ANALYSIS OF SMALLHOLDER FARMERS' AWARENESS AND PREFERENCES FOR BIOFUEL INVESTMENTS FOR LIVELIHOOD DIVERSIFICATION IN KENYA

A thesis submitted in partial fulfillment of the requirements for the award of Master of Science degree in Agricultural and Applied Economics

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university.

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DEDICATION

This thesis is dedicated to my parents Mr. Jacob Ochieng and Mrs. Mary Ochieng for their unwavering support and the sacrifices they have made to enable me to achieve the very best.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AfDB African Development Bank

ASDS Agricultural Sector Development Strategy

CAP Common Agricultural Policy

CE Choice Experiment

CS Compensating Surplus

CV Contingent Valuation

EU European Union

FGD Focus Group Discussion

GDP Gross Domestic Product

GHG Green House Gases

GoK Government of Kenya

IFAD International Fund for Agricultural Development

ILO International Labor Organization

KNBS Kenya National Bureau of Statistics

KSHS Kenya Shillings

LCM Latent Class Model

MDGs Millennium Development Goals

MNL Multinomial Logit

MRS Marginal Rate of Substitution

NGO Non-Governmental Organization

RP Revealed Preference

RPL Random Parameter Logit

SD Standard Deviation

SE Standard Error

SP Stated Preference

SSA Sub-Saharan Africa

USD United States Dollar

USA United States of America

WEBCO Western Biofuel Company

WHO World Health Organization

WTA Willingness to Accept

WTP Willingness to Pay

ABSTRACT

Poverty continues to be a problem in some parts of the world and is typically severe among small-scale farmers. Biofuel investments are emerging as a possible alternative livelihood diversification strategy. However, little is known on farmers' awareness and preferences for biofuel investments. Specifically, the study focused on characterization of smallholder farmers' livelihood strategies, their awareness and preferences for biofuel investments. The survey data was generated from a multistage area sample of smallholder farmers in Western Kenya. Descriptive statistics were used in the characterization of smallholder farmers' livelihood strategies. A binomial logit was applied to assess the factors that would influence the probability of farmers being aware of biofuel investments. Further, the Choice Experiment (CE) approach and the Random Parameter Logit (RPL) were used to elicit farmers' preferences for biofuel investments.

The results of the study showed that majority of the farmers depend on agricultural-based livelihood activities that face major economic challenges such as low and delayed payments. Only about 41% of the farmers were aware about biofuel investments as a possible alternative livelihood strategy. The main factors that had a significant effect on the level of awareness were age of the household head, gender of the household head, education of the household head, membership to farmer group by the household head, access to extension services and the household size. Pooled results from the preference analysis indicated that farmers had positive preference for short contract length, quarter piece of land to be leased out, permanent type of employment and renewable contracts. The study also estimated Compensating Surplus (CS) measures, which indicated that farmers in Kakamega are willing to accept higher compensation compared to their counterparts in Bungoma for them to participate in biofuel investments. These findings offer useful insights to policy-makers on the design of biofuel investments to address the livelihood challenges in Western Kenya and other areas with similar conditions.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Poverty continues to be a problem in some parts of the world despite improvements in the global trade regime and significant enhancements in agricultural productivity through the Green Revolution Technologies. Approximately 1.2 billion people (20% of the global population) live in extreme poverty (earning less than USD$2.5 per day) (United Nations, 2012; FIRA, 2008). The incidence of poverty is greatest in the rural areas and is typically severe among small-scale farmers, that is, those farmers who cultivate less than 2.5 acres of land. Countries in the developing world continue to be the hardest hit by poverty with 70% of the world's poorest (1.4 million individuals) currently living in rural areas (IFAD, 2011). Studies that have been done in various countries such as Zambia, Brazil and India (see for example, Bigsten and Tengstam, 2011; Rahut and Scharf, 2012) indeed confirm that livelihood diversification can assist in generating new sources of income to help poor farmers exit poverty.

Livelihood diversification refers to developing a large number of enterprise mix in favor of high value and more remunerative enterprises. For rural households, diversification may be in the form of supplementing farm income with non-farm income, increasing the number of crops grown and types of livestock reared and use of resources in different farm enterprises (Ellis, 2000). The main objectives of livelihood diversification include increasing the income of smallholders, generating additional employment, stabilizing farm incomes over time, mitigating risks and conservation of natural resources. The potential benefits of livelihood diversification include improved incomes, reduction of risks such as crop failure and market failure (Ali, 2003).

In developing countries such as Kenya, there are various challenges that necessitate the pursuit of livelihood diversification. These include high population growth, land pressure, low agricultural productivity, failed markets and climate change that reduce profitability. Rapid population growth has led to increased pressure on land and this has resulted to fragmentation of land into uneconomical sizes that cannot support sustainable agriculture (Lung and Schaab,

2004). In an attempt to address these challenges, various alternative forms of off-farm diversification activities have emerged. These include shifts from farm labor to non-farm wage employment and rural-urban migration. However, these livelihood options have shortcomings in that there is a limit on the amount of labor that can be employed at any given time and also there is excessive pressure on limited resources due to rural-urban migration. According to the World Bank (2010), 30% of Kenyans currently live in the cities/peri-urban areas. According to the International Labor Organization (ILO) (2009), Kenya's population is facing a general unemployment rate of 40%, reaching about 70% among the youth in some remote and resource-constrained localities. Increased rural-urban migration creates pressure on the limited resources in the urban centers. Unemployment on the other hand leads to increased social evils such as criminal activities among the unemployed communities in their quest for survival. It thus appears reasonable to create alternative livelihood strategies for the unemployed youth within their rural areas.

Due to the reasons discussed above, other forms of livelihood diversification strategies have emerged enabling farmers to diversify their livelihoods without necessarily having to move to urban centers where resources are already limited. For example, the biofuel investments are emerging as a possible alternative livelihood diversification strategy in developing countries (Darkwah *et al.,* 2007). Biofuel refers to renewable energy that is produced from plant matter or agricultural waste referred to as biomass. It could either be in liquid or gaseous form. Biofuel investments refer to livelihood strategies that involve farmers' growing crops that can be used to produce fuel and selling to the biofuel companies. It could also be in the form of farmers selling their land or leasing their land to the biofuel companies. In addition to this, it could involve farmers providing labor to the biofuel companies. Authors such as Banda (2008), Novo *et al*. (2010), Resnick and Thurlow (2012) and Darkwah *et al.* (2007) argue that nations with high potential to produce biofuel such as Brazil, South Africa and Mozambique could take advantage of the biofuels industry in that it has the capacity to reverse the decline of agricultural commodity prices and offer an opportunity for agricultural and rural development by offering alternative market for agricultural produce. The authors further suggest that biofuels could help in creation of jobs for poverty alleviation.

Jumbe et al. (2009) further indicate that development in the biofuel sector offers both promises and challenges for developing countries in SSA. While skeptics argue that biofuel production threatens food supplies for the poor, others note that if well managed, biofuels can be produced profitably and stimulate rural economic growth in developing countries. Amigun *et al.* (2011) show that the emerging biofuel industry can help to create local economic opportunities in agriculture and industry, for example, providing an alternative market for crops, providing market for crop residues and also help to improve the environment through reduction of greenhouse gas emissions. Darkwah *et al.* (2007) also highlight that African countries such as Kenya, Tanzania and Malawi that have vast land, varieties of biofuel feed stocks, favorable climate for growing energy crops and low cost of labor ought to take advantage of this emerging industry.

Although Kenya has not participated in large scale biofuel investments before, the government is currently reviewing policies and legislations (GoK, 2006; Gok, 2014) that would possibly support development of biofuels such as ethanol and biodiesel. The Ministry of Energy and Petroleum has developed a biodiesel strategy through its National Biofuel Committee. In addition, a Kenya Biodiesel Association is being formed with support from all sectors of the biofuel industry. Also there are proposals to invest about KSh 12 billion by Western Biofuel Company (WEBCO) funded by investors from Britain, China and Qatar in collaboration with the Bank of Africa and Equity Bank in Kenya. The proposed biofuel complex that is still at a planning stage is aimed at producing fuel ethanol from tropical sugar beet in Bungoma (Chullen, 2012).

As biofuels are now gaining popularity as an alternative livelihood source, issues on social acceptance, such as awareness and preferences are very key in ensuring level of success of a given development project such as biofuel investments. Awareness refers to the important role that community enthusiasm and knowledge has in building sustainable societies. Delivering knowledge to communities in remote areas requires strategies for effective communication. Awareness and preferences are vital tools in shaping public acceptability, which is increasingly being seen as a constraint to beneficial and sustainable exploitation of renewable energy.

1.2 Research problem statement

Reliance on a narrow range of economic activities such maize and sugarcane farming that face major economic challenges such as lack of markets, low and delayed payments has led to persistent poverty in Western Kenya specifically Bungoma and Kakamega Counties. UNICEF (1994) further observed that low incomes make households unable to provide education for their children leading to low levels of school enrollment. The maize industry in this region is faced with lack of a milling factory in Bungoma, despite high volumes of maize produced in the area. As a result, farmers have to transport the maize more than one hundred kilometers to Kisumu city for milling; suffice to mention that most smallholder farmers with limited resources find it difficult to sell to far-away millers due to exorbitant transport costs (Nangendo, 1994; Omiti *et al.,* 2009). Since Bungoma shares borders with Uganda, which also produces maize, the cross border trade generally depresses maize prices in the region (Kimenju and Tschirley, 2008). Therefore, these force farmers to sell their crops at throw away prices.

The residents of this area also traditionally depended on the Webuye Pan Paper industry as a major source of income for over a decade before it was shut down some years ago due to mismanagement and operational inefficiencies. This further magnifies the poverty situation leading to little or no income to sustain their livelihoods (Masayi and Netondo, 2012). Kakamega County on the other hand, is home to over one million people and like Bungoma, struggles with hardships of severe poverty, facing 73% of its population. This is further compounded by high levels of unemployment and low literacy levels among the youth. According to the Kenya National Bureau of Statistics (KNBS) (2010), Western Kenya has relatively high poverty index compared to other regions in Kenya. The KNBS estimates that about 32% of households in Western Kenya are among the hardcore poor as opposed to an average of about 20% for all rural areas in Kenya. A household is considered poor if it is unable to meet its minimum basic consumption needs. It is defined as hardcore poor if its consumption levels are inadequate to meet basic food needs alone, even if all non-food consumption is foregone.

Biofuel investments which are being promoted in this region could serve as an important livelihood diversification strategy and possibly enable rural households to exit poverty. However, most of these biofuel investment companies would require farmers to either lease out their land or grow the biofuel crops on their own farms or even sell out their land. Farmers in this

region are mostly familiar with lease of land arrangements between neighbors for traditional crops, which do not come with a lot of restrictions in terms of use of shared resources such as foot paths, water points, land use rights and land access rights. In such traditional arrangements, although farmers would lease out their land, they would still enjoy the benefits of these common resources. These farmers are not familiar with leasing out their land for large scale commercial purposes such as biofuel investments that would entail restrictions such as land right restrictions, restrictions to foot paths, playing grounds and restriction to water points , which may disrupt the way in which they carry out their livelihood activities.

For example, these biofuel investment companies may use land or water unsustainably. This would disrupt livelihoods in that it may lead to a situation which there may be limited or no access to water for crop and livestock farming which is the pre dominant livelihood activity in this area. Also, these biofuel investors may require some people to relocate to other areas against their wish. This would contribute to lack of local ownership of the development projects to be implemented. It is worth noting that current tensions among communities and/or conflict with development investors are mostly caused by dispute over access to land and water which are already diminishing resources in most parts of Kenya.

While these biofuel investments have been shown to have potential to help farmers exit poverty, they at the same time, come with various restrictions as discussed. For this reason, these biofuel investments will be beneficial to farmers and be more effective towards poverty reduction only if farmers who are the major stakeholders are aware of the potential benefits and or challenges of biofuel investments as an alternative livelihood strategy. As noted by, Braun (2007), farmers in many low income developing countries are unaware of the opportunities presented by biofuel investments and thus risk missing out on how best to harness the potential benefits. Despite the high level of support of renewable energy in general, attitudes among some parts of the 'public' who may not be aware can be more negative and conflict may occur within the process of planning approval (Walker, 1995). Poor access to agricultural information results to information-related problems such as moral hazard and adverse selection which in turn increases transaction costs and hence discourages farmers from participating in emerging alternative livelihood activities (Omamo, 1998).

Lack of information between the sellers (farmers) and the buyers (biofuel investors) would make transactions more costly. Consequently, lack of information especially on the part of poor farmers, for example information on biofuel investments, would make farmers spend time and resources getting the buyer to honor the terms of the agreement thus incurring enforcement costs (Poulton *et al.*, 2006). Given the significance of knowledge delivery and acquisition in the early phases of an emerging technology/livelihood alternative, the dearth of literature from the farmers and potential user's standpoint is noticeable in terms of whether farmers are aware of the potential of biofuel investments as an alternative livelihood activity (Villamil *et al.*, 2008).

Also, lack of stakeholder consultation and their exclusion from investment planning (from negotiation to implementation) often leads to program rejection and conflicts (Amigun *et al.*, 2011). For example, a proposed sugar production investment by Mumias Sugar Company was rejected about three years ago in Tana delta region in Kenya due to inadequate consultation with the farming and pastoralist communities in the area. Further, programs or investment projects that fail to consider local people's needs and aspirations in terms of their preferences tend to collapse or lead to disruption of rural livelihood patterns, that is, lack of sustainability. Studying farmers' awareness and preferences would enable policy makers to understand why communities may object to relatively large bio energy projects. It would also assist the developers of such projects to avoid delays and refusal of planning consent associated with adverse local opinions (Upham and Shackley, 2007; Amigun *et al.*, 2011). Understanding farmers' views and incorporating them in investment program design (for example biofuel) is therefore necessary. This study is therefore important so as to know how biofuel investments can be designed so as to fit in the context of the enterprise mix and livelihood patterns of farmers in Western Kenya. It also appears reasonable to understand the levels of monetary compensation that these farmers would be willing to accept in order to participate.

1.3 Objectives

The purpose of this study was to analyze smallholder farmers' awareness and preferences for biofuel investments for livelihood diversification in Kenya. The specific objectives were:

- To characterize farmers sources of livelihoods

- To analyze farmers awareness of biofuel investments as an alternative livelihood strategy.
- To assess monetary compensation levels that farmers would be willing to accept for inclusion of various features in biofuel investment design.

1.4 Hypotheses

- Farmers are not aware of biofuel investments as an alternative livelihood strategy
- Farmers are not willing to accept any significant monetary compensation to have biofuel investment features.

1.5 Justification

Assessment of farmers' livelihood options in Bungoma and Kakamega Counties would help to better understand the challenges and opportunities facing their livelihood activities. In addition to this, as stated by Batz *et al.* 2003, a priori identification of farmers' awareness and preferences would help to design and develop more acceptable and cost effective biofuel policies and programs, for example, biofuel investments in Kenya. In this regard, according to the Bungoma County Development Profile, 2013, alternative green energy is being promoted in the County and this would boost job creation in the area. This study is therefore important in that it will assist Kenyan policy makers in the design of biofuel investments which is one of the development priorities in this County. This will therefore enhance achievement of Kenya's Vision 2030 which aims at transforming Kenya into a middle income country by 2030 (GoK, 2013).

Also, this study is justified because, given Kenya's Agricultural Sector Development Strategy (ASDS) 2010-2020, it was important to analyze smallholder farmers' livelihood strategies, awareness and preferences for biofuel investments in terms of how they should be designed so as not to stifle ASDS vision of ensuring a food secure and prosperous nation (GoK, 2010). Though biofuel investments have been shown to have great potential in spurring rural development and reduce poverty, if not well designed, they could compete with arable land meant for food crops and this may have adverse effect on food security. This therefore justified the need to understand how these investments should be designed so as not to jeopardize attainment of food security.

Also, according to current policies on energy in Kenya that are being reviewed, renewable energy is being promoted nationally as it has the capacity to enhance energy security, mitigate climate change, generate income, create employment and generate foreign exchange savings (GoK, 2014). This study therefore sought to involve the farmers in deciding how the biofuel investments should be designed in order to reflect their needs, opinions and desired participation to minimize conflicts on land use. This would help in ensuring local acceptance to reduce wastage of resources and enhance sustainability.

1.6 Study area

This study was carried out in Western Kenya specifically Bungoma and Kakamega Counties. These study sites were chosen to represent areas where livelihood activities face major economic challenges and climatic conditions favor the growth of a variety of biofuel crops. Also these study areas were chosen to represent areas where there are proposals to carry out biofuel investments which could serve as a possible alternative livelihood strategy. According to the KNBS (2010), farmers in these regions depend on a narrow range of agricultural based livelihood activities centered on maize and sugarcane farming. These livelihood options are faced with challenges such as low and delayed payments which mostly come as a result of delayed harvesting (Waswa *et al.,* 2012; Wawire and Kipruto, 2006). The authors further indicate that this delayed harvesting has an adverse effect on the quality of the cane which later results into low payments. On average, cane is harvested after 35 months instead of after 18 months which is the cropping cycle. The payments for the harvested cane are done after six months or even more instead of the stipulated 30 days. The price of sugar cane fluctuate from as high as KSh 5800 to as low as KSh 3500 per ton.

In Bungoma County, there are proposals to set up a biofuel complex to produce ethanol fuel from tropical sugar beet. In Kakamega County, Lugari, Hamisi, Malava and Mumias districts were chosen to represent issues related to poverty effects of straddling in that the households are not quite able to fully exit poverty. Specific problems, as discussed earlier, include issues like problems with market access due to lack of maize milling factory, population pressure and problems related to contract farming respectively which has resulted into high poverty incidence in the area. Also in relation to market access, the various sugar cane factories in that region such

as Butali Sugar, West Kenya and Mumias sugar offer competitive prices. Sometimes the farmers from Mumias transport their sugar to Butali to fetch better prices. This competition for better pricing has made many households abandon other livelihood activities and focus on sugar cane. This has created a problem in that food crops are no longer grown and some residents resort to stealing from those who grow some food crops. This situation creates a need for livelihood diversification and now that biofuel investments are emerging in this region, it could serve as a possible alternative livelihood activity. Therefore the study was carried out in this area to find out whether farmers would prefer to participate in emerging alternative livelihood activities such as biofuel investments to assist them exit the poverty trap. An indicative map of the study sites is shown below.

