RISK MANAGEMENT AMONG AGRICULTURAL HOUSEHOLDS AND THE ROLE OF OFF-FARM INVESTMENTS IN UASIN GISHU COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

This thesis is my original work and has not been presented in this or any other university for the award of a degree or diploma.

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DEDICATION

I dedicate this work to my parents, brothers and sisters for their support and understanding in the pursuit of my studies.

ABSTRACT

Farmers face many risks which arise from natural, economic and socio-political environments. Risk sharing institutions like national insurance and credit schemes that help reduce the burden of risk to society are weak in Uasin Gishu county. Private sector insurance products are still in their developing stages and this has prompted farmers to turn to self insurance strategies that include diversification and social mechanisms for coping with risk. Off-farm investment is one of the diversification strategies whose prevalence and effectiveness in risk management have not been evaluated. This study sought to determine risk attitudes of farmers, to identify the determinants of off-farm investments and to investigate the effectiveness of off-farm investments in risk management. Data was collected from 100 randomly selected farm households. The ELCE method was used and exponential utility functions fitted by the method of nonlinear least squares and used to estimate the coefficients of absolute risk aversion. A logit model was used to identify determinants of off-farm investments. Effectiveness of off-farm investments in risk management was assessed by simulating the effect of replacing the weight of off-farm income with that of farm income on the coefficient of variation of total income. Results indicated that the major risks of concern to farmers were drought, market/price, pests and diseases and institutional risks with prevalence rates of 59, 34, 4 and 3% respectively. All the farmers in the study were risk averse. Years of experience in farming, employment income, gender and farm income significantly determined off-farm investment decisions. Simulation results showed that off-farm investment income reduces risk. Government policies and institutional mechanisms that reduce risk (such as crop insurance and irrigation technologies) and those that facilitate farmers' access to assets like off-farm investments in order to manage risks in farming are required.

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ACRONYMS AND ABBREVIATIONS

CE	-	Certainty Equivalent
DAO	-	District Agricultural Officer
ELCE	-	Equally Likely Certainty Equivalent
EU	-	Expected Utility
EUM	-	Expected Utility Model
GDP	-	Gross Domestic Product
GoK	-	Government of Kenya
KSh	-	Kenya Shillings
MOA	-	Ministry of Agriculture
NPV	-	Net Present Value
OLS	-	Ordinary Least Squares
SEU	-	Subjective Expected Utility
SFP	-	Safety First Principle
SPSS	-	Statistical Package for Social Scientists
USA	-	United States of America
AERC	-	African Economic Research Consortium

DEFINITION OF TERMS

Coping:- the methods used by households to survive when confronted with unanticipated livelihood failure.

Covariant risk:- a risk that affects all households in a locality and arises out of factors that prevail on all the households equally such as rainfall and market price conditions.

Ex-ante strategies:- risk management strategies that are employed prior to the occurrence of the risk in order to reduce the loss once it occurs.

Ex-post strategies:- strategies employed by households to cope with losses after the risk occurs.

Household:- An independent male or female producer and his/her dependants (Ellis, 1988) who must have lived together for a period not less than six months. They make joint economic decisions.

Idiosyncratic risk:- a risk that affects a household individually, it arises due to factors such as field specific problems, a disease that affects a household member etc.

Off-farm investment:- all business investments in secondary and tertiary sector activities that use raw physical intermediate inputs and process them into manufactured goods or produce services using capital and labour.

Risk management:- the systematic application of management policies, procedures and practices to the tasks of identifying, analyzing, assessing, treating and monitoring risk (Hardaker *et al.,* 2004).

Risk:- is variability of outcomes. Although risk refers to situations where probabilities can be attached to outcomes, this study assumes risk and uncertainty are subjective issues based on the decision makers' personal viewpoint about the occurrence of events.

Moral hazard:- the tendency of insured people to change their behavior in way that leads to larger or more frequent claims against the insurer. It is a cause of market failure in insurance brought about by information asymmetry.

Adverse selection:- another cause of market failure in insurance caused by information asymmetry, those who face higher risks of an insurable loss tend to buy insurance cover to a greater extent than those with average or lower expectations of loss.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Agriculture is the major economic sector of Kenya. It represents 24% of the country's GDP, 65% of the country's exports and 18% of the total formal employment (GoK, 2007). It is for this reason that the Kenya government has identified agriculture as one of the key sectors that are expected to provide the growth necessary for the achievement of the Kenya Vision 2030.

