EFFECTIVENESS OF JATROPHA CURCAS LIVE FENCE IN MANAGING
HOUSEHOLD RISKS AND VULNERABILITY IN
KILIFI COUNTY

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UNIVERSITY

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DECLARATION

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K101/CTY/PT/23244/2013

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DEDICATION

I wish to dedicate this study to my loving Parents, Grandmother and all the people of Kilifi County.
ACKNOWLEDGEMENT

My deepest appreciation goes to my supervisors Dr. James Maingi and Dr. Perez Onono for their guidance, encouragement and availability throughout the study period.

I am also greatly indebted to CISP who granted me an internship and FAI who supported me financially.

I wish to also acknowledge the support and responses given by the Jatropha hedgerow farmers in Kilifi County without whom this work would not have been accomplished.

Lastly but most importantly, I thank God for His strength, inspiration and favor throughout the study period. It is by His grace and mercy that I have come this far.
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<tr>
<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<td>CDM</td>
<td>Clean Development Mechanisms</td>
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<td>CSD</td>
<td>Commission on Sustainable Development</td>
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<td>CISP</td>
<td>International Committee for the Development of Peoples</td>
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<td>EU</td>
<td>European Union</td>
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<td>EEP</td>
<td>Energy and Environment Partnership</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
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<td>FAI</td>
<td>International Assistance Foundation</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>GHG</td>
<td>Greenhouse gases</td>
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<td>IEA</td>
<td>International Energy Agency</td>
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<td>IPCC</td>
<td>International Panel on Climate Change</td>
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<td>KARI</td>
<td>Kenya Agricultural Research Institute</td>
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<td>KEFRI</td>
<td>Kenya Forestry Research Institute</td>
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<td>KENGEN</td>
<td>Kenya Electricity Generating Company</td>
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<td>MDG's</td>
<td>Millennium Development Goals</td>
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<td>MoA</td>
<td>Ministry of Agriculture</td>
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<td>MoE</td>
<td>Ministry of Energy</td>
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<td>NEMA</td>
<td>National Environmental Management Agency</td>
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<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
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<td>UNCED</td>
<td>United Nations Conference on Environment and Development</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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<td>WAC</td>
<td>World Agro Forestry Center</td>
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OPERATIONAL DEFINITION OF TERMS

*Biofuels:* are liquid fuels derived from other materials such as waste plant in this case from the Jatropha Curcas seeds

*Biomass:* is biological material derived from living, or recently living organisms that is often used as fuel in rural areas

*Climate Change:* is the change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties.

*Consumption smoothing:* is the act of stabilizing consumption levels through the income received from growing of the Jatropha hedgerow.

*Efficiency:* is the ratio of actual output to maximum potential output obtainable from a given input level or the ratio of minimum potential input to actual input required to produce the given output.

*Energy Security:* is the uninterrupted availability of energy sources at an affordable price.

*Financial Inclusion:* delivery of financial services at affordable costs to the marginalized parts of society

*Food Security:* is a condition related to the ongoing availability of food.

*Hedgerows:* these are live boundaries, limits or borders.

*Informal Insurance schemes:* an insurance system that is not officially recognized and is not legally binding.
Pareto Efficiency: A reallocation of goods that allows more of something to be produced without the sacrifice of something else.

Pro Poor Development: development aimed at increasing economic benefits to the poorer members of the society.

Renewable Bio mass: Biomass that is sustainably produced with no harm to the environment.

Rural Development: the process of improving the quality of life and economic wellbeing of people living in rural areas.

Savings: the proportion of income that is not consumed and can be used for other activities.

Social Risk Management: elaborate mechanisms of self protection that households use to mitigate idiosyncratic and covariate risks.

Social Protection: policies and programs that guarantee a minimum standard of living for the needy in society.

Sustainability: the ability to be use resources without completely using them up.

Vulnerability: is the inability of the needy in society to cope with risk.
Growing of Jatropha curcas has been received with mixed feelings in Kenya. The plant has tremendous potential to be Africa’s most excellent bio-fuel feedstock. However, there have been concerns that the plant is not commercially viable and that it negatively affects food production and security. The lack of factual information coupled with politics surrounding the growth of the plant has compromised its uptake by local farmers. This has however not dampened the spirits of pro poor development supporters who view the plant as a potential solution to rural poverty. Live fences (Hedgerows) are a common occurrence in rural Kenya. They are frequently used as fences because of their low cost and aesthetic value. The growing of Jatropha as a hedgerow can easily be brushed off as a non beneficial undertaking considering the previous research findings on the non viability of the plant but inherent in it is a coping mechanism that households may use to mitigate against idiosyncratic and covariate income risks. The lack of risk mitigation mechanisms means that households prone to income shocks cannot smoothen consumption when faced with a risk. In the recent past, there has been a great emphasis on a social protection agenda that protects not just the chronically poor but also the vulnerable populations against idiosyncratic and aggregate shocks. A few households in coastal Kenya have embraced the technology but it is not clear whether there are any significant savings and benefits arising from the endeavor. The purpose of this study was therefore to analyze the effectiveness of the Jatropha hedgerows in managing household risks and vulnerability by first defining the relationship between household Consumption and income from Jatropha hedgerows and secondly by analyzing the effectiveness of the hedgerow in protecting the vulnerable society. The study employed a diagnostic research and involved the collection of primary data through questionnaires and schedules from forty pre selected households who had successfully grown the hedge to maturity and were receiving an income from the sale of seeds, oil and other by products from the hedge. Correlation and regression analysis were run to ascertain the relationship between household consumption and income from Jatropha hedgerows and a demographic analysis conducted to ascertain the participation of women and older members of society in the project. The results of the analysis show that Income from Jatropha hedgerows is positively correlated to household consumption proving that the Jatropha hedgerow is an effective tool for household consumption smoothing. The results also show that women and older members of society, who are the most vulnerable in the society, are participating and benefiting from the project. The findings of the study lead to the conclusion that Jatropha curcas hedgerows are effective in managing household risks and vulnerability. The study recommends that a comprehensive research on Jatropha curcas as a plant be carried out by KARI or any other relevant institution to verify claims such as low oil content and high toxicity that have surrounded the growing of the plant. The study also recommends that social protection be extended beyond financial and income related considerations to include investments that support informal arrangements and upgrade the nonprofit sector especially those that have sustainable development at their core.
CHAPTER ONE

INTRODUCTION

1.1. Background

Two centuries after the agrarian and industrial revolution in Europe it would have been organically expected that by now human beings could feed themselves and through diffusion of various innovative technologies have tackled the problem of poverty as well.