Figure 1: Study sites in Western Kenya

Source: KNBS, 2010

1.7 Organization of the thesis

Chapter one focused on the background of the study, research problem statement as well as the objectives of the study. It also touched on issues surrounding the justification of the study and the study area. Chapter two highlights a review of studies on livelihood diversification and how the biofuel industry is emerging as an alternative livelihood strategy. Chapter three addresses the methodology. Thereafter, the theoretical framework is discussed in detail. Chapter four provides a detailed discussion of the results, while conclusions and policy implications are summarized in chapter five.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Livelihood diversification

This chapter provides an overview of what livelihood diversification entails and why it is important to smallholder farmers who often live below the poverty line. A review of studies on livelihood diversification strategies and how the biofuel industry is emerging as an alternative strategy is also discussed. Thereafter, a review of preference analysis studies is discussed.

2.1.1 Review of livelihood diversification concepts

Rural households' practice of livelihood diversification in developing countries has received considerable attention in the Development Economics literature (Damite and Negatu, 2004). Diversification refers to the process by which productive resources are allocated among different income generating activities both on-farm and off-farm (Abdulai and Crolerees, 2001). According to Barret *et al.* (2001), very few people derive all their income from any one source, hold all their wealth in the form of any single asset or use their resources in just one activity.

There are various conflicting views regarding whether specialization or diversification is the best strategy to enable poor smallholder farmers exit poverty. Various studies are of the opinion that diversified specialization is the way to go. This is supported by authors such as Farhauer and Kröll (2011) who argue that diversified specialization has the advantage of higher productivity levels and higher growth rate levels compared to purely diversified or even purely specialized livelihood strategies. Other authors such as Owusu (2007), state that having multiple livelihood strategies is the best option. This is because it ensures that planning and development both at the small scale level and national level are successful. This helps to shield against shocks when any form of disaster strikes. Hence both players at the small scale level such as smallholder farmers could adopt such strategies.

Also, the term livelihood diversification strategy has received wide and diverse definitions. Some look at it as sometimes a means to enable accumulation for consumption and investment; others view it as a means sometimes employed to help spread risk, or to cope with temporary crises.

While others look at it as an adaptive response to longer-term declines in income or entitlements, due to serious economic or environmental changes beyond local control (Adams and Mortimore 1997; Dercon and Krishnan 1996; Ellis 2000). Other studies such as Khatun and Roy (2012) have been carried out on the factors that condition the extent of livelihood diversification and found that, factors such as age, gender and income have significant influence on the level of livelihood diversification. These studies have confirmed that livelihood diversification does not take place in a vacuum but is conditioned by various factors. However, these studies have been carried out in other countries out of Africa such as India, with little emphasis on the African context, specifically, Kenya. In addition to this, various studies have highlighted the impact of livelihood diversification. Delgado and Siamvalla, (1997) and, Collier and Gunning (1999) argue that diversification may counteract the advantages of specialization. Others such as Bardhan and Urdy (1999) found that it could be considered as an ex-ante risk management measure for securing more stable household income and consumption.

Also, other studies such as Damite and Negatu (2004), Barret *at al.* (2001) and, Dercon and Krishnan (1996) have focused on the determinants of adopting highly diverse portfolio of activities by rural households. However, these studies have been done in other countries within Africa but with little or no focus on the Kenyan context. Though information on rural Africa already exists, it is still important to carry out a study in rural Kenya because the study contexts are different and the challenges facing the target population in the different countries are also different. This would assist in designing development interventions that address the unique needs of farmers in rural areas such as those in Kenya. From the studies above, it can be noted that most of these have not looked at other new forms of diversification that are currently emerging such as biofuel investments and how farmers would want to participate in them and how they should be designed so that farmers may opt to add them into their portfolio of livelihood activities. Most of the current studies reviewed above, have substantially focused on the existing forms of diversification and the issues surrounding them. In addition to this, little has been done on emerging forms of livelihood diversification such as biofuel in terms of farmers' level of awareness and their preferences in terms of how they should be designed to address their livelihood challenges.

2.2 The biofuel industry and income diversification

Global interest in farm-based energy, in particular liquid fuels derived from crops and agricultural wastes, or biofuel is gaining momentum around the world. Indeed, in the first five years of the 21st century, worldwide production of ethanol doubled and production of biodiesel quadrupled (Caldwell, 2007). Fuels derived from agricultural sources offer an alternative to the rapidly increasing price, the increasing scarcity and the toxicity of petroleum fuels. In general, factors driving the demand for biofuel, besides global warming policies include: rising fuel prices, growing energy demand, awareness of renewable energy resources and possibilities to expand the crop market internationally (Msangi *et al.,* 2006). The biofuel industry is emerging as an alternative livelihood diversification activity in developing countries. Arguments coming from nations with potential to produce biofuel such as Brazil suggest that biofuels could reverse the decline of agricultural commodity prices and offer an opportunity for agricultural and rural development (Novo *et al.,* 2010).

In Africa, Malawi is among the few countries that started producing bioethanol from sugar cane molasses since the early 1980s. This ethanol is blended with petrol at the ratio of one to nine. The Malawian government is yet to pass a bill to make the blending mandatory. South Africa is the leading country in Africa to develop advanced technologies for large-scale production of biofuel. South Africa plans to invest R2-billion to build an ethanol plant to help a hopeful biofuel sector that could reduce the country's reliance on imported fuel. The potential market size for biodiesel in South Africa is about 1 billion liters if it is to replace 10% of its diesel consumption by 2010 (Nolte, 2007). Also, South Africa's main justification for supporting biofuel is that the expected gains from the biofuel industry will contribute to poverty alleviation. This would be enhanced through job creation and that the country needs to diverse into less environmentally damaging sources.

Development in the biofuel sector offers both promises and challenges for developing countries in Sub Saharan Africa. While skeptics argue that biofuel production threaten food supplies for the poor, others argue that if well managed, biofuel can be produced profitably and stimulate rural economic growth in developing countries (Jumbe *et al.,* 2009). In Mozambique, the recent slowdown in poverty reduction has highlighted the need for agricultural growth and the potential benefits of large scale biofuel investments. In addition to spurring rural development, biofuel

could reduce Mozambique's reliance on oil imports. It is estimated that the current biofuel investments could create as many as 150,000 jobs (Resnick and Thurlow, 2012). In Kenya, where biofuel policy documents are still under review, the biofuel industry is said to have the potential in creation of jobs and this will enhance poverty alleviation.

Authors such as Darkwah *et al.* (2007), Kojima and Johnson (2005) and Peskett *et al.* (2007) argue that if the biofuel industry is properly guided for establishment, it could generate enormous number of jobs and stimulate rural economic development. Janssen *et al.* (2010) postulate that the agricultural sector in most SSA countries is dominated by subsistence farming with associated low investment and yields as compared to developed countries. The development of modern bio-energy systems therefore offers opportunities for investment and infrastructure improvements in agriculture with the promise to diversify agricultural production and thus to stimulate socio-economic development. Hence, in Africa today the main focus of bio-energy development is on liquid biofuels (plant oil, biodiesel, bio ethanol) as transport fuel and rural electrification initiatives. Also, other studies have focused on the economic feasibility of production of biofuel from various crops. These studies have little focus on how biofuel investments could contribute to alternative source of income and rural development (see for example, Moraa *et al.* 2010; Maung and Gustafson, 2010).

Janssen *et al.* (2010) and Peskett *et al.* (2007) suggest that considerable justifications have been made about the role of biofuels in development and poverty reduction. For example, it has been argued that energy crops are beginning a green revolution in Brazil. A bio product-based agro-revolution can offer a new development paradigm. Biofuels can provide a solution to the twin problems of poverty and climate change; and countries in the tropics have comparative advantage in biofuels production, which can play a role in job creation and food security.

These studies above indeed confirm that biofuel investments can be a livelihood diversification strategy in various countries in the SSA. However in the Kenyan case, a few studies such as Moraa *et al.* 2009, GTZ and GoK, 2008 have focused on the growing biofuel industry in Kenya. However, little is known whether the biofuel industry can be a sustainable alternative livelihood option for the people of Bungoma, Western Kenya where various biofuel investments are being promoted in terms of whether farmers are aware and how these investments should be designed.

2.3 Review of preference analysis studies

This section provides a review of various methods that have been used to measure preferences for non-market goods and services

2.3.1 Valuation of non market goods and services

There is increasing interest among economists in the problem of valuing non-market goods and services (Alpizar *et al.,* 2001). Non market resources provide outputs or services which are not bought and sold for example 'public' goods such as recreation, wilderness, and clean air among others. These non-market goods and services are not traded in well functioning traditional markets. In this case, ordinary markets do not exist for such public goods because under public policy there is no charge for the good or service or there is an arbitrarily determined charge (which does not reflect the full cost of providing the service or its true market value) (Mitchell and Carson, 1989). That is, they are not supplied by private firms and consumers do not pay market prices. Nonetheless, individuals benefit from their use and therefore the loss of such goods leads to welfare losses to individuals (Dolan and Metcalfe, 2008).

Economists who are concerned with efficiency in the allocation of scarce resources are concerned with how these kinds of tradeoffs should be evaluated (Reira and Signorello (2012). The reasons for valuing non-market resources include attempting to get the value derived from actually using or enjoying the resource and the existence value, that is, the value derived purely from the existence of a resource. The value of these non-market goods is defined in terms of willingness to pay (WTP) or willingness to accept (WTA). With respect to the WTA concept, it is defined in terms of willingness to accept compensation for giving it up. As a result of these issues conventional microeconomic techniques cannot be used in valuing non-market goods and services (Alpizar *et al.,* 2001). Various methods have therefore been developed to measure non-market goods and services. These methods include Revealed Preference (RP) Methods and Stated Preference (SP) Methods.

2.3.2 Revealed preferences and stated preference methods

Revealed preference (RP) and stated preference (SP) methods are the two main approaches that have been commonly used in the economic valuation of non-market goods (Garrod and Willis, 1999). The RP approach, including the travel-cost and hedonic price methods, evaluates product

demand by examining purchases of related goods in the private market place. This approach is appropriate when a market exists for those goods, in which the data are obtained from actual market behavior or based on actual choices made in the observable situations (Morikawa *et al.*, 2002).

The SP approach, including the Contingent Valuation (CV) Method and CE, measures how people value goods through explicit questions. SP data are collected by presenting hypothetical scenarios to respondents and asking for their preferences, for example emerging biofuel investments without a well-established market. Hence the focus of this study would be to establish a hypothetical biofuel market in order to assess farmers' preferences. The basic idea is that relative important scales on different product attributes can be derived on the basis of responses to such hypothetical questions (Bates, 1988). Responses from SP approach often contain useful information on tradeoffs among attributes. However, these responses may not be valid for forecasting actual behavior due to their unknown bias and error properties. In particular, SP data provides useful information when new products (for example biofuel investments) or attributes are introduced, in which case RP data is not yet available (Kroes and Sheldon, 1998).

Data collected from eliciting decision makers' preferences for various alternatives in a real world setting is called RP data. RP data on actual decisions provide good information on outcomes but little or no information about the relevant importance of the various attributes to the decision makers (Birol *et al.*, 2006). On the other hand, SP data is collected from eliciting decision makers' preferences for a series of hypothetical or simulated alternatives. However, SP data provide little information on outcomes but good information on trade-offs within the various attributes (Adamovicz and Louviere, 1994).

Decision makers face different circumstances when making RP and SP choices. Several studies in environmental and transportation economics have shown RP and SP dataset to be significantly different but correlated with one another. SP parameters are significantly larger than RP parameters. Such differences are attributed to differences in unobserved factors/error (Bhat and Castelar, 2002; Adamovicz and Louviere, 1994. Results of separate RP and SP studies with application in environment and health conducted by Bhat and Castelar (2002) and Mark and Swait (2004) indicated that the error variance of the SP data is smaller than that of the RP data.

RP studies often use data on a non-market good of interest to calculate a marginal rate of substitution (MRS) between the price of the land and the non-market good. One shortcoming of this method is that it assumes that the land market is in equilibrium when there are good reasons to suppose that it is not (Greenwood et al., 1991). SP studies construct a hypothetical contingent market where the individual is asked to state his/her WTP for the non-market good. A major constraint of this method is that it assumes individuals have a coherent set of preferences when there are good reasons to suppose they do not (Slovic, 1995).

CV and CE are approaches within the SP method. CV is a direct survey approach to estimating consumer preferences. By means of an appropriately designed questionnaire, a hypothetical market for example, biofuel investments in Kenya, is described where the good or service in question can be traded. This contingent market defines the good itself, the institutional context in which it would be provided, and the way it would be financed. Respondents are then asked to express their WTA for hypothetical change in the level of provision of the good/service. Theoretically, CV is well rooted in welfare economics, namely in the neo-classical concept of the economic value based on individual utility maximization theory.

The CE approach was initially developed by Louviere and Woodworth (1983). In CE method, respondents are presented with a series of alternatives differing in terms of attributes and levels and asked to choose their most preferred option. A base line alternative corresponding to the status quo or 'do nothing' situation is usually included in each choice set (Hanely *et al.*, 2001). Also, the status quo option is include as an alternative because one of the alternatives must always be in the respondents' feasible choice set thereby ensuring that welfare measures are those that are consistent with the demand theory (Louviere et al., 2000; Benett and Blamey, 2001; Bateman *et al.*,2003).

Whilst in principle, CV can also be applied to estimate the value of attributes of the program, for example, by including a series of CV scenarios in a questionnaire or by conducting a series of CV studies, it is a more costly and cumbersome alternative. Hence, CE does a better job than CV in measuring the marginal value changes in various characteristics of environmental program. This is often a more useful focus from a management/policy perspective than focusing on either the gain or loss of the good, or on a discrete change in its attributes. This is because CE entails

the estimation of attribute values as constituents of the value of the whole non-market good (Hanely *et al.,* 2001; Washbrook *et al.*, 2006; Breustedt *et al.,* 2008).

CEs are more informative than discrete choice CV studies as respondents get multiple chances to express their preferences for a valued good/service over a range of payment amounts. For example, if respondents are given 8 choice pairs and a 'do nothing' option, they may respond to as many as 17 bid prices, including zero. In fact CE can be seen as a generalization of discrete choice CV questions where there are two or more goods involved (Hanley et al., 2001). Various studies on farmer preferences have been carried out using CEs (see for example Otieno *et al.,* 2011; Susaeta *et al.*, 2010; Villamil *et al.*, 2008). Studies on farmers' preferences for biofuel investments have been well documented in developed countries such as United States of America (USA), Germany and Sweden (see for example, Fewell *et al.,* 2011 and Amigun *et al.,* 2011). Based on the above review, this study will apply the CE approach in analyzing farmers' preferences for biofuel investments as an alternative livelihood option in Western Kenya for poverty alleviation. In addition to this, this study will contribute to literature on preference in that it aims at attempting to analyze farmers' preferences for biofuel investments based on their current livelihood activities and enterprise mix.

CHAPTER THREE

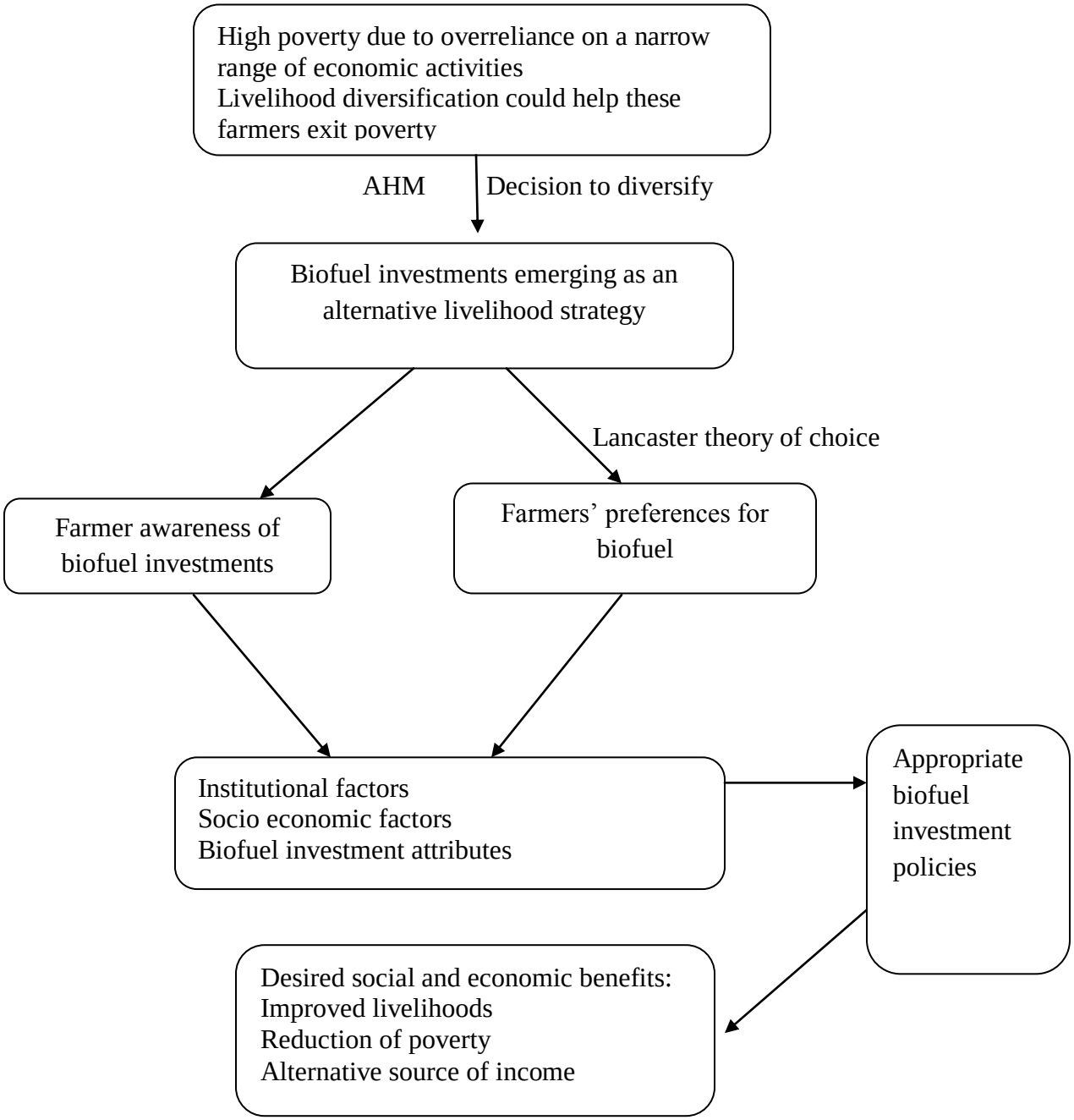
3.0 METHODOLOGY

3.1 Conceptual framework

As indicated in Figure 2, farmers in Western Kenya continue to fall into poverty due to over reliance on a narrow range of livelihood activities. Biofuel investments that are being promoted in this region could serve as possible livelihood diversification option. This study therefore aims at analyzing whether farmers are aware of these emerging biofuel investments and their preferences towards them. This concept is based on the Agricultural Household Model (AHM) which provides a theoretical rationale for income diversification in that rural households aim at maximizing their utility (Karttunen, 2009). In their quest to maximize their utility, which could be in the form of ensuring sustainable income, rural livelihoods would constantly be searching for alternative livelihood sources. The main factor that would influence diversification includes among others, the need to spread risks more so related to farm income.

