BIOFUELS AND FOOD CROP PRODUCTION: A CASE STUDY OF MPEKETONI DIVISION, LAMU DISTRICT KENYA

BY

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DECLARATION

I **ILYAS MREMI GEOFFREY** do declare that this work is my original work and has not been submitted in this university or any other institution of higher learning before for an academic award and should not be reproduced without my consent.

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APPROVAL

I do hereby certify that this work has been done under my supervision and do approve it for submission in partial fulfilment of the requirement for the award of a degree in Environmental management in Kampala International University.

Signature: ……………………………………..

MR. OMUNA DANIEL

Date: 02/Dec/2011

DEDICATION

To almighty God, my beloved parents and my dear brothers and sisters, relatives and friends for their kindness and support. Also not forgetting comrades for their support and encouragement they displayed in the past three years to all I appreciate their efforts.

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May Allah's Blessing be Upon You All.

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LIST OF ACRONYMS

AD	Anaerobic Digester
DME	Dimethyl Ether
FAO	Food and Agriculture Organization
FTL	Fischer Tropsch Liquids
GDP	Gross Domestic Product
GOK	Government of Kenya
ICESCR	International Covenant on Economic Social And Cultural Rights
IDCC	Integrated Gasification Combine Cycle
IDPs	Internally Displaced Persons
NEMA	National Environmental Management Authority
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of the Petroleum Exporting Countries
RVP	Rift Valley Province
UNEP	United Nations Environmental Programme
USAID	United States Agency for International Development

ABSTRACT

The principal aim of the study was to assess the degree of bio fuels and its role in food crop production in Mpeketoni division in Lamu district, Coast Kenya. The study was conducted among large bio fuel scheme farmers, smallholder farmers and collaborative reserve farmers. Bio fuel was looked upon as a critical issue towards problems associated with food crop production such as high food prices, scarcity of food, land tenure conflicts between the inter-cultural tribes and changes in food patterns among others which were included in the statement of the problem. The significance of the study to the Government in terms of provision of aid such as provision of relief food and sending funds among other aids.

The researcher had to base on the methodology which focussed on the description of the methods and techniques that were used to gather information for effective analysis of that data. This Chapter as well covers the study area comprised of the geographical location of the study area in coast province, Kenya which was situated 459 kilometres south east (138°) of the approximate center of Kenya and 446 kilometres east (102°) of the capital Nairobi. Sampling design was derived using the Sloven's formula in that 65 being the population, by using the Sloven's formula the researcher arrived at 55 which were the targeted respondents, data collection instruments such as use of questionnaires, interviews as well as observation were used to obtain important information about population under study in order to obtain accurate and sufficient information. Reliability and validity of the instruments were considered for purposes of accessing the worthiness of the instruments to generate correct data; data processing involved organizing the correct and well answered questionnaires. Analysis was done by use of frequency tables, percentages and pie charts.

Lastly but not least the research covered a descriptive study design in which both qualitative and quantitative methods were adopted. Data was analyzed, coded and presented using tables and pie charts followed by discussions of the research findings. For example, among the findings, the researcher assessed the driving factors which promoted the use of bio fuels and according to the findings; the researcher could tell that availability (40%) was the major driving factor to use of bio fuels. This was because the materials for bio fuel preparation could be locally found.

Lastly the researcher presented the conclusions as well as the recommendations of the research study. The researcher's conclusions were based in both negative and positive way concerning the concept of bio fuel production. For example, the researcher stated in the conclusion that in addition to bio fuel causing rising up of food prices, they could increase green house emissions and contribute to water shortages which in turn impacted on food production. This was a negative contribution of bio fuel. The researcher once again stated the positive side of bio fuel, that they helped in energy diversification and more sustainable since energy is derived from renewable sources such as Jatropha, soy beans and corn among others and that they as well provided alternatives to energy. One of the recommendations was encouraging intercropping of Jatropha to ensure protection of food security so as to yield a variety of food crops for human consumption hence food stability.

CHAPTER ONE

1.0 INTRODUCTION

This chapter is all about the background of the study, statement of the problem, the purpose of the study, research questions, and scope of the study and significance of the study.

1.1 Background

Humans rely on consistent sources of food for nutritional sustenance. In the developed world, technology has rendered these sources virtually invisible, as the disparity and complexity between end-consumers and food sources has continued to grow. By contrast many areas of the world lacking modern infrastructure continue to rely on natural sources of water for crop irrigation (Husak, 2005). These populations rely directly on agriculture for their livelihood. Thus, the concept of "food security" is very important to developing world. The United States Agency for International Development (USAID) was founded in 1985 in response to devastating famine throughout Sub-Saharan Africa in the 1970s and 1980s. This period was marked by the catastrophic Ethiopian famine of 1985, in which over 1 million lives were lost (FEWS NET, 2005). The USAID defines an area as *food secure* "When all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life." (Pub.L. no. 83-480, 1954)

Many African countries are at constant risk of requiring food aid from external sources. In 2005, the Food and Agriculture Organization (FAO) reported that 24 countries in Sub-Saharan Africa faced exceptional food emergencies (FAO, 2005). Food security is determined by a variety of factors, but can be simplified as the relationship between the amount of food available in any given year, and the amount of people living in the area. However, many phenomena affect the availability of food, including complicated socio-economic and political factors. Some of these issues, such as civil-disruption, governmental unresponsiveness and corruption are beyond the scope of physical science. Yet, because of a direct, measurable correlation between climate and food availability in most African drought-prone countries, the estimation of yearly food production provides great insight into regional food security status. In a seminal study of the causes of African famine, the authors noted that "The underlying cause of famine is crop failure which undermines the incomes of the already very poor" (Mellor and Gavian, 1987). As such, the accurate mapping and tracking of planted area and food production on a large scale aids assessments of food availability and can ultimately help determine the quantity and nature of food aid.

Bio fuels are organic primary and/or secondary fuels derived from biomass which can be used for the generation of thermal energy by combustion or by using other technology. They comprise both purpose-grown energy crops, as well as multipurpose plantations and by-products (residues and wastes). The term "by-products" includes the solid, liquid and gaseous residues and wastes derived from biomass processing activities. They are plant material and animal waste, and specifically grown crops which can be burnt to produce energy. It is sometimes known as "biomass burning". Biomass material may include tree and grass crops, and forestry, agricultural and urban waste. It is the oldest source of renewable energy known to humans. Bio fuels are considered to be renewable sources of energy because the energy they contain comes from the Sun (FAO, 2000).

Bio fuels are renewable liquid fuels produced from plant or animal material (biomass), Plants store their energy as sugar, starch or oil. These have a high-energy value and can be converted to liquid bio fuels. Currently, the two main types of liquid bio fuels are biodiesel, produced from plant oil and bio ethanol and from plant derived sugar or starch. Bio fuels can be directly substituted for, and blended with, conventional fossil fuels without the need for major modification of vehicles or refuelling infrastructures. Unlike other renewables, bio fuel energy does release carbon dioxide into the atmosphere, but it is only returning to the atmosphere as much as was removed through photosynthesis during the plant's lifetime. Burning fossil fuels, by contrast, returns carbon dioxide to the atmosphere that has been locked away in the Earth's crust for millions of years. (Wikipedia.biofuel.com June 2011). Crops can be grown with the purpose of being burnt to produce energy, for example willow and oil seed. Energy from waste can also be generated by burning the methane given off from waste landfill sites. Methane is a powerful greenhouse gas, and burning it would help to reduce the amount of methane in the atmosphere.

Kenya and in particular Lamu has not been left behind in the effort to develop bio fuel industries. There are currently plenty of bio fuels and particularly bio diesel activities on the ground with a number of NGOs, government ministries and agencies and individual entrepreneurs engaged in the development of biodiesel crops and associated processes (GOK, 2007).

1.2 Statement of the problem

Recurrent seasons of failed or poor rains, sustained high food prices, environmental degradation, outbreaks of disease, and flooding have led to deteriorating food security conditions throughout Kenya, straining coping mechanisms, exacerbating existing chronic poverty, and contributing to increased inter-ethnic conflict over access to limited land and water resources. Food insecurity in Kenya has also occurred in the context of on-going civil and political unrest, including violence associated with the December 2007 election that displaced more than 663,000 people in Nairobi and across areas of Rift Valley, Western, Nyanza, and Coast provinces, according to the Government of Kenya (GOK). Although the majority of displaced individuals have subsequently returned to areas of origin, vulnerabilities among remaining internally displaced persons (IDPs) and disruptions to agricultural production in affected areas have contributed to increased food insecurity. Since bio fuels currently rely predominantly on agricultural commodities they are closely interlinked with the global agricultural markets. The growing demand for bio fuel feed stocks has therefore been recognized as contributing to the recent rise in global food prices, sparking widespread criticisms of bio fuels for weakening food security (FAO, 2008; Naylor et al., 2007; Runge and Senauer, 2007). This response has largely turned the debate about bio fuels into one of food-versus-fuel, bringing food security to the forefront of this important dialogue. Therefore, assessing the impact of bio fuels on the food production situation necessitates an accurate quantification of both changes in food prices as well as in revenues. Such an analysis requires a robust modelling framework.

1.3 General objective

To find out the role of bio fuels in Food crop production in Mpeketoni division, Lamu district, Kenya.

1.4 Specific objectives

1. To identify the types and classifications of bio fuel production in Mpeketoni division.

2. To find out the driving factors to the use of bio fuels in Mpeketoni division.

3. To assess the effects of bio fuels in food crop production in Mpeketoni division.

1.5 Research questions

1. What are the types and classifications of bio fuel production in Mpeketoni division?

2. Which are the driving factors for the use of bio fuels in Mpeketoni division?

3. Are there effects of bio fuels in food crop production?

1.6 Scope of the study

Geographical scope

The study was carried out in Mpeketoni which is a small town and an administrative division in the mainland part of Lamu District, Coast Province, Kenya.

Content scope

The research highlighted the impact of bio fuels in food crop production

Sample scope

The researcher targeted farmers in the area especially those who were involved in bio fuel production since they were most prone to the problem of food insecurity.

Time scope

The research was conducted in a duration of seven months ranging from May to November 2011.

1.7 Significance of the study

The study would be important to the government in that it would help identify the most prone areas experiencing food insecurity and give priority to such areas by sending funds, offering relief food, helping policy makers such as National Environmental Management Authority (NEMA) as well as organizations such as United Nations Environmental Program (UNEP) to develop rules and regulations on proper utilization of Energy resources such as bio fuels. This will help safeguard food crop production. It would also be useful because it would contribute to the researcher's fulfilment of the requirement for the award of bachelor's degree in Environmental management. It would help researchers identify technologies, best practices and indigenous knowledge to be used by households to use alternative energy sources, increase crop and livestock productivity among the farmers.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter entails reviewing other researchers' and scholars' views about the topic under study. It consists of concept of bio fuels and food crop production, classification and types of bio fuels, reasons for using bio fuels, the effects of bio fuels on food production and the conceptual framework.