Agricultural sector in Kenya is characterised by the existence of both large scale and smallholder farms. There are currently more than 5 million smallholder farmers who account for about 75% of the total agricultural production in the country (GoK, 2007). Large farms are fewer in number and produce the remaining 25%. The smallholder farms are mainly subsistence, in which food crops are grown together with cash crops. Important food crops include maize, wheat, tubers, beans, sorghum and millet. Cash crops on the other hand include tea, coffee, pyrethrum and fresh flowers (Nyikal and Kosura, 2005). The sector faces challenges that include high cost of inputs (especially the price of fertilizer and seeds), poor livestock husbandry, limited extension services, over-dependence on rain-fed agriculture, lack of markets, and limited application of agricultural technology and innovation (GoK, 2007).

However, the economic performance of the agricultural sector is usually uncertain due to its biological nature in addition to relying mainly on rain fed agriculture and livestock rearing under natural conditions. This type of production is inherently risky because of variability of rainfall, animal mortality due to livestock diseases and fluctuations in output prices. The environment in most of low income countries is characterized by crop diseases, flooding, illness of household members and crime. All these create uncertainty (Capitanio, 2008).

As a result of a combination of many factors, many people in low income countries including Kenya live in poverty and food insecurity. They face many risks and uncertainties which arise from natural, economic and socio-political environments. These risks and uncertainties easily

trigger food shortages, deterioration in nutritional status and destitution (Pinstrup-Anderson *et al.,* 2001).

A number of studies show that farmers are risk averse. They manage risk by preferring enterprises that provide satisfactory levels of security even if at the expense of higher income. They diversify into a number of activities to spread risk. They also prefer to use established techniques of production, and to be self sufficient in food requirement through increased food production (Nyikal and Kosura, 2005). Risk plays an important role in farmer decision making and therefore affects agricultural productivity and thus growth and development. Lack of institutional innovations like crop insurance and affordable credit in developing countries to shift part of the risks from the private to the public sector makes risk management an important part of smallholder production decisions (Besley, 1995). Private sector provided insurance products have not developed due to problems of moral hazard and adverse selection (Hazzel, 1998 and 2003).

An increasing number of smallholder farmers now derive part of their income from non-farm sources. As much as 40-45 % of household income by 1997 was derived from non-farm sources in sub-Saharan Africa (Reardon, 1997). Off-farm investment is just one of the sources. Readon *et al.,* (2006) report that in poorer zones and among poorer households, labor-intensive household-based manufacturing may dominate, as with beer brewing in much of Africa. It is expected that the off-farm investments made by farmers in Uasin Gishu county include rental property, *posho*-mill, shop, savings account and common stock. From observation and review of literature, off-farm investment seems to be a viable option in risk management. A portfolio containing both on-farm and off-farm investments offers better risk management because the two are not directly subjected to the same risks.

1.2 Statement of the Problem

Smallholder farmers in Uasin Gishu county face many risks in their farming activities. For example, in the past, the county has recorded drought, crop and animal diseases and pests as well as fluctuations in prices of both farm produce and inputs. As a result, there has been variability in household income. Risk hinders farmers from pursuing their farming as a business. The risk

situation is complicated by the fact that they operate in an environment with weak markets. They do not have access to sufficient support institutions that can help them cope with risks. The policies described for risk management include risk sharing institutions like national insurance and credit schemes that help reduce the burden of risk to society. Since private sector insurance products in agriculture are still in their development stages, farmers have chosen self insurance strategies that include social mechanisms and diversification for coping with risk. The effectiveness of self-insurance strategies including off-farm investment in risk management has not been evaluated. This study intends to fill this knowledge gap.

1.3 Objectives of the study

The main objective of this study was to investigate risk management among agricultural households and evaluate the role of off-farm investment in risk management in Uasin Gishu county.

Specific Objectives:

i. To identify the major types of risks of concern to farmers
ii. To establish the nature of on-farm and off-farm risk management strategies used by agricultural households
iii. To determine risk attitudes of farm households
iv. To identify determinants of off-farm investments
v. To establish the effectiveness of off-farm investments in risk management

1.4 Research questions

i. What are the most common types of risks that face agricultural households?
ii. Which types of on-farm and off-farm risk management strategies do agricultural households use?
iii. What are farmers' risk attitudes?
iv. What are the determinants of off-farm investments?
v. Are off-farm investments an effective risk management strategy?

1.5 Justification of the study

Risk has important implications to agriculture in that it affects the types of investments that farmers make. Ultimately, it affects the level of farm output achieved and economic growth especially in Kenya where agriculture contributes up to 24% of GDP. Information on the role of off-farm investments on household risk management represents important contributions to existing body of knowledge. It brings out the kind of farmers that make off-farm investments as well as the types of investments they make. This is important since it can be used by government to assist farmers cope with risks.

