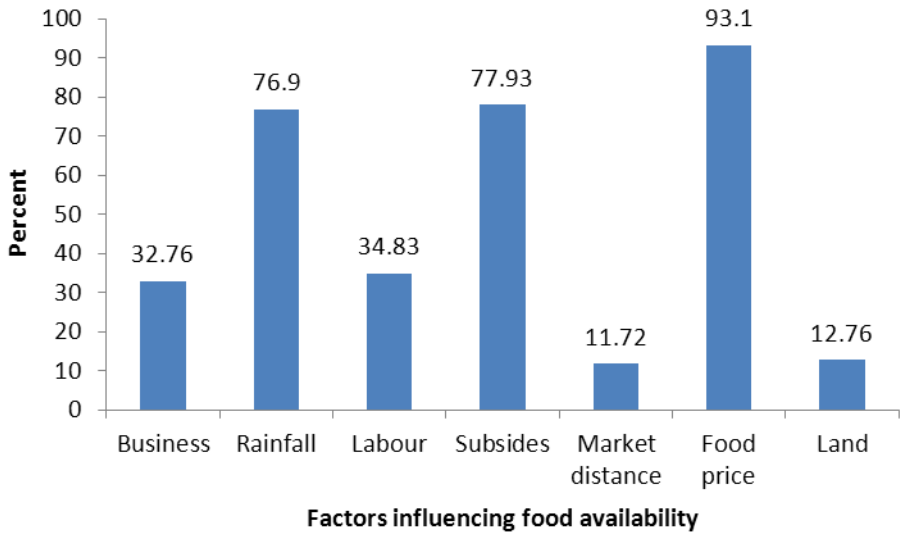

Figure 12: Factors influencing food availability in Meru District

4.5 Interview with Key Informants

More than three quarters (80%) of the key informants reported that, jatropha cultivation in the District was done under small-scale farming controlled by farmers themselves and that, farmers plant jatropha as hedge in their farm and few of them intercrop with other food crops. They also reported that there was no biofuel production because the company responsible for its production had become bankrupt and closed business.

Concerning knowledge on jatropha cultivation, they confirmed that farmers in the District have no appropriate knowledge on jatropha cultivation. However, all of these experts strongly agreed that jatropha seeds were essential raw materials for biofuels production but after the company that was responsible for biofuels production closed, only few people have engaged in soap making and few of the farmers are cultivating the crop for the purpose of fencing and demarcating their farms.

More than half (60%) of the District Agricultural experts were of the opinion that jatropha commercialization currently would be able to raise the income of small-scale farmers. On the same, 40% of them strongly disagree that current cultivation would raise the income among farmers involved in particular crop. In that case, most of the farmers were then out of jatropha business due to market failure. Only few farmers were still producing the crop for soap making, which is also not a promising business compared to the associated hard work put into the product. For example, the price of 5 kg of jatropha seeds was 500 TZS whereas hard work is required to harvest such amount of seeds. Unless a higher price is offered to these farmers, jatropha cultivation will not be able to raise the income among farmers in the District.

The views of the District Nutrition and Agriculture experts over the effects of biofuel production were almost consistency. All of them were of the view that, biofuel production might have some critical effects to the equilibrium of food availability in the District. Furthermore, they also reported that, their farmers had no knowledge on the impact of biofuel production on food security.

Experts' viewed that, despite of its cessation, an introduction of biofuel production in Meru District has promoted employments to the public in the District because farmers at the time of its commencement were imparted with knowledge and skills on product development and obtained oils, fertilizers and energy generation from jatropha. *"Even after its termination, some of the farmers still engage in soap making though at a small scale*" one of the experts observed.