2.1 The concept of bio fuels

2.1.1 History of bio fuels

Bio fuels in the solid form have been in use ever since man discovered fire. Wood was the first form of bio fuel that was used even by the ancient people for cooking and heating. With the discovery of electricity, man discovered another way of utilizing the bio fuel. Bio fuel had been used since a very long time for the production of electricity. This form of fuel was discovered even before the discovery of the fossil fuels, but with the exploration of the fossil fuel like gas, coal, and oil the production and use of bio fuel suffered a severe impact. With the advantages placed by the fossil fuels they gained a lot of popularity especially in the developed countries. Liquid bio fuels have been used in the automotive industry since its inception. (http/:Biofuel.org.uk June 2011). One of the first inventors to convince the people of the use of ethanol was a German named Nikolaus August Otto. Rudolf Diesel is the German inventor of the diesel engine. He designed his diesel engine to run in peanut oil and later Henry Ford designed the Model T car which was produced from 1903 to 1926. This car was completely designed to use hemp derived bio fuel as fuel. However, with the exploration of huge supplies of crude oil some of the parts of Texas and Pennsylvania petroleum became very cheap and thus lead to the reduction of the use of bio fuels. Most of the vehicles like trucks and cars began using this form of fuel which was much cheaper and efficient (http/:Biofuel.org.uk June 2011).

In the period of World War II, the high demand of bio fuels was due to the increased use as an alternative for imported fuel. In this period, Germany was one of the countries that underwent a serious shortage of fuel. It was during this period that various other inventions took place like the use of gasoline along with alcohol that was derived from potatoes. Britain was the second country which came up with the concept of grain alcohol mixed with petrol. The wars frames were the periods when the various major technological changes took place but, during the period of peace, cheap oil from the gulf countries as well as the Middle East again eased off the pressure. (http/:Biofuel.org.uk June 2011). With the increased supply the geopolitical and economic interest in bio fuel faded away. A serious fuel crisis again hit the various countries during the period of 1973 and 1979, because of the geopolitical conflict. Thus (OPEC), organization of the petroleum Exporting countries made a heavy cut in exports especially to the non OPEC nations. The constant shortage of fuel attracted the attention of the various academics and governments to the issues of energy crisis and the use of bio fuels. The twentieth century came with the attention of the people towards the use of bio fuels. Some of the main reasons for the people shifting their interest to bio fuels were the rising prices of oil, emission of the greenhouse gases and interest like rural development (http/:Biofuel.org.uk June 2011).

2.1.2 First generation bio fuels

Are made from sugar, starch, vegetable oil, or animal fats. Grains such as wheat yield starch that is fermented into bio ethanol. Sunflower seeds (and other seeds and grains) can be pressed to yield vegetable oil that can be used in biodiesel. Because these crops are edible, their use in bio fuels has been criticized for causing food shortages and price rises by taking food away from the human food chain. The most common first-generation bio fuels are vegetable oil, biodiesel, bio alcohol, biogas, syngas, and solid bio fuels. Edible vegetable oil is not generally used as fuel, but lower quality oil can be. Used vegetable oil is increasingly being processed into bio diesel, the most common bio fuel in Europe. Common sources of biodiesel include animal fats, vegetable oils, soy, and other seeds high in oil, palm oil, hemp and algae (http/:Biofuel.org.uk June 2011).

In general, first generation bio fuels are produced from cereal crops (e.g. wheat, maize), oil crops (e.g. rape, palm oil) and sugar crops (e.g. sugar beet, sugar cane) using established technology. The use of first generation technology has been the subject of considerable media attention, widespread public and political debate, and campaigns by civil societies to draw attention to the environmental and social impacts of bio fuels from food crops. First-generation bio fuels are not being produced commercially anywhere today. They are made from non-edible feed stocks, which limit the direct food vs. fuel competition associated with most first generation bio fuels. Such feed stocks can be bred specifically for energy purposes, thereby enabling higher production per unit land area, and more of the above-ground plant material can be converted to bio fuel, thereby further increasing land-use efficiency compared to first generation bio fuels (http/:Biofuel.org.uk June 2011).

On the other hand, first-generation bio fuel systems require more sophisticated processing equipment, more investment per unit of production, and larger-scale facilities (to capture capital-cost scale economies) than first-generation bio fuels. In addition, to achieve the commercial energy and (unsubsidized) economic potential of second-generation bio fuels, further research, development and demonstration work is needed on feedstock production and conversion (http/:Biofuel.org.uk June 2011).

2.1.3 Second generation bio fuels

Second generation bio fuels are produced from cellulosic materials (lignocellulosic feed stocks). These raw material options may result in the production of more fuel per unit of agricultural land used and require less chemical and energy input per production and harvesting resulting in a higher yield in terms of net GJ energy produced per hectare land used. Such raw materials may be considered more sustainable and do not compete directly with food. However, there can be competition for land use as well as competition between the potential use of cellulosic materials for liquid bio fuels and current (rapidly expanding) use for heat and power generation through combustion as solid bio fuels. New technology is being developed to produce bio fuels from cellulosic materials. More detailed information is available on individual pages for each product (http/:Biofuel.org.uk July 2011).

Second-generation bio fuels can be classified in terms of the processes used to convert the biomass to fuel: biochemical or thermo chemical. Second-generation ethanol or butanol would be made via biochemical processing. Second-generation thermo chemical bio fuels may be less familiar to readers, but many are fuels that are already being made commercially from fossil fuels today using processing steps that in some cases are identical to those that would be used for bio fuel production. These fuels include Fischer-Tropsch liquids (FTL), methanol, and dimethyl ether (DME). Many efforts are ongoing worldwide to commercialize second-generation bio fuels. In the case of biochemical fuels, breakthroughs are needed in research and engineering of microorganisms designed to process specific feed stocks, followed by large-scale demonstrations to show commercial viability. Some 10 to 20 years are probably required before commercial production could begin on a substantial basis. In the case of thermo chemical fuels, since many of the equipment components needed for bio fuel production are already commercially established for applications in fossil fuel conversion, and processing is relatively indifferent to the specific input feedstock, less development and demonstration efforts are needed. Commercial production of thermo chemical bio fuels could begin in five to 10 years (http/:Biofuel.org.uk July 2011).

2.2 The concept of food crop production

Since the World Food Conference of 1974, the concept of food security has evolved into the now generally agreed definition adopted in 1996 during the World Food Summit:"Food security exists when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and preferences for an active and healthy life" (FAO, 1996).This definition integrates availability of nutritionally adequate food, access to food, biological utilization of food, and stability (Lovendal et al., 2006). Availability refers to the presence or reasonable proximity to the individuals of sufficient quantities of appropriate food coming from domestic production, commercial imports, or donors. Access refers to adequate incomes or other resources to assure appropriate food consumption. Biological utilization refers to the ability of the individual to convert food commodities into energy. Finally, stability means that these conditions have to be fulfilled at present but also in any future point of time.

Contrary to Malthus's view, the development of the agricultural technology has succeeded to support a growing human population and has improved the nutritional situation in most part of the world. The world's average diary calorie consumption per capita was in 1999 about 2800kCal, which is substantially above the minimum requirement estimated around 2000 k Cal (FAO, 2002), This implies that the actual food production is able to assure a sufficient alimentation for the entire population. Global shortage, at least in a middle term, is not expected (Ingco et al., 1996). If food supply were unequally distributed, a world of abundance and international trade should be able to compensate for such disparity. However, some 800million people (FAO, 2004) are still chronically suffering from hunger mainly concentrated in developing countries with low GDP per capita. About 75 % of this undernourished population lives in rural areas (IFAD, 2001) with a shortage of purchasing power and a lack of resources to produce their own food.

Malnutrition and poverty are tightly linked. Sub-Sahara Africa is of special concern because it is the only region in the world where the nutrition situation has been constantly worsening

(Devereux et al., 2001 and Rukuni, 2002). Since the late Sixties, the number of malnourished people has increased roughly at the same rate as the population. This indicates that strategies to alleviate poverty and secure food access in the region were not successful (Boussard et al., 2005). Countries of Sub-Saharan Africa have the capacity to produce enough food to meet their domestic needs, or to increase their agricultural exports and generate sufficient foreign exchange to enable them to import food (Boussard et al., 2005).However, policy failed to develop this potential. At the end of colonialism, emphasis was put on industrialization financed by taxation on exports of cash crops like coffee and cotton. This strategy led to an important urban-rural bias, a decline of traditional food production, and a rapid growth of rice and wheat imports.

In the early 1970s, global food production suddenly dropped and generated a world food crisis, which put food-deficient developing countries in a difficult situation. At the same time, food aid decreased from 16,8 millions in 1964/1965 to 7 millions tons of cereals in 1973/1974 (Shaw,2007). Responding to this situation, the World Bank launched in 1979 the Structural Adjustment Program to promote agricultural and overall development through market liberalization and removal of governmentally distorted price incentives. Unfortunately, these corrections occurred just when the external terms of trade for Africa's agricultural exports were falling and had negative impacts on the poor, which could not be compensated with additional social programs (Delgado, 1995).Political instability, war, draught, widespread HIV/AIDS (Thangata, 2007) are still limiting the food production in many African countries. A green revolution like in Asia did not yet occur. The cereal production per capita is very low at about 150 kg per year (Dyson, 1999). The area of irrigated land and the cereal yield show only a very small rise. The increase in cereal production comes mainly from land expansion (Dorward et al., 2001). Many African countries depend on food aid and imports, which are limited by a low national budget. The poor nutritional situation has considerable negative impact on the physical and intellectual development of the children threatening even more their chance to come out of poverty. Hunger is not only a consequence but also a cause of poverty. Therefore, poverty alleviation programs will only succeed if access to food is secured.

2.3 Classifications and types of bio fuels

Bio fuels can be grouped into three general forms; solid, liquid or gas. Within each group, there can be number of fuel types, and in some cases, interaction or inter-processing between the fuel types.

2.3.1 Classifications of bio fuels

Bio fuels can be grouped into three general forms; solid, liquid or gas. Within each group, there can be number of fuel types, and in some cases, interaction or inter-processing between the fuel types.

2.3.1.1 Solid Bio fuels

These are solid forms of biomass which are used directly or pre treated, by drying and/or pelletizing, for use in direct combustion applications to produce heat and/or electricity. Solid bio combustibles are the most common and widely understood form of bio fuels. Presently, combustion is the largest volume of conversion of biomass to energy. Solid biomass is burned in a large number of boiler furnaces and heaters in the forest products industries. The market for biomass fuel pellets is developing. Solid bio combustibles are the most common and widely understood form of bio fuels.