The United Nations in 2000 under the Millennium Declaration committed to achieving eight goals by 2015 that would help improve the living standards of the poor in the world and foster sustainable development (Persons, 2013). Fourteen years later, a report of the high level panel for eminent persons on the post 2015 Development Agenda reports that the Millennium Development Goals (MDG’s) did not focus enough on reaching the poorest and excluded people and that the MDG’s fell short by not integrating the economic, social and environmental aspects of sustainable development (Persons, 2013). The post 2015 global development agenda aims to rectify this and carry forward the spirit of the MDG’s that are centered on sustainable development and social inclusion (Persons, 2013).
Social exclusion has been a major huddle in the road to development. Exclusion on the global level brought about categorization of countries, the first, second and third worlds all with different quality of lives for their citizens. At country level, exclusion has led to massive inequalities and detestable living standards for the poor. It is in this backdrop that the international community has settled on the 'leave no one behind' approach. This approach emphasizes on global partnerships and cooperation to achieve sustainable development and improved living standards for all (Persons, 2013). Though there have been considerable efforts and tremendous good will from stakeholders a paradigm shift is well over due in the development arena. Participatory development needs to be taken a notch higher, pragmatism in the way projects are designed, implemented, monitored and evaluated. Over reliance on farfetched foreign solutions to local problems and poor policy implementation by governments have left the people disenfranchised. The formal solutions, often mal diagnosed, have necessitated the birth of local, people centered, informal solutions.

The concept of social risk management asserts that individuals, households, and communities are exposed to multiple risks from different sources, both natural (such as earthquakes, floods, and illness) and manmade (such as unemployment, environmental degradation, and war). Poor people are typically more exposed to risk and have less access to effective risk management instruments than people with greater assets and endowments. This vulnerability makes individuals risk-averse and unwilling or unable to engage in high-risk/return activities. Under these circumstances, poor people have developed elaborate mechanisms of "self-protection" such as asset accumulation in
good times, diversification of income sources, and creation of informal family and community "risk-pooling" arrangements. However, these arrangements are often relatively expensive and inefficient, and the coping strategies available once a shock occurs often reduce poor people's human capital (for example, cutting back on meals or pulling children out of school to help generate income). This gives rise to the need for public intervention (WorldBank, 2001).

Informal solutions though non conventional are playing a central role in helping the rural poor cope with the ever increasing challenges of marginalization and social exclusion. The rural population as a result of their high exposure to risk and lack of adaptive capacity become the most vulnerable in the event of a shock. The lack of access to important services such as insurance and credit facilities robs the households of tools to rightfully deal with shocks that interfere with their already paltry incomes and low consumption levels. There are several sensible reasons why households cannot fully insure consumption against income fluctuations. The well known problems of moral hazard, information asymmetries, and deficient ability to enforce contracts may result in no or incomplete insurance markets (Alderman, 1992).

According to FAO one in eight people in the world suffer from chronic hunger and malnutrition. The situation is more prevalent in Africa where one in every four people are under nourished (FAO, 2013).

In Sub Saharan Africa, climate change and other vagaries of weather have had adverse effects on the population a majority of who depend on Agriculture as their source of
livelhood. Erratic weather patterns, failed rains, crop diseases, pests and volatile commodity prices are just some of the risks that small holder farmers are facing (Hoogeven, 2001). Differences in the timing, intensity and quantity of rainfall and other weather phenomena like storms, precipitation and cloud cover, the incidence of disease, pests, fire or attacks by wild animals cause yields to fluctuate unpredictably. Variations in the price of inputs and marketed output cause farm profits to vary, and illness at the moment of planting may seriously affect the household’s income for that year (Hoogeven, 2001).

Over the last few years a large literature has attempted to quantify the impacts of climate change on agricultural productivity at the regional as well as at the country level. The general consensus emerging from this literature is that climate change will negatively affect agricultural productivity and yields, and that the impacts will vary across countries as well as within countries. To the extent that yield changes are good predictors of the changes in the welfare level of rural households, and ultimately of the changes in the poverty rates at least in the rural areas, these findings suggest that climate change would have significant effects on poverty rates (Skoufias, 2011).

According to (Morduch, 1995) if there are complete markets for credit, then transitory income shocks that is shocks that differ from the average over time should be smoothed away by borrowing and saving and should not affect consumption patterns. Most of these rural small holder farmers have no access to complete markets for credit and even
if they do they simply cannot afford them and therefore it is no surprise the income fluctuations they face when their expected outputs are compromised. Income risk therefore becomes a central feature of rural farmers in developing countries.

According to Becker's 1965 model of household production Consumption levels are sensitive to income (Baxter, 1999). Shocks on income translate to a drop in consumption. Small holder farmers do not have the capacity to influence policy and neither do they have ability to control world commodity prices let alone control the vagaries of weather. Farmers have to come up with risk management strategies that will protect their living standards against fluctuations in income as they way await the implementation of institutional and policy reforms that were meant to formally insure them from risks.

Consumption insurance therefore entails insuring household consumption from income variability (Morduch, 1999). This would ensure Food and non food consumption levels are smoothened over time regardless of the shocks in income. Growing of Jatropha as a hedge becomes a coping mechanism households. The strategy is based on the premise that in the event farm output is compromised due to any risk factor (poor rainfall, pests), the household will still have income from the hedge to compensate for the lost income thereby smoothening consumption.

In rural areas, the variability of income maybe reduced through a variety of mechanisms, including choosing crops whose yields and prices display low correlations
Alderman, 1992). Jatropha curcas L. is a bush or small tree (up to 5 m height) and belongs to the euphorbia family. The genus Jatropha contains approximately 170 known species. The genus name Jatropha derives from the Greek *jatrós* (doctor) *trophe* (food), which implies medicinal uses (Ltd).

Jatropha curcas L. (also called the physic nut) is found to be a potential alternative source of renewable energy since its cultivation and oil extraction contribute to sustainable development, poverty alleviation, combating of desertification and women empowerment in developing countries (Cynthia, 2011).

Jatropha grows in the harshest of conditions and requires little amount of resources to tend and therefore is not vulnerable to most of the risks that other plants face thus its yield is almost guaranteed. The seeds are crashed to produce oil which can be used as a cheaper alternative to kerosene and paraffin. Families are able to save that portion of income that they would have used to buy the fossil fuel while at the same time generate extra revenue from the sale of the bio fuel (Tunje, 2014).

Hedgerows are limits, boundaries and borders. At the landscape level, hedgerows have a major role in controlling physical, chemical and biological fluxes, as well as being cultural indicators (Baudry, 2000). Jatropha hedges provide soil erosion control, increase water entrapment and infiltration, and protect crops from wandering livestock as well as oil production for local use (Brittaine, 2010). Population growth leads to agricultural innovations that allow a growing rural population to sustain itself with the same amount of land but with more labor input. The adoption and diverse application of
live fences is a technological innovation, which creates a spatial division in the production and allocation of ecosystem services. Live fences are a form of ecology-as-technology, or in other words both human made and natural capital, because the plants would not grow by themselves in such a manner, and yet they provide additional ecosystem services by and of themselves (VanderHorst D, 2014). The cost of growing the hedge is minimal and so is the labour input required and after two to three years farmers are able to start harvesting the seeds. Income from the savings made from using a cheaper alternative of fuel and income received from the sale of other Jatropha by products (such as soap) can be used to smoothen consumption when there is a shock in income anticipated from the farm output (Tunje, 2014).

The hedgerow not only acts as a risk management tool but also as a proponent for a cleaner environment. Biomass energy provides 68% of Kenya’s national energy requirements and it is expected to remain the main source of energy for the foreseeable future. In 2000, Kenya was reported to use 34.3 million tonnes of biomass for fuel of which 15.1 million tonnes was in form of fuel wood while 16.5 million tonnes was wood for charcoal processed in kilns with only 10% efficiency. Up to 43% of the national consumption was from sustainable supplies while 57% was from unsustainable supplies (Mugo, 2010).