Having this in mind, this study aimed at finding out whether these farmers are aware of these biofuel investments that are being promoted in their area. Also, it should be noted that, to enhance sustainability, development projects should be designed with the major stakeholders' views and opinions. This study therefore linked households' decision to diversify and how emerging investments such as biofuel could serve as an alternative livelihood strategy. This study therefore attempted to look at how these biofuel investments can be designed in order to fit the enterprise mix of the rural farmers. Hence, their preferences towards these emerging biofuel investments were analyzed and this was based on the Lancaster theory of consumer choice (Lancaster, 1966). Thereafter, with appropriate biofuel investment policies, biofuel investments can be effectively designed and would enhance poverty reduction and improvement of livelihoods.

Figure 2: Conceptualization of biofuel investments as an alternative livelihood strategy for smallholder farmers in Kenya



Source: Author's conceptualization

3.2 Sampling procedure and data collection

The multistage sampling approach was used. This sampling approach was used because of its advantage of cost effectiveness and efficiency compared to other sampling methods such as the simple random sampling approach. Multistage sampling is especially useful in situations where a sampling unit has to be sequentially selected by going through various hierarchical levels such as administrative units as is the case in Kenya. Also, it is advantageous because it can be effectively used in areas where a list of sampling units is not readily available (Som, 1973). The first stage involved the selection of the study areas. The two study areas, Bungoma and Kakamega Counties, were purposively selected as discussed earlier. The next stage involved selection of districts with the two Counties. Within each of the two counties, districts were randomly selected based on those where livelihoods face economic challenges. In the third stage, divisions were randomly selected from the list of all the divisions within each of the districts. In the fourth stage, a sample of locations was randomly selected and from these, sub locations were selected randomly. The sample units were subsequently drawn randomly from the sub-locations. The systematic random sampling approach was used to select the respondents. The household was defined according to KNBS (2010) as "…a person or groups of persons related or unrelated who live together, are answerable to the same head and who share a common source of food." The household heads were ascertained by asking whether they are the ones who make the critical household decisions that are important to the entire household. If they confirmed that they make decisions on behalf of the entire household then they qualified to be a respondent.

In Bungoma County, three districts, namely Bungoma East, Bungoma South and Bungoma West, were selected based on economic challenges. From these districts, four divisions were selected. Thereafter, a total of 10 locations were randomly selected. Finally, a total of 20 sub locations were randomly selected from which 180 households were randomly drawn and household heads interviewed as shown in Table 1. In Kakamega, five districts were selected based on economic challenges, poverty effects of straddling and to represent areas where biofuel investments have not yet been proposed. Then one division from each district was selected, to make a total of five divisions. From these divisions, 7 locations were randomly selected. From these 7 locations, a total of 20 sub locations were randomly selected and from these, a total of 162 households were also randomly drawn and household heads interviewed as shown in Table 2.

Table 1: Sub locations sampled in Bungoma County

Market Challenge	Sample (n)	Sub location	Location	Division	District	County
Depended on pan paper industry that was shut down						
	10	Matulo	Matulo	Webuye	Bungoma East	Bungoma
	10 10	Khalumuli Ng'welo	Sitikho			
	10	Kituni	Misikhu			
	10 10	Miendo Namawanga	Miendo			
Problems with contract farming						
	10 10	Muanda Musala	Muanda	Bumula	Bungoma South	Bungoma
	10 5 10	Muanda Lumboga Bukusu South	Bukusu South			
	5 10	Kanduyi south Musikoma	Musikoma	Kanduyi		
	10 10	Tuti Kibabii	Kibabii			
	5 5 10	Sang'alo east Sang'alo north Kong'oli	Bukembe			
Poor market access						
	10 10	Chwele Mukuyu	Chwele	Chwele	Bungoma west	Bungoma

Source: Author's survey, 2013

Table 2: Sub locations sampled in Kakamega County

Market Challenge	Sample (n)	Sub location	Location	Division	District	County
Problems with contract farming						
	10 10	Ivunzi Butsotso	Butsotso	Lurambi	Kakamega	Kakamega
	10 10	Shireye Emusandi	Shibuli			
Problems with contract farming						
	10 10 10 10 10	Ekero Ebwaliro Ebulingi Ebuhanga Emasinde	Ekero	Mumias	Mumias	Kakamega
Poor market access						
	10 10 10	Munyuki Rusa Mwamba	Lumakanda	Lugari	Lugari	Kakamega
	5 5 5	Mukuyu Mwamba Masutsu	Mautama			
Problems with market access						
	3 2 5 7	Mausi Malekha Namshia Chegulo	Chegulo	Kabras	Malava	Kakamega
Population pressure and declining land sizes						
	10	Shikomoli	Gisambae	Jepkoyai	Hamisi	Kakamega

Source: Author's survey, 2013

The sample size of 342 used in this study provided sufficient statistical degrees of freedom because it was greater than the minimum acceptable sample size of thirty for policy inferences (Battacharya and Johnson, 1977). Similar studies that have analyzed preferences normally require a sample of at least 200 respondents (Hanley *et al.,* 2001; Otieno *et al.,* 2011). In this study, it was therefore intended to capture 200 respondents in each of the study areas. However, during the survey period there were various challenges experienced such as time and cost constraints. Insecurity was also a problem during the time when the survey was being done. This was brought about by political rivalry which led to numerous killings in some parts of the study areas. As a result, only 162 and 180 respondents were interviewed successfully in Bungoma and

Kakamega respectively implying an 80% response rate that was sufficient in eliciting farmers' preferences.

This study used data collected from farmers and the procedures that were employed included the use of a questionnaire (comprising both quantitative and qualitative data). Also, a Focus Group Discussion (FGD) in which qualitative data was collected was also carried out. The FGD was conducted so as to validate the attributes of the biofuel investments. It was conducted through oral discussions with the members who constituted farmers, extension officers and ministry of land officers. A checklist containing questions regarding the biofuel investments was used to guide these discussions. In addition to this, the data collection from the questionnaires aimed at obtaining direct information from the farmers in terms of their current livelihood activities, awareness of biofuel investments and their preferences for biofuel investments as an alternative livelihood activity. A questionnaire was therefore developed in order to ensure that the information gathered is reliable.

The questionnaire captured issues on personal details of the respondent such as their name and their geographical location. Also, issues on land ownership and utilization were captured focusing on whether the farmers own the land they have or not and what crops they currently grow. The enterprise dynamics section focused on issues related to the current enterprises that the households are engaging in. The questionnaire also focused on issues related to awareness of biofuel investments and sources of information. Thereafter, the CE section included various biofuel investments options to elicit farmers' preferences. Lastly, questions on institutional services such as access to credit and socio demographics such as age and gender were also included (See Appendix 1 for more details). The data was therefore collected from 342 farmers through face-to- face interviews by trained enumerators through a pre-tested semi structured questionnaire.

3.3 Choice Experiment design

3.3.1 Design process

The CE design process began by identifying the policy relevant biofuel investment attributes or features. The emerging biofuel industry was conceptualized to have two types of attributes or features, that is, compulsory features and optional features. The compulsory features are those that must be adhered to by all farmers, biofuel investment companies and other stakeholders who may prefer to participate in the biofuel investments.

According to the codes of ethics for business in Kenya and the Companies Act, Chapter 486 of the laws of Kenya, any business investments that are to be set up should adhere to the relevant laws (GoK, 1959). Compulsory features that these biofuel investments are meant to comply with include disclosure of the origin of the biofuel investors. This would be useful to policy to ensure that the biofuel investors are indeed genuine investors. Legal means of negotiations by investors especially when entering into contracts with farmers is another compulsory feature. This will be useful to policy to ensure that the design of the biofuel investments would be in such a way that protects the farmers from extortion by some investors. Also full disclosure of identity of the investor and the legal registration of the biofuel industry to be established among others are other compulsory features. This is useful in the design of policy to ensure that farmers and the biofuel industry enter into legally binding agreements. This would ensure that negotiations between the farmers and the biofuel investors are fair and transparent in catering for the needs of both the farmers and the biofuel investors. Lastly, once the contract is signed, legal means must be followed by farmers to settle any post contract disputes that may arise (GoK, 1959; GCNK, 2012). These aspects are very key in that, if they are not adhered to, they may cause protests and disruptions such as those that were experienced at the Tana Delta region in 2012 between the local communities and the multinational investors which led to massive destruction of lives and property (Otieno, 2014).

The optional features are those that give farmers the chance to make a decision and are the ones that are mainly used in the design of the CE (Caussade *et al.*, 2005; Narrod *et al.*, 2008; Louviere *et al.*, 2000). The optional features are key in the CE design because they assist people with varied views and standpoints to have a common understanding in eliminating a problem that

affects each of them (Ostrom, 1996). For example, an emerging biofuel industry which may threaten their collective livelihoods through, for instance, grabbing their land or relocating them to other areas against their wish.

In coming up with the optional attributes it was envisaged that there could be three categories of farmers based on how they would want to participate in biofuel investments. That is, those farmers who may want to sell their land to the biofuel investors, those farmers who may want to lease out their land and those farmers who may want to grow the biofuel crops in their own farms. The rationale for the likely existence of these groups of farmers stems from the level of comparative advantage towards engaging in certain type of enterprise or enterprise mix and how effectively it can address their livelihood needs (Amanor-Boadu, 2013). For example, in any given society, there are those individuals who may have a comparative advantage in terms of land endowment hence they may be willing to participate by either leasing their land or selling their land. On the other hand, there may be those who have comparative advantage in terms of agricultural skills and would be more willing to grow the biofuel crops on their farms and sell to the biofuel companies.

However, the scope of this study was limited only to those farmers who may be willing to participate in biofuel investments through leasing out part of their land to a biofuel company. This is because most foreign investment companies bring out development projects, such as biofuel investments, through foreign land leases. As discussed earlier, farmers in Western Kenya are familiar with lease arrangements between neighbors that do not come with a lot of restrictions. However, they are not familiar with lease of land arrangements with foreign investors that may come with a lot of restriction in terms of land use rights. This is the reason why this study focused on lease of land arrangements. The optional attributes included lease contract length in years, land size to be leased out as a percentage of total land owned, employment type either none, permanent or casual, renewability of contract and price per acre.

The process of identification of these policy relevant biofuel investment features was done through a review of literature on biofuel policy design. To supplement this, in-depth interviews with key officials at the Ministry of Agriculture and a FGD were also carried out to validate these attributes and their levels in the CE design. Table 3 shows the biofuel investment attributes

for those famers who may opt to participate in biofuel investments by leasing out part of their land. Farmers in Western Kenya mostly depend on sugarcane farming as their source of livelihood. The sugarcane is grown in form of contracts between the farmers and the sugar companies (KSB, 2011). This implies that they would be more familiar with livelihood activities that are carried out in form of contracts. Contract length was therefore included as an attribute in CE design. Inclusion of contract length was also important because, contracts regulate most economic transactions. In a principal agent framework which may involve biofuel investors and farmers, contract length is crucial in determining both the principal's and agent's stake in the duration of the investments (Bandiera, 2005).

The levels chosen were two years, five and ten years. Two years was included to cater for the current situation in Western Kenya where farmers grow sugarcane which has a cropping season of about 18-24 months (KSB, 2011, Parsons 2004). As noted in the FGD, currently the farmers grow sugarcane, which has a minimum contract length of about two years because the crop takes about 18 months from planting to harvesting. Five years and ten years are chosen as other levels for the contract length to cater for multiple cropping seasons. Also, it was assumed that farmers would prefer longer contracts to shorter ones so that they would benefit from cash inflows over a longer period of time. Also longer contracts are assumed to be cheaper and more convenient for the biofuel investment companies so as to enable them to recoup their initial investment costs, ensure continuity in the supply of the biomass and to ensure continuous operation of the investments.

Land is a limited factor of production and as reported by the KNBS (2012), land sizes in various parts of Kenya are on a declining trend due to population pressure. Therefore, since biofuel investments are land based, it was important to include land in the CE design. This would help in understanding how land can be effectively managed with respect to biofuel investments without compromising food security and culture which are also heavily dependent on land. The levels chosen were 25%, 50 and 75% of the total land owned. The size of land that could be leased out could be at least 25% and at most 75% of the total household land owned. Although some farmers would be willing to lease out all their land, it was deemed important to consider leaving some part of their land, either 25% or 50% of it, for their own food production and for cultural

aspects such as shrines as well as burial sites, which are important in African culture. Therefore, the threshold/limit was put at 75% of the total land owned to be leased out. This would allow some land to be available for the household's own production and other ancestral purposes. Previous deals that have involved lease of entire pieces of land for very long periods of time, for example, 10 years have resulted in constant conflict between the land owners and investors (Hughes, 2006, Yamano and Deininger, 2005, World Bank, 2003).

The population in Western Kenya faces a high poverty incidence with about 32% of the households being hardcore poor according to the KNBS (2010) and Dose (2007). This is further compounded by the near sole dependence on sugarcane farming that faces challenges of delayed payments and low payments as discussed earlier. The farmers depend only on a narrow range of livelihood activities as earlier discussed and they used to depend on the Webuye pan paper industry that was recently shut down. Barret *et al.,* (2006) highlights that livelihood diversification could help poor farmers exit poverty. Employment was therefore included as an attribute to bring in aspects of diversification and to act as an incentive to participate in the biofuel investments so as to broaden the range of income sources available to the farmers. Also, employment was included as an attribute because the biofuel industry has been shown to offer job opportunities in countries such as Brazil (Effanga, 2010). The levels included were no employment (none), permanent and casual employment depending on the length of the contract. Renewability of contract was also included as an attribute because it would offer a possibility of continuous flow of income for resource poor farmers who choose to participate in biofuel leases (Bijman, 2008).

Lease price per acre was also included as an attribute so as to enable estimation of the marginal rate of substitution (MRS) between the attributes in CE design and money (Hanemann, 1984). The lease price levels were KSh 10,000, 15,000 and 20,000. There is a difference in the market price levels of lease of land based on the purpose of lease. That is, lease of land for agricultural purposes, lease of land for public utility purposes and lease of land for industrial purposes. Tax rates vary substantially between countries. In most African countries, the land tax under non-traditional tenure, e.g. on leasehold or freehold land, is based on plot size. For example, in the Gambia, annual rates vary from US$0.05 equivalent for agricultural land to US$0.30 and 0.90

per 100 ft (94 m2) for commercial/industrial and residential property respectively. These differences in tax regimes hence have a direct effect on the prices of land depending on the purpose.

This implies that, the value of agricultural land is more dependent on its productive capacity rather than on its market price compared to land for commercial purposes which are valued at their current market prices. Whereas, the price of land for public utility purposes, is based on the size of the plot (FAO, 2003). In the Kenyan context, land rates vary depending on the location of the land. The highest rate is 8% which applies in Nairobi where land is for commercial purposes (GoK, 2012). The price levels were based on the average market lease prices. The 10,000 represents 50%, 15,000 represents 75% and 20,000 represents 100% of the average market price of lease of land. The reason why these price levels were included is because in as much as farmers would be willing to accept 100% of the average market price of lease of land, there is a tradeoff. Given a consumer basket, a rational consumer would look at the various attributes of a good or service available. For example, a farmer who is viewed as a consumer of the biofuel investments will also consider the other biofuel investment attributes in addition to the price before making a decision. This is tandem with the completeness axiom of consumer choice which implies that a consumer can compare the existing bundles of goods and services, and arrange them in order according to their preferences or decide whether he/she is indifferent (Osterdal, 2006). From the FGD discussions, three levels were chosen for each of the attributes except renewability of contract which had two levels.

Table 3: Biofuel investment attributes for lease of land option

Biofuel investments attribute	Attribute levels
Contract length	2 years 5 years 10 years
Land size	25% 50% 75%
Employment to household members	None Casual Permanent
Renewability of contract	Yes No
Lease price per acre (KSh)	10,000 15,000 20,000

Note: The exchange of the Kenya Shilling to the dollar as at June, 2013 was USD$ 1 = KSh 84

3.3.2 The design of Choice Experiment

The experimental design should be designed so that respondents can understand and provide quality data (Beharry-Borg and Scarpa, 2010a; Lusk and Narrod, 2005; Hensher and Rose, 2009). Choice designs are built from factorial design that can either be full factorial design or fractional design. Factorial designs are used to study the effects of two or more factor attributes on a dependent variable. Full Factorial designs are those that consist of all possible combinations of the levels of the factors. However, the problem with full factorial design is that practically, it is too cost prohibitive and tedious to have respondents consider all possible combinations (for example, biofuel investments alternatives). For this reason, researchers often use fractional factorial designs which have fewer runs than the full factorial design (Kuhfeld, 2005; Hedayat *et al.,* 1999).