Regarding engagement in jatropha cultivation, the agricultural experts blame farmers that they quickly adopted jatropha cultivation without an extensive evaluation as to whether

such production would be sustainable in terms of its price or not. They asserted that farmers tend to engage in any new crop cultivation for the sake of income, forgetting all about other things, including the negative effects of such a crop on food security.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Socio-economic Demographic Characteristics

Farmers across the study area were from young to elderly ages as their ages ranged between 18 and 82 years. However, majority of Jatropha farmers were within the working age group of between 43 and 60 years. This implies that performance of jatropha production is very important in the wellbeing of the society and their food security status throughout the year since most farmers are in the working age group and are the ones who are very important for development of the society. On average, the community is food insecure, this could be due to the productive group being engaged in jatropha production and not food crops. Jatropha production, however, did not generate sufficient income to ensure farmers' ability to access other foods from the market.

Both men and women are involved in Jatropha cultivation, men account for about 80%. This is probably because, in many African communities men are the heads of the families as well as owners of the production resources like land (Caniëls and Romijn, 2008), hence this may have contributed to the low proportion of women in this sample.

Existing literature shows that education contributed to about 50% of variation in the total agricultural output in Tanzania (Amani, 1992). From this study, findings show that, majority of farmers have primary education. This implies that Jatropha farmers in the study area had a modest basic knowledge that could be used to improve food security status and to make wise choice concerning jatropha production if were given correct information.

The study findings identified that 86% of the farmers are living in houses built of brick walls tiled or iron sheet roofing. Therefore, majority of the farmers in the study area live under good settlement reflecting that they do not depend on income generated from Jatropha production activities.

5.2 Jatropha Production

Jatropha production in Meru District is done by small scale farmers who cultivate jatropha as hedge on their farm and few of them intercrop it with other food crops, hence protect their farm from animals and theft. It also serves as demarcation of farm plots (Plate. 1). According to Hennemann (2013), the jatropha plant has been used in most countries as hedge for protection of farms due to its toxicity to humans and many animals The plant is drought resistant, which is widely cultivated in the tropics as a living fence, because it is not browsed by animals (Hennemann, 2013).

Plate 2: Jatropha planted as hedge/fence in maize farm at King'ori Street, King'ori Ward in Meru District.

Jatropha has also been used for energy generation and the most interesting use of Jatropha lies in oil production. This is when the seeds are pressed to extract Straight Vegetable Oils (SVO). The use of Jatropha oil as fuel is high especially where many people have seen its potential because of the limitation of the world's fossil fuel resources (Amani, 2006). In the surveyed villages by year 2007 jatropha oil was used as source of energy for cooking. However, in 2009 they stopped using jatropha oil due to its higher price. It was sold at 12 000 TZS per litre. This is too expensive compared to firewood that they collect from bushes for free or kerosene which is cheaper. Few farmers use the seed cake that remains after oil pressing as source of energy for cooking (plate 2). The increase in price was due to low production as most of farmers had abandoned cultivation of jatropha due to the closure of Diligent Company that was the main buyer of the seeds. Furthermore, the use of manually operated machine for oil extraction uses a lot of human energy, which does not match with the amount of oil extracted. This has also contributed to low production of oil and increase in price.

(a) **(b)** **(c)**

Plate 3: Jatropha seed (a), hand machine used for extraction of jatropha (b) and a five litre of jatropha oil (c) in Leguruki Ward, Meru District

The collected jatropha seeds in Meru District were mainly used by the cottage industry to extract oil for making soap and the remaining cake was used as manure or fuel for cooking. The soap production activity produces bar soaps and liquid soaps for laundry, cleaning and bathing soaps. It was observed that bath soap helps to improve skin health due to its medicinal property as it contains a compound known as Jatrophine which is assumed to have anti cancerous properties (Robinson and Beckerlegge, 2008). The oil has strong purgative action and it is also used to treat skin diseases and to soothe pain such as rheumatism. A decoction of leaves is used against cough and as an antiseptic (Robinsonand and Beckerlegge, 2008). The soap is sold within the village at a price of 1000 TZS for a bar soap and 10 000 TZS for a 5 litre container of liquid soap (plate 2). The main customers for the products are foreigners who come to visit and also a few village members.