The sources of solid bio fuel are wastes coming from the processing of wood products, pulp and paper, sawdust, charcoal, agricultural waste products, dried manure, and domestic refuse (renewable energy. no, 2010). Solid biomass is often used as a raw material for bio fuel. Using a finely grounded sawdust1, solid biomass like the wood pellets requires the highest refining degree and compression (renewable energy. no, 2010). Unlike other sources of energy, solid biomass can be available either in convenient form like firewood or inconvenient form like sawdust, agricultural waste, or wood chips. As a source of energy, solid bio fuel like wood pellets can burn directly in stove or furnace in order to produce heat or increase steam.

Solid bio fuels include wood, sawdust, grass cuttings, charcoal, agricultural waste, non-food energy crops, and dried manure. When raw biomass is in a suitable form, it can burn directly in a stove or furnace to provide heat or steam. When it is in a less convenient form (such as sawdust), it can be shaped into pellets and burned in a pellet stove.

2.3.1.2 Liquid Bio fuels

There are a number of types of liquid bio fuels, but three (bio-oil, biodiesel, and bio ethanol) are examined in this report.

2.3.1.3 Gaseous Bio fuels

There are two types of gaseous bio fuels; biogas and bio syngas. Both are very different and are created through very different processes, but both are used in gaseous form.

2.3.2 Types of bio fuels

Given below are some of the types of bio fuels that are in use today.

2.3.2.1 Biogas

Biogas is generated when bacteria degrade biological material in the absence of oxygen, in a process known as anaerobic digestion. Since biogas is a mixture of methane (also known as marsh gas or natural gas, Methane CH_4) and carbon dioxide (CO_2). It is a renewable fuel produced from waste treatment. Anaerobic digestion is basically a simple process carried out in a number of steps by many different bacteria that can use almost any organic material as a substrate - it occurs in digestive systems, marshes, rubbish dumps, septic tanks and the Arctic Tundra. Humans tend to make the process as complicated as possible by trying to improve on nature in complex machines, but a simple approach is still possible (Paul Harris, 2008).

2.3.2.2 Biodiesel

The use of vegetable oil as a fuel source in diesel engines is as old as the diesel engine itself. However, the demand to develop and utilize plant oils and animal fats as biodiesel fuels has been limited until recently. The technical definition of biodiesel is: "The mono alkyl esters of long fatty acids derived from renewable lipid feedstock such as vegetable oils or animal fats, for use in compression ignition (diesel) engines" (National Biodiesel Board, 1996). In simple terms, biodiesel is a renewable fuel manufactured from methanol and vegetable oil, animal fats, and recycled cooking fats (U.S. Department of Energy, 2006).

2.3.2.3 Bio Ethanol

This type of bio fuel is produced from biomass, sugar cane, or agricultural crops. Cars that run on it are governed by the very same physics laws as those that use gasoline, implying that due to the process of combustion, both of them produce CO_2. However, there is a vital difference. Since burning ethanol actually results in recycling CO_2, because the process of photosynthesis while the plant had been growing had already removed it from the atmosphere. Whereas, using diesel or gasoline actually injects additional amounts of CO2, which had been fixed underground in the deposits of oil for millions of years. Ethanol can be made either from hydrocarbons (petroleum) or carbohydrates (biomass). For the purposes of this report, only those made from biomass sources are considered. It is important to note, however, that the vast majority of ethanol used today is produced from hydrocarbons, and is used as a chemical feedstock in a variety of large-scale industrial applications. It is produced when ethylene (created through high temperature "cracking" of large hydrocarbons) is catalyzed with hydrogen to form ethanol. Bio ethanol is the most widely used liquid bio fuel. It is made by converting starch crops into sugars, which are then fermented into bio ethanol and distilled to fuel grade. It is mainly used as a fuel oxygenate to improve combustion and reduce tailpipe emissions. This is the most widely used liquid bio fuel. It is made by converting starch crops into sugars, which are then fermented into Bio ethanol and distilled into fuel. It is mainly used to enhance vehicle performance, and as a fuel oxygenate to improve combustion and reduce tail pipe emissions (Biofuel.org.uk 2010).

2.3.2.4 Bio-oil

This fuel is typically created through the thermo-chemical pyrolysis process, and can be burned directly to generate heat, burned in a steam boiler or turbine to generate electricity, or used as a feedstock for an array of chemical products and natural resins. It has a higher energy density than the original biomass, and can be easily handled, and/or stored for limited periods. This fuel is created through the thermo-chemical pyrolysis process, and can be combusted directly to generate heat, burned in a steam boiler to generate electricity, or used as a feedstock for an array of chemical products and natural resins. It has a higher energy density than the original biomass, and can be easily handled and stored (although shelf-life is limited due to settling) (Biofuel.org.uk 2010).

2.3.2.5 Bio syngas

Bio syngas is an intermediate fuel that is created through the thermo-chemical gasification process where high temperature reactions convert carbonaceous materials, *e.g.* coal, petroleum, petroleum coke or biomass, into carbon monoxide (CO) and hydrogen (H_2). The resulting gas is called producer gas or syngas4, and is referred to as bio syngas if derived from biomass sources. In addition to syngas, the gasification process also can produce Hydro carbon liquids and char. Syngas is the abbreviation for Synthesis gas. This is a gas mixture mixture that comprises of carbon monoxide, carbon dioxide and hydrogen. The syngas is produced due to the gasification of a carbon containing fuel to a gaseous product that has some heating value. Some of the examples of syngas are as follows a gasification of coal, waste to energy gasification, steam reforming of natural gas to generate hydrogen. The name syngas is derived from the use as an intermediate in generating synthetic natural gas and to create ammonia or methanol. Syngas is also an intermediate in creating synthetic petroleum to use as a lubricant or fuel. Syngas has 50% the energy density of natural gas. It can be burnt and is used as a fuel source. The other use is as an intermediate to produce other chemicals. The use of syngas as a fuel is accomplished by the gasification of coal or municipal waste. In these reactions, carbon combines with water or oxygen to give rise to carbon dioxide. This carbon dioxide combines with carbon to produce carbon monoxide. Syngas is used as an intermediate in the industrial synthesis of hydrogen and ammonia. During this process, methane (from natural gas) combines with water to generate carbon monoxide and hydrogen. As a residue of energy gasification, syngas is produced and this is used as a fuel to create electricity. If syngas consists of a considerable quantity of nitrogen, this nitrogen must be separated. Both carbon monoxide and nitrogen have similar boiling points and thus, recovering pure carbon monoxide by cryogenic processing is very difficult. The gasification process is used to convert any material that has carbon to a syngas that is made up of carbon monoxide and hydrogen. One of the uses of this syngas is as a fuel to manufacture steam or electricity. Another use is as a basic chemical building block for many users in the petrochemical and refining industries. Gasification is a very vital process. It raises the value of low value feed stocks by transforming them to marketable products and fuels (Biofuel.org.uk 2010).

The general raw materials used for gasification are coal, petroleum based materials or other materials that would be rejected as waste. From these materials, a feedstock is prepared. This is inserted to the gasifier in dry or slurry form. In the gasifier, this feedstock reacts in an oxygen starved environment with steam and oxygen at elevated pressure and temperature. In this way, syngas is manufactured. This syngas comprises of 85% of carbon monoxide and hydrogen and small amounts of methane and carbon dioxide.

The syngas so produced may contain some trace elements of impurities. These are removed from the syngas. Further, they are recovered or redirected to the gasifier. For example, sulphur is recovered in the elemental form or as sulphuric acid and both of these can be marketed. If the syngas is to be put to use to generate electricity, then it is generally used as a fuel in an IGCC (integrated gasification combine cycle) power generation configuration. There are commercially available technologies to process syngas to generate industrial gases, fertilizers, chemicals, fuels and other products (Biofuel.org.uk 2010).

2.3.2.6 Bio char

Bio char is just charcoal made from biomass which is plant material and agricultural waste hence the name 'bio char'. It is a fine-grained charcoal produced from pyrolysis: the slow burning of organic matter in a low or no oxygen environment. What differentiates bio char from charcoal is its purpose; it is produced as an additive to soils, mainly to improve nutrient retention and carbon storage. Bio char is a charcoal substance produced from the controlled, incomplete combustion of Bio mass in an oxygen-free or oxygen-limited environment. As a soil amendment, bio char creates virtually permanent carbon sinks (1,000-2,000 years); dramatically improves soils; and has multiple environmental benefits. Bio char is a carbon-negative technology, and can remove CO2 on gigaton scales, to combat climate change. It is one of the few carbon negative technologies at our disposal. Bio char production systems are scalable, and have appropriate developed and developing country applications (International Bio char Initiative 2009). During bio char production, up to 50% of the biomass feedstock C is retained in the crystalline bio char structure (Lehmann, 2007).

2.3.2.7 Wood-Based Bio-Fuels and Bio-Products

Refers to wood-derived processed fuels and chemicals, generated through conversion of the chemicals found in wood into other forms, and generally serving as replacements for petroleum-derived products currently in the market place. This analysis does not cover the production of solid fuels for use in conventional combustion as a thermal energy source (e.g., firewood or the production of wood pellets) or the production of electricity from the combustion of wood at wood-fired power plants. While these are important existing and potential markets for wood, and represent tangible ways that wood can be used to meet our energy needs, they are not part of this analysis, which focuses on the wood conversion technologies that are moving from the research and development stage toward commercial scale deployment. Wood, or other cellulosic material, can be used in a number of ways to provide useful energy. Traditionally, wood has been combusted to generate heat, either for direct thermal applications (heating houses, providing steam for manufacturing uses, etc.) or harnessed to generate electricity. A number of new technologies grouped into fermentation, pyrolysis, gasification and fractionation are now approaching commercial maturity (A Maine Status Report, 2006).

2.4 Driving factors to use of bio fuels

2.4.1 Availability

It is renewable. Unlike fossil fuels, bio fuels can be easily produced from raw agricultural materials. These facts ensure that the reservoir of fuel will never end and that we can keep producing it, like we produce our food (www.Drohilm.green energy.com) (2011).

2.4.2 Price

Since the reservoir is virtually unlimited, we can assure that as time goes by, the oil prices will increase duo to the increase in demand/production ratio, while the bio fuels prices will decrease duo to the progress in agriculture science and techniques. In a few years from now, it is almost certain that bio fuels prices will be much lower than fossil fuels, so the sooner you start using it, the better (www.Drohilm.green energy.com) (2011).

2.4.3 Independence

Bio fuels are easy to produce, and propose a new prospect to fuel consumers - unlike today's when huge company controls the fuel industry and supply, making the small consumer a slave to their will, bio fuels will allow individuals and small manufacturer to get into this business and increase the competition. This is good both to the manufacturers and to the clients (www.Drohilm.green energy.com) (2011).