The continued high dependence on wood fuel and other forms of biomass as the dominant primary sources of energy largely to meet household energy needs has contributed to unsustainable harvesting of biomass with attendant negative impacts on
the environment, which could be attributed to serious climate variability and associated unpredictability in rainfall patterns. In addition, continued consumption of biomass fuels contributes to poor health among users due to excessive smoke emissions in poorly ventilated houses (Energy, 2004).

**Key Policy Interventions**

In Kenya the environment has also been recognized as an important pillar for sustainable development. This can be witnessed through the various policy interventions that the Government is putting in place in its quest of improving the quality of lives of all its citizens. Some of the policy interventions include;

**Vision 2030**

Vision 2030 is Kenya's development blueprint that is meant to steer Kenya into a Middle income country with a high quality of life for its citizens by the year 2030. Energy is one of the infrastructural enablers of the three "pillars" of Kenya's Vision 2030. The level and intensity of commercial energy use in a country is a key indicator of the degree of economic growth and development (Planning, 2012). The need for clean renewable sources of energy cannot be over emphasized.

**National Energy Policy**

According to Sessional Paper No. 4 of 2004 on Energy (Energy, 2004) the National Energy Policy seeks to encourage wider adoption of renewal energy technologies, and thereby expanding their role in the country's energy supply matrix. The policy includes
the commitment that the government will promote the growing of appropriate tree species (which can be grown on low and medium potential agricultural lands) for production of feedstock to manufacture biodiesel. It recognizes the need to set aside land for production of energy crops from which bio fuels can be produced and calls for the formulation of strategies to optimize land use, as well as to harmonize land use policies with energy policy.

**National Bio fuel policy**


Its broad objectives are: Improving energy security by reducing reliance on imported fossil fuel; Promoting sustainable local energy resource use to substitute or complement imported fossil fuels; Facilitating access to clean energy for household use (heating, lighting and cooking); Complementing and diversifying energy for transport, industries household and off- grid electrification; Promoting rural development through investment in bio fuels; Increasing income earning opportunities and alleviate poverty; Contributing to improved health of populations; Harnessing natural resources
sustainably through optimal utilization of renewable energy resources; Promoting research and development in bio fuels; and Contributing to the achievement of Vision 2030.

The policy has a clear preference for carefully selected drought-tolerant bio fuel feed stocks which can be grown without damaging remaining forest or taking up agriculturally productive land, and which can regenerate and develop marginal non-food lands while maintaining wildlife, forests and other vital ecosystems services. Jatropha and the planned development of the plantations of Jatropha as a hedge plant proposed under this project are consistent with the preference.

The policy recognizes that bio fuels have the potential to unlock significant socio-economic benefits in rural areas. It argues that a bio fuels industry could provide important drivers for rural development, through the growing of feed stocks on agriculturally marginal land and the labour-intensive production chain, which in turn would help to alleviate poverty, stem rural urban migration, increase income generation for poor families, create employment and reverse environmental degradation (Tunje, 2014).

In Kenya, the rural poor with their meager incomes are forced to bear with volatile prices of fossil fuel. Most of the rural households heavily depend on wood fuel, kerosene and paraffin to cater for their ever increasing energy needs. Constrained by
their meager incomes, the rural households are not able to save as most of their income
is spent on purchasing the fossil fuels (kerosene and Paraffin). The government under
the Rural Electrification Program has tried to connect rural households to the grid but
despite these efforts the cost of electricity is still too high and most of the households
prefer the traditional option of biomass (Energy, 2004).

This has led the UNFCCC to come up with the concept of Renewable Biomass.
Renewable Biomass is biomass originating from areas where land remains a forest; and
Sustainable management practices are undertaken on these land areas to ensure, in
particular, that the level of carbon stocks on these land areas does not systematically
decrease over time (UNFCCC, 2005).

The rush for bio fuels has been largely driven by three main issues: climate-change
mitigation, energy security and agricultural development. The idea of producing energy
from a reproducible source is readily appealing. However, bio fuels relying on large-
scale adoption of intensive monoculture practices are almost certain to impact
negatively on people and livelihoods (Campion, 2014).

Land use is a sensitive matter especially for a country that aims at being food secure and
for one that heavily relies on Agriculture as its main source of income. Hedgerows are
an efficient way of planting Jatropha as there is no opportunity cost of land. Land is
used for farming other crops and farmers are assured of income from both the hedge
and the farm if output is not compromised. The hedge as earlier stated becomes an
income guarantee scheme for the household should income from farm outputs be
impeded.

Consumption smoothing requires that consumption levels are insured from income
shocks. In the event, that the farm output is maximum, income from the hedgerow can
be saved for another season. Saving is an important component of poverty alleviation. It
is only through saving that households can smoothen their consumption when their farm
yield incomes are compromised due to poor rainfall, pest attacks and poor commodity
prices among other threats (Morduch J., 1995).

1.2. Statement of the Problem

As the world moves towards a broader understanding of poverty reduction and the
relationship of risk to poverty, the standard concepts and interventions are no longer
sufficient. A paradigm shift that argues for the development of social protection
programs that not only help poor women and men cope with the result of downturns,
but proactively helps them take on higher return activities with less concern about the
risks (Worldbank, 2001). Social Protection policies and programs aim to guarantee a
minimum and stable level of income for the needy in society, while providing them
with the necessary means to smoothen income over time and eventually exit poverty.
Putting mechanisms in place for risk mitigation assists vulnerable households maintain
consumption levels potentially protecting them from falling into poverty. When full
markets for consumption smoothing do not exist, risk aversion can affect how
households decide both the composition and nature of income generating activities
Jatropha curcas is a bio fuel that requires minimal inputs such as labour, pesticides and fertilizers to grow. It is considered a low risk plant and therefore when grown as a hedge, it becomes the perfect risk mitigation tool.

Another problem envisioned in this study is the aspect of environmental degradation. Biomass energy provides 68 percent of Kenya’s national energy requirements and it is expected to remain the main source of energy for the foreseeable future. In 2000, Kenya was reported to use 34.3 million tonnes of biomass for fuel of which 15.1 million tonnes was in form of fuel wood while 16.5 million tonnes was wood for charcoal processed in kilns with only 10 percent efficiency (Mugo, 2010). Africa is the worst affected continent by the effects of climate change. There is need to identify alternative sustainable sources of energy that will contribute to environmental conservation.

1.3. Research Questions

The study sought to answer the following questions;

i. What is the effect of income from Jatropha curcas hedgerows on household consumption levels?

ii. What is the potential of Jatropha curcas hedgerows as a tool for social protection?

1.4. Objectives of the Study

The main objective of the study was to determine the effectiveness of Jatropha curcas hedgerows in managing Household risks and vulnerability.
Specific objectives of the study included:

i. To determine how the income from Jatropha curcas hedgerows affected household consumption levels;

ii. To establish the potential of Jatropha curcas hedgerows as a tool for social protection.

1.5. Significance of the study

With most of the developing countries passing through a demographic transition, support to the vulnerable especially women and the elderly has become an increasingly important issue in social protection. Studies on Jatropha curcas have focused on its commercial viability when grown as a main crop by small holder farmers. No study has been done to analyze the hedgerow's effectiveness in dealing with household risk and vulnerability. This constitutes the gap in knowledge that the study aims to fill.