Contrary to many sources, Jatropha is not a nitrogen-fixing plant and has been used as good organic fertilizer which has nitrogen content similar to chicken manure and richer than cow dung (Robinson and Beckerlegge, 2008). This scenario has also been observed in the study area where a number of farmers use the cake that remains after oil pressing of jatropha seeds as manure in their farms**.**

The community in Meru District also uses jatropha plant for the purpose of land rehabilitation. Jatropha has also been used on land rehabilitation in most societies in Africa for a number of decades (World Bank, 2008). The plant has been of greater uses in this area due to its ability to resist drought and being able to withstand currents caused by water movement on soil surface and therefore prevent erosion.

5.3 Income Generated from Jatropha Production

This study has shown that after the closure of the Diligent Company, production of jatropha declined and farmers are no longer depending on the crop to generate of income. Very few farmers (3%) earn less than 21 000 TZS per year. Another study done by Kalebi also reported that, the contribution of jatropha to the total household income was smallest compared to other contributors such as livestock, maize, black beans, beans, groundnut and coffee (Kalebi, 2010). Hence jatropha cultivation is not an income generating crop, and therefore it will not raise household income, and will not lead to food security at household level. By all standards, it leads to food insecurity by competing with food crops for agricultural inputs.

5.4 Agriculture Area under Production

Respondents in Kingóri, Leguruki and Maji ya Chai wards of Meru District are small-scale farmers since the mean agricultural land per household in the study area is 3.6 acres and all farming activities are done by family members. This implies that farmers cultivate small pieces of land hence get small harvest, which is not sufficient to meet their household requirement, hence food insecurity.

Two percent (2%) of agricultural land was occupied by jatropha plants. This was against conceptual frame work which assumes that the jatropha plant will not occupy any productive land hence leaving land for food crop cultivation. Since jatropha cultivation occupied productive land, land allocated for crop production decreased; hence, little food was produced which in turn might have contributed to household food insecurity in this area.

5.5 Production of Main Staple Food in Pre - and Post - Jatropha Production

Maize is considered as the main staple food in the District. Production level of maize was 18.2 bags. However, with the introduction of jatropha the production of maize has decreased. The number of people harvesting 24-29 bags per season diminished from 1% to 0% bags per season per household. Also those harvesting 18 - 23 bags per season diminished from 4% to 3% bags per season per household. This might be the result of reduced land as about 2% of the total agricultural land was converted to jatropha production instead of food production. Because of this, production is likely to cause food insecurity as it has interfered with the production of maize, leaving the community with little food.

5.6 Community Knowledge on Jatropha Production

Most of the farmers (80%) did not have enough knowledge on jatropha cultivation and the company that introduced the crop did not provide sufficient knowledge on cultivation and processing. The District and the Ward Agricultural Officers confirmed that farmers were not provided with sufficient information and skills on the cultivation of the crop. It has become a habit that farmers' decision to adopt a crop is based only on the market information and not on how to cultivate and process for the market. Introduction of jatropha for biofuel production at first was associated with the promise of the market after harvest since the Diligent Company provided seed to farmers to plant and later buy harvested seeds at TZS 300 per Kg. This was very attractive and enticed farmers to start production. Therefore, farmers engage in jatropha production directly or selling their land to investors for jatropha production without knowing the impact of doing so. For example in Kisarawe District in Coast Region, about 10 000 people had to abandon their land to give way for jatropha farming (Daily News /10/04/2012) which in reality there was no production and villagers were left with no land to use for cultivating other crops. There is

evidence that biofuel production in the country is displacing local small farmers from their farm land and therefore creating social-economic issues in Tanzania (Sulle and Nelson 2009).

The community in Meru District was food insecure since three quarter of the respondents had no access to enough food at all times for an active, healthy life for all household members. Devereux and Maxwell (2001), emphasize that for the household to be food secure, the household needs to have food in their home place or near to the homestead but the household must have power to be able to purchase that food while food availability is greatly influenced by environmental factors (Devereux and Maxwell, 2001). In this study environmental factors played a big role in determination of food security status in the household as majority of community members depended on rainfall which is unreliable due to climate change, hence food availability depends on amount of rain they get during that season.