Fractional factorial designs could either be orthogonal or efficient. Orthogonal design refers to the relationship between factors and other factors and it ensures that estimates across factors are independent (Bliemer and Rose, 2010; Espinosa-Goded *et al.,* 2010). Another aspect in the design is efficiency. This refers to the measure of the information content of a design. The more efficient a design is, the more information the researcher gets for each question asked (Espinosa-Goded, 2010). In the present study, a fractional factorial design was used in a pre-test survey of

42 farmers to obtain a priori coefficients. These were later used to generate the efficient design that was applied in the actual survey. The efficient design had a *D-efficiency* measure of 89% and a *B- estimate* of 80%. This implies presence of low standard errors and a high level of utility balance (ChoiceMetrics, 2009).

Some choice experiments have many choice sets. Some could have 36 choice sets or even 72 choice sets. These may be too many judgments for one respondent to make. Quality of data can decline if subjects are asked to make too many choices. Therefore, it is advisable to block the choice sets so that the subjects see just a subset of the design at a time. The number of blocks used depends on the number and complexity of the choice sets. For example, 36 choice sets can be divided into two blocks of size 18, 3 blocks of size 9, 6 blocks of size 6 or 9 blocks of size 6. During the pre test survey of this study, there were 36 choice sets from the orthogonal design that were divided into 6 block of size six. However, the respondents were fatigued by the time they were asked the fourth choice task. Therefore, in the efficient design, it was deemed practical to generate 24 choice sets which were blocked into 4. This is what was applied in the actual survey.

Therefore in the current study, the respondents were randomly assigned to one of the six choice sets in the biofuel investment through lease of land option. Each choice task constituted three alternatives, that is, biofuel investment A, biofuel investment B and a neither option/alternative as shown in Table 4. Also, all the biofuel investment attributes were set at the zero level. During the interviews with the respondents, and especially in the CE section of the questionnaire, respondents were asked to consider only the attributes present in the choice tasks when making their decisions on which biofuel investments alternative they would prefer. Also, they were asked to treat each task independently. The CE design was generated using the NGENE software.

Table 4: Example of biofuel investment choice set

Now I will show you different biofuel investment options that can be made by combining these features, please compare the different biofuel investment types shown to you each time and indicate which one you prefer.			
	Biofuel investment alternative A	Biofuel investment alternative B	Neither A nor B
Contract length	10 years	2 years	
Size of land	25%	75%	
Employment to household members	casual	none	
Renewability of contract	no	yes	
Price per acre (KSh)	10,000	20,000	
Choice question: Which biofuel investment option would you prefer?			

3.3.3 Choice experiment survey

Before the CE exercise, preliminary questions and a summarized introduction of biofuel investments through lease of land option were asked in the questionnaire so as to prepare the respondents for the choice exercises. These preliminary questions included those on awareness on biofuel and how these farmers would like to participate in biofuel investments, either through growing of the biofuel crops, lease out part of their land, selling their land or providing labor to the biofuel company. Also, questions on how important farmers regarded the biofuel investments attributes were included using a likert scale where 1= not important, 2= moderately important and 3= very important. (See Appendix 1 for details).

During the CE exercise, the enumerators who were well trained thoroughly explained the biofuel investments through lease of land option, including their purpose, the compulsory features and the optional features. This was done so as to enable the respondents to easily understand the CE task and to make independent choices which would adequately reflect their preferences. Also, during the CE exercise, each respondent was faced with four different choice sets which were picked from the six blocks and arranged into profiles. From these choice sets, the respondents

were then asked to select the alternative which they preferred the most. The complete list of the profiles/blocks of the choice sets from the CE design is in Appendix 4.

In the actual survey, one respondent on average took about an hour to complete an entire questionnaire. In one day, each of the enumerators could comfortably interview 7 respondents. The entire field work for the two study areas was carried out in the months of April and May, 2013 for Bungoma and June, 2013 for Kakamega.

3.4 Theoretical framework and model specification

3.4.1 Analysis of awareness of biofuel investments

The binomial logit model was used to analyze the factors that influence farmers' probability of being aware of biofuel investments. Empirically, the model was specified as follows:

$$Y_i = \begin{cases} 1 = \text{aware} \\ 0 = \text{otherwise} \end{cases}$$

where Yi refers to the binary random variable

Binary choices are modelled in terms of probability distributions defined over the set of outcomes (Maddala, 2000).

Binary choice models can be anchored in either random utility approach, latent regression approach or the conditional mean functional approach. In the random utility approach, utility derived from each choice is unknown to the analyst but can be measured as a probability (random variable) that a decision is likely to be made.

The respondent derives utility U_0 from choice 0 as shown below

$$U_0 = \beta' 0_x + \varepsilon_0 \text{ ……………………………………………………………………… (1)}$$

and utility U_1 from choice 1 as shown below

$$U_1 = \beta' 1_x + \varepsilon_1 \text{ ……………………………………………………………………….. (2)}$$

In this case, ε_0 and ε_1 are the individual specific, random components of the individual's utility that are unaccounted for by the measured covariates, x. The choice of alternative 1 reveals that $U_1 > U_0$, or that $\varepsilon_0 - \varepsilon_1 < \beta'0_x - \beta'1_x$.

In the latent regression approach, a latent regression is specified as

$y^* = \beta'X+\varepsilon$. …… (3)

The observed counterpart model is: y = 1 if and only is y*>0. This is the basis for most of the binary choice models in econometrics. It is the same as the reduced form presented under the random utility approach. The conditional functional approach assumes that y is a binary variable, taking values 0 and 1, and formulates a priori that

Prob [y=1] = F (β'X) …… (4)

where F is any function of the index that satisfies the axioms of probability,

$0 \leq F(\beta'X) \leq 1$ …… (5)

and

F (β'X) =0XProb[y=0|X] +1xProb[y=1|X] …… (6)

is the conditional mean function for the observed binary y (Greene, 2003).

Therefore, the binary logit model is a random utility model in which it is assumed that the random parts of the utility functions are distributed as independent extreme values. This can therefore be specified as follows:

Prob [y_i=1] = $\dfrac{\exp(\beta' x_i)}{1+\exp(\beta' x_i)} = \Lambda(\beta' x_i)$ ..... (7)

having a density function

$F'(\beta' X_i) = \Lambda(\beta' x_i)[1 - \Lambda(\beta' x_i)]$ ..... (8)

In this study, the binomial logit model was empirically estimated as follows:

$\Pr[AWARENESS_i = 1] = \beta_i X + \varepsilon_i$..... (9)

where $AWARENESS_i$ refers to the probability of being aware of biofuel investments as an alternative livelihood activity by the i^{th} farmer (1= farmers is aware, 0= otherwise). X represented a vector of factors which were hypothesized to influence farmers' probability of either being aware of biofuel investments as an alternative livelihood activity or not. These factors included age of the household head, gender of the household head, education level of the household head, access to credit by the household head, access to extension by the household head, membership to group by household head, household size and land size. β_i represented the vector of parameters to be estimated and the ε_i is the statistical error term.

In addition to this, marginal effects were also estimated to measure the instantaneous effects of variations in any of the independent variables on the predicted probability of being aware of biofuel investments as an alternative livelihood activity, with all other independent variables being held constant. The marginal effects were therefore computed as follows:

$\beta_i = \frac{\partial(\beta i \times i + \varepsilon i)}{\partial \beta i \times i}$ for continuous independent variables .....(10)

or

$\beta_m = [\Pr AWARENESS_i = 1] - [\Pr AWARENESS_i = 0]$ for dummy-coded variables ..... (11)

The binomial logit model was estimated using NLOGIT version 4.0 software (Green, 2007).The descriptive results were analyzed using SPSS version 16.0 software.

3.4.2 Analysis of choice experiment data

The analysis of CE data is based on the Lancaster theory of consumer choice (Lancaster, 1966). This theory states that preferences for goods/services are a function of the attributes of the goods/services rather than the goods themselves. According to McFadden, (1974), CE data is based on random utility theory whereby discrete choices are described in a utility maximizing framework. In CE, there are various models that can be used for analysis and these include Multinomial logit (MNL), Random Parameter Logit (RPL) and the Latent Class Model (LCM).

In the specification of the MNL, the choice of an alternative represents a discrete choice from a set of alternatives which are represented by an overall utility function (McFadden, 1974). The model is specified as follows:

$U_{in} = V_{in} + e_{in}$ …… (1)

In this overall utility function, each alternative is represented by a utility function that encompasses a deterministic component (V_i) and a stochastic component (e_i). The deterministic component is specified as a linear index of attributes of the different alternatives for example, biofuel investment alternatives. The (e_i) represents unobservable influences on individual choices.

Prob {I chosen} = Prob {Vi + ei >Vj + ej, $\forall$ j e C } …… (2)

Where, *C* is the set of all possible biofuel investment alternatives. In this case there are three alternatives; biofuel investments alternative *A*, *B* and the neither option representing the status quo.

Assuming that there is extreme value distribution for the error terms and that there is independence between choice scenarios and the individual, the probability of choosing any alternative can be represented by:

$$\text{Prob } \{i\} = \frac{e^{svi}}{\sum_{i=c} eVj} \quad \text{…… (3)}$$

The MNL has various shortcomings such as violation of consumers' axiom of transitivity and stability of choices by imposing independence of unobserved factors over time. The MNL also assumes the independence from irrelevant alternatives (IIA). Due to this it does highlight the changing levels of substitution between alternatives. Also, it assumes that tastes are homogeneous across respondents. The RPL is therefore superior to the MNL in the analysis of preferences as it accounts for preference heterogeneity among respondents and was introduced by Cardel and Dumber (1980). The RPL is preferred in the analysis of preferences as it allows the coefficients of the model to vary among individuals in a random manner. Also, according to Revelt and Train (1998), it eliminates the IIA property of the MNL which is restrictive.

Therefore in the RPL, the utility U_{int} derived by person 'n' from alternative i in choice set *t* can be given by:

$U_{int} = \beta_n X_{int} + e_{int}$ ………………………………………………………………………… (4)

Where: X_{int} is a vector of policy attributes (biofuel investments attributes), β_n is an individual-specific vector of parameters in the population density function and e_{int} is the IID random term independent of β_n and X_{int}. In the estimation of WTA biofuel investments as an alternative livelihood activity, the following equation was used as suggested by Hanemman (1984).

$WTA = +\ 1 * \frac{\beta k}{\beta p}$ ……………………………………………………………………………… (5)

Where βk is the coefficient for an attribute/attribute level (in this case, contract length, size of land, employment type, and renewability of contract) and βp is the price attribute.

Once the WTA values have been computed, the overall compensating surplus (CS) can be computed using the following equation according to Hanemann (1984).

$CS = \frac{1}{B_p} (V_1 - V_0)$ …………………………………………………………………….. (6)

In the above equation, V_i represents the value of the indirect utility associated with the biofuel investment attributes and V_o represents the indirect utility of the baseline scenario (no biofuel investments). Therefore, the overall CS is the difference between the values of the indirect utility

associated with the presence of biofuel investments and the indirect utility without biofuel investments. These values are thereafter converted into monetary terms using the coefficient of the price attribute (B_p).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Characterization of smallholder farmers' livelihood strategies and awareness of biofuel investments

Farmers' characteristics influence farming decisions and are important in understanding decisions related to livelihood activities. Statistical tests (t-test) of differences in means of key variables relating to the respondents in the Bungoma and Kakamega were used to examine if farmers in the two regions are significantly different.

Land is a limited factor of production in Kenya. As shown in Table 5, average farm sizes in the study areas were about 3.1 acres in Bungoma while in Kakamega the average land sizes were about 2.6 acres. Though the results showed that land sizes in Bungoma were relatively larger than those in Kakamega, they were not statistically different. The high potential agricultural areas are very densely populated and land sizes are very small. Comparisons between farm size and cultivated area indicated that half of the land was under maize, beans and sugarcane while a quarter of the land in some cases was under other crops such sorghum, cassava and bananas which are not very remunerative. These declining land sizes have a direct effect on investments such as those related to biofuel which are land intensive It would therefore be interesting to know whether farmers would still prefer to participate in such investments given the declining land sizes.

This study conceptualizes livelihood diversification activities/strategies to be the process by which households construct a diverse portfolio of activities to aid in the improvement of their standards of living (Ellis, 2000). Livelihood activities in the study areas are mainly focused on agricultural activities although some farmers also engage in other off-farm and nonfarm activities such as trading, tailoring, welding and teaching among others. As shown in Figure 4, farmers in the study areas can be grouped in terms of the level of livelihood diversification and the income sources for the different livelihood groups. Therefore, the current enterprise mix in Bungoma and Kakamega was categorized into three groups. Those farmers who derive over 75% of their monthly income from crop farming, those farmers who derive over 75% of their monthly income

from crop and livestock farming and those farmers who derive over 75% of their monthly income from off farm and nonfarm activities. From the results it can be seen that over 60% of the farmers depend on crop and livestock farming and only about 40% of the farmers in the study area engage in some form of off-farm livelihood activity.

The results of the study also showed that in Bungoma, 98% of the farmers grow maize, about a half of the farmers also grow sugarcane, 80% of the farmers grow beans and 38% of the farmers also grow other crops such as sorghum, cassava and bananas. Also, results of the study indicated that less than half of farmers sampled market their maize while all of the farmers who grow sugarcane market their sugar cane. In Kakamega, 98% of the farmers grow maize. About a half of the farmers grow sugarcane, three quarter of them grow beans while a third of the farmers grow other crops such as sorghum, bananas among others. In the pooled sample, 98% of the farmers grow maize while less than a half of them market their maize. More than half of the farmers sampled grow sugarcane and all of them market their sugarcane, while only about a third of the farmers grow other crops like sorghum, cassava and bananas. These results indeed confirm that although the farmers grow a variety of crops, they majorly depend on maize and sugarcane farming. These results indeed confirm that maize and sugar cane are rated as the two most important crops in the study areas.

As shown in Table 6, majority of the farmers cited challenges related to production, marketing, post harvest and institutional that faces their current livelihood activities. These findings are consistent with those highlighted by KNBS, (2012). These challenges call for policies that support alternative more remunerative livelihoods that assist farmers exit the poverty web. These challenges indeed confirm that there is need for these farmers to add other livelihood activities into their portfolio so as to reduce the shocks created by economic challenges facing their currently livelihood activities as already discussed. Even though land sizes are already on a declining trend, it would be interesting to know whether farmers would be willing to participate in alternative livelihood activities such biofuel investments so as to supplement the little income that they derive from their current source.

Figure 3: Land utilization and crops marketed

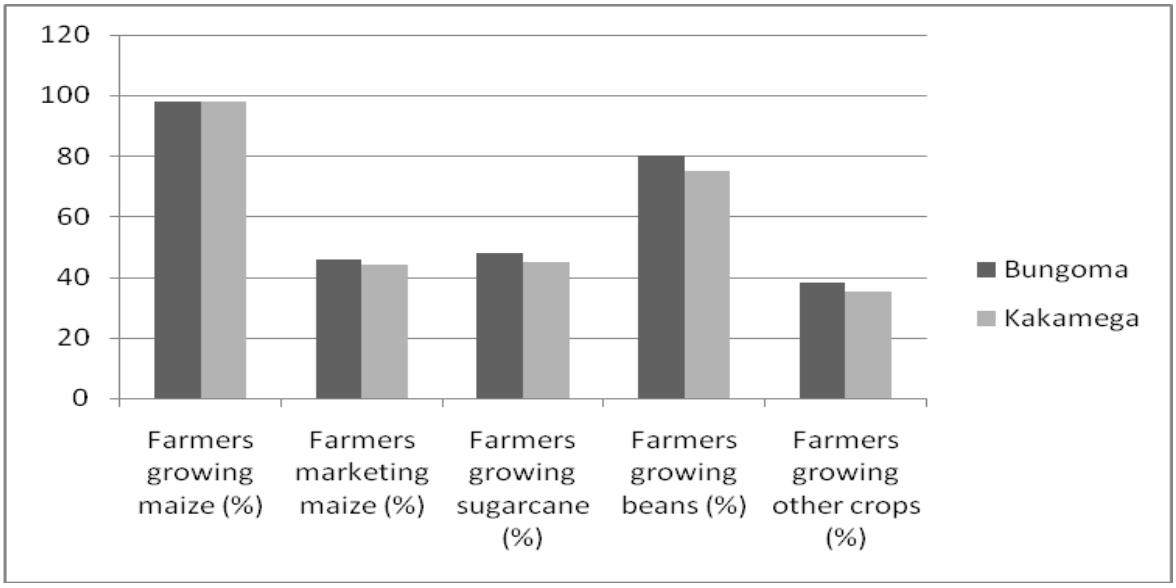
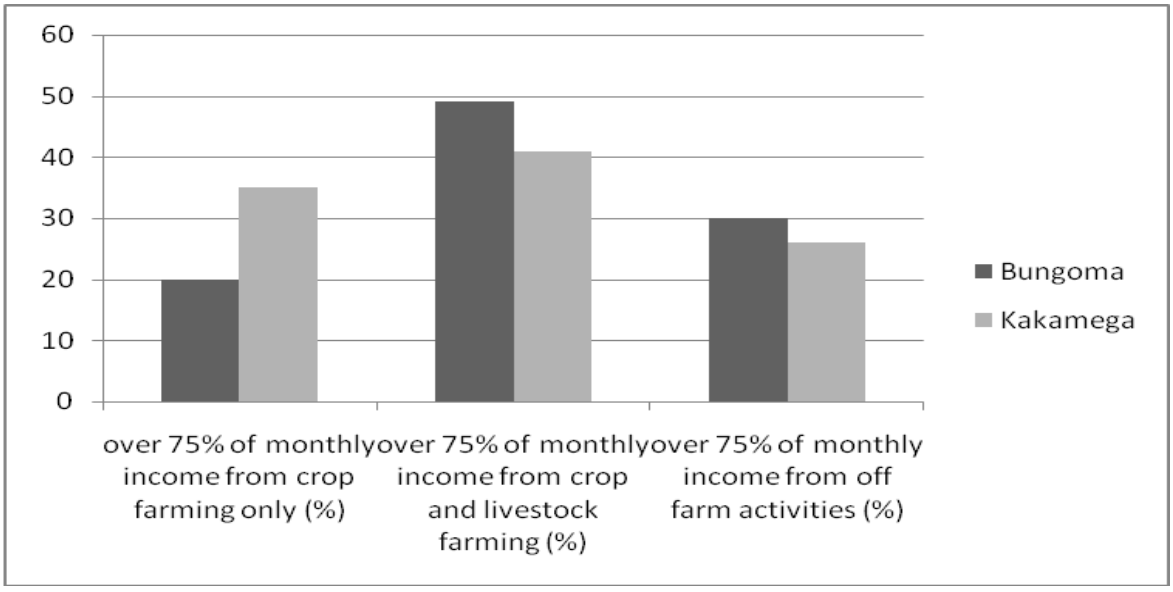