The study was therefore useful in two tiers. The first tier being it provided information on a potential solution to consumption smoothing for the rural poor. The rural poor who mostly happen to be small scale farmers have no ways of cushioning themselves from income volatility caused by phenomena such as climate change and unemployment. The results of the study would be highly valuable to poor households that are keen on insuring their consumption against income shocks.

The second being a source of information on a tool that Development partners, both Governmental and Non governmental, can use to promote social protection and
environmental conservation all of which are crucial for sustainable development. The results of the study will be used by the International Committee for the Development of People (CISP) in the design and implementation of social protection programmes that are aimed at positively transforming the lives of the vulnerable in society. Kenya's national biomass energy policy objective is to ensure sufficient supplies of the resource to meet demand on a sustained basis while minimizing the environmental impacts associated with biomass energy consumption. Specifically the policy provides for increasing support for Research and Development, including capacity building for technology transfer, support property rights and innovations (Energy, 2004). The study also sought to complement the Government's aforementioned effort.

1.6. Scope of the study

The Study was done in 2015 and data was collected in the month of March 2015. The study focused on 10 farmers from four clusters who had been pre selected on the basis of the success of their hedges and were actually receiving an income from the sale of Jatropha seeds, oil and other by products. The farmers were identified by CISP through their Monitoring and Evaluation activities conducted at the end of 2014. Hedges had to be producing a critical mass of seeds and farmers were already earning an income from the sale of seeds, oil and other by products.

1.7. Organization of the Study

The project was organized into five chapters. Chapter one outlined the introduction of the study. Chapter two gave the literature review both theoretical and empirical. Chapter
three highlighted the research design and methodology that was adopted by the researcher. Chapter four highlighted the empirical findings and Chapter five gave the Summary, Conclusions and Policy implications.
2.1. Introduction

This chapter presents a review of Consumption theories both classical and neo classical in an attempt to understand the consumption behaviour of households. This is followed by a literature review of Jatropha curcas growing and its role in pro poor development.

2.2. Theoretical review

The starting points for much neoclassical economic research on saving and asset accumulation have been the life cycle hypothesis (LCH) (Ando and Modigliani 1963; Modigliani and Ando 1957; Modigliani and Brumberg 1954) and the permanent income hypothesis (PIH) (Friedman 1957). Both of these theories assume that individuals and households are concerned about long-term consumption opportunities and therefore explain saving and consumption in terms of expected future income. These models assume that saving is a way to "smooth" consumption in the face of income fluctuations. Building up assets and avoiding excessive debt can help families insure against unforeseen disruptions, increase economic independence and improve socio economic status (Eds, 1989).

The following are consumption theories that have been formulated over the years all attempting to explain consumption behavior:
1. Keynesian Theory of Consumption

According to John Maynard Keynes, an economic agent by natural instinct tend as a rule on average, to increase his consumption as his income rises, but not by as much as the increase in his income. Keynes postulates that as a rule households increase their utility by consuming more of the produced goods and services as their income increases (Alimi, 2013).

Based on Keynesian consumption function, aggregate consumption is a stable, linear function of disposable income,

\[ C_t = \alpha + \beta Y_t \]

where \( C_t \) and \( Y_t \) denote the (real values of) total personal consumption expenditure and total disposable income, respectively at time \( t \). \( \beta \), the marginal propensity to consume (MPC) is expected to be constant and positive but less than unity, so that higher income leads to higher consumption. The autonomous component of consumption, \( \alpha \), is assumed to be small but positive (Alimi, 2013).
2. Relative Income Hypothesis

James Duesenberry in 1949 challenged Keynes construction of consumption behaviour by introducing psychological factors associated with habit formation and social interdependencies based on relative income concerns (Palley, 2008).

Relative income hypothesis states that the satisfaction (or utility) an individual derives from a given consumption level depends on its relative magnitude in the society (e.g., relative to the average consumption) rather than its absolute level. It is based on a postulate that has long been acknowledged by psychologists and sociologists, namely that individuals care about status (Darity, 2008). Status fortunately or unfortunately is not an immediate concern for the rural poor.

3. Fisher's Model of Intertemporal consumption

Fisher makes the assumption that the consumer is forward-looking and chooses consumption for the present and future to maximize lifetime satisfaction. Consumer's choices are subject to an intertemporal budget constraint, a measure of the total resources available for present and future consumption. The timing of income is irrelevant since the consumer can borrow and lend across periods. Current consumption depends on lifetime income not current income so long as the consumer can borrow and save.

In his Theory of Interest, Fisher begins with the basic determinants of time preference or impatience. He divides his discussion into two parts: the influence of economic factors and what he calls personal factors. Fishers says that an individuals impatience
depends on four characteristics of his income stream: the size, its time shape, its composition and its risk. The role of size is quite clear. In general it may be said that, other things being equal, the smaller the income, the higher the preference for present over future income that is the great impatience. This claim is in direct contrast to the life cycle and Permanent Income theories which postulate that all savers smooth their consumption over their lifetimes regardless of their levels of income (Thaller, 1997).

Fisher theorises that, the poor are much more impatient than the middle class. Fisher is clear that the effect of income or impatience is partly rational or irrational. The irrational aspect of the matter is often to relax foresight and self control and to tempt us to trust the 'luck of the future' if only the all engrossing need of the present necessities can be satisfied (Thaller, 1997).

4. **Permanent Income Hypothesis**

The Permanent Income Hypothesis by Milton Friedman postulates that households consumption at a point in time is determined not just by its current income but also by the expected future income. If households have reason to believe that that their future income may decline then they would take the available necessary measures to ensure that their consumption is smoothened.

The simplest form of the Permanent Income Hypothesis (PIH) asserts that households base their consumption decisions on their permanent rather than current income, where
permanent income is the expected annuity obtainable from the discounted value of lifetime resources (Friedman, 1957). The PIH has many powerful implications, one of which is that the elasticity of consumption with respect to current income should vary systematically with the degree of permanence in the changes to households' income (Seater, 2006).

The magnitudes termed "permanent income" and "permanent consumption" that play such a critical role in the theoretical analysis cannot be observed directly for any individual consumer unit. The most that can be observed are actual receipts and expenditures during some finite period, supplemented, perhaps, by some verbal statements about expectations for the future. The theoretical constructs are ex ante magnitudes; the empirical data are ex post. Yet in order to use the theoretical analysis to interpret empirical data, a correspondence must be established between the theoretical constructs and the observed magnitudes (Friedman, 1957).

According to the permanent income hypothesis with quadratic preferences, households save for a rainy day the transitory component of income innovations and consume entirely the permanent one (Pistaferi, 2001). Consumers use saving and borrowing to smoothen consumption in the event of fluctuations in income. The options of borrowing and saving are however not available to the rural poor.
5. Life cycle Hypothesis of Consumption and Saving

The Life Cycle hypothesis posits that the main motivation for saving is to accumulate resources for later expenditure and in particular to support consumption at the habitual standard during retirement. This implies that an essential observable implication of the Life Cycle Hypothesis is the existence of phases of life, notably during the retirement period, when consumption tends to exceed earned income finances by negative saving in the form of a reduction in wealth accumulated in the earning span (Modigliani, 2005). Though the rural poor go through the same phases of life, the luxury of saving when young is not available to them.