2.4.4 Healthier

Bio diesel and ethanol are much safer than bio fuels - they are much better to the environment, and have a great implication regarding global warming and air quality. If you care about the air that you and your children are breathing, you must take it under consideration. (www.Drohilm.green energy.com) (2011).

2.4.5 Energy diversification

Bio fuels can help diversify the fuel supply for transport, and thus decrease the transport sector's dependence on oil (www.Drohilm.green energy.com) (2011).

2.4.6 Better to the engine

Bio fuels are not only healthier to the environment, but also much better to the engines. Much research done by the automobile industry shows that biodiesel and ethanol increase the efficiency of the engine and it life span (www.Drohilm.green energy.com) (2011).

2.4.7 Have good political implications

At present, oil producing countries enclose a huge power in their hands, allowing them to take advantage of their power to harm other countries, and jeopardise world peace. Crossing to a different fuel source will dramatically reduce the pressure of oil deficiency, allowing many suppressed countries to flourish (www.Drohilm.green energy.com) (2011).

2.5 Effects of bio fuels on food crop production

The effect of developing bio fuels is the competition with traditional agriculture for resources, especially land. The supply for land being unchanged, an additional land demand for the production of bio fuels leads to higher land prices. The magnitude of this effect depends on the value of the land elasticity, which reflects the scarcity of land, and on the productivity of bio fuels. The higher the yields are, the lower is the pressure on the land market. This causes an increase in the production cost of food, which shifts the supply curve of food proportionally to the change in land price divided per the yield of food. Finally, a new equilibrium point is found in the food market. Doornbusch and Steenblik, as quoted by FAO 2008 in their paper prepared for the Organization for Economic Co-operation and Development (OECD), argued that government policies around the world to replace oil with ethanol and other liquid bio fuels could draw the world into a "food-versus-fuel" battle. They focused in particular on the impact on food prices. "Any diversion of land from food or feed production to production of energy biomass will influence food prices from the start, as both compete for the same inputs." Putting it starkly, the 'food versus fuel' game could make it possible for a car owner in a developed country to fill his or her tank (50 litres) with bio fuel produced from 200 kg of maize, which would have been enough to feed one person for one year. The purchasing power of the owner of the car is of course vastly higher than that of a food insecure person in a developing country; in an unregulated world market there is no doubt who would win (FAO, 2008).

Using the IMPACT model Rosegrant et al. (2006) show that an aggressive bio fuels growth scenario without technology improvement would lead to a strong increase in feedstock prices, especially for cassava (+135 % by 2020) and oilseeds (+76% by 2020). However, the introduction of second generation bio fuels and crop yield improvements could mitigate this effect significantly (+54 % for cassava and +43% for oilseed).The food price plays a dual role in developing countries and was described as the "food price dilemma" by Timmer (2000). On one hand, high food prices reduce the real income of consumers and threaten their access to food. On the other hand, they generate incentives in the rural sector and promote agricultural productivity, which can positively influence the entire development process and decrease poverty. The food price effect of the development of bio fuels is an increasing concern for the food security in developing countries questioning the compatibility between poverty reduction and climate conservation policies. Based on projections by IFPRI4, Runge and Senauer estimate that bio fuels development could be responsible of 600 million additional hungry people worldwide by 2025. They strongly criticize the current corn-based-ethanol policies of the US (Runge and Senauer, 2007). However, the supposed negative effect might be overcome if there venue of the concerned population increases simultaneously.

Another problem associated with liquid bio fuel production concerns land concentration and evictions. Evidence indicates that the production requires large entities of land and plantation-type production. This leads to a pressure for ownership concentration, and it opens up for a much higher degree of external investors' inland ownership and production than under more traditional forms of production. Foreign investors see a profit in bio fuel as long as their markets are guaranteed, but they see no profit in investing in cassava and other traditional food in Africa and elsewhere for local food production (FAO, 2008). The process of land concentration, monoculture and eviction or marginalisation of those who have traditionally lived there is likely to have a particularly negative impact on women's role in agriculture. In many developing countries, women have the most important role both in production and preparation of food. A recent FAO study analyses the risks that women will face if large-scale production of feedstock for bio fuel goes ahead. The authors argue that liquid bio fuels production might contribute to the socio-economic marginalisation of women and female-headed households in several ways. Firstly, large-scale plantations for such production require an intensive use of resources and inputs to which smallholder farmers; particularly female farmers traditionally have limited access. Secondly, if so-called 'marginal' land is converted into bio fuel plantations (which e.g. is done with some Jatropha plantations in India) these areas can no longer be used as common property resources, which have traditionally supplied food, fodder, fuel wood, building materials and other locally important resources. The same problems concerning marginal lands can be expected in Africa

(FAO, 2008). Mono cultural production of feedstock for bio fuel can cause a number of environmental harms. Monoculture production is also harmful for biodiversity, which in turn has considerable consequences for the necessary dietary diversity which is required for adequate food (FAO, 2008).

Soybeans are most directly affected by the demand for corn-based ethanol because corn and soybeans tend to compete for land area. This is because corn and soybeans can be used in rotation, for example rotating a corn and a soybean crop every other year. In practice, other cycles including other crops are used. As the price of corn rose substantially in 2007-08, reflecting the increase in demand, the cropping pattern has changed, with more corn production relative to soybeans. This has led to a noticeable decrease in overall soybean production and increased its price (Westcott, 2007). The primary impact of bio fuels on food inflation is from increases in the farm prices of commodities that contribute to producing our food supply, like corn, soybean meal, soybean oil, wheat, barley, and oats. Farm prices are largely determined by supply and demand. In the initial years of the bio fuels era, demand for corn and soybean oil increased sharply. Increased demand results in higher prices for corn and soybeans. Higher corn and soybean prices in turn provide greater incentives for farmers to increase acreage, especially corn acreage. As more acres are converted to the production of corn, fewer acres are available for other crops that compete for the same land. Thus, greater demand for energy crops also results in increasing prices for other crops that must compete for the same land. Consumer food prices can eventually be expected to rise as these higher crop prices are passed through the food system. How quickly varies by food item. Changes in the price of wheat are quickly passed to flour prices, which then more slowly are reflected in bread and bakery products. Changes in soybean oil prices are quickly passed to food processors who make salad dressings, cooking oils, and margarine. However, those food manufactures may be slower to reflect these price changes to grocery stores (Corinne and Chris, 2007).

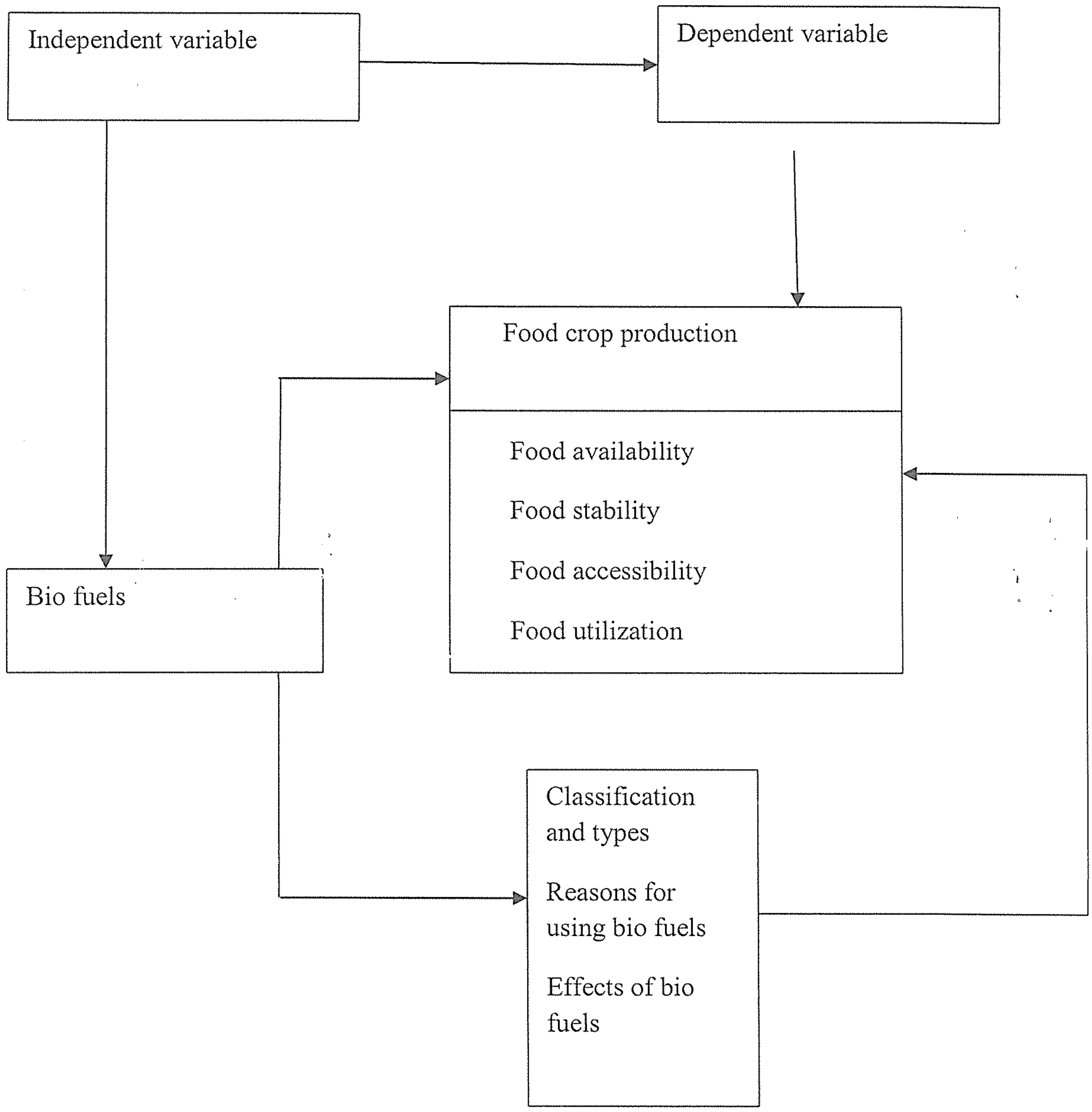
Many common bio fuels have contributed to record high food prices in recent years because they divert food for fuel production and/or come into competition with food crops for similar resources (Runge and Senauer, 2007; Naylor et al., 2007; Peskett et al., 2007). Planting Jatropha on marginal lands with irrigation would indirectly compete with other agricultural crops by increasing the demand for such a scarce resource. "If the same land and other resources are needed for both food and bio fuel feedstock crops, their prices move together even if the feedstock crop cannot be used for food" (FAO, 2008). Coming into competition with food for water would put pressure on food crops during an already volatile time for food production. Furthermore, this competition could contribute to an even greater rise in food prices – with potentially catastrophic implications for food security, since food prices are one of the most important determinants of food security (UN-Energy, 2007). This demonstrates that even if Jatropha is planted on marginal lands in, there is a strong potential for it to compete with food crops for water resources, yielding significant consequences for food security.