5.7 Household Food Security Status

Some studies associate household head education level with the household food security status (Bashir *et al.,* 2012). The current study observed that the level of education of household head influences food security status. Households whose head had secondary education had high probability of being food secures than those with no education, primary education or with adult education. Severely food insecurity was observed in households whose household head had adult education than either no education, primarily or secondary educational household's heads. Educated people tend to be more aware about eating and lifestyle hence make them to choose wisely what to do with food or money. With little amount of money an educated person can buy food for his/her family while

uneducated can use the money to buy alcoholic beverage or do other things with that money and leave his/her family without food leading to food insecurity in his/her family.

Similar studies reported by other researchers presenting the same disparities in education level and household food security status include Bahiigwa (1999) in his empirical analysis on households' food security in Uganda. According to him, "there is no specific pattern that indicates that the higher the level of education of the household head, the more food secure a household will be." The findings in two periods of his study show that households headed by people with advanced level education were more vulnerable to food insecurity than those with primary and O-level education. However, his findings also indicated that, households headed by household head who were not educated had food insecurity as well. These findings are however contrary to this study and to those presented by Bashir *et al.,* (2012) who examined the situation of landless households in Pakistan. According to them, household whose household heads had high education, schooled for at least 8 to 12 years , were food secured than bellow this, and the chances of been secured increased by more than ninety percentages.

5.8 Farm Size and Food Security

More than 75% of the households with less than two acres of land were experiencing severe food insecurity access. Other studies have shown that in rural areas, land ownership has a greater contribution in household food security. However, sometimes this is not the case as a household whose members are too old to engage in cultivation activities, despite having a large piece of land, may also experience food insecurity as well (Bashir *et al.,* 2012; Lall and Chhetri, 2006). Nevertheless, in most cases, in these settings the landless households have an increased risk of being food insecure than their corresponding households (Yasin, 2000) and this is a common phenomenon (Lall and Chhetri, 2006).

Despite the fact that over 90% of the producers in Africa are small-scale farmers living in rural areas, 70% of them are food insecure and 30% of these are landless farmers (Yasin, 2000). In that case, agricultural land size is not the only element to elucidate food security status, as other factors exist. Low fertility in soils, minimal use of external farm inputs the pre- and post-harvest losses should be of significant consideration too (http://www.un.org/africa).

5.9 Jatropha Production and Food Security

Based on the observation during this study, jatropha was cultivated as fence/hedge systems. The Diligent Company taught farmers to plant in that system by telling them that the plant would not occupy any land and would serve as a demarcation for their farm, therefore protecting their farms at the same time getting money for selling the seed after harvest. That notion was not true since the plant occupied 2% of agricultural land in the studied area and therefore, reduced the land for other food crop cultivation. The impact of jatropha cultivation was already seen on the harvest of maize since there was a reduction in number of the number of maize bags harvested after the introduction of jatropha cultivation. Therefore jatropha cultivation had upset the equilibrium of food production and it might have been one of the factors causing food insecurity in this District. The study by Kalebi (2010), in Rukwa and Arusha on the effects of jatropha cultivation over food security indicated that, its cultivation negatively impacted on food security in these regions.

5.10 Factors Influencing Food Availability in Meru District

Food security has four pillars, which are availability, accessibility, utilization and stability. Food availability is the first factor which affects food security, Food availability depends on local production, ability to import and the efficiency of the distribution systems. Food

production in Tanzania faces several problems. This study in Meru District found that communities are food insecure, jatropha cultivation is seen as a major factor affecting food availability since the plants had already occupied two percent of agricultural land. It should also be noted that jatropha cultivation has also taken some labor and some people invested their energy, fertilizers, and water which are the resources for it to grow. All of these affect production of foods crops. Other factors mentioned to affect food availability are discussed in the following section.