2.3. Empirical Review

A study conducted by (Tomomatsu, 2007) concluded that current market conditions did not make Jatropha production an attractive investment for small holder farmers in Kenya. This was based on the key assumption that farmers would engage in Jatropha seed production in order to sell to private bio diesel enterprises that would compete with whole sale supplies of diesel. The paper however adds that other value chains exist for Jatropha bio diesel production in which small holder farmers might be able to attract more attractive outcomes. The study found that though Jatropha appears to be the potential crop that enables “win-win” relationship among all the actors in the value chain, the desired rural economic benefits may not be achieved by the simple
introduction of Jatropha production to local communities based on the low prices of seed and feed stock. (Tomomatsu, 2007).

Kallback, M (2008) conducted a study on the feasibility of Jatropha curcas as a Bio fuel feed stock in Kenya. He concluded that in order for the industry to be successful, the productivity of Jatropha needs significant R&D to improve productivity in order to reduce average costs of production. Also intensive research and development needs to be undertaken to increase potential yields, and decrease average production costs so as to lower farm gate price for the seed (Kallback, 2008).

The World Agro forestry Center in Nairobi in 2010 undertook a cost benefit analysis of growing Jatropha in Kwale District. An Investment Rate of Return of eleven percent, Benefit Core Ratio of 0.62 and a Net Present Value of (28267.56) showed that the growing of Jatropha was not feasible. The group observed that the average acreage of Jatropha is 0.5 acres per farmer with each farmer having around 1330 meters in mono cropping and 1000 Jatropha plants in intercropping regimes. Low yields of up to 0.1 kilogram per plant proved to be a major drawback to farmers’ expectations from Jatropha (Mogaka et.al, 2010).

2.4. Overview of Literature

The authors reviewed above have highlighted the potential of Jatropha Curcas as an antidote to the global energy crisis and a possible agent for pro poor development.
Nonetheless, the authors have also expressed their reservations regarding the economic viability of growing the plant for smallholder farmers mostly due to the high opportunity cost of land and low rates of return. They however failed to explicitly analyze the viability of growing the plant as a hedge and its ensuing effect in managing household risks and vulnerability. Hence the study seeks to fill this gap by analyzing the effectiveness of the Jatropha hedgerows as a household consumption smoothing tool and its broader potential as a tool for social protection. This would be conducted by analyzing how the income received from the hedgerows affects household consumption and by conducting a demographic analysis to ascertain its effect on the welfare of vulnerable members of society.
CHAPTER THREE

METHODOLOGY

3.1. Introduction

This chapter presents the research methodology. First a presentation of the research design is provided. This is followed by an explanation on the target population, description of research instruments, description of sample and finally, sampling procedures, description of data collection procedures and a description of data analysis procedures.

3.2. Research Design

The study employed a diagnostic research to identify the factors motivating households to grow the hedgerow and the resulting relationship between the growing of the hedgerow and household consumption.

3.3. Theoretical Framework

Poor rural households’ consumption levels are dependent on the incomes they receive. Since the levels of income are quite low it is no surprise that these households cannot access the most basic of necessities. The quality of life of the rural poor is pegged on the level of income the household can generate. The lack of credit and other crucial financial services robs the households the ability to smoothen their consumption in times of income shocks.
The Keynesian Theory of Consumption postulates that men are disposed, as a rule and on the average, to increase their consumption, as their income increases, but not by as much as the increase in their income (Keynes, 1936). According to the Keynesian Theory of Consumption, an economic agent by natural instinct tends as a rule on average, to increase his consumption as his income rises, but not as much as the increase in his income. The theory postulates that as a rule households increase their utility by consuming more of the produced goods and services as their income increases (Alimi, 2013).

Based on Keynesian consumption function, the Absolute Income Hypothesis, aggregate consumption is a stable, linear function of disposable income,

\[ C_t = \alpha + \beta Y_t \]

Where \( C_t \) and \( Y_t \) denote the (real values of) total personal consumption expenditure and total disposable income, respectively at time \( t \). \( \beta \), the marginal propensity to consume (MPC) is expected to be constant and positive but less than unity, so that higher income leads to higher consumption. The autonomous component of consumption, \( \alpha \), is assumed to be small but positive (Alimi, 2013). This research in line with Keynesian Theory of Consumption aims to establish whether income from the Jatropha curcas hedgerows significantly affects household consumption and therefore be regarded as a consumption smoothing tool.
The effectiveness of the hedges would be corroborated by the ability of the income from the Jatropha hedges to significantly affect household consumption. The absolute income will be decomposed into income from main source \((Y_m)\) and income from Jatropha curcas \((Y_j)\). The theoretical model from the Absolute Income Hypothesis takes the form:

\[
C_i = \alpha + \beta Y_i \tag{1}
\]

\[
Y_i = Y_m + Y_j \tag{2}
\]

\[
C_r = \gamma + \beta' (Y_m + Y_j) + \epsilon \tag{3}
\]

where \(C\) and \(Y\) represent current consumption and income, while the subscripts \(m\) and \(j\) stand for the main income and Jatropha income components, respectively. The subscript \(i\) indexes households. Equation (1) indicates that consumption is proportional to income. Equation (2) defines absolute income which is the sum of their corresponding main income and Jatropha income components. Equation (3) denotes the consumption function with the two decomposed incomes as the explanatory variables.

3.4. Empirical Model

The Empirical model in this study was developed in the theoretical framework. The empirical model would have Household consumption as the dependent variable and both incomes from main income generating activities and Jatropha hedgerows as the independent variables. Following the Keynesian model of consumption which has Consumption dependent on absolute income, the empirical model would decompose the
absolute income into two; Income from main income generating activities and Income from Jatropha hedgerows. Consumption would be a function of Income from main income generating activities and Income from Jatropha hedgerows. The model estimated was given as:

\[ c_i = \beta_0 + \beta_1 Y_m + \beta_2 Y_j + \epsilon \]

where \( \epsilon \) is a random disturbance term.

### 3.5. Definition and Measurement of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption (dependent) ( c_i )</td>
<td>Value of goods and services consumed by a household</td>
<td>Monthly expenditure on food and non food items</td>
</tr>
<tr>
<td>Main Income ( Y_m )</td>
<td>Income from Household’s main income generating activities</td>
<td>Monthly Income from main sources of revenue e.g. farm, employment</td>
</tr>
<tr>
<td>Jatropha Income ( Y_j )</td>
<td>Income from Jatropha hedgerows</td>
<td>Monthly Income from Jatropha hedgerows products</td>
</tr>
</tbody>
</table>

*Source (Researcher, 2015)*

### 3.6. Data type and Sources

Primary data was collected from households by the use of Questionnaires and Schedules in situations where the respondents were illiterate. Monthly expenditures on food and non food consumption was collected jointly with the household monthly income from the Jatropha hedges and other sources of income.
3.7. Target Population

1200 farmers from Malindi and Magharini districts in Kilifi County have been on a four year European Commission funded project that is being implemented by CISP and KEFRI since 2011. Under the project, Farmers have been grouped into 4 clusters of 300 farmers based on the unique features of the project sites. The four clusters are namely Mida, Mijomboni, Kakuyuni and Marekebuni. The study targeted Jatropha hedgerow farmers in the four clusters.