Currently 27% of the land under cultivation for Jatropha bio fuel projects around the world is agricultural land that could otherwise be used for food production (Jatrophabook, n.d.). Of this 27%, 13% is on land that used to be under food production (Jatrophabook, n.d.). This highlights a further threat to food crops – the potential for crop switching. It is evident that there is a multitude of ways in which bio fuels could come into competition with food crops, despite the claims that state otherwise. Such competition has the potential to decrease availability of food and drive up food prices, weakening access to food. The rapid expansion of bio fuels at the expense of food crops has been recognized by the FAO (2008) as one of the factors that contributed to a significant rise in food prices in 2007-2008. By the end of 2007, the price of wheat, corn and soybeans had doubled in less than two years. Wheat reached $10/bushel, corn reached $5/bushel and soybeans reached $13.42/bushel, breaking or approaching record highs (Brown, 2008). "Some countries will benefit from higher prices, but the least-developed countries, which have been experiencing a widening agricultural trade deficit over the last two decades, are expected to be considerably worse off" (FAO, 2008). These drastic price increases had enormous implications for global food security. Food became increasingly unaffordable for the poor, sparking food riots in a number of countries around the world (Adams, 2008). Bio fuels similar risks to food security if it comes into competition with food for land or other resources.

Due to the current environmental and socio-economic conditions, there is a high risk of bio fuel crops coming into competition with food production. This could occur if crops for bio fuel required fertilizer or water inputs, thus competing with food for the same resources. Bio fuel crops would also compete with food if it were planted on limited arable land. However, Jatropha bio fuel is widely acclaimed for avoiding such competition with food and the subsequent effects o food security (BP, 2007; Tattersall, 200; Malibiocarburant, n.d.; Centre for Jatropha Promotion, n.d.). This is largely because it is an inedible plant and can be grown on marginal lands that would not otherwise support food crops. Jatropha seeds contain a high concentration of phorbol esters making them toxic, and therefore inedible, to both humans and animals (Adolf, Opferkuch, Hecker, 1984). Since Jatropha is not a food crop, it does not divert food for fuel production. This is a significant element of Jatropha that makes it unique to other currently popular bio fuel feed stocks, such as corn ethanol. "Filling the 25-gallon tank of an SUV with pure ethanol requires over 450 pounds of corn –which contains enough calories to feed one person for a year" (Runge and Senauer, 2007). This statistic powerfully highlights the potential for food crops that are used as bio fuel feedstock to weaken food security by lowering the availability of food, and thereby access to food. Jatropha's inedibility thus helps to lessen potential competition with food crops and lower the risk for food security.

Jatropha is also said to be suitable for marginal lands because it is well adapted to poor soils with low nutrient content (Heller, 1996; Ogunwole et al., 2008). It has been demonstrated that Jatropha is not only able to grow on poor soils; it also helps to remediate these soils, offering long-term ecological benefits. In a study conducted by Ogunwole et al. (2008), Jatropha grown on marginal soils improved soil aggregation, helping to decrease soil erosion. The study also found that Jatropha has the potential to increase carbon sequestration in soils, increasing the soils nutrient content (Ogunwole et al., 2008). The use of Jatropha to reclaim marginal lands could help to improve future availability of food. However, it is likely that this benefit could not be realized if the Jatropha was being grown for bio fuel production. Similarly to the issue with water, Jatropha can grow on marginal lands; however, it will require fertilizer to produce an economically viable yield for bio fuel production (Achten et al., 2008; Foidl, Foidl, Sanchez, Mittelbach, Hackel, 1996). This could further increase the risk of Jatropha coming into competition with food and threatening food availability and food prices. This occurred in Vietnam where increases in food production led to increased competition for fertilizer. As a result fertilizer prices rose, becoming a contributing factor to mounting food prices (Bradsher and Martin, 2008). However, in reality, bio fuels compete with food production for resources like land and water and, thus, impact the price of food commodities. In the last two years, the price of maize has increased about 60 percent due to recent expansion of bio fuels production (World Bank, 2007).

2.6 Conceptual framework



Source: Researcher 2011

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents and describes the methods and techniques that were used to collect data and analyze that data. It includes the study population, the area of the study, sampling design, data collection instruments, reliability and validity, data processing and analysis.

3.1 Research design

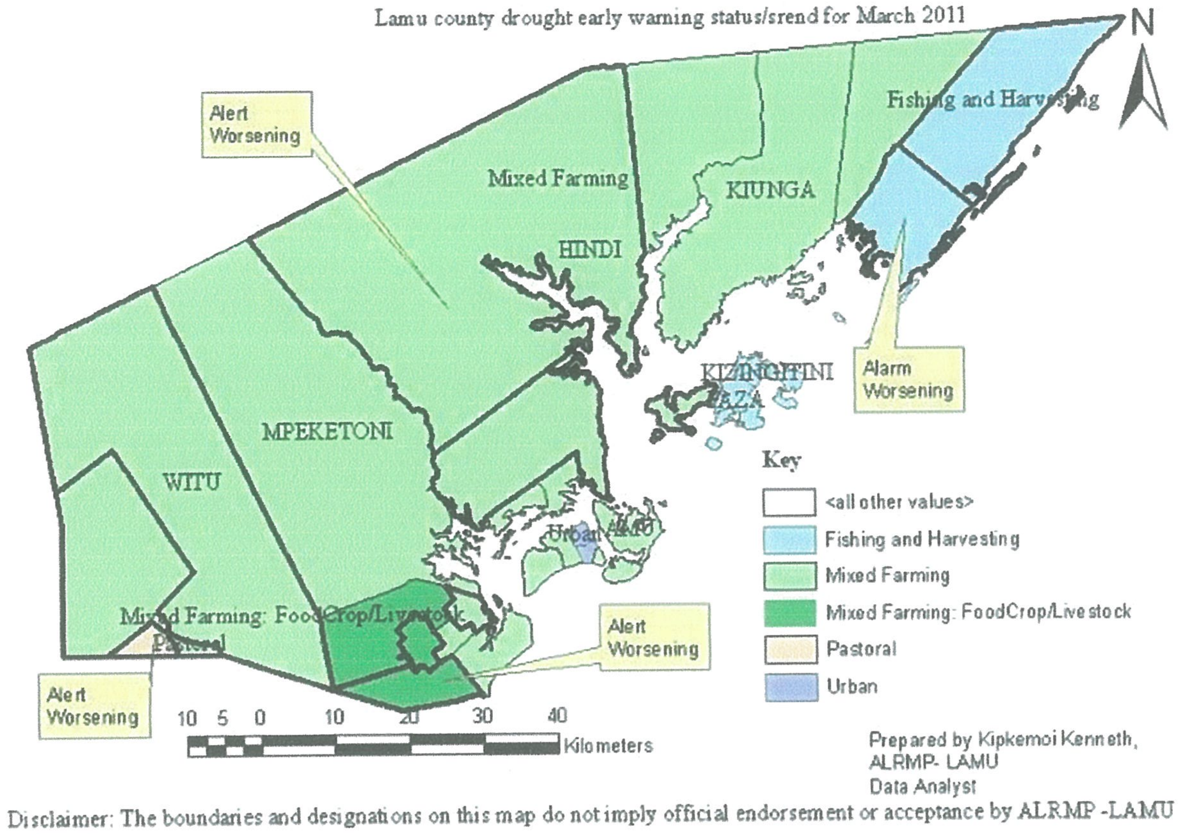
This study followed a descriptive research design. Both qualitative and quantitative methods were used to assess the contribution of bio fuels on food crop production in Lamu district. The quantitative techniques according to Marshal Ross Man (1995) are appropriate for research that deals in department with complexities and processes such as the respondents experiences, attitudes, and benefits that are normative and sensitive in nature. This method was used to collect and analyze data on the contribution of bio fuels on food crop production as well as different responses from investors. The methods were used to quantify and make numerical comparisons between the respondents. I chose this method due to the fact that accuracy is inevitable and it minimized biasness and increase reliability of the results. The qualitative techniques were used to assess the status of bio fuels and food crop production from relevant literatures and through the observations which were made on the effects of bio fuels.

3.2 Study area

3.2.1 Geographical location

Lamu District, with a latitude of -2.08 (2° 4' 60 S) and a longitude of 40.75 (40° 45' 0 E), is a administrative region (administrative division) located in the area / state of Coast in Kenya that is a part of Africa. The location is situated 459 kilometres south east (138°) of the approximate center of Kenya and 446 kilometres east (102°) of the capital Nairobi. A 100 square km area around Lamu District has an approximate population of 34019 (0.00034 persons per square meter) and an average elevation of 15 meters above the sea.

Lamu District is a district of Kenya's Coast Province. Its district headquarters is Lamu town. The district covers a strip of northeastern coastal mainland and the Lamu Archipelago. Lamu District has a population of 72,686 (1999 census) and its land area is 6,167 km^2.



Source: Drought monitoring bulletin, March 2011

3.2.2 Vegetation

There are extensive mangrove forests in the area. The natural vegetation in Lamu District can be divided into six broad groups. These groups are characterised by the dominant physiognomic vegetation types as stated below. The natural vegetation in Lamu District can be divided into six broad groups. These groups are characterised by the dominant physiognomic vegetation types such as: Acacia-Euphorbia type (Acacia Thorn-Bushland), Low land Dry Forest (Manilkara-Diospyros Type), Lowland Dry Forest (Cynometra-Manilkara Type), Lowland Rain Forest, Lowland Moist Savanna, Mangrove Forest

3.2.3 Administrative divisions

Lamu district has only one local authority, Lamu county council. The district has two constituencies: Lamu West and Lamu East.

Division	Population	Urban population
Amu	17,310	12,839
Faza	7,474	0
Hindi	7,072	1,335
Kiunga	3,310	0
Kizingitini	6,010	0
Mpeketoni	25,530	773
Witu	5,980	1,322
Total	**72,686**	**16,269**

Source: 1999 census

3.2.4 Economy

Lamu's economy was based on slave trade until abolition in the year 1907. Other traditional exports included ivory, mangrove, turtle shells and rhinoceros horn, which were shipped via the Indian Ocean to the Middle East and India. In addition to the abolition of slavery, construction of the Uganda Railroad in 1901 (which started from the competing port of Mombasa) significantly hampered Lamu's economy. Tourism has gradually refueled the local economy in recent times.

China has begun feasibility studies to transform Lamu into the largest port in East Africa, as part of their String of Pearls strategy.

3.2.5 Temperature

Temperatures throughout the district are usually high ranging from 23^0 C to 32^0 C. The hottest months are December and April while the coolest months are May and July. Mean relative humidity in the district is 75%. The total amount of evapo transpiration is 2,230 mm per annum with the highest values occurring in March and September and the lowest in May. Comparison of evaporation and rainfall show that rainfall deficits occur in all months except for May. The largest deficit occurs from January to March.