1.6 Limitation and Scope of study

The study was confined to Uasin Gishu county, which was chosen because it is one of the counties where agriculture is the most important economic activity. It characterized the risks that farmers face, how it affected their behavior, how they managed them and specifically focused on the role of off-farm investments as a risk management strategy. It covered both small and large scale farmers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

Empirical literature indicates that risks reduce the willingness of farmers to undertake activities and investments that have high returns but with some chance of loss (Shapiro *et al*., 1992; Weisensel and Schoney, 1989 and Gadhim *et al.*, 2005). The impact of risk is more severe on the poor than for the better-off farm households and this implies that it increases inequality. Risk results in unwillingness or slowness in the adoption of innovations (Ellis, 1988). Inputs like improved seeds and chemical fertilizer are used in less than optimal quantities. The use of less than optimal levels of improved inputs is partly due to risk aversion (Yesuf, 2007).

2.2 Risks in Agriculture

Ellis (1988) identified four types of risks: natural hazards (weather, pests and diseases), market fluctuations (of output prices), social uncertainty (due to differences over control of resources) and state actions and wars. According to Hardaker *et al.,* (2004), three major types of risk in farming can be identified; yield, price and transaction risks. Hazell and Norton (1986) report that the types of risks farmers face depend on the type of farming system, climate and policy and the institutional environment. Most economic analyses downplay the distinction between risk and uncertainty on the assumption that these are subjective issues based on the decision makers' personal viewpoint about the occurrence of events.

2.2.1 Production or Yield Risk

Yield variability occurs because agriculture is subject to many uncontrollable events that are related to weather such as insufficient rainfall, diseases and pests. These are risks that arise because of natural causes (Valdes and Konandreas, 1981). Production for a specific crop depends on biophysical factors (erratic rain, type of soil and its quality, diseases and pests) and input prices, resource endowment and household specific consumption requirements. Yield risk can be measured using the coefficient of variation, which is a measure of randomness relative to the mean yield value (Hardaker *et al.,* 2004). Yield variability has an effect on the goal of meeting rising aggregate demand and on price and market stability (Hazzel, 1988). It leads to unstable farmer income, unstable household food production, variable supplies and prices to consumers.

2.2.2 Price Risk or Market Risk

This is the risk associated with changes in the prices of output or inputs which may occur when the farmer has made a commitment to produce. Farmers are exposed to unpredictable competitive markets for inputs and outputs. It includes risks that result from unpredictable exchange rates (Hardaker *et al.,* 2004).

Price and yield risks are not independent, they are related. High transportation and marketing costs in developing countries isolate local rural markets from national and international markets. Since yield fluctuations are correlated within a small area, local prices determined by local production and demand are volatile, and for an individual farmer are negatively correlated to their production. The farmers therefore face yield and price risks that are correlated depending on the level of regional market integration (de Janvry and Sadoulet, 1995). Price risks depend on the consumers' ability to substitute products and on the extent of market integration. Market integration is dependent on infrastructure and the types of markets available. Developing countries have poor infrastructure and thin markets (low productivity and so low marketed surplus). Price variability leads to income problems for farmers while inter-annual price variability makes planning difficult by introducing uncertainty (Hazzel, 1998 and Ellis, 1998). Price uncertainty generally leads to inefficient resource allocation (Gabre-Mahdin *et al.,* 2003).

2.2.3 Institutional Risk

Institutions are mechanisms that are used to structure human interactions in the presence of uncertainty. They help to reduce uncertainty and risk in human exchange (Kirsten and Karaan, 2005). This includes political risk, which is the risk associated with unfavorable policy changes. An example is changes in tax or credit policy and restriction on the use of a certain pesticide that alters the cost of production. Sovereign risk is the risk that foreign governments will not honor commitments such as trade agreements (Hardaker *et al.,* 2004). Also under institutional risk is transaction risk. This results from opportunistic behavior and the reliability of transacting partners. It is represented by the losses incurred as a result of the failure (a) in enforcing exclusive property rights, (b) in enforcing required attributes, (c) in completing the intended transaction or (d) in protecting transaction benefits from third party predation (Dorward *et al.,* 2007). Uncertainty arises due to imperfect information, bounded rationality (inability to utilize all information available) and opportunism. All these lead to uncertainty and risk of transaction

failure. Opportunism can lead to unpredictable and potentially damaging behavior by transacting parties (Dorward and Omamo, 2005).