3.8. Sampling Procedure and Sample Size

The study used Purposive sampling to identify the sample of interest. Following monitoring and evaluation activities conducted by the proponents of the project 10 farmers from each cluster were identified as having grown the hedge successfully with a critical mass of yield as at the end of 2014 and had begun receiving an income from the sale of seeds and other Jatropha by products. The study focused on the 40 farmers who had been identified from the monitoring activity.

3.9. Data collection Instruments and Procedures

Quantitative and qualitative data was collected from households using questionnaires and schedules. The instruments used are presented in Appendix 8.
3.10. Data Analysis

The First objective which was to determine how the income from Jatropha hedgerows affected household consumption was achieved by running a correlation and regression analysis of income on consumption. A correlation analysis was conducted to identify any association between the variables and a regression analysis conducted to ascertain the significance of the relationship. A positive association between Household consumption and Income from Jatropha hedgerows was identified leading to the conclusion that the hedgerow could be used in managing household risk.

The Second objective which was to evaluate the potential of Jatropha curcas hedgerows as a tool for social protection was achieved by conducting a demographic analysis to ascertain the age and gender distribution of the farmers who have adopted the practice. The results were presented in the form of tables and charts in the next chapter.
CHAPTER FOUR

EMPIRICAL FINDINGS

4.1. Introduction

This chapter contains empirical findings from data collected and analyzed using SPSS with respect to each of the individual research questions of the study. Tools such as tables and charts are used to present the data with a brief summary of the main findings given at the end of each analysis.

4.2. Factor Analysis

The factor analysis involved analyzing the variables of interest, that is, Consumption and Income from main income generating activities and Income from Jatropha hedgerows. The analysis would form a basis for the correlation and regression analysis that would be useful in identifying a relationship between the variables. Statistics on the factor analysis included the mean, standard deviation, maximum and minimum values of Consumption, Income from main income generating activities and Income from Jatropha curcas. The results are presented on Table 4.1.
Table 4.1: Descriptive Analysis of Variable data.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption Expenditure</td>
<td>Kshs. 6340</td>
<td>2704.96</td>
<td>18000</td>
<td>3000</td>
</tr>
<tr>
<td>Income from Main Income generating Activities (Ym)</td>
<td>Kshs. 12275</td>
<td>5458</td>
<td>30000</td>
<td>5000</td>
</tr>
<tr>
<td>Income from Jatropha hedgerows (Yj)</td>
<td>Kshs. 211</td>
<td>82.35</td>
<td>390</td>
<td>45</td>
</tr>
</tbody>
</table>

Source (Survey Data, 2015)

a. Consumption

Household consumption was considered to provide data on how much the family was spending every month on food and non food items. This would be important in analyzing the effect Income from Jatropha hedgerows has on household consumption. The descriptive analysis shows that household's had a mean expenditure of Kshs. 6,340 ($70) per month with a standard deviation of 2704.96. This high amount is attributed to the high cost of basic necessities such as food. Due to poor harvests caused by failed rains most of the farmers are forced to spend a significant amount of their paltry incomes on food. An average household was comprised of 8 members. The fact that households are large in terms of size makes the situation more dire. Other than food, expenses such school fees, transport, alcohol and tobacco also contributed to high expenses. Households also spent some amount in the purchase of durable goods such as bicycles, stools while others were saving up for cheap mobile phones. The high
standard deviation of Kshs. 2704.96 and huge range, that is between kshs. 18000 and 3000, is attributed to the huge disparities in consumption expenditure among households.

b. **Income from Main Income generating Activities**

Income from the main income generating activities was considered to provide data on how much the household was earning from their main income generating activities. The descriptive analysis shows that the 40 households had a mean income of Ksh.12,275 with a standard deviation of Kshs. 5,458 with variables ranging between Kshs. 30,000 and Kshs. 5,000. The high standard deviation and huge range is attributed to the large income disparities among households. Most of the farmers who depend on rain fed agriculture have been forced to diversify their activities. Erratic weather patterns have led to poor harvests that have consequently led to low incomes. This has forced farmers to look for other income generating activities to supplement the household income. Households had supplemented their incomes to include incomes from multiple occupations such as Crop farming, Dairy keeping, Fish selling and selling of items weaved from coconut palms. This situation had been necessitated by the poor returns from farming and the lack of formal employment. The farmers had been turned into entrepreneurs by default.
c. **Income from Jatropha curcas hedgerow**

Data on monthly income from sale of Jatropha seeds, Oil and other by products was collected from the farmers. A correlation and Regression analysis would be run to find the relationship between the monthly income from Jatropha hedgerows and the households consumption levels. The data on income was an aggregate of income from the sale of Seeds, Oil, and Briquettes. The farmers were selling their Jatropha products through the Community Business Organizations in their respective cluster areas.

The descriptive analysis shows that households had a mean income of ksh.211 with a standard deviation of Kshs. 82.35 and a range of between Kshs. 390 and Kshs. 45. Despite the incomes being low, the variable showed a relatively high standard deviation and huge range, this can be attributed to the disparities in income among the households. The incomes depended on the seed yield and thus the longer the perimeter of the hedge the more the income. Seeds bought and sold through the CBO were retailing at Kshs. 20 per Kilo while 1 litre of Jatropha Oil was retailing at Kshs. 165. It takes roughly 5 kgs of seed to produce one litre of Oil. As the market for Jatropha products continue to grow the prices will also increase. Demand for Jatropha by products has been increasing as more and more households adopt the new fuel that is clean, cheaper and accessible. Jatropha Oil burns three times as much as kerosene used for lighting and from the seedcake, briquettes are formed that can be used in place of charcoal.
4.3. Empirical results

The specific objectives of the study were to determine how the income from Jatropha curcas hedgerows affected household consumption levels and to establish the potential of Jatropha curcas hedgerows as a tool for social protection. Findings on each are presented on the following section.

4.3.1. Effect of Jatropha Curcas on household consumption.

a. Correlation analysis

A Correlation analysis of monthly household expenditure on consumption, Income from Main income generating activities and Monthly income from Jatropha by products was conducted to identify any existing relationship between the three variables. The analysis was specifically intended to identify any association between Income from Jatropha hedgerows and Household consumption.
Table 4.2: Correlation Analysis of Household Consumption, Main income (Ym), and Income from Jatropha hedges (Yj).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Consumption</th>
<th>Income M</th>
<th>Income J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Coefficient</td>
<td>1.000</td>
<td>.392*</td>
<td>.332*</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.012</td>
<td>0.012</td>
<td>.037</td>
</tr>
<tr>
<td>N</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>.392*</td>
<td>1.000</td>
<td>.182</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.012</td>
<td>.262</td>
<td>.262</td>
</tr>
<tr>
<td>N</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>.332*</td>
<td>.182</td>
<td>1.000</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.037</td>
<td>.262</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>

*. Correlation coefficient is significant at the 0.05 level (2-tailed).