3.3 Study population/target population

This study targeted farmers totalling to 65, the sample size was derived at by using sampling technique that ensures that each farmer gets a chance of participating in the study. Out of the 65 targeted respondents the researcher sampled 55 respondents.

The sample (55) was arrived at using the Sloven's formula of sampling.

$$n = \frac{N}{1+Ne^2}$$

N: Population of the study

n: Sample size

e: degree of confidence level at 95% which equals to 5%

$(n = N/1 + N(e^2)$

Where n = sample size, N = Constant, e^2 = level of significance = 0.05.

During the study, the respondents were chosen depending on their availability and willingness to take part in the research.

3.4 Sample selection

According to Oso and Onen (2005) in applying purposive sampling the researcher decides who should be included in the sample, it is used to collect focused information, typical and useful cases are selected. This research was stratified sampling technique to select farmers from various departments that were included in the sample. Stratified sampling technique is a technique that identifies subgroups in the population and their proportions and select from each subgroup to form a sample). It groups a population into separate homogenous subsets that share similar characteristics so as to ensure equitable representation of the population in the sample. The differences in case are the departments. The researcher used simple random sampling technique in a sense that whether one is on probation or confirmed were to be put into consideration. Respondents were identified depending on their availability and willingness to take part in the study.

3.5 Data collection instruments

3.5.1 Questionnaires

These are research instruments community used to obtain important information about population under study. Each item in the questionnaire is developed to address a specific. Objectives, research questions or hypothesis of the study according to Mugenda and Mugenda (2003) questionnaires can be structured or close-ended or un structured or open ended. Close ended questionnaires contain questions which are accompanied by a list of all alternatives from which respondents select the answer that best describes their situation. Open ended questionnaires contain questions which give the respondents complete freedom of response. Those free response questions permit an individual to respond in his or her own style or words. The researcher used questionnaires because respondents could fill them at their free time thus providing an opportunity to get correct and accurate information.

3.5.2 Interviews

An interview is an oral administration of questionnaire or interview schedule (Mugenda and Mugenda 2003) Interviews are face to face encounters. To obtain accurate information through interviews a researcher needs to obtain maximum co-operation from the respondents prior to conducting the interview. The researcher used interviews because they provided in depth data which was impossible to get using questionnaire. Also through interviews very sensitive and personal information could be extracted from the respondents by honest and personnel interaction between the respondents and the interviewer.

3.5.3 Observation

It is a data collection instrument under which the researcher explains what happens in real life situation of respondents and then classified the happenings which are related to the study for further analysis. The main reasons as to why the researcher used observation are, it enabled firm and first hand information to be obtained.

3.6 Data analysis and presentation

After collecting all the data, only correctly filled questionnaires were processed and analyzed. Analysis was done using frequency tables, percentages and pie charts.

3.7 Validity and reliability of research instruments

3.7.1 Validity

A pilot study was conducted among the sampled population. The purpose was to access the worthiness of the instruments to generate correct data so that items discovered to be in appropriate in answering the research questions and attaining the research objectives were modified to improve the quality and the appropriateness of the instruments or be discarded.

3.7.2 Reliability

Reliability refers to the consistency that an instrument demonstrates when applied repeatedly under similar conditions (Kerlinger, 1983). The reliability of the research instruments was established by the researcher before analysis and consequent presentation. This was achieved by comparing the pilot and final data collected. The same instruments were presented to experts from Kampala International University inclusive of the supervisors for careful scrutiny.

CHAPTER FOUR

PRESENTATION OF FINDINGS AND DISCUSSIONS

4.0 Introduction

This chapter puts forward the study findings which are in line with the study objectives. The chapter utilized quantitative data presentation and analysis techniques such as frequencies and percentages. The findings were obtained through the use of questionnaires, interviews, reading through documents and observation.

4.1 Background information of the respondents

4.1.1 Respondents' level of education

Table 1: Level of education

Level of education	Frequency	Percentage
Primary	17	31%
Secondary	24	44%
College	10	18%
University	04	07%
Total	**55**	**100**

(Source: Field study 2011)

Most farmers (44%) had attained secondary level of education while (31%) had primary education, (18%) had college certificate and (07%) had gone up to university being the lowest. The researcher could therefore tell that farmers with high education level as those with secondary education are the majority while those with degrees being the minority. In respect to this, the researcher evaluated that those farmers with higher level of education (Secondary level) could be attributed to the fact that majority stepped out of secondary level to assist in the growing demand of bio fuels in terms of cultivating as well as planting of Jatropha and soy beans to maximise yields since the government demanded human resource on a larger scale level. In response, majority of secondary students had to drop out after their studies and decided to join the farmers' training association in regards to bio fuel production in that they gained knowledge and skills in respect to the concept of bio fuel production thus reliable information was obtained from them.

4.1.2 Gender Distribution of Respondents

Table 2: Sex of respondents

Sex	Frequency	Percentage
Male	37	67%
Female	18	33%
Total	**55**	**100**

(Source: Field study 2011)

From the above table it can be noted that, (67%) of the respondents and (33%) were males and females respectively. This literary implied that the farmers composed generally most of males than the females in Mpeketoni division. As a result, this implied that from the biological point of view, males are energetic and therefore have the capacity to work for long hours in regards to various agronomic practises such as cultivation, planting, application of fertilizer and harvesting of bio fuel crops such as corns, sunflower, sugarcane, soy beans and Jatropha. The majority of men travel from their different home locations such as Kiunga, Hindi and Faza divisions within Lamu district to Mpeketoni division so as to look for employment opportunities since Mpeketoni division expanded employment base in respect to production of bio fuel in large schemes of agricultural lands as well as being smallholder farmers.

4.1.3 Distribution of Respondents by Age

Table 3: Age of respondents

Age group	Frequency	Percentage
15-25	13	24%
26-35	29	53%
36-45	08	15%
46 and above	05	09%
Total	**55**	**100**

(Source: Field study 2011)

It is evident from the table that most respondents were in the middle age group between 26 and 35 which represented (53%) followed by age group 15-25 with (24%), age group 36-45 had (15%) while the group 46 and above had (09%) respectively. The high percentage of the respondents between the age group of 26-35 years could be attributed to the reason that majority were in the teenage hood stage thereby having the strength to migrate from their home areas to Mpeketoni division desperately seeking for employment in order to support their families in that they were already in the family setting. Consequently, as a result of their age, they could contribute towards delivering their experience in terms of technical knowledge and skills to help in the agricultural production of bio fuels. In addition, most of the internally displaced persons in Mpeketoni division were the young generation in that; they as well participated as active farmers' to seek income as well hence increasing the human labour thereby assisting in the planting and harvesting of bio fuel crops such as cassava and sun flower among other bio fuel practises.

4.2 Types and classification of bio fuels

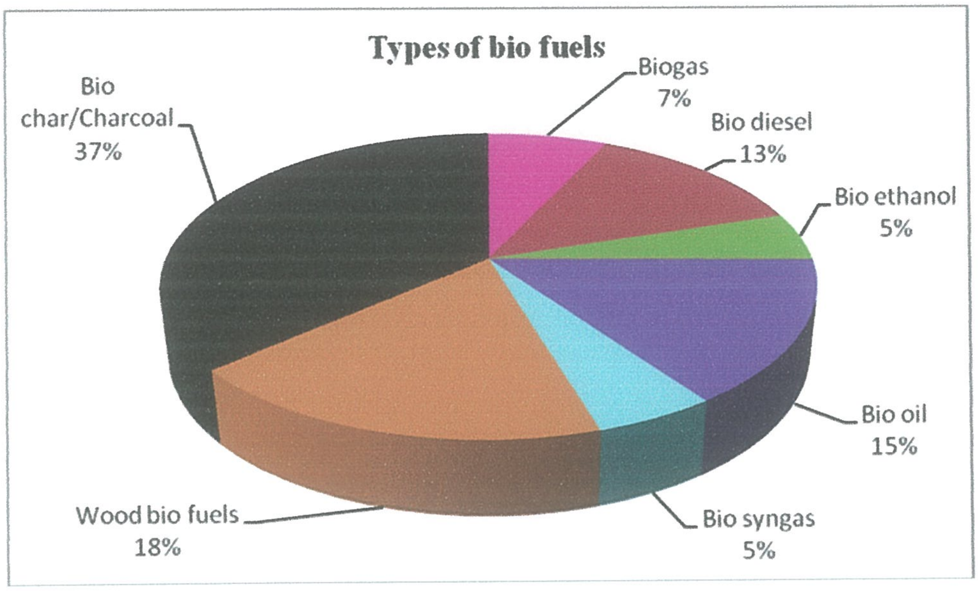
4.2.1Types of bio fuels

Table 4: Types of bio fuels

Type of bio fuel	**Frequency**	**Percentage**
Biogas	04	07%
Bio diesel	07	13%
Bio ethanol	03	05%
Bio oil	08	15%
Bio syngas	03	05%
Wood bio fuels	10	18%
Bio char/Charcoal	20	37%
Total	**55**	**100%**

(Source: Field study 2011)

Fig 1: Pie chart showing types of bio fuels



Source: From the above table

According to study findings in figure 1, it was established from an analysis made from the respondents' reactions that charcoal (37%) was the major bio fuel used, wood (18%), bio oil (15%), bio diesel (13%), bio ethanol (07%), bio gas and bio syngas (05%) each. According to the respondents, it was reported that charcoal (36%) was a major preference of bio fuels. This was because the farmers could easily obtain trees for charcoal burning. Also most lands were dedicated for tree growing to be harvested for charcoal production in towns. Farmers who used charcoal said that it was the cheapest source of fuel.

Wood followed with (18%) since most of them had small parcels of land which had wood lots hence generation of firewood and saw dust.

Bio oil (15%) was commonly obtained from crops such as sunflower and soy beans and it was at this percentage because some of those crops were consumed as food before transformation into bio fuels.

Bio diesel (13%) was a little bit preferred but commonly used by vehicle owners for transportation purposes and running of certain machines such as crushers which were used in processing and producing bio fuels. It also had to be blended with petroleum which made it expensive.

Bio gas (07%), bio ethanol and Bio syngas (05%) were not so much embraced. In bio gas production, the respondents said it had limitations such as being explosive and could catch fire therefore no one should have naked flames in the vicinity of a digester and electrical equipment must be of suitable quality, normally "explosion proof". Other sources of sparks are any iron or steel tools or other items, power tools (particularly commutators and brushes), normal electrical switches, mobile phones and static electricity. There was also bad odour from the bio gas digester as a result of decomposition of organic matter by bacteria.