5.10.1 Business and crop price performance at the market

Relationship between crop price and business as factors influencing food availability in the District was noted. Most farmers had the view that food availability in the market in their District is influenced by food prices in the market place. If the food price in the market goes up, most of them would tend to sell the food they cultivated so that they could earn money for other household expenditures but leaving little food in their households for household consumption. For them, when the price of food in the market becomes low, they would not sell most of the food produced waiting until the price peaks up.

For example, when the price of maize goes up at the harvest time, many farmers would tend to sell most of the maize produced remaining with very little maize in their homes. One study in Kenya that analyzed market participation among poor rural households, observed that, the immediate postharvest selling among small- scale farmers was very high compared to large-scale farmers (John and Mathenge, 2012). Therefore, in such a year, the household remained with little food and became food insecured. Otherwise, if the maize price at the beginning of the season of a year is low, many farmers would not sell their maize, waiting for the price to rise, hence remaining with their produce in their homes. According to FAO (2010), households make choices on how much to store and how much

to sell depending on the market price, their own consumption needs, storage facilities and their needs for immediate cash.

Farmers put business, as one of the significant factors for food availability in their homes with the focus that some of the consumed foods in their household are not originally from their household produce, they had to buy at the market place. At the same time, it is not all of their produce being consumed as food; some of the produces like coffee are produced for cash purposes, so they have to sell them to acquire money for other household needs. Therefore, presence of a strongly business oriented network determines the food availability in their households and the market places.

5.10.2 Agricultural Subsidies

Agricultural subsidies were seen as an important factor for food availability by more than three quarters of the respondents. When agricultural inputs such as agrochemicals, including fertilizers and pesticides are offered either by the government or by non-governmental companies, and at low prices, they would use those inputs on their farms hence get more yields. Meanwhile, most of the farmers fail to buy agrochemicals sold at high prices when there is no government subsidies and this result into cultivation without using them hence crop failure and getting low yields.

In the early 1970's to mid 1990s, the government of Tanzania was responsible in providing subsidies on fertilizers and pesticides to farmers at a zero cost. During this time the majority of farmers in the District were able to cultivate large piece of land and harvest more yields, especially maize. However, after the introduction of free market economy and privatization, the government is no longer involved in provision of such subsidies, the

system has substantially changed, thus leaving the private sector to supply fertilizers and pesticides at cost.

The price charged by these private companies is high for a small-scale farmer to buy fertilizers and pesticides. Farmers claim that the cost of agricultural inputs has kept on increasing year after year while the effectiveness of the supplied pesticides is deteriorating- as the current supplied pesticides do not have the ability to kill most of the destructive insects. Therefore, in this case, farmers are now buying the agricultural inputs at high cost while the return is minimal and only a few of them are able to buy.

5.10.3 Rainfall

All crops cultivated need rain in order to grow well, crops grown whether cash crops or the food crops need it. This factor was mentioned by more than three quarters of the respondents. Inadequate rain leads to crop failure or low yields. Further, when drought happens, most of the farmers fail to cultivate large areas since the land might be too dry to cultivate. Therefore, when drought happens many fail to grow most of the crops they plan to grow in a specific season. In such circumstance, this would not only result into poor crops harvest but also the non-crop agricultural sector like livestock performance would also deteriorate because many livestock would die due to lack of adequate pasture.

Conversely, heavy rainfall is also disastrous to most of the grown crops in the District such as maize and cassava. Maize needs approximately rainfall of 450 to 600 mm per season (Jéan, 2013). So a considerable rainfall bellow or above this amount, would impair its production. For that reason, rain plays a significant role in both crops performance in the field and at the same time livestock keeping.

5.10.4 Labour

Workforce is considered as an important factor in any production process. When workers exist food in their household would also go high as they tend to cultivate more and therefore harvest more, provided that other factors such as rainfall, agricultural inputs including fertilizers and others are favorable. Nevertheless, some finding in other studies found that a large household negatively affects the status of households' food security Bashir *et al.* (2012). Therefore, being a household with many household members might be an influential factor in the production process- whether food or cash crops. However, this might cause household food insecurity on the other hand.