Source (Research data, 2015)

Using the Spearman's rho test, at 5% level of significance, the results show that there exists a positive correlation between Consumption and Income from main income generating activity (Ym) and between Consumption and Income from Jatropha seeds, Oil and other by products. The results suggest that household monthly consumption expenditure could be dependent on the main income generating activities and also on income received from the Jatropha hedgerows.
b. Regression Analysis

A regression analysis of Consumption on Incomes from Main income generating activities and Jatropha by products was conducted to come up with a linear model that could best describe the relationship between the variables. The results are presented in table 4.3.

Table 4.3: Regression Analysis of Consumption on Income from main income generating activities (Ym) and income from Jatropha hedgerows (Yj)

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Coefficient</th>
<th>T - statistic</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3470.94</td>
<td>2.69</td>
<td>0.01</td>
</tr>
<tr>
<td>Income M</td>
<td>0.43</td>
<td>2.83</td>
<td>0.01</td>
</tr>
<tr>
<td>Income J</td>
<td>0.04</td>
<td>0.24</td>
<td>0.81</td>
</tr>
<tr>
<td>Adjusted R- squared</td>
<td></td>
<td>0.70823</td>
<td></td>
</tr>
<tr>
<td>F – statistic</td>
<td></td>
<td>2.339</td>
<td></td>
</tr>
<tr>
<td>Sig. of F statistic</td>
<td></td>
<td>2.31</td>
<td></td>
</tr>
</tbody>
</table>

Source (Research data, 2015)

The adjusted R – squared measures the success of the regression in predicting the values of the dependent variable within the sample. The adjusted R – Squared is the fraction of
the variance of the dependent variable explained by the independent variables. The adjusted R – Squared of 71 percent given by the results is fairly impressive implying that most of the variations in household consumption expenditure is explained by the variables in the model. The F- Statistic in the estimation results tests the hypothesis that all of the slope coefficients in a regression are zero. The computed F – value 2.339 is greater than the critical value of 2.31 implying that the slope of the coefficient of independent variables has taken none zero values. This is an indication that there exists a meaningful relationship between dependent and independent variables and hence statistical reliability of the model estimated. At 5 percent significance level, the constant term has a positive coefficient, showing that if all independent variables remain constant, the household would still consume. Income from main income generating activities was found to have a positive coefficient and a t value of 2.83. This indicates that income from the main income generating activities is significant in determining household consumption. This is consistent with economic theory.

The analysis shows that income from Jatropha hedgerows had a positive coefficient of 0.04 and a t value of 0.24, the t value 0.24 is less than the critical value 0.81, meaning that the effect is not significantly different from zero. This indicates that income from Jatropha hedgerows is not significant in determining household consumption. However, the positive coefficient shows that should income from Jatropha hedgerows increase, so will household consumption.

The findings are in line with those of Tomomatsu and Swallow who concluded that current market conditions did not make Jatropha production an attractive investment for
small holder farmers in Kenya (Tomomatsu, 2007). Incomes from Jatropha curcas though increasing are still low and cannot significantly affect household consumption expenditure. However, the income from Jatropha hedgerows does have a positive correlation to Household consumption meaning it can be used to smoothen household consumption in times of income volatility.

4.3.2. The potential of growing Jatropha curcas as a tool for Social Protection

A demographic analysis was conducted to answer the second research question which was to evaluate the potential of the hedgerows as a tool for social protection. The demographic analysis entailed analyzing the farmer's gender and age distribution to ascertain whether women and the elderly were participating in growing the hedgerow.

a. Gender of the Farmers

The analysis on Gender was considered to evaluate the potential impact of the Jatropha hedgerow as a tool for gender promotion. This analysis would assist in establishing if there were women growing the hedgerow and could therefore be viewed as a tool for gender empowerment. The analysis show that 52.5% of the respondents were male while 47.5% were Female. Out of the 40 households that were interviewed, 19 of the respondents were women while 21 were men.
The findings show that interest in growing of the Jatropha hedgerows is almost equally represented by both genders. 47.5 percent of the farmers were women compared to 52.5 percent who were male. In previous times, participation of women in projects geared towards socio economic transformation was very low due to societal practices and beliefs that restricted their role to domestic affairs. Women's roles in the household include collecting of firewood which at times had them walking for long distances to make sure the family would have a cooked meal in the evening. Women were also risking their lives by venturing deep into forests in search of firewood. It is of no surprise then, when the findings show that women were strongly represented in growing of the hedgerow. The hedgerow would ensure that they would not have to walk kilometers damaging their backs by carrying loads of firewood and on top of that they could earn an income from the sale of the byproducts.

b. **Age of the Farmers**

The age of the farmers was considered to ascertain who in the society was growing the hedgerow in terms of age. This would be useful in understanding the psyche of the
The farmers were grouped into three categories, Young, Middle aged, and old. The results are shown in the table below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>18 - 29</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>Middle aged</td>
<td>30 - 49</td>
<td>17</td>
<td>42.5</td>
</tr>
<tr>
<td>Old</td>
<td>50 and above</td>
<td>22</td>
<td>55</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40</td>
<td>100</td>
</tr>
</tbody>
</table>

Source (Research data, 2015)

The results show that the farmers ages ranged between 28 yrs to 64 yrs. 2.5 percent of the farmers were between the ages of 18 and 29, 42.5 percent of the farmers were between the ages of 30 and 49 while 55 percent of the farmers were 50 years and above. More than half of the total farmers growing the hedge were over 50 years old.

The findings show that growing of the hedgerow was popular among the older members of the society. Contrary to expectations that farming was for the youthful and physically strong, growing of the Jatropha hedgerows was an affair for the older members of society. This finding could be used to imply that farmers viewed the Jatropha hedgerow as a social welfare tool that could easily offer them an extra source
of income. At 50 years old the body cannot engage in labour intensive activities and more so in areas where basic health care is nonexistent.

In Kenya, the Government does not have a social protection policy for the older members of society. The older members of society in Kilifi county rely on their children for their upkeep and should they fail for whatever reason they are left at the mercy of well wishers. Jatropha curcas hedgerows require low labour and financial inputs and thus provide a viable source of income that is not demanding for the older members of the society and can be used to cushion them against income risks.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1. Introduction

This Chapter presents the summary, conclusion and Policy implications of the study. First, a presentation of the summary of the major findings that includes a brief description of the methodology is given. This is followed by a conclusion from the findings and finally the policy implications.

5.2. Summary of the major findings

The study had set out to analyze the effectiveness of planting Jatropha curcas live fence as a tool for managing household risks and vulnerability. The specific objectives were to determine how the income from Jatropha hedgerows affects household consumption levels and to establish the potential of the hedge as a tool for social protection.

The study was guided by the Keynesian theory on consumption which postulates that household consumption is dependent on income. Primary data was collected on all the variables on the empirical model using questionnaires.

To meet the first research objective, income had to be decomposed into income from main income generating activities and income from Jatropha hedgerows after which a correlation and regression analysis was conducted. The analysis involved analyzing and identifying how Household Consumption, Income from main income generating activities and Income from Jatropha hedgerows were related. The findings showed that Household consumption was positively affected by income from the Jatropha
hedgerows though the relationship was weak. However, when grown as a hedge the Income from Jatropha hedgerows could still be used to manage household risk as it provides an extra source of income for the household.