4.2.2 Classification of bio fuels

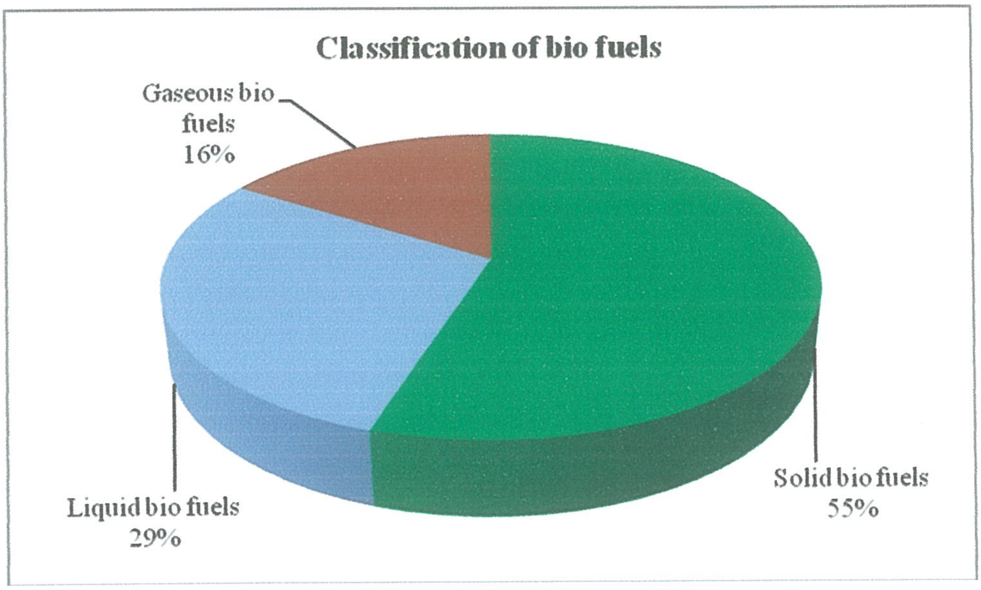
There were three major classifications of observed by the researcher and they included solid, liquid and gaseous bio fuels as shown in the table below.

Table 5: Classification of bio fuels

Classification of bio fuels	Frequency	Percentage
Solid bio fuels	30	55%
Liquid bio fuels	16	29%
Gaseous bio fuels	09	16%
Total	**55**	**100%**

(Source: Field study 2011)

Fig 2: Pie chart showing classification of bio fuels



Source: From the above table

From the figure 2 above, it was deduced that most farmers used solid bio fuels (55%). The reason was attributed to often being a by-product, residue or waste-product of other processes, such as farming, animal husbandry and forestry as opposed to liquid bio fuels which came second (29%) having an implication that the respondents lacked storage facilities for the liquids and there were much losses in terms of leakage thus preferring the solid bio fuels. Unlike solid bio fuels and liquid bio fuels, gaseous bio fuels had (16%) because the respondents' facilities broke down which needed every now and then maintenance.

4.3 Reasons for using bio fuels

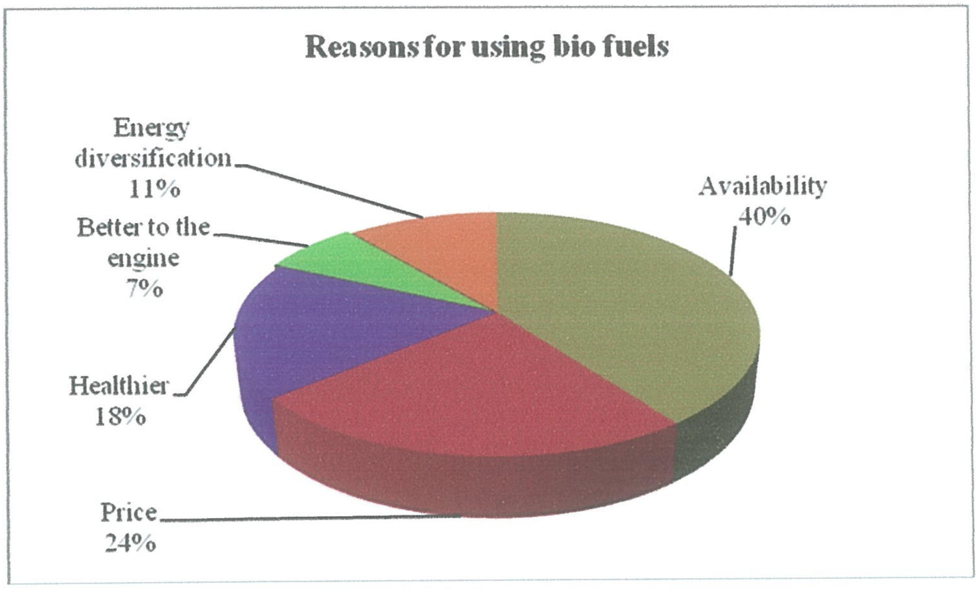
The researcher sought to find out whether there were reasons that made the respondents adopt the use of bio fuels. The results were as follows;

Table 6: Reasons for using bio fuels

Reasons for using bio fuels	**Frequency**	**Percentage**
Availability	22	40%
Price	13	24%
Healthier	10	18%
Better to the engine	04	07%
Energy diversification	06	11%
Total	**55**	**100%**

(Source: Field study 2011)

Fig 3: Pie chart showing reasons for using bio fuels



Source: From the above table

From the field it was found out that availability (40%) was the major driving factor to use of bio fuels. This was because the materials for bio fuel preparation could be locally found. Price (24%) was also a contributing factor since the respondents argued in terms of the costs in relation to energy sources such as electricity as they compared it to charcoal. It was cheaper to buy and prepare charcoal than to generate electricity. In terms of healthiness (18%), the respondents related it to aspects such as reduction in carbon emission which causes global warming saying that they are environmental friendly. Better to the engine (07%), was because they do not cause knock to engines, contain no lead and mercury as well as they cause no carbon accumulation in engines. Energy diversification (11%) meant that the respondents could have alternative energy sources other than depending on one, mainly fossil fuels such as coal and gas.

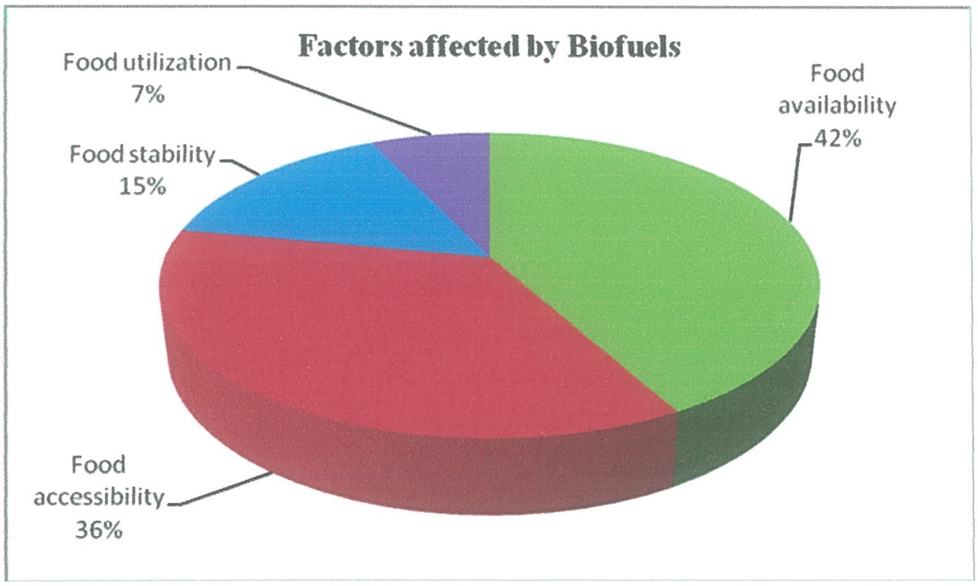
4.4 Food factors affected by bio fuels

Table 7: Food factors affected by bio fuels

Food factors	**Frequency**	**Percentage**
Food availability	23	42%
Food accessibility	20	36%
Food stability	08	15%
Food utilization	04	07%
Total	**55**	**100%**

(Source: Field study 2011)

Fig 4: Pie chart showing factors affected by bio fuels



Source: From the above table

Food availability (42%) addressed the "supply side" of food production and was determined by the level of food production, stock levels and net trade. Food availability was low as a result of food for human consumption being diverted for bio fuel production as well as low output of food production. Food accessibility (36%), the respondents had ways and means which enabled them to acquire food. The "ways" included whether food was own-produced, purchased, given or gathered from the wilds. This was attributed as a result of food scarcity and hiking of food prices which were majorly the contributing factors. In food stability (15%), the respondents argued that those conditions of food availability, accessibility and food utilization had to be fulfilled at present but also in any future point of time. Food

Utilization (07%) was commonly understood as the way the body made the most of various nutrients in the food. The respondents did not know about sufficient energy and nutrient intake by individuals as the result of feeding practices, food preparation and diversity of the diet had changed because of bio fuel production.

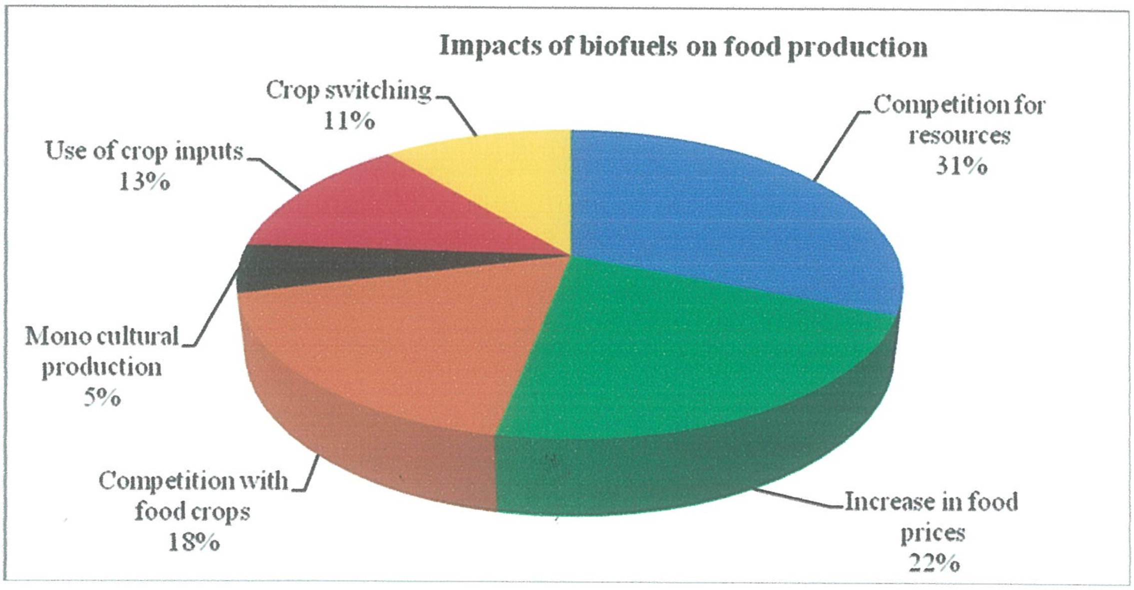
4.5 Impacts of bio fuels on food crop production

Table 8: Impacts of bio fuels on food crop production

Impacts of bio fuels	Frequency	Percentage
Competition for resources	17	31%
Increase in food prices	12	22%
Competition with food crops	10	18%
Mono cultural production	03	05%
Use of crop inputs	07	13%
Crop switching	06	11%
Total	**55**	**100%**

(Source: Field study 2011)

Fig 5: Pie chart showing impacts of bio fuels on food production



Source: From the above table

The researcher identified that competition for resources (31%) was the major impact of bio fuels. Resources such as land for crops, water for irrigation were meant for bio fuel crops giving no time for growing food crops.