Figure 4: Categories of farmers based on their enterprise mix



Source: Author's survey, 2013

Table 5: Land size and economic challenges facing current livelihood activities

Challenges	Bungoma n= 180	Kakamega n= 162	pooled n= 342
Average farm size (acres)	3.1	2.6	2.7
Production challenges			
Input acquisition (%)	65.0	34.0	50.3
Cost of inputs (%)	76.0	87.7	81.6
Crop & livestock diseases (%)	97.2	84.0	90.9
Damage of crops in farm by pests	95.0	14.2	56.7
Market challenges			
Delayed payments (%)	72.2	49.4	61.4
Low payments (%)	73.3	50.6	62.6
Lack of markets (%)	75.6	12.3	45.6
Flooded markets (%)	76.7	42.0	60.2
Unfavorable prices (%)	99.4	59.3	80.4
Institutional & post harvest challenges			
Access to credit (%)	71.7	32.1	52.9
Lack of storage (%)	55.0	21.6	39.2
Damage of crops by pests, diseases (%)	73.3	52.5	75.1
Loss of cane during transportation (%)	72.2	36.1	55.2

Source: Author's survey, 2013

As shown in Table 6, about 34% of the farmers in the pooled sample had access to credit in the last five years mostly from banks and the majority used the credit to purchase fertilizer and pay

school fees and only less than 1% used the credit for investment purposes in other livelihood activities. This results show relatively low access to credit services in both regions (though not statistically different). As shown in Table 6, in the pooled sample 45.3% of the farmers had access to extension services within the past twelve months. There was a statistical difference in the levels of access to extension services by farmers in the two regions. Farmers in Kakamega had low access to extension service with only 28% of the farmers having access to extension services. Bungoma on the other had a slightly higher extension service access with 67% of the farmers having accessed extension services over the last twelve months since the survey was carried out. The most important source of extension was the government extension service. These results are consistent with those of Muyanga and Jayne (2006) that cited lack of and weak extension services in Kenya to train farmers on better ways to manage their agricultural enterprises. The low access to extension services was attributed to an underperforming extension service sector. This could therefore explain the low levels of extension access in some parts of Western Kenya. Also, the membership to farmer groups in the two regions was statistically significant. In Bungoma, 51.7% of the farmers were members of farmers' groups which were formed to teach farmers on proper agricultural practices so as to increase yields and increase incomes. In Kakamega, a relatively low percentage, of only 30.2% of farmers being members of farmers group.

As shown in Table 6, the average age of the household head in the pooled sample was about 46 years. The youngest respondent was 20 years old while the oldest was 80 years old. Experience comes with age and this therefore implies that farmers in these regions are experienced in agricultural practices which are their main stay (Pinstrup-Andersen and Rajul, 2001). Poor people have greater opportunities to earn income, advocate supportive policies, and increase their social capital when they achieve literacy and numeracy. Like good health, education has tremendous and lasting impact on economic growth and on the material well being of individuals. However, only an average of 9 years of formal education of the household head was reported which corresponds to incomplete secondary school. The minimum education level reported was no education at all while the highest education level reported was 17 years which corresponds to above University education. Though the levels of education in the two regions seemed not to differ much, the difference was statistically significant. In Bungoma, the average

level of education was about 10 years of schooling while in Kakamega it was about 9 years of schooling. The total monthly income of the farmers was a skewed distribution with about 80% of the farmers earning less than KSh 10,000 per month which is characteristic of most smallholder farmers as reported in the KNBS (2012). Though the results showed a slight difference in income between farmers in the two regions, the difference was not statistically significant. The average monthly income reported was KSh 4700 which translates to approximately USD 1.8 $ per day. This implies that farmers in this region live below the poverty line of USD 2.5 per day.

Table 6: Institutional services, Socio-economic demographics and awareness of biofuel

Characteristic	Bungoma n=180	Kakamega n=162	Pooled n=342
Access to credit (%)	37.2	30.9	34.2
Access to extension services (%)	60.6	28.4	45.3
Average age of household head (years)	47.28	45.7	46.4
Gender (% Male)	50	53.1	51.5
Average level of education of household) (years)	9.78	8.81	9.32
Average level of income (kshs)	4500	4900	4700
Average family size (persons)	7	6	7
School attendance frequency for those <18 years (%)			
Attend regularly	52.2	68.5	59.9
Irregular attendance due to financial problems	37.8	23.4	30.7
Never attends	10	8	9.4
Farmers aware about biofuel (%)	51.7	30.2	41.5
Farmers aware about sugar beet (%)	23.3	6.8	15.5

Source: Author's survey, 2013

In Bungoma, about half of the households were male headed households, while in Kakamega, 53.1% were male headed households. Though these results show some slight difference, it was not statistical. The average household size reported was 7 persons per household. The smallest household size reported was one person and the largest household size reported was 40 persons in a household. In Bungoma, the average family size was 7 while in Kakamega it was 6. Though these results show little variation in the size of the household, the differences are significant. These results are contrary to findings by KNBS (2010), which noted that Kenya has a mean household size of 5 persons. This difference could be attributed to the fact that the current study on focused on the Western part of Kenya while the KNBS carried out a national survey. Only 60% of the household members of school going age attend school regularly while 31% of household members of school going age do not attend school regularly due to financial problems while 9% of the household members of school going age do not attend school at all. In Kakamega, 53% of the households were male headed households while 47% of the households were female headed households. Only 66% of those in the school going age category attend school regularly, 23% of those in the school going age category do not attend school regularly due to financial constraints while 8% do not attend school as shown in Table 6.

Awareness about biofuel was relatively high in Bungoma compared to Kakamega. In Bungoma, 52% of the farmers were aware about biofuel investments as an alternative livelihood activity. This relatively high level of awareness of biofuel investments in Bungoma could be attributed to the fact that currently there are already biofuel investment proposals underway in this region. Among these, about 74% had heard about it from farmers' workshops and extension officers. Half of the farmers also knew of the benefits of biofuel such as clean source of energy, cheaper source of energy and renewable source of energy. Only 23% of the farmers were aware about sugar beet crop which can be used to produce biofuel. In Kakamega, only about 30%, of the farmers were aware about biofuel investments as an alternative livelihood activity. Among these, majority of them had also heard about it from extension officers and farmers' and farmers' workshops while very few knew of the benefits of biofuel as an alternative livelihood activity.

Table 7: Independent sample t- test

Variable	F	Sig	t	df	sig (2 tailed)	mean diff	st error diff
Land size	0.69	0.41	-1.07	340	0.28	-0.16	0.15
Access to credit	6.11	0.01	1.24	340	0.22	0.06	0.05
Access to extension	18.15	0.00	6.28	340	0.00 ***	0.32	0.05
Group member	32.32	0.00	4.10	340	0.00 ***	0.21	0.05
Age	0.01	0.94	-1.34	340	0.18	-1.91	1.43
Gender	0.68	0.41	0.57	340	0.57	0.03	0.05
Level of education	1.55	0.21	-2.72	340	0.01***	-0.96	0.35
Level of income	1.49	0.22	1.40	340	0.16	1309.19	934.58
Household size	0.45	0.50	-2.79	340	0.01***	-1.06	0.38
Aware of biofuel	32.32	0.00	4.10	340	0.00 ***	0.21	0.05

Notes: Equal variances are assumed
Statistical significance reported at the 95 % confidence interval

Source: Author's survey, 2013

4.2 Factors influencing farmers' awareness of biofuel investments as alternative livelihood activity

Table 8 indicates the factors that were hypothesized to influence farmers' probability of being aware of biofuel investments as an alternative livelihood activity. These are the variables that were used in the binomial logit model. It was hypothesized that farmers' probability of being aware of biofuel investments as an alternative livelihood activity is a function of a set of factors such as age of the household head, gender of the household head, household income, education

of the household head, access to credit, membership to farmers' group by the household head, access to extension services, land size and the household size. Age of the household head was included as a variable because in most rural societies, livelihood decisions are mostly taken by the household head. In this study, therefore only the age of the household head was included. It was posited that the household with an older Head would have a higher probability of being aware of biofuel investments as an alternative livelihood activity (Young and Shortle, 1984).

Gender was also included as a variable because sometimes the gender of the household head may influence the probability of a farmer being aware of biofuel investments as an alternative livelihood activity or not. However, sometimes, male headed households would likely be more aware than female headed households. This would be probably because men are more likely to visit shopping centers more often where they can easily access information sources such newspapers, internet and television. As a result, the expected sign was hypothesized to either be positive or negative (Demeke, 2003).

Income of the household was also included as a variable because a household's level of income would have an influence on farmers' probability of being aware of biofuel investments as an alternative livelihood activity or not. Income was hypothesized to have a negative effect on farmers' awareness of biofuel investments as alternative livelihood activity. This is because it was hypothesized that the lower the income of a household, the more likely the household head would be aware of alternative sources of livelihoods, for example biofuel investments, so as to supplement their income sources. This is because such poor households would be constantly searching for alternative sources of income, for example biofuel investments, in order to supplement with the little they have. Also, education was included as a variable and hypothesized to have a positive effect on farmers' probability of being aware of biofuel investments as an alternative livelihood activity (Demeke, 2003). Credit was included as a variable, because the actual borrowing from institutional as well as non institutional sources is considered as a factor that would influence the probability of farmers being aware of biofuel investments as an alternative livelihood activity. It was therefore relevant to hypothesize a positive relationship between awareness of biofuel investments as an alternative livelihood activity and institutional credit.

Swinton (2000) argues that memberships to a farmers group, development group or self help group is an important social capital in determining the probability of farmers' being aware of development projects for example, biofuel investments as an alternative livelihood activity or not. Therefore, a positive relationship was hypothesized to exist between awareness of biofuel investments as an alternative livelihood activity and membership to a farmers group. Access to extension services exposes farmers to a variety of issues related to agriculture and also new interventions regarding alternative livelihood activities especially for farmers. Access to extension services was therefore posited to have a positive influence on farmers' probability of being aware of biofuel investments as an alternative livelihood activity.

Land size was hypothesized to have a positive relationship with the probability of farmers' awareness of biofuel investments as an alternative livelihood activity. This is because biofuel investments are mostly land-based and therefore, those farmers who have bigger land sizes would be more likely to be constantly searching for alternative uses of the extra land that they may have and would therefore be more likely to be aware of a variety of land based alternative livelihood activities for example, biofuel investments (Genius *et al.,* 2006).

Lastly, household size was also hypothesized to be an important factor in determining the probability of farmers being aware of biofuel investments as an alternative livelihood activity. With large family sizes, the dependency ratio also increases and would prompt households to be constantly on the lookout for alternative livelihood activities for example biofuel investments so as to generate additional income to cater for the entire household. It was therefore hypothesized that a positive relationship exists between the probability of farmers being aware of biofuel investments as an alternative livelihood activity and the size of the household (Carswell, 2000).

Table 8: Description of variables used in the binomial logit model

Variable	Description of variables	expected sign
AGE	age of respondent in years	+
GENDER	gender of respondent (0= female, 1= male)	+/-
INCOME	income of household in Kenya shillings	+
EDUCATIO	education of household head in years	+
CREDIT	access to credit (0=No, 1=Yes)	+/-
GROUPMEM	membership to group (0=No, 1=Yes)	+
EXTENSIO	access to extension services (0=No, 1=Yes)	+
LANDSIZE	size of land in acres	+
HOUSEHOL	number of household members	+

For econometric analysis, each of the factors that were hypothesized to influence farmers probability of being aware of biofuel investments as an alternative livelihood activity were tested for multicollinearity which is typically a problem of cross sectional data. This was done through the Variance Inflation Factor (VIF) which was calculated as shown below:

$$VIF_i = \frac{1}{1- R_i^2}$$

Where VIF refers to the variance inflation factor and R refers to the artificial regression with the i^{th} independent variable as a dependent variable.

In this study, the mean VIF was 1.25. Each of the independent variables also had VIF of between 1.08 and 1.50. Since all the VIF for the independent variables were less than 5, this indicated zero multicolliniearity (Maddala, 2000). This therefore justified the inclusion of these variables in the binomial logit model as indicated in Table 9.

Table 9: Variance inflation factors (VIF) for the independent variables

Variable	VIF
AGE	1.50
GENDER	1.16
INCOME	1.16
EDUCATIO	1.28
CREDIT	1.08
GROUPMEM	1.25
EXTENSIO	1.25
LANDSIZE	1.22
HOUSEHOL	1.35

Source: Author's survey, 2013

The results of the determinants of farmers' awareness of biofuel investments are shown in Table 10. The log likelihood function and the chi square value indicate that the model was fit. Factors such as age of household head, gender of household head and membership to group by household head were found to significantly affect farmers' probability of being aware of biofuel investments in Bungoma County. In Kakamega County, factors such as age of household head, membership to farmer group by household head and access to extension services were found to significantly affect farmers' probability of being aware of biofuel investments as an alternative livelihood activity. In the pooled sample, factors such as age of household head, gender of household head, education level of household head, membership to farmer group by household head, access to extension services and household size were found to significantly affect the probability of farmers' awareness of biofuel investments as an alternative livelihood activity.

Marginal effects of the pooled sample are also indicated in Table 10. The marginal effects help to give the actual effect of the variations in each of the independent variables, which were hypothesized to influence farmers' probability of being aware of biofuel investments as an alternative livelihood activity.

In the binomial logit model, the chi square test indicates that the chi square value is significant at below the 10% level. The null hypothesis that farmers are not aware of biofuel investments is rejected. It is concluded that farmers have some level of awareness of biofuel investments which are significantly conditioned by various socio economic and institutional factors. Results of the study also reveal that the age of the household head was found, contrary to what was expected, to have a negative but significant effect on farmers' probability of being aware of biofuel investments as an alternative livelihood activity. This means that awareness of alternative livelihood activities for example biofuel investments as an alternative livelihood activity decreases with advancing age. It had been thought that with advancement in age, also comes experience which gives older people more prospects of being aware of numerous livelihood diversification activities for example biofuel investments which have recently gained increasing publicity. This result may however, be explained by the fact that older people are usually more rigid and risk averse in terms of trying out new technologies or new enterprises that may arise compared to younger people/farmers.

Gender of the household head was found to have a positive effect on farmers' probability of being aware of biofuel investments. It was expected that gender could either have a positive or negative effect on farmers' awareness. This can be attributed to the fact that decisions for a household to diversify livelihood activities or the need for a household to look for information on alternative livelihood activities depends on the household head who could either be male or female. Therefore regardless of the gender of the household head, the probability to be aware about alternative livelihood activities or not would either be positively or negatively be influenced by gender of the household head.

Also, as expected, education was found to have a positive effect on farmers' probability of being aware of biofuel investments as an alternative livelihood activity. As noted by Khatun and Roy (2012), highly educated persons are more likely to diversify their livelihood options through either salaried jobs or self employment among others. Therefore, investing in education and increasing access to higher education would help rural households in getting alternative income. Improvement in the education level would increase the probability of increasing awareness on

alternative sources of income, for example, biofuel investments and livelihood diversification for poverty reduction.

In addition to this, membership to farmer group by the household head had a positive effect on farmers' probability of being aware of biofuel investments as an alternative livelihood activity. This can be attributed to the fact that, being a member of a farmer group or self help group increases one's social capital. This increases access to information, in this case, agricultural information, for example, information of livelihood diversification through biofuel investments. This could also be as a result of the presence of a strong and active farmers group and farmers field schools that expose farmers to various issues related to agriculture and other emerging agricultural technologies that could serve as alternative livelihood strategies.

As expected, access to extension services was found to have a positive influence on farmers' awareness of biofuel investments as an alternative livelihood activity. This can be explained by the fact that extension services officers are charged with the responsibility of disseminating information on agriculture and farmers who have had contact with extension officers would be more likely to be aware on latest developments in the agricultural sector for example with regards to livelihood diversification among smallholder farmers through biofuel investments. Also, the approach in the extension service delivery (farmer-teacher) that is farmer friendly enables farmers to learn a lot about emerging issues in agriculture, for example, alternative livelihood strategies, such as biofuel investments to help them get alternative sources of income.