To meet the second research objective, a demographic analysis was conducted to ascertain who were the partakers of the project and whether there were vulnerable members of the society being positively affected by the program. The findings would be useful in establishing the potential of Jatropha curcas being grown as a tool for social protection. The results showed that 2.5 percent of the farmers were between the ages of 18 and 29, 42.5 percent were between the ages of 30 and 49, and 55 percent of the farmers were 50 years old and above. This indicates that growing of the hedgerow was popular among the older members of the society. With regard to the gender of the farmers, the findings show that 47.5 percent of the farmers were female compared to 52.5 percent who were male. Findings from the demographic analysis imply that participation in the project was equally represented by both genders but more popular with the older members of society.

5.3. Conclusions

From the findings, the Jatropha hedgerows do positively affect household consumption. The relationship may be weak but it does affect consumption and hence can be used to smoothen it in times of volatility. The hedgerow also affects both genders and the aging members of the society and therefore validates its potential as a tool for social protection. Social risk management involves investing in resilient sources of income
that assist vulnerable households maintain consumption levels. In summary, the Jatropha hedgerow is an effective tool for managing household risks and vulnerability.

Lack of factual information on Jatropha curcas has negatively affected its uptake by farmers. A comprehensive research on Jatropha curcas as a plant should be carried out by KARI or any other relevant institution to verify claims and perspectives such as, low oil content and high toxicity, that have surrounded the growing of the plant.

Population growth necessitates us to come up with agricultural innovations that will allow a growing rural population to sustain itself with the same amount of land but with more output. The adoption of hedgerows is a technological innovation that will allow households to optimally use land. In addition, the use of the bio-fuel and its biomass will ease pressure from the environment acting as a conservation tool.

5.4. Policy Implications

Findings from the study show that income from Jatropha curcas hedgerows does not significantly affect household consumption and therefore cannot be used to advise policy. However, the potential of bio-fuels as substitutes for fossil fuels and as a solution to environmental and social problems obligates us to change our view on the importance of bio-fuels in sustainable development. Sustainable development is dependent on the formulation and implementation of sound policies encompassing economic growth, social inclusion and environmental conservation. Jatropha curcas hedgerows empower households economically, are a source of income for women, men and the elderly and are the perfect substitute for biomass and firewood thereby
contributing to environmental conservation. Jatropha curcas hedgerows should be considered as a viable strategy when formulating policies that are geared towards sustainable development.

Social Protection policies and programs aim to guarantee a minimum and stable level of income for the needy in society, while providing them with the necessary means to smoothen income over time and eventually exit poverty. Putting mechanisms in place for risk mitigation assists vulnerable households maintain consumption levels potentially protecting them from falling into poverty.

The importance of linking risk management to poverty reduction cannot be over emphasized. Access to market based interventions such as saving mechanisms and insurance programs can mitigate some of the risks but not all. The government needs to come up with holistic policies that are a mix of Informal, Market based and Public strategies.

The concept of social risk management extends beyond the realm of social protection. Viewing social risk management only from the perspective of social protection would mean missing out on many effective and efficient policy actions that could be taken outside the sector. This implies taking a holistic approach in coming up with interventions that assist individuals, households and communities in coping with risks. This makes it necessary for all relevant sectors to coordinate in coming up with the
fitting interventions. Social protection should extend well beyond financial and income related considerations it must include investments to support informal arrangements and upgrade the nonprofit sector especially those that have sustainable development at their core.

5.5. Recommendations for Further research

This study was limited to an analysis of how Jatropha Curcas hedgerows could be used in Managing household risks and vulnerability. Further research should be conducted in the following areas:

1. The viability of growing Jatropha Curcas as a main crop

2. What other crops when grown as hedges would contribute to managing household risk and vulnerability.
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Mogaka, M. (2010). *Reality or romantism, potential of Jatropha to solve energy crisis and improve livelihoods*.


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Thomas, R. &. (2012). *Gender, Production and Consumption: Allocative efficiency within farm households*.


## Appendix 1

Table 4.5: Frequency distribution of Household consumption

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Source (Research data, 2015)
## Appendix 2

### Table 4.6: Frequency distribution of Income from main income generating activities (Ym)

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*Source (Research data, 2015)*
### Appendix 3

**Table 4.7: Frequency distribution of income from Jatropha hedgerows (Yj)**

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*Source (Research data, 2015)*
## Appendix 4

### Table 4.8: Age distribution of Farmers

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*Source (Research data, 2015)*
Appendix 5

Figure 1 Bar graph of household expenditure frequencies

Source (Research data, 2015)
Appendix 6

Figure 2: Bar graph showing the frequency of income received from Jatropha hedgerow

Source (Research data, 2015)
Miller Wanjau  
P.O. Box 33133 - 00600  
Nairobi.

2nd March 2015.

Dear Participant,

RE: EFFECTIVENESS OF JATROPHA CURCAS HEDGEROWS IN MANAGING HOUSEHOLD RISK AND VULNERABILITY QUESTIONNAIRE.

I am visiting your household today because you have been chosen to participate in the survey being undertaken as part of my graduate work at Kenyatta University. I would be grateful if you could spare 15 to 20 minutes of your time to answer some questions.

The aim of the study is to analyse the effect of Jatropha hedgerows in managing household risk and how they contribute to social protection. Data from the questionnaire would be valuable in contributing to a better understanding of the effectiveness of Jatropha Curcas hedgerows.

All data collected will be treated as confidential and after analysis the information will be used to inform policy on social protection or act as a basis for further research on Jatropha Curcas hedgerows. Thank you for your time.

Yours Faithfully,

Miller Wanjau.
Appendix 8

QUESTIONNAIRE

Instructions

Questions are to be filled by the Head of the Household

Kindly answer the questions below. Please tick where appropriate.

1) Name

2) Age

3) Gender

4) How many Family members are in your household?

5) How much do you spend on Food and Non Food items (fuel, school fees, transport) every month? Kshs

6) How much do you spend on Fuel for cooking and lighting every month? Kshs

7) Are you employed?

Yes [ ]
No [ ]

8) If yes, State the level of your income per month
   a) 0 – 1500 [ ]
   b) 1501 – 3000 [ ]
   c) 3001 – 4500 [ ]
   d) 4501 – 6000 [ ]
   e) Over 6000

9) What other income generating activities do you engage in?
   a) Crop Farming [ ]
   b) Fishing [ ]
   c) Masonry [ ]
   d) Other. Specify. [ ]

How much do you earn from these activities every month?
   a) 0 – 500 [ ]
   b) 501 – 1000 [ ]
   c) 1001 – 1500 [ ]
   d) 1501 – 2000 [ ]
   e) Over 2000

10) Please state the income received from Jatropha hedgerows per month
    a) 0 – 100 [ ]

60
b) 101-200 [ ]
c) 201-300 [ ]
d) 301-400 [ ]
e) Over 400

11) State the factors that motivated you to grow Jatropha hedgerows
   a) To get extra income from sale of Jatropha Oil and by products
   b) As a source of fuel for household use
   c) As a boundary to keep off intruders
   d) For aesthetic purposes
   e) Other. Specify

12) How do you intend to use the income received from the Jatropha hedgerows?
   a) Save for future investment [ ]
   b) Immediate Household consumption [ ]
   c) Save to smoothen future consumption [ ]
   d) Other. Specify

13) Would you advice other Households to plant the Jatropha Hedgerows?

14) Additional comments

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