Increase in food prices (22%) was as a result of low purchasing power of the respondents because of food shortage which as a result, contributed to poverty.

Competition with food crops (18%) such as soy beans, cassava and sunflower occurred because of high demand of bio fuels to enhance energy diversification and food crops.

Use of crop inputs (13%) such as fertilizers, pesticides and seeds which are meant for raising food crops are diverted and applied to bio fuel to maximise its production thus leading to low food crop production.

Crop switching (11%) was identified through changing of the agronomic patterns of growing food crops and later substituting with bio fuel crops. As a result, there was a decrease in food diversification thereby contributing to a decrease in food supply.

In mono cultural production (05%) the farmers grew only one type of bio fuel crop to meet the use and demand of the crop unlike in food crops where the farmers changed the crops in different planting seasons thus contributing to loss of soil structure and fertility in terms of the nutrients being exhausted thus cannot sustain food crop production.

4.6 Condition of food before introduction of bio fuels

Table 9: Condition of food before introduction of bio fuels

Condition of food before bio fuel introduction	**Frequency**	**Percentage**
Sufficient	30	55%
Insufficient	12	22%
Average	10	18%
Don't know	03	05%
Total	**55**	**100%**

(Source: Field study 2011)

In relation to the status of food before the adoption of bio fuels the respondents were asked to give condition of food in their area before bio fuels were introduced and most of them said food was sufficient (55%), insufficient (22%), average (18%) and those who didn't know (05%). Food was sufficient before bio fuel generation because there were vast lands dedicated for raising food crops. In addition, there was lack of knowledge and skills for the bio fuels extraction since no techniques were embraced. (22%) for insufficient, it was attributed to poor soils in the area in terms of lack of clay content which could have brought about the soil moisture. Lack of favourable climate, in that it was dry and hot without frequent rains. Food production was average (18%) because some of the respondents could not notice any change before and after introduction of bio fuels. This was attributed by the fact that some farmers had not embraced the ethic of comparison and effective analysis in pointing out the possible differences. Those who didn't know about the impacts of bio fuels were as a result of them being unaware of bio fuels and how they affect food production.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0. Introduction

This chapter was concerned with conclusions and recommendations of the research study.

5.1 CONCLUSIONS

The production of bio fuel had been blamed for rising food prices and shortages by diverting resources from the cultivation of food crops. While the ethanol industry disputed the impact of bio fuels on food prices, citing economic analyses, other respondents had questioned the benefits of bio fuels, saying that in addition to driving up food prices, they could increase greenhouse gas emissions and contribute to water shortages which impacted on food production. Production of bio fuels had distorted food markets in three main ways. First, it had diverted grain away from food for fuel, with over a third of corn being used to produce ethanol and about half of vegetable oils going towards the production of biodiesel. Second, farmers had been encouraged to set land aside for bio fuel production. Third, it had sparked financial speculation in grains, driving prices up higher.

The prices of seeds had also gone up, one of the respondents said that in 2006, a kilo seeds went for 1000 shillings (US$15), today half a kilo of seeds goes for 3000 shillings ($46) it's very expensive. Crops like sugarcane, corn and Jatropha were used to produce bio fuel, an alternative to fossil-based fuels like petrol. Bio fuels helped tackle climate change problems and improve rural employment and livelihoods. They also helped diversify energy portfolios, ameliorate trade balances and improve air quality. However they are not a panacea and present several limitations and problems. Because of these, the expansion of the agricultural frontier was a key concern. On the social side, there were important concerns about the impacts of bio fuel production on food security especially on food quantity, food accessibility and food quality.

5.2 RECOMMENDATIONS

The government should carry out more research on the potentials of ethanol production and also on ethanol management technologies to reduce negative environmental risks for instance groundwater and soil contamination. Soils and water are essential in crop production hence the need to protect such resources to enhance crop growth.

Reforms in the agricultural sector need to be done in order to give farmers better support especially in times of crop failure or bad market prices.

Before designing and implementing policies to promote bio fuels, national governments need to have a clear understanding of the potential sustainable development benefits. From an economic point of view, it is necessary to identify the right policies for the industry to take off. Evidence so far suggests that the countries currently at the forefront of bio fuel development owe their progress to a set of economic incentives and domestic policies that allowed this to happen. From an environmental point of view, policies should promote investment in environmentally suitable farming practices and technologies. From a social point of view, policies should enable the fair participation of small farmers in the food supply chain.

To prevent competition with food, policies should be in place that limits the location and type of bio fuel crops such as Jatropha plantations. Such a policy should encourage or mandate intercropping of Jatropha to ensure the most protection of food security and that agricultural land is not used for bio fuel production.

If using Jatropha or other plants which have the possibility to grow on marginal land with little water needs, make sure that it is only produced there and is not allowed to be cultivated on good land, even if the productivity of bio fuel would then have been better.

At present, bio fuels represent a fast and growing industry. The challenge is to balance large scale industry development with small-scale local production and use. These sectors need to co-exist and build upon the strengths that each has to offer. The development of a bio fuels industry in sub-Saharan Africa would need to be done in a sustainable manner, addressing issues such as agricultural land competition, scarce water resources, soil erosion, biodiversity concerns, food versus fuel issues, equity concerns of large versus small-scale bio fuels development, and bio fuels trade issues. A range of promising energy crops for sustainable development and use of small-scale bio fuels development have been identified, of which Jatropha appears highly promising. Where possible, it is recommended that perennial crops be a priority over annual crops, and multi/inter cropping be considered to enhance economics. The issue of bio fuels for cooking was also raised as a potential opportunity; however there is need for more affordable stoves is has been expressed frequently.

More comprehensive assessments of the amount of degraded land in the world that might be suitable for bio fuel production set against its other potential uses such as for food production or forestry or natural regeneration, also considering the economic viability of bio fuels produced on degraded land should be encouraged.

Action to sustainably boosted yields in currently low-yielding countries and regions such as Africa should be highly encouraged so as to produce more crops per hectare of land for both food and energy use.

Research into the environmental performance of advanced (often referred to as second and third) generation bio fuels such as those derived from wastes and sources such as switch grass and marine algae is also needed.

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APPENDICES- APPENDIX I: QUESTIONAIRE FOR FARMERS

I' m an undergraduate student at Kampala International University carrying out a research on" **BIOFUELS AND FOOD CROP PRODUCTION: A CASE STUDY OF MPEKETONI DIVISION LAMU DISTRICT".** This research is part of requirement of the award of Bachelors of Environmental Management.

Dear respondent you are therefore requested to spare some time in filling this questionnaire as honestly as possible. All the information you give will be treated with maximum confidentiality it deserves. Thank you very much.

INSTRUCTION: PLEASE TICK WHERE APPROPRIATE

SECTION A: PERSONAL INFORMATION

1) Sex

a) Male [ ] b) Female [ ]

2) Age

a) 15 -25yrs [ ] b) 26-35yrs [ ] c) 36-45yrs [ ] d) 46 and above [ ]

3) Education level

a) Primary [ ] b) Secondary [ ] c) College [ ] d) University [ ]

e) Others specify ....

4) Marital Status

a) Single [ ] b) Married [ ] c) Widowed [ ] d) Divorced [ ]

5) Population of household

One child [ ] 2-5 [ ] above 5 [ ]

6) Occupation of household

Peasant farmer [ ] Business [ ] Religious Leader [ ] Other Specify.....................

SECTION B: TYPES AND CATERGORIES OF BIO FUELS

7) What do you understand by the term bio fuels?

....
....
....

8) Which types of bio fuels do you use mostly?

Biogas [ ] Biodiesel [ ] Bio Ethanol [ ] Bio-oil [ ]

Bio syngas [ ] Wood [ ] Charcoal [ ]

9) How do you classify your bio fuels?

Solid Bio fuels [ ]

Liquid Bio fuels [ ]

Gaseous Bio fuels [ ]

10) For how long have you produced bio fuels?

Less than 5 years [ ] 5-10 years [ ] above 10 years [ ]

11) Which crops do you commonly use for bio fuels?

Maize [ ] wheat [ ] sugarcane [ ] palm oil [ ] Barley Oat [ ] Potatoes [ ]

Soy beans [ ] Coconut [ ] sun flower [ ] Jatropha [ ]

12) From the crops given above in 10, choose one and briefly explain how bio fuels are obtained from it

....
....
....

SECTION C: DRIVING FACTORS TO USE OF BIO FUELS

13) Are there reasons that led you to adopt bio fuel production?

Yes [ ] No [ ]

14) How did you come to know about bio fuels?

Recommendation from friend/relative [ ] TV/Radio Advertising [ ]

Newspaper [ ] seeing the field [ ] others specify...............................

15) Would you recommend someone to use bio fuels?

Yes [ ] No [ ]

16) What could be your suggestions on the factors to consider before adopting the use of bio fuels?

....
....
....
....
....

17) What reasons made you adopt bio fuel production?

Availability [ ] Price [ ] Healthier [ ]

Better to the engine [ ] Have good political implications [ ]

SECTION D: EFFECTS OF BIO FUELS ON FOOD CROP PRODUCTION

18) Are there any negative effects of bio fuels on food crop production?

Yes [ ] No [ ]

If yes, briefly explain

....
....

19) Do you think if there is any relationship between bio fuels and food crop production?

Yes [ ] No [ ]

20) Which of the following factors is greatly affected by bio fuels?

Food availability [ ] Food stability [ ]

Food accessibility [ ] Food utilization [ ]

21) What are the impacts caused by bio fuels on food production?

....
....
....
....

22) What was the condition of food before the impacts of bio fuel production?

Sufficient [ ] Insufficient [ ] Average [ ] Don't know [ ]

23) Give your opinion on the effects of bio fuels on food crop production

....
....
....
....

24) How can we minimize the effects of bio fuels on food crop production?

....
....
....

Thank you for your cooperation. Allah bless you