The size of the household was also found to have a positive influence on farmers' probability of being aware of biofuel investments as alternative livelihood activity. These results are consistent with those found by Rahut and Scharf (2012) who also found a positive effect of family size/household size on level of diversification. In this study therefore, the positive effect of household size on probability of farmers' being aware of biofuel investments as an alternative livelihood activity can be attribute to the fact that, large households may be constantly looking for alternative livelihood sources so as to supplement their current sources of income so as to comfortably cater for all the household members' financial needs. This would therefore explain a higher probability of larger households of being aware of a variety of alternative livelihood activities for example biofuel investments

Table 10: Binomial logit estimates of factors influencing farmers' awareness of biofuel investments as an alternative livelihood activity

Variable	Bungoma	Kakamega	Pooled sample	marginal effects (Pooled sample)
AGE	-0.04 (0.02) ***	-0.04(0.02)*	-0.04(0.01) ***	-0.01(0.00) ***
GENDER	1.38 (0.35) ***	0.13 (0.43)	0.80 (0.26) ***	0.19(0.06) ***
INCOME	0.00 (0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
EDUCATIO	0.09(0.65)	0.09(0.06)	0.09(0.04) **	0.02(0.01) **
CREDIT	-0.09(0.38)	0.50(0.06)	0.13(0.26)	0.03(0.06)
GROUPMEM	0.79(0.38) **	0.70(0.40)*	0.70(0.26) ***	0.17(0.06) ***
EXTENSIO	0.01(0.38)	1.21(0.42) ***	0.72(0.26) ***	0.17(0.06) ***
LANDSIZE	-0.08(0.07)	0.08(0.15)	0.01(0.10)	0.00(0.02)
HOUSEHOL	0.08(0.07)	0.06(0.05)	0.08(0.04) **	0.02(0.01) **
χ^2(p- value)				65.86 (0.000)

Note: Standard errors are in parentheses
***, **, * indicate statistical significance at 1%, 5% and 10% level respectively

4.3 Farmer preferences for biofuel investments

4.3.1 Description of variables

The variables used in the model are shown in the Table 11. A likelihood ratio test was done and the utility parameters for all biofuel investments through lease of land option were entered as random parameters assuming a normal distribution, except the price attribute that was specified as fixed. This is because in a normal population, it is expected that some respondents would have positive preferences or negative preferences. Also, the reason why the price is set as fix is so as to ensure that there are no extreme positive or negative values (Revelt and Train, 1998).

Table 11: Description of variables used in the choice analysis

Variable	Description
SHORT	contract length of 2 years (1=yes, 0= otherwise)
LONG	contract length of 10 years (1=yes, 0= otherwise)
QUARTE	size of land to lease out 25% (1=yes, 0= otherwise)
THREEQ	size of land to lease out 75% (1= yes, 0= otherwise)
PERMAN	employment type permanent (1= yes, 0= otherwise)
CASUAL	employment type casual (1=yes, 0= otherwise
YES	renewable contract (1=yes, 0=otherwise)
PRICE	lease price per acre (50%, 75%, 100%)

4.3.2 Empirical estimation

The results for the RPL models for the preferences for biofuel investments are reported in Table 12. The results reveal that compared to medium length contracts of 5 years and contrary to what was expected, farmers in Bungoma and Kakamega have a positive preference for short contract lengths of 2 years and have negative preference for long contract lengths. This may be due to the fact that the biofuel investments are a new venture and due to this, farmers may only want to participate in short contracts for a start as they monitor the progress of their investments before they can decide to venture in such investments over a long period of time. These results are similar to those of Fewell *et al.* (2011), which also indicated that farmers preferred shorter contracts with biofuel companies as opposed to long contracts. Compared to giving out half of the land that they own, farmers in both Kakamega and Bungoma have higher preference to lease out only a quarter of their land. This result could be attributed to the fact that the biofuel investments are still a new venture and the farmers would want to start by leasing out a small portion of their land first as they monitor the progress of their Investments so that they may

decide on the whether they would participate in these biofuel investments for a longer period or not.

Compared to being offered no employment in the biofuel companies and as expected farmers in Bungoma and Kakamega have a higher preference to be offered permanent employment. This result may be due to the fact that people generally prefer permanent employment because one is guaranteed of the stability of income as compared to casual employment where one can lose their job at any time hence risks of unstable income. Also, compared to non renewable contracts, farmers prefer renewable contracts. The parameter estimate for lease price per acre is significant and positive in sign as expected for WTA studies. This therefore allowed computation of tradeoffs between each attribute and money.

These results indicate that in both study areas, farmers have similar preferences for the attributes in the proposed biofuel investment attributes. The estimated RPL models for both study sites and the pooled sample all exhibited good fitness. They all had pseudo R squared values above 18%. Simulations by Dominic and McFadden (1975) show that values of ρ^2 between 0.2-0.4 are equivalent to values between 0.7-0.9 for the R^2 in the case of the ordinary linear regression. In the pooled sample, all attribute coefficients had highly significant standard deviations except three quarter size of land. This showed that there is heterogeneity in the preferences for the biofuel investments. The chi-square test indicates that the chi square value is significant at below the 10% level and therefore rejects the null hypothesis that farmers are not willing to accept any significant monetary compensation to have biofuel investment design features.

Also, means and standard deviations of the normally distributed coefficients were estimated as shown in Table 13. This showed the probability distribution of the population according to the proportion that places a positive value on a particular attribute and the proportion that places a negative value on it. In Bungoma, over 80% of farmers had a positive preference for each of the attributes included in the CE except long contract length and renewability of contract attributes. Over 90% of the farmers had a negative preference for long contracts while slightly over 30% of the farmers had a negative preference for contracts that are renewable. The high percentage of farmers who had a negative preference for long contract length could be due to the fact that, as discussed earlier, biofuel investments are a new venture and farmers wouldn't want to engage in

such long contracts due to risks and uncertainties associated with new investment ventures. As for the slightly high percentage of farmers having a negative preference for renewable contract lengths, this could be attributed to the fact that it would not be easy for a farmer to know whether they would prefer renewable contract lengths or not for a new venture which they have previously not engaged in. Most farmers would want to decide whether they would prefer renewable contracts or not, after they have already engaged in the biofuel investments and monitored the progress and the returns they are getting. Overall in Bungoma, most of the farmers preferred the biofuel investment attributes through lease of land option that were included in the CE.

In Kakamega, over 80% of the farmers also had a positive preference for quarter size of land, permanent employment and casual employment. However, some farmers had slightly lower positive preferences for short contract length, long contract length, three quarter size of land and renewability of contract. This could possibly be explained by the fact that land sizes in Kakamega are smaller and even though biofuel investments could serve as possible alternative livelihood, farmers in this area may be more skeptical about engaging in these biofuel investments which are land intensive. In Kakamega, results of the study indicated that land sizes were lower than that of their counterparts in Bungoma. The fact that land is a more limited factor of production in this area, could explain why only about 63% of the respondents had a positive preference for short lease of land contract length while over 80% had a negative preference for long contract length attribute. Only 66% of the respondents had a positive preference for three quarter size of land to be leased out. Moreover, only 53% of the respondents had a positive preference for renewable contracts. Similarly as their counterparts in Bungoma, this could be explained by the fact that the respondents would only have a positive preference for renewable contracts only after they have engaged in the biofuel investments and assessed the returns they would get and how the investments are progressing. Overall in the pooled sample, over 70 % of the respondents had a positive preference for most of the biofuel investment attributes. This therefore implies that a combination of these attributes indeed captured respondents' preferences for biofuel investments through lease of land option.

Table 12: Random parameter estimates for preferences for biofuel investments

	Coefficient (standard error)		
Variable	Bungoma	Kakamega	Pooled sample
SHORT	1.86(0.76) ***	1.68(1.22)	1.47 (0.48) ***
LONG	-3.52 (0.96) ***	-13.45(6.17) **	-3.56(0.76) ***
QUARTER	4.66(1.45) ***	13.17(5.81) **	4.41 (0.97) ***
THREEQUA	2.00(1.23)	4.97(3.05)	1.26 (0.72)*
PERMANEN	3.74 (1.07) ***	10.34 (3.94) ***	3.54 (0.71) ***
CASUAL	2.06 (0.60) ***	8.86 (4.06) **	2.19 (0.47) ***
YES	0.95 (0.37) **	0.47 (0.611)	0.91 (0.26) ***
PRICE	0.036 (0.007) ***	0.06 (0.166)	0.038(0.005) ***
Standard deviations of parameter distributions			
sdSHORT	1.49(1.44)	5.03 (2.13)**	2.43 (0.59)***
sd LONG	3.68 (4.25)***	15.19 (6.14)**	4.41(0.95)***
sdQUARTER	1.35 (1.73)*	12.59 (5.01)**	2.99(0.55)***
sdTHREEQUA	2.46 (2.61)***	11.43 (4.59)**	0.27(0.57)
sdPERMANEN	3.08 (3.11)***	6.50 (2.41)***	3.47 (1.03)***
sdCASUAL	1.62 (2.09)**	6.00 (2.40)**	1.77 (0.70) **
sdYES	2.37 (3.54)***	5.11 (2.17)**	1.75 (0.38) ***
Log likelihood	-336.13	-711.90	-1502.0
χ^2 (p-value)	909.73(0.000)	849.88 (0.000)	1712.65(0.000)
Adjusted R2	57%	59%	56%
N respondents	180	162	342
N choices	720	648	1368

Note: Statistical significance at 1%, 5% and10% are shown by ***, **, and * respectively.

Table 13: Percentage positive distribution of preferences for attributes

Percentage positive distribution of preferences for attributes

Attribute	Bungoma	Kakamega	Pooled sample
	%	%	%
	n = 180	n = 162	n = 342
SHORT	89.37	63.06	72.88
LONG	16.81	18.78	20.98
QUARTER	99.97	85.24	92.99
THREEQUA	79.21	66.82	100.00
PERMANEN	88.69	94.43	84.62
CASUAL	89.93	93.01	89.20
YES	65.57	53.66	69.85

Table 14 indicates farmers' WTA compensation for various biofuel investments attributes for them to participate through lease of land as alternative livelihood activity. The WTA values also clearly indicate that farmers have heterogeneous preferences for the biofuel investments through lease of land option attributes. In the pooled sample, farmers are willing to accept compensation ranging between KSh 1,443 and KSh 6,295 for the inclusion of short contract length of 2 years in the leases. Even with compensation, farmers would not want long contract lengths of 10 years to be included as a feature in the biofuel investments. This could be attributed to the fact that farmers may be skeptical towards new ventures such as those of biofuel. For this reason, they would prefer shorter contract length at first as they monitor the progress of the investments. Also, farmers would be willing to accept compensation ranging between KSh 6,265 and KSh 16, 853 for the inclusion of leasing out a quarter piece of their land as an attribute in biofuel investments. In addition to this, farmers are willing to accept compensation ranging between KSh 5,761 and KSh 12,767 and a range of KSh 3,369 and KSh 8,131 for the inclusion of permanent employment type and casual employment type respectively as attributes in biofuel investments design. Lastly, farmers are willing to accept compensation ranging between KSh 1,153 and KSh 3,627 for the inclusion of renewable contracts as biofuel investment through lease of land attribute. Based on the WTA values the attributes can be ranked as follows: Quarter piece

of land to be leased out, permanent type of employment, casual type of employment, short contract length and lastly renewable contracts.

The results of the study showed that farmers are WTA a higher compensation for leasing out quarter piece of land to be included as an attribute in the biofuel investment program design. Also, results of the study also reveal that they prefer to lease out only a quarter piece of their land as compared to giving out three quarter of their piece of land. This could be attributed to the fact that a great deal of uncertainty surrounds participation in biofuel investments which are just emerging with no well structured markets. The uncertainty is further compounded by the fact that most of the biofuel investment companies may establish contracts with clauses which may state that incase the biofuel crops are damaged by natural climatic causes, then there would be no payment to the farmers for the land they lease out. Such clauses bringing more uncertainty on whether the net returns will continually be forthcoming (See for example, Fewell *et al.,* 2011).

This high compensation amount could be attributed to the fact that farmers in this region mainly engage in livelihood activities that are land intensive (crop and livestock farming or crop farming only) and land is a limiting factor of production. Since the biofuel investments would require them to lease out some portion of their land, however small, this would trigger them to want more compensation to cater for the foregone income they normally get from the use of that land which will be leased out.

When these figures were compared with local context in terms of average wages, it was found that these biofuel investments indeed offer better wages compared to the current sources of livelihood. For instance, a local farmer who is employed as a casual worker is paid about between KSh 150 and KSh 200 per day. This translates to about on average between KSh 3000 and KSh 4000 per day. Therefore, when the proceeds from biofuel investments are added to their current sources of income, then these farmers would have improved incomes which would translate to improved livelihoods.

Table 14: Marginal WTA values for biofuel investments through lease of land option in Kenya shillings (Kshs)

Marginal WTA (95% confidence interval)			
Variable	Bungoma	Kakamega	Pooled sample
SHORT	50.77	29.06 [d]	38.69
	(14.98 to 86.56) [c]	(-11.83 to 69.95)	(14.43 to 62.95)
LONG	-95.74	-232.72	-93.39
	(-144.19 to 47.29)	(-375.23 to -90.21)	(-127.06 to -59.72)
QUARTE	126.54	227.91	115.59
	(39.48 to 213.60)	(71.42 to 384.40)	(62.65 to 168.53)
THREEQ	54.46 [d]	85.97	32.96 [d]
	(-19.04 to127.96)	(-8.54 to 180.48)	(-7.38 to 73.30)
PERMAN	101.61	178.98	92.64
	(48.53 to 154.69)	(85.33 to 272.63)	(57.61 to 127.67)
CASUAL	56.18	153.29	57.50
	(23.90 to 88.46)	(57.62 to 248.96)	(33.69 to 81.31)
YES	25.87	8.05[d]	23.90
	(6.60 to 45.14)	(-13.53 to 29.63)	(11.53 to 36.27)

Note: Confidence intervals have been calculated from standard errors.
[c] indicates confidence intervals which have been computed using the standard errors
[d] insignificant at 10% level

Farmers are willing to accept a relatively high compensation for permanent employment type and casual employment type to be included as an attribute in the biofuel investments program design. This could be attributed to the fact that farmers have narrow range of livelihood activities which they depend on and would be willing to be offered employment in the biofuel investments company so as to supplement the income they get from the narrow range of livelihood activities that are faced by major economic challenges as highlighted earlier.

The results of the study indicate that farmers would require some moderately low compensation for short contract length to be included as an attribute. This shows that farmers are more comfortable engaging in short contracts as opposed to long contracts. This can be attributed to the fact that, longer contract lengths are deemed to be undesirable particularly in the early stages of a developing market such as the biofuel investments in Kenya. Also very long contract length

of, say 10 years, brings more hesitation due to uncertainty with regard to opportunity costs of not growing traditional crops/food crops. As a result, farmers are reluctant to enter into such long term contractual arrangements explaining why they would be willing to enter into short term contracts of, say 2 years, as shown by their willingness to accept a moderately low compensation for such an attribute to be included in biofuel investment program designs.

The results of the study also show that farmers are willing to accept a relatively low compensation for renewable contracts to be included as an attribute in the biofuel investments program design. This could be attributed to the fact that since biofuel investments are a new and emerging venture, farmers would not be really keen on whether the contract is renewable or not because they may first of all want to try it out first before they would fully decide to continue participating in it or not. Hence whether they would want a renewable contract or not would not be such a major issue since they do not know how the biofuel investment would progress in order for them to decide on whether they would want renewable contracts or not.

To assess the possible sources of heterogeneity in preferences, interactions were done between the mean estimate of the utility parameters and farm/farmer characteristics in a RPL model estimated on the pooled sample of smallholder farmers. Various interactions were carried out between farm/farmer characteristics and the various biofuel investments attributes as shown in Table 15.

Table 15 : RPL interactions description

Interaction	Description
THQ*GEN	Interaction between three quarter size of land to be leased out and gender
PERM*GEN	Interaction between permanent type of employment and gender
LONG*CRED	Interaction between long contract length and access to credit
CASL*CRED	Interaction between casual type of employment and access to credit
THQ*LAND	Interaction between three quarter size of land to be leased out and size of land owned
PERM*LAND	Interaction between permanent type of employment and size of land owned
QUAT*LAND	Interaction between quarter piece of land to be leased out and the size of land owned
QUAT*HHZS	Interaction between quarter piece of land to be leased out and the size of the household
THQ*HHZS	Interaction between three quarter piece of land to be leased out and the size of the household
PERM*HHZS	Interaction between permanent type of employment and the size of the household

Source: Authors' Survey, 2013

Testing of various interactions with farm/farmer characteristics was also done and the models that interact mean preference for long contract length of 10 years, casual type of employment and permanent type of employment with these covariates, were found to fit the data best. Therefore, the interaction effects of long contract length of 10 years, casual type of employment and permanent type of employment are shown in Table 16. These are variations in the mean preference of contract length occasioned by the relevant farm/farmer characteristics. Access to credit, size of land and household size are significant sources of heterogeneity in preferences for long contract length of 10 years, casual type of employment and permanent type of employment respectively. The standard deviation for casual type of employment as indicated in Table 16 is insignificant. This indicates that preference for casual type of employment does not vary more than is captured by the farm and farmer characteristics that were interacted with it. However, the standard deviations of long contract length of 10 years and permanent type of employment, are still highly significant, which indicates that preferences for long contract length of 10 years and

permanent type of employment vary more than is captured by the farm and farmer characteristics that were interacted with them.

Although farmers on the whole had a negative preference for long contract length of 10 years, this negative preference was majorly among farmers who seek credit facilities. This could be attributed to the fact that farmers who constantly access credit would not be willing to lease out their land for a long period of time of, say 10 years. This could be due to the fact that their land usually serves as security/collateral so as to enable them to access credit which they use to finance their agricultural production and other financial obligations which they may have. Therefore, leasing out their land to biofuel investments would mean that their land is tied to the biofuel company and this therefore would deny them the chance to use it as collateral in case they need to access credit in formal financial institutions. This explains the negative preference for long contract length of 10 years to be mostly among farmers who mostly seek credit facilities.

Also, farmers who mostly seek credit facilities were found to have a positive preference for casual type of employment. This could possibly be due to the fact that, most financial organizations that offer credit facilities usually require that, for example if the credit seeker does not have an asset to serve as security/collateral, they could attach their pay slips showing that at least they have some form of employment which would guarantee the repayment of the loan. This therefore could possibly explain why the positive preference for casual type of employment was mostly among farmers who mostly seek credit facilities.