5.10.5 Land availability

Contrary to other production processes that the third world countries are going through in some of their production activities, farming activities have never been transformed since ancient times it takes place on the surface of land. Meanwhile, it needs an extensive area rather than small one. Crops cultivation and livestock keeping are no exception on this. Its location, fertility and area are amongst the central aspects determining and productivity, some of them not only in the agricultural sphere but also in other businesses.

Crop cultivation needs an extensive area for it to be carried out compared to livestock keeping, though to some extent livestock among most traditional livestock keepers, the condition is reversed- as they need a large area for their livestock herds. Locality is also an important factor for land productivity. For example, mountainous land might not be good for crop production but can be productive in other sectors of the economy like tourism and mining. On the agricultural domains, especially on crop cultivation, a fertile land has better returns compared to infertile land. The latter would need a lot of inputs to fertilize it. So when acquainted with these, land becomes an important factor for food availability

5.10.6 Distance from the market

As in many communities, in most cases the Meru population is also not-sufficient in terms of food needs to feed from its own production. Some foods they have to buy from the market. Thus, household distance from the market as well as good infrastructures is of significant consideration. Households far away from the food market and at the same time poorly connected with infrastructure network, would have problems to get food from the market.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

We reject the null hypothesis at 95% confidence interval that the production of jatropha as raw materials for biofuel production, will unlikely lead to food insecurity in Meru District since the cultivation occupies two percent of agricultural land hence decrease land for cultivation, while at the same time that jatropha cultivated is not income generating.

The impact of the two percent of agricultural land being occupied by jatropha is already seen since there is a reduction of the number of bags of maize harvested in post jatropha cultivation, while the community in the study area is already food insecure since only sixteen percent of them were able to access food all the time.

Jatropha cultivation being the major factor which influences food availability directly in the production site, It competes with other crops in the area and occupies time and energy. Other factors which influence food availability in Meru District are food prices in the market, lack of agricultural subsidies, climate, labor, business and market distance.

6.2 Recommandations

In the view of above findings, discussion and conclusion, this study recommends as follows :

i. The Government has to ensure food security in Meru District through improved agriculture practices.

ii. The Government through agriculture extension officers have to continue to provide agriculture subsidies in terms of fertilizers to farmers.

iii. The Government has to ensure provision of social services to curb urban migration of the young generation to remain on the land.

iv. Farmers have to be educated about the advantages and the disadvantages of crops when introducing new crop. This will help them to adopt or not to adopt crop.

v. Farmers are advised not to jump into a new crop without having enough knowledge about that crop, also are advised not to sell all food crops without remembering to put some food for use before the coming next harvest.

vi. Further studies are called for, to investigate why previous Biofuel projects failed in Meru District.

vii. Further studies are called for, to investigate other factors mentioned to cause food security in Meru District.

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APPENDICES

Appendix 1: Farmers Questionnaire: Questionnaire Used in the Research on Biofuel Production and Food Security: A Case Study of Meru District, Arusha Tanzania

The research you are about to participate in is for MSc. Human Nutrition student at Sokoine University of Agriculture in Morogoro- Tanzania. Information you provide shall strictly be confidentially as shall individually not be exposed to any other third part, however, they shall be aggregated and be used for the purpose of writing a dissertation. Please, fill free to participate and share out your experiences on jatropha cultivation.