Generally, on the whole, farmers were found to have a positive preference for permanent type of employment. However, results from the interactions indicate that this positive preference was mostly from farmers who generally had smaller land sizes. This could be explained by the fact that farmers who had smaller land size would mostly prefer permanent type of employment to enable them to supplement the income which they get from their small pieces of land. This would enable them to have a guaranteed and reliable source of income given the declining land sizes that generate little or no income from agriculture. In addition to this, although farmers on

the whole had a positive preference for permanent type of employment, this positive preference was mostly among farmers who had larger household sizes. With larger household size, the dependency ratio increases and this could therefore prompt households to search for alternative sources of income, for example, permanent type of employment in the biofuel investment companies so as to ensure constant reliable income to comfortably cater for the household members' needs. This therefore could be an explanation as to why the positive preference for permanent type of employment was mostly among farmers who had larger household sizes.

Table 16: RPL with interactions estimates for biofuel investment attributes and derived standard deviations of parameter distributions

Variable	Coefficient (standard error)
SHORT	1.33 (0.40) ***
LONG	-3.62 (0.84) ***
QUARTER	5.71 (2.39) **
THREEQUA	5.76(2.64) **
PERMANEN	4.07(1.36) ***
CASUAL	2.05(0.59) ***
YES	0.97(0.32) ***
PRICE	0.04(0.32) ***
THQ*GEN	-0.49(0.79)
PERM*GEN	-1.37(0.95)
LONG*CRED	-4.18(1.87) **
CASL*CRED	1.74(0.85) **
THQ*LAND	0.67(0.63)
PERM*LAND	0.68*(0.31) **
QUAT*LAND	0.16(0.63)
QUAT*HHZS	0.10(0.29)
THQ*HHZS	0.26(0.26)
PERM*HHZS	0.36(0.17)
SdSHORT	0.25(0.45)
SdLONG	4.57(0.87) ***
SdQUARTE	3.65(0.89) ***
SdTHREEQ	0.66(0.95)
SdPERMAN	1.95(0.69) ***
SdCASUAL	0.99(0.83)
SdYES	2.52(0.51) ***
SdTHQ*GEN	2.73(0.79) ***
SdPERM*GEN	2.54(1.05) **
SdLONG*CR	4.76(1.53) **
SdCASL*CR	0.96(0.68)
SdTHQ*LAN	0.45(0.18) ***
SdPERM*LAN	0.85(0.28) ***
SdQUAT*LA	0.19(0.12)*
SdTHQ*HHZS	0.14(0.13)
SdTHQ*HHZS	0.28(011) ***
SdPERM*HH	0.13(0.07) *

Note: Statistical significance at the 1%, 5% and 10% are shown by ***, ** and * respectively

4.3.3 Policy scenarios

To better implement biofuel policies in Bungoma and Kakamega counties, it was deemed necessary to characterize farmers based on their enterprise mix. This categorization is important to policy because it will assist in the design of biofuel investments in an appropriate way that does not have a negative effect livelihood structure of the farmers in Western Kenya. As reported in Figure 4, farmers in these regions can be categorized into three distinct groups based on their current livelihood activities. These include those farmers who derive over 75% of their monthly proceeds from crop farming (category 1), those farmers who derive over 75% of their monthly returns from crop and livestock farming (category 2) and those farmers who derive over 75% of their monthly wage from off farm activities such as trading, motorcycle business, tailoring and welding among other activities (category 3).

Results indicated that in Bungoma, 20.6%, 49.4% and 30% of the farmers belong to category 1, 2 and 3 respectively. In Kakamega, 35.2%, 40.7% and 24.1% of the farmers belong to category 1, 2 and 3 respectively as shown in Figure 4. Based on these categories of farmers three policy scenarios were developed so as to facilitate the implementation of biofuel investments policies that would better target the population in the study areas. Also, this would assist to formulate policy recommendations regarding farmers' WTA biofuel investments through lease of land option. For the first category of farmers, a policy scenario was developed with suggested attributes such as such as short contract length of 2 years, 50% of owned land to be leased out, casual employment type, and a renewable contract. For the second category of farmers, a policy scenario was developed with suggested attributes such as contract length of 5 years, 25% of owned land to be leased out, no employment provided and a non renewable contract. Also, for the third category of farmers, a policy scenario was developed with suggested attributes such as contract length of 10 years, 75% of owned land to be leased out, permanent type of employment and a renewable contract.

In the policy scenario targeting the first category of farmers, a 2 year contract length was included so as to target short cropping seasons which farmers are already familiar with. Currently, the farmers grow crops, for example sugar cane, that have a maximum cropping season of approximately 18 months (KSB, 2011). Therefore, they would expect that when they

lease out their land to the biofuel company to grow the biofuel crops, the maximum cropping season would be about two years before they get the returns from the land that they have leased out. Another attribute that was included was 50% of owned land is to be leased out. This is because, since this category of farmers mostly utilize their land for crop farming only, it would be practical for them to lease out about half of their land to the biofuel company without substantially disrupting their livelihood activities. Compared to crop and livestock farming, crop farming only is less land intensive (IFAD, 2005). In addition to this, casual employment type is included because, with casual employment, farmers in this category will also have time to attend to their crop farming activities. Hence this type of employment would be suitable for this category of farmers because it would not lead to a total neglect of their current livelihood activity which is crop farming (Kalejaiye, 2014, Richardson, 2014) A renewable contract type is include as an attribute because it was envisaged that this category of farmers, since they only majorly depend on crop farming, they would want renewable contracts with the biofuel company to as to have an additional source of income.

In the policy scenario targeting the second category of farmers, a 5 year contract length was included to cater for the gestation period of livestock and to also allow for planning purpose on how to use the land (Norman *et al.,* 2009). 25% of land to be leased was included because crop and livestock farming is land intensive compared to crop farming only. Therefore, it was seen fit to only require these category of farmers to lease out only a quarter of their land because this would not have an adverse effect on their current livelihood activity. Also, it was realized that since crop and livestock farming is already labor intensive, it would be ideal to offer this category of farmers no employment so that even though they would participate in biofuel investments by leasing out their land, they would still be available to carry out their crop and livestock farming which is an important source of their livelihood. Finally, a non renewable contract was included because, since these farmers already have multiple sources of income therefore, they may not be very keen on whether the contract is renewable or not.

For the third category of farmers, the policy scenario included, a 10 year lease of land contract was included because this category of farmers already derives over 75% of their monthly income from off farm activities. Hence, even though they engage in such long contract length, their

livelihood activities would not be destabilized. Also, 75% of owned land to be leased out, was included as an attribute since this category of farmers already derive over 75% of their income from off farm activities which are not land intensive, hence would be comfortable to lease out a three quarters of their land. A permanent employment type was also included because this category of farmers are already accustomed to carrying out off farm activities and therefore offering them permanent employment would better suit them compared to the other category of farmers. Lastly, a renewable contract type is included for this category of farmers because they already normally derive over 75% of their monthly income from off farm activities hence may want to broaden their range of off farm activities so as to increase their income (Akter *et al.,* 2005).

Practically, different biofuel investors would be ready to implement various biofuel investment features and at the same time, various categories of farmers would be comfortable with different biofuel investment packages. Therefore, to better cater for the interests of the investors and that of the farmers, it was deemed important to illustrate how these farmers with different enterprise dynamics/enterprise mix might respond to different combinations of the biofuel investment attributes. This was done through computation of CS estimates following equation 6. The CS estimates were computed for the three policy scenarios as shown in Table 17. These scenarios include policy scenario for those farmers who derive over 75% of their monthly earnings from crop farming, those farmers who derive over 75% of their monthly earnings from crop and livestock farming and those farmers who derive over 75% of their monthly earnings from off farm activities such as welding, motor bike business, trading, tailoring, and carpentry among others. The CS estimates for all the three scenarios were positive. This suggests that farmers prefer a change from the baseline of no biofuel investments through lease of land option as an alternative livelihood activity.

The CS estimates are however significantly different in that farmers who derive over 75% of their monthly wage from crop and livestock farming had higher CS compared to those who derive over 75% of their monthly wage from crop farming. Those farmers who derive over 75% of their monthly wage from off farm activities had the lowest CS. Given that farmers who derive over 75% of their monthly revenue from crop and livestock farming have the highest CS, this

implies that for them to accept to participate in biofuel investments through lease of land option, they would require higher compensation to cater for the foregone income they normally earn from crop and livestock farming which is land intensive. Those farmers who derive over 75% of their monthly revenue from off farm activities have the lowest CS implying that even though they lease out their land, they would not be greatly destabilized in terms source of income because most of their income comes from off farm activities which are not land intensive. This therefore explains why they would be willing to accept little compensation in order for them to participate in biofuel investments through lease of land option.

It is worth noting that though the CS for farmers who derive over 75% of their monthly is the lowest, the results also show that it is insignificant. This could be explained possibly by the fact that probably most of these farmers who derive over 75% of their monthly returns from off farm activities are not residents of these areas and hence are not the owners of the land they reside on. Also, the results indicate that the CS estimates for Kakamega are higher than those of Bungoma. This implies that farmers in Kakamega are WTA higher compensation than their counterparts in Bungoma. This could be attributed to the fact that land sizes in Kakamega are relatively smaller compared to those in Bungoma as discussed earlier. This therefore could explain why they would only be willing to participate in biofuel investments through lease of land option if they are offered higher compensation. This is because, also as the results indicate, most their livelihood activities are land based and if they would opt to lease out their land, they would only be left with very little land to carry out their current livelihood activities.

In terms of implementation, scenario 2 would be the most applicable because it is the most preferred as evidenced by the high CS estimate. Also, for implementation purposes, it would be more practical to start with this kind of policy scenario because the results of the study showed that a large percentage of the farmers in the study areas already fall into this category in terms of their enterprise mix. Hence policy makers would design biofuel investments that would require farmers to lease out only a quarter size of their land, offer casual employment, non renewable contracts and 5 year contract durations. This would ensure that the biofuel investments are introduced to the farmers as an alternative livelihood option without disrupting their current livelihood activities which is mainly centered on crop and livestock farming.

Table 17: Attribute levels and compensating surplus for biofuel investment Policy Scenarios

Note: standard errors are in parentheses

Attributes												Compensating surplus		
	Contract Length			Size of land			Employment			Renewabil-ity				
Scenario	Short	Medium	Long	Quarter	Half	Three quarter	None	Permanent	Casual	Yes	No	Bungoma	Kakamega	Pooled sample
1	√				√				√	√		13,281.7*** (29.39)	19, 040.6*** (57.25)	12, 009.8*** (19.59)
2		√		√			√				√	20,858.9*** (55.11)	38,925.9 *** (117.73)	19, 699.5*** (34.74)
3			√			√		√		√		6,031.9 [a] (43.16)	3,223.0[a] (36.94)	3221.61[a] (26.83)

√ indicates that the attribute is present in the policy scenario at the non-zero level
*** indicate the SC estimates are significant at the 1% level
[a] indicates that the CS estimates are insignificant

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Summary of results and conclusions

This study shed light on smallholder farmer's livelihood strategies, awareness and preferences for biofuel investments in Kenya. It sought to characterize farmers' sources of livelihoods through descriptive statistics and assessed the factors that condition farmers' level of awareness using the binomial logit model. The study used data from 342 smallholder farmers spread across Bungoma and Kakamega counties.

The study found that farmers continue to solely rely on non remunerative agricultural enterprises such as maize and sugarcane farming. These enterprises were found to suffer various challenges such lack of markets, delayed payments and low payments respectively. For example about two thirds of the respondents cited challenges of delayed payments especially with regards to sugar cane. Less than half of the farmers were aware about biofuel investments as an alternative livelihood strategy. Empirical results also indicated that gender of the household head, education of the household head, access to extension services, membership to group and household size, had a significant positive effect on farmers' probability of being aware of biofuel investments as an alternative livelihood activity while age of the household head had a significant negative effect.

Also, this study highlighted farmers' preferences for biofuel investments as an alternative livelihood strategy. Findings from the preference analysis indicated that farmers in both study areas had high preference for short contract lengths compared to long contract lengths, leasing out a quarter of their land as opposed to leasing out three quarter of their land, permanent type of employment in comparison to casual type of employment and renewable contracts compared to non renewable contracts. Although farmers in both regions had similar preferences for the biofuel investments attributes, there was a difference in the amount of compensation that they would be willing to accept. Farmers in Kakamega were willing to accept higher compensation compared to their counterparts in Bungoma.

In terms of implementation, scenario 2 would be the most applicable because it is the most preferred as evidenced by the high CS estimate. Also, for implementation purposes, it would be

more practical to start with this kind of policy scenario because the results of the study showed that a large percentage of the farmers already fall into this category in terms of their enterprise mix.

5.2 Policy implications and recommendations

This study recommends that since the benefits of biofuel can only be harnessed by farmers, who are aware, more information platforms should be developed in order to create awareness among poor farmers on potential alternative livelihood strategies such as biofuel investments. Since factors such as access to extensions service, education of household head and membership to group were found to have a significant positive effect on farmers' probability of being aware, policies should focus on these issues. Improvement of the current extension service through proper remuneration and improvement of working conditions should be done so as to incentivize extension officers to reach even the marginalized farmers. Also, biofuel investment companies could consider investing in extension service by training some of their staff on how to offer expertise agricultural advice such as agricultural investments in order to improve farmer awareness on various investments such as biofuel investments. Farmers should also be encouraged to be part of farmers groups as this increases their social capital and better places them to know more about agricultural issues and even other alternative, more remunerative activities that would help them exit poverty.

Since farmers on the whole had higher preference for short contract lengths, leasing out a quarter piece of land, permanent type of employment and renewable contracts, biofuel investments policies should therefore include these features in the design. This would ensure that the needs of the farmers are accounted for therefore creating a sense of ownership by farmers in the biofuel investments. This would therefore facilitate acceptance and sustainability of biofuel investments.

Lastly, given that biofuel investments are land based and could have a potential threat on food security in the study areas where results have shown that land sizes are on the declining trend, it is important to incorporate the priority recommendations of County Development Plans (CDP) and ASDP so as to ensure that such development plans such as biofuel investments receive higher budgetary allocations and political mileage.

5.3 Contribution to knowledge

This study contributed to the literature on farmers' awareness and preferences for biofuel investments as an alternative livelihood strategy. Indeed, it is worth noting that biofuels have received considerable interest worldwide. However, much of the information available about biofuels is based on speculations. Little empirical evidence exists in terms of what farmers (who are the major stakeholders) really want in terms of the design of the biofuel investment programs and policies, especially in the Kenyan context. Also, most studies on biofuel focus on farmers in general; this study assessed how biofuel companies could target different categories of farmers based on their enterprise mix and the intensity with which they utilize their land.

5.4 Limitations of the study and suggestions for further research

This study focused on only those farmers who may opt to participate through lease of land. Future research could be done how farmers can participate in biofuel investments through of land but based on other aspects other aspects other than categorization based on enterprise mix which was the focus of this study.

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APPENDICES

Appendix 1: Household survey questionnaire

UNIVERSITY OF NAIROBI

DEPARTMENT OF AGRICULTURAL ECONOMICS

APRIL 2013

Analysis of smallholder farmers' livelihood diversification strategies and preferences for biofuel investments in Kenya

Introduction

The University of Nairobi is carrying out a research on analysis of smallholder farmers' livelihood strategies and preferences for biofuel investments in Kenya specifically Bungoma and Kakamega counties. This study is being carried out so as to get insight on the various livelihood options of the smallholder farmers of these areas and the challenges that they are currently facing. It then goes further to look at the emerging biofuel industry and how it can be a potential alternative source of livelihood for the people of these areas who according to Kenya National Bureau of Statistics are falling into poverty due to the challenges facing their current livelihood activities. Also, by carrying out this study, it will help to inform policies that will lead to the improvements in the livelihoods of the people of this area. This study targets farmers who are 18 years and above in these counties. About 400 farmers will be selected randomly using the multi stage cluster sampling approach. The information gathered here will strictly be used for purposes of this research only.

Section A: Personal details

1. Questionnaire number ……2. Date of interview……..

3. Name of enumerator …….

4. Start time…… end time……

5. Name of respondent…….. (Optional)

6. County ……7. District …….

8. Division ……9. Location ……

10. Sub location ……11. Village…….

12. Zone: Urban …….. Peri urban ……. (Tick where appropriate)

Section B: Land ownership and utilization

1. How much land do you own? (in acres)

	Leased[1] owned[2]
Leased	
Owned	
Total acres	

2. Which crops do you currently grow? (Tick all that apply) the amounts apply to the previous season.

	Maize[1] sugarcane[2]beans[3]sorghum[4]	Acreage/apportionment of land (acres)	Amount produced(kg)	Amount marketed(kg)	Amount consumed (kg)
Maize					
Sugarcane					
beans					
Sorghum					
Others, specify					

Section C: Enterprise dynamics

3. What is your enterprise mix, how would you rank them and what challenges if any are they facing?

	Tick the enterprise you are engaged in Maize[1],sugarcane[2] sorghum[3] beans[4]poultrykeeping[5]motorcycle[6]tailoring[7]teaching[8]traders[9]welding[10]others	Rank based on the enterprise that generates >75% of monthly income	Challenges(refers to challenges along the value chain)		
			Production challenges Input acquisition[1] cost of inputs[2] Crop and livestock diseases and pests [3]	Market challenges Delayed payments[1] low payments[2] Lack of market[3] Flooded market[4] Unfavorable price[5]	institutional challenges/post harvest challenges access to credit[1] sugarcane wasted during transportation[2] lack of storage[3] delayed harvesting of sugarcane[4] pest damage while in storage area[5]
Maize					
Sugar cane					
Sorghum					
Beans					
Dairy					
Poultry keeping					
Motorcycle					
Tailoring					
Teaching					
Traders					
Welding					
Others, specify					

Section D: Awareness and perceptions on biofuel (Fuel from plants, plant residues or waste matter)
4. Do you know about biofuel? [0]Yes…… [1]No…… (Tick where appropriate)
5. If yes, what was your main source of information? Tick the most appropriate

	Farmers' workshop/field school[1],Radio[2],TV[3],internet[4],extension officers[5]others[6]
Farmers' workshop/farmer field schools	
Radio	
TV	
Internet	
extension officers	
Other (please specify)	

6. Do you know of the benefits of biofuel? [0]Yes..... [1]No…… (Tick where appropriate)
7. If yes, what benefits of biofuel do you know?

	Clean source of energy[1],cheaper source of energy[3],alternative source of income[4]others[5]
clean source of energy	
cheaper source of energy	
alternative source of income	
Renewability	
others, please specify	

8. Are you aware of sugar beet crop which can be used to produce biofuel? [0]Yes…… [1]No……. Tick where appropriate

9. If yes, what was the source of information? Tick where appropriate

	Farmers' workshop/field school[1],Radio[2],TV[3],internet[4],extension officers[5]others[6]
Farmers' workshop/farmer field schools	
Radio	
TV	
Internet	
extension officers	
Other (please specify)	

10. If yes, are you aware of how sugar beet is produced? [0]Yes….. [1]No…… (Tick where appropriate)
11. If yes, are you aware of the benefits of sugar beet as a biofuel crop? [0]Yes…. [1]No…..
12. If yes, what benefits of sugar beet as a biofuel crop do you know? Tick all that apply

	Fast maturing period[1],high soil nutrient benefits[2],high valued biofuel crop [3] others[4]
Fast maturity period	
High soil nutrient benefits	
high valued biofuel crop	
others, please specify	

13. Suppose a biofuel industry is to be set up, how would you want to participate? (all that apply)

	By growing the biofuel crops[1],by leasing your land[2],by selling your land[3], by providing labor to the biofuel company[4],None[5]
by growing the biofuel crops	
by leasing your land	
By selling your land	
by providing labor to the biofuel industry	
None	

14. If you would opt to lease out your land, how important are these features? Tick where appropriate

Feature	Not important [1] Wt < 5	Moderately important[2] Wt = 5	Very important[3] Wt > 5
Contract length/lease length			
Size of land			
Employment to household members			
Renewability of contract			
Price per acre			

Section E: Choice experiment on preference for biofuel investments

Suppose a biofuel industry is established in this area with the option to lease and it comprises compulsory and optional features. The compulsory features include but are not limited to the following

1. The origin of the investor must be fully known. (Foreign investor or local investor?)
2. The investors must follow legal means of negotiations especially when entering into contracts with farmers regarding how the farmers would want to participate in the biofuel industry either by leasing or selling land. In any of these options legal procedures must be followed.
3. Also, investors' identity must be known. Personal details of the investor must be known explicitly to the farmers to ensure that the investors are not fraudulent dealers.
4. Investors of the biofuel industry and the biofuel company must be legally registered to operate within the country as a whole and within the region to ensure that farmers are dealing with genuine companies.
5. Once the contract is signed, legal means must be followed by farmers to settle any post contract disputes that may arise.

The optional features include, but are not limited to the following

1. Contract length-This refers to the duration of the agreement between the farmers and the biofuel industry in years.
2. Size of land-This refers to the amount of land to be dedicated for biofuel crops or the amount to be leased out to the biofuel company to facilitate growing of crops for biofuel production.
3. Renewability of contract-Indicates whether the contract of the farmers with the biofuel company would be renewable or not.
4. Employment to household members-This refers to farmers would want to be offered employment in biofuel company in order for them to participate in the biofuel investments.
5. Price per acre- this refers to the price that farmers will be willing to accept to be paid if they may opt to lease out their land to the biofuel company.

The optional biofuel investments features could have the following levels:

Lease of land option

Biofuel investment attributes	Description	Attribute levels
Price per acre	Refers to the average lease price per acre	10,000 15,000 20,000
Contract length	Refers to the length of the lease	2 years 5 years 10 years
Land size	Refers to the size of land that the farmer may want to lease	25% 50% 75%
Employment to household members	Refers to the type of employment the farmer may want	None Permanent Casual
Renewability of contract	Refers to whether contract is renewable or not	Yes, No

Now I will show you different biofuel investment options that can be made by combining these features, Please compare the different biofuel investment types shown to you each time and indicate which one you prefer.

Validation of attributes

15. Were you looking at all attributes before making a decision? [0]Yes…… [No]…….

16.If yes, which specific attributes were you looking for?

1…….

2……

3……

17. Are there some attributes you did not consider when making your decision? [0] yes……. [1]No……

If yes, which specific attributes did you not consider?

1…….

2…….

3…….

18. Which attributes did you find most important when making your decision on which biofuel investment option to choose?

1……

2……..

3…….

Section F: Institutional services

19. Have you ever applied for credit in the last five years? [0]Yes…….. [1] No……..

If No, proceed to question 22

20. If yes, where did you apply for credit? Tick where appropriate

	Agricultural Finance Cooperation [1],Farmer group[2],Bank[3],Local SACCO[4],Local trader[5],Local Non Governmental Organization[6],Relative/friend[7],others[8]
Agricultural Finance Cooperation	
Farmer group	
Bank	
Local SACCO	
Local trader	
Local Non Governmental Organization	
Relative/friend	
Others, specify	

21. Did you get the credit you applied for? [0]Yes….. [1]No…...

22. If yes, what proportion of the credit you applied for did you get? ..... %

23. If you got credit, what did you use the credit for? Tick all that apply

	Food[1],school fees[2],fertilizer[3],livestock feeds[4],livestock drugs[5],family health cost[6],fuel[7],household items [8],clothing[9],others[10]
Food	
School fees	
Fertilizer	
Livestock feeds	
Livestock drugs	
Family health costs	
Fuel/energy/firewood/timber	
Household items eg soap	
Clothing	
Others	

24. If you applied for credit and did not get, what were the reasons?

	Too far[1],No security[2],others[3]
Too far	
No security	
Others, specify	

25. If you have not applied for credit, what are the reasons that have made you not to apply for credit?

	Not aware[1],No security[2],Don't know the procedure[3],others[4]
Not aware	
No security	
Don't know the procedure	
Others, specify	

26. Did you get government extension service visits in the last 12 months? [0]Yes …..[1] No…….

27. If yes, how many times in the last 12 months did you get information from government extension service providers?

28. What are your sources of information on agricultural related issues? Rank them in order of importance-where you get most of your information from)

	Government t extension officer[1],fellow farmers[2],church meetings, NGO [4]Kenya Agricultural Research Institute[5],Agrovet shops[6],radio[7],textbooks[8],students[9],others[10]	Rank
Government extension officer		
Fellow farmers		
Church meetings		
Non Governemntal Organization extension agents		
Kenya Agricultural Research Institute		
Agro vets shops		
Radio		
Text books		
Students		
Others		

29. How often does the main extension service provider visit your farm? ……..

30. Do you own a mobile phone? [0]Yes….[1] No…..

31. If yes, do you use your mobile phone to access agricultural information? Tick where appropriate [0]Yes…… [1]No……

32. Are you a member of any farmer group? [0]Yes…… [1]No……

Section G: Socio demographic factors
33. What is your age? ……. (Years)
34. What is your gender? [0]Female……. [1] Male……..
35. What is your level of education?

	Incomplete primary[1],completed primary[2],incomplete secondary[3],completed secondary[4],completed college[5],university and above[6]did not go to school[7]
Incomplete primary	
Completed primary	
Incomplete secondary	
Complete secondary	
Completed college	
University and above	
Did not go to school	

36. What is your monthly level of income? ..... (Kenya shillings) Tick where appropriate

Kenya shillings	0-10000[1],10001-20000[2],20001-30000[3],above 30000[4]
0-10000	
10001-20000	
20001-30000	
Above 30000	

37. What is the total number of household members? .....

38. What is the school attendance frequency for those under 18years old?

1.Attends regularly	
2.Irregular attendance due to financial problems	
3.Irregular attendance due to other reasons	
4.never attends	

Thank you for your participation.

Appendix 2: Focus Group Discussion Questionnaire

UNIVERSITY OF NAIROBI
ANALYSIS OF SMALLHOLDER FARMERS' LIVELIHOOD STRATEGIES AND PREFERENCES FOR BIOFUEL INVESTMENTS IN KENYA
FOCUS GROUP DISCUSSION QUESTIONNAIRE

APRIL, 27TH 2013

The purpose of this focus group discussion is to obtain preliminary insights on current livelihood strategies and how emerging biofuel investments (production of fuel from plants) could possibly serve as an alternative livelihood option. These issues are relevant to the choice experiment design procedure.

Checklist for discussion
1. What are the general livelihood activities in this area and what challenges are they facing?
2. Are you aware of fuel that can be generated from plants or waste matter and do you know about sugar beet crop?
3. If an industry is established here to produce fuel from plants, would you want to participate in it as an alternative livelihood option and what features in general would you like it to have?
4. How important are legal features such as Origin of the investor, legal means of negotiations to be followed investors' identity must be known, investors must be legally registered
5. How important are the following aspects of biofuel investments if there was an option to participate either by leasing your land?
Please consider the following attributes/features described below.

Lease of land option

Biofuel investment attributes	Description	Attribute levels
Contract length	Refers to the length of the lease	2 years 5 years 10 years
Land size	Refers to the size of land that the farmer may want to lease	25% 50% 75%
Employment to household members	Refers to the type of employment the farmer may want	None Permanent Casual
Renewability of contract	Refers to whether contract is renewable or not	Yes, No
Price per acre	Refers to the average lease price per acre	10,000 15,000 20,000

Do these attributes adequately describe biofuel investments?

Appendix 3: NGENE choice experiment design syntax

(i) Orthogonal design for pre test survey
Lease option

```
Design
; alts = alt1, alt2
; rows = 36
; block = 6
; orth = sim
; model:
U(alt1) = b0+b1*x1[0,1,2]+b2*x2[0,1,2]+b3*x3[0,1,2]+b4*x4[0,1,2]+b5*x5[0,1]/
U(alt2) =    b1*x1      +b2*x2     +b3*x3      +b4*x4     +b5*x5$
```

(ii) Efficient design for actual survey

```
Design
;alts = alt1, alt2
;rows = 24
;block = 6
;eff = (mnl,d)
;model:
U(alt1) = b1[-
1.024]*x1[0,1,2]+b2[0.582]*x2[0,1,2]+b3[1.294]*x3[0,1,2]+b4[0.301]*x4[0,1]+b5[0.004]*x5[0,1,2]/
U(alt2) = b1      *x1     +b2      *x2       +b3       *x3       +b4       *x4       +b5       *x5$
```

Appendix 4: List of all choice sets

Lease of land option: Profile 1

Scenario 1

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10 years	2 years	
Size of land	25%	75%	
Employment to household members	casual	none	
Renewability of contract	no	yes	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 2

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2 years	10 years	
Size of land	75%	25%	
Employment to household members	none	casual	
Renewability of contract	yes	no	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 3

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10years	2years	
Size of land	75%	25%	
Employment to household members	Permanent	permanent	
Renewability of contract	no	yes	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 4

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10years	2years	
Size of land	25%	75%	
Employment to household members	casual	none	
Renewability of contract	yes	no	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Profile 2

Scenario 1

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2years	10years	
Size of land	25%	75%	
Employment to household members	permanent	casual	
Renewability of contract	no	yes	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 2

	Biofuel investment alternative A	Biofuel investment alternative B	Nether
Contract length	5years	5years	
Size of land	25%	75%	
Employment to household members	casual	none	
Renewability of contract	no	yes	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 3

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2years	2years	
Size of land	75%	25%	
Employment to household members	none	casual	
Renewability of contract	yes	no	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 4

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	5years	10years	
Size of land	75%	25%	
Employment to household members	none	casual	
Renewability of contract	no	yes	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Profile 3

Scenario 1

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	5years	5years	
Size of land	50%	50%	
Employment to household members	casual	none	
Renewability of contract	yes	no	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 2

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10years	2years	
Size of land	75%	25%	
Employment to household members	casual	permanent	
Renewability of contract	yes	no	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 3

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	5years	2years	
Size of land	50%	50%	
Employment to household members	permanent	casual	
Renewability of contract	no	yes	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 4

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2years	10years	
Size of land	25%	75%	
Employment to household members	none	permanent	
Renewability of contract	yes	no	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Profile 4

Scenario 1

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	5years	5years	
Size of land	50%	50%	
Employment to household members	none	permanent	
Renewability of contract	yes	no	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 2

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	5years	5years	
Size of land	50%	50%	
Employment to household members	permanent	none	
Renewability of contract	no	yes	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 3

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2years	5years	
Size of land	50%	50%	
Employment to household members	permanent	none	
Renewability of contract	yes	no	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 4

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	5years	5years	
Size of land	50%	50%	
Employment to household members	none	casual	
Renewability of contract	no	yes	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Profile 5

Scenario 1

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2years	10years	
Size of land	50%	50%	
Employment to household members	none	casual	
Renewability of contract	no	yes	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 2

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10years	5years	
Size of land	50%	50%	
Employment to household members	casual	none	
Renewability of contract	yes	no	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 3

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2years	10years	
Size of land	75%	25%	
Employment to household members	none	casual	
Renewability of contract	yes	no	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 4

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10years	2years	
Size of land	25%	75%	
Employment to household members	casual	none	
Renewability of contract	yes	no	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Profile 6

Scenario 1

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10years	2years	
Size of land	75%	25%	
Employment to household members	casual	permanent	
Renewability of contract	no	yes	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 2

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	2years	10years	
Size of land	25%	75%	
Employment to household members	permanent	permanent	
Renewability of contract	no	yes	
Price per acre	15,000	15,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 3

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	5years	5years	
Size of land	25%	75%	
Employment to household members	permanent	permanent	
Renewability of contract	yes	no	
Price per acre	10,000	20,000	
Choice question: Which biofuel investment would you prefer?			

Scenario 4

	Biofuel investment alternative A	Biofuel investment alternative B	Neither
Contract length	10years	2years	
Size of land	75%	25%	
Employment to household members	permanent	permanent	
Renewability of contract	no	yes	
Price per acre	20,000	10,000	
Choice question: Which biofuel investment would you prefer?			

Appendix 5: Binomial logit commands

```
LOGIT; Lhs=AWARENES
        ; Rhs=ONE, AGE, GENDER, INCOME, EDUCATIO, CREDIT, GROUPMEM,
                EXTENSIO, LAND SIZE, HOU...
       ; Marginal effects$
```

Appendix 6: Random parameter logit commands

(i)Parameters for biofuel investments through lease of land option attributes

```
READ; FILE="C:\Users\David\Documents\COPYCAVS\Joy Isabel\Pooled Lease.xls"$
--> Sample; all$
--> RPLOGIT; Lhs=CHOICE
   ; CHOICES=1, 2, 3
   ; Rhs = SHORT, LONG, QUARTER, THREEQUA, PERMANEN, CASUAL, YES, PRICE
   ; FCN=SHORT (N),
         LONG (N),
         QUARTER (N),
         THREEQUA (N),
         PERMANEN (N),
         CASUAL (N),
         YES (N),
         PRICE(C)
   ; pds=4
   ; halton
   ; pts =100$
```

(ii)Willingness to Accept(WTA) estimates

```
   -> WALD; Labels=b1,
                   b2,
                   b3,
                   b4,
                   b5,
                   b6,
                   b7,
                   b8,
                   sd_b1,
                   sd_b2,
                   sd_b3,
                   sd_b4,
                   sd_b5,
                   sd_b6,
                   sd_b7,
                   Fix_b8
                   ; start=b
                  ; Var=Varb
                  ; Fn1= (b1/b8)
                  ; Fn2= (b2/b8)
                  ; Fn3= (b3/b8)
                  ; Fn4= (b4/b8)
                  ; Fn5= (b5/b8)
                  ; Fn6= (b6/b8)
                  ; Fn7= (b7/b8) $
```

(iii)Interactions estimates for biofuel investment attributes

```
 Sample; all$
create;THQGEN=THREEQUA*GENDER$
create;PERMGEN=PERMANEN*GENDER$
create;LONGCRED=LONG*CREDIT$
create;CASLCRED=CASUAL*CREDIT$
create;THQLAND=THREEQUA*LANDSIZE$
create;PERMLAND=PERMANEN*LANDSIZE$
create;QUATLAND=QUARTER*LANDSIZE$
create;QUATHHZS=QUARTER*HOUSEHOL$
create;THQHHZS=THREEQUA*HOUSEHOL$
create;PERMHHZS=PERMANEN*HOUSEHOL$


Sample;all$
--> RPLOGIT;Lhs=CHOICE
   ;CHOICES=1,2,3
   ;Rhs=SHORT,LONG,QUARTER,THREEQUA,PERMANEN,CASUAL,YES,PRICE,THQ
GEN,PERMGEN...
   ;FCN=SHORT(N),
            LONG(N),
            QUARTER(N),
            THREEQUA(N),
            PERMANEN(N),
            CASUAL(N),
            YES(N),
            PRICE(C),
            THQGEN(N),
            PERMGEN(N),
            LONGCRED(N),
            CASLCRED(N),
            THQLAND(N),
            PERMLAND(N),
            QUATLAND(N),
            QUATHHZS(N),
            THQHHZS(N),
            PERMHHZS(N)
   ;pds=4
   ;halton
   ;pts=100$
```

(iv) Compensating surplus for three biofuel investments through lease of land option policy scenarios

```
--> WALD; Labels=b1,
                b2,
                b3,
                b4,
                b5,
                b6,
                b7,
                b8,
                sd_b1,
                sd_b2,
                sd_b3,
                sd_b4,
                sd_b5
                sd_b6,
                sd_b7,
                Fx_b8
          ; start=b
          ; Var=Varb
          ; Fn1= (1/b8)*(b1*1+b2*0+b3*0+b4*0+b5*0+b6*1+b7*1)
          ; Fn2= (1/b8)*(b1*0+b2*0+b3*1+b4*0+b5*0+b6*1+b7*1)
          ; Fn3= (1/b8)*(b1*0+b2*1+b3*0+b4*1+b5*1+b6*0+b7*0) $
```

Appendix 7: Formula for calculating WTA ranges

Min WTA ± 1.96 SE

Where Min WTA refers to the minimum willingness to accept estimate
SE refers to the standard error of the minimum willingness to accept estimate.