SECTION A:
FARMER'S CHARACTERISTICS (Fill the gap or circle one)

1.1 Date of interview

1.2 Questionnaire number

1.3 Ward name

1.4 Sex of respondent — a) Male — **b**) Female

1.5 Age of respondent (years) — a) Under 18 — b) Between 18-25 — **c)** Between 26-55 — **d)** 56 and above

1.6 Marital status of respondent — a) Single — b) Married — **c)** Widow (er) — **d)** Divorced/separated

1.7	Education level of respondent	a. Primary school b. Secondary school c. Certificate	**d)** Certificate **e)** Degree **f)** Informal
1.8	Type of shelter owned by respondent (*if more than one, please characterize the main building)*	a. Brick walls, tiled or iron sheet roofingii) b. Consolidated mud walls, with iron-sheet roofing	**c)** Simple mud walls with thatched roofing **d)** Others

SECTION B

FOOD SECURITY (Fill the gap)

NO.	QUESTION	RESPONSE OPTIONS	CODE
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	….|___|
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	….|___|
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks)	….|___|

		2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	….|___|
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	….|___|
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	….|___|
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|

6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	….|___|
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	….|___|
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes	….|___|
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was	0 = No (questionnaire is finished)	….|___|

	not enough food?	1 = Yes	
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	….|___|

SECTION C

FACTORS INFLUENCING FOOD AVAILABILITY

3.1 Which factors are influencing food availability at your households? (mention)

SECTION D

JATROPHA PRODUCTION

4.1 Do you cultivate Jatropha?

a) Yes
b) No

4.2 Why do you cultivate Jatropha

a) Hedge/Fence
b) Own energy supply
c) Rehabilitating of degraded land
d) Commercialization so as to diversify income sources

4.3 What is the total size of your farmland under agriculture (size in acres)?

4.4 What is total size of your farmland under jatropha cultivation (size in acres)

4.5 How many bags of maize were you harvesting per year before Jatropha cultivation?

4.6 After jatropha cultivation how many bags of maize are you harvesting ?

4.7 How much income did you get from selling jatropha seed this season? (Tshs)

4.8 Mention the effects of jatropha cultivation

SECTION E:

COMMUNITY KNOWLEDGE AND ATTITUDE ON JATROPHA PRODUCTION AND FOOD SECURITY

5.1	Knowledge on how to cultivate jatropha is well known to farmers	a) Strongly disagree b) Disagree c) Neither agree nor disagree d) Agree e) Strongly agree
5.2	The cultivation of jatropha has raise the family income	1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree
5.3	The community gets enough food because of jatropha cultivation for commercial	1. Strongly disagree 2. Disagree 3. Neither agree nor disagree

		4. Agree 5. Strongly agree
5.4	Farmers know the consequence of biofuels production to food security	1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree
5.5	Biofuels production wills unlikely lead to food insecurity	1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree

Thank you very much for your time and participation in this research

Appendix 2: District Administrative Checklist Questionnaire Used in the Research on Biofuel Production and Food Security: A Case Study of Meru District, Arusha Tanzania

The research you are about to participate in is for MSc. Human Nutrition student at Sokoine University of Agriculture in Morogoro - Tanzania. Information you provide shall strictly be confidential as shall individually not be exposed to any other third part, however, they shall be aggregated and be used for the purpose of writing a dissertation. Please, fill free to participate and share out your experiences on jatropha cultivation in your administrative context.

1.	Do you know biofuels	a) yes b) No
2	Biofuels production is well known at Meru District.	1. Strongly disagree 2. Disagree 3. Neither agree nor disagree 4. Agree 5. Strongly agree
3	Biofuels production at Meru District is done in what scale.	1. Large 2. Medium 3. Small
4	Biofuels production will raise income of small scale farmers	a) Strongly disagree b) Disagree c) Neither agree nor disagree d) Agree e) Strongly agree
5	Give the reason(s) for you answer (4) above	

6	Small scale farmers have knowledge on how to cultivate Jatropha	a) Strongly agree. b) Strongly disagree c) Disagree d) Neither agree nor disagree e) Agree f) Strongly agree
7	Biofuels production will affect food availability.	a) Strongly disagree b) Disagree c) Neither agree nor disagree d) Agree e) Strongly agree
8	What are the factors influence food availability at the district?	

Thank you very much for your time and participation.