Other risks include: ***human or personal risks*** (this is the disruptive change that may result from such events as death, divorce, injury, or the poor health of a principal in the firm***), asset risk*** (involves theft, fire, or other loss or damage to equipment, buildings, and livestock) and ***financial risk*** (results from the way the firm's capital is financed. Interest rates on borrowed capital fluctuate and there may be cash flow difficulties if there are insufficient funds to repay creditors. The farmer also faces a probability of losing his capital) (Hardaker *et al.,* 2004).

2.3 Risk Management Strategies

Farm size, age, innovativeness and risk aversion determine the choice of risk management strategy by farmers (Pennings, *et al.,* 2008). The identification of the sources of risk is important because it helps to choose the appropriate management strategy. Different farming systems, the ratio of agricultural income to total family income, as well as the size of arable land, differentiates their risk response.

According to Wencong *et al.,* (2006) the decision maker's risk preference affects the type of agricultural activities and corresponding scales that are selected. It also affects micro agricultural production structure and stable growth of households' income. Given a fixed amount of productive resources such as arable land, capital and labor force, the combination of production activities with the highest level of expected income/risk would be selected if the decision maker was a risk taker. For combinations of activities with a lower risk level, diversification might reduce risks to some extent at a cost of total return. Risk management strategies can be classified into two broad categories; ex-ante risk management and ex-post strategies.

2.3.1 Ex-ante Strategies

Farmers implement ex-ante strategies because of lack of mechanisms to cope with risks ex-post. Natural hazards can be managed by irrigation, crop insurance and by growing resistant varieties. Market risks are managed by price stabilization programs, provision of information and credit subsidies. Social and state hazards on the other hand are political issues. The situation of

smallholders can be improved by increasing their political participation in decisions which affect their welfare and their future (Ellis, 1988). Market risks can also be managed by inventory management as well as forward and futures contracts. Other responses include income diversification and farm enterprise diversification, organization flexibility, avoidance of high risk enterprises and holding liquid reserves of cash and credit. Income diversification involves widening the income earning portfolio. Farm enterprise diversification is used to edge against yield and price risk, disease and pest attack as well as seasonality. Farmers also adjust the level of inputs and output in trying to manage risk (Ellis, 1998). Valdes and Konandreas (1981) report that a particular producer may reduce yield risk by farming geographically dispersed plots of land. Others use cultural practices like growing short-season varieties that mature early in the season. Another strategy of managing risk is investing off-farm. A portfolio of farm and off-farm investments reduces risk (Mishra and Morehart, 2001).

People diversify their assets, activities and income because of several reasons: to manage risk (achievement of an income portfolio with low covariate risk between its components), to handle seasonality in farming activities, credit market failures (by investing to increase income generating capabilities in the future) and to iron out problems in labor markets (Ellis, 2000). Other reasons are diminishing returns of factors of production, reaction to crises or high transaction costs which encourage self sufficiency, to benefit from complementarities in enterprises such as livestock-crop enterprises and specialization due to comparative advantage that may arise from superior technology or skills (Barret *et al.,* 2001). In the presence of weak or incomplete financial markets, households diversify in order to hold a portfolio that lowers risk by smoothing consumption and income flows. The theory behind diversification is that returns from different enterprises are not positively correlated (Mitchell and Macleod, 2006). Roumasset (1976) reported that diversification is an efficient learning device. For example, when farmers plant small plots of land with new varieties or apply different levels of fertilizer to different plots of land.

Risk management, as noted above, is one of the reasons for diversification; it is not the only reason. Findings show that diversification increases with wealth in rural Africa (Readon *et al.,*

1997 and Barret *et al.,* 2000 and 2001). From observation and review of literature, off-farm investment seems to be a viable option in risk management.

2.3.2 Ex-post Risk Strategies

These are coping strategies once livelihoods are threatened. Ex-post strategies include re-deploying labor, depleting food reserves on farm, drawing down on other savings and asset liquidation. These strategies also include the sale of productive assets like livestock as the last resort and activation of informal insurance networks within the extended family e.g. food, gifts or other remittances, loans from informal welfare groups. The problem with these networks is that they are located within the same locality and so can only cope with idiosyncratic risk and not covariant risks.

2.4 Effect of risk on Welfare of Producers

Risk has a negative effect on welfare. Under the situation of isolated markets, there is a negative correlation between the individual's own production and the market price. The expected profit will be lower under uncertainty than under certainty. This is because a good year for an individual producer corresponds with a good year for most other producers thus resulting in a fall in the local market price. Since the producer receives a low price whenever output is high, and a higher price when output is low, for average production the farmer receives a price lower than the average price. This implies that risk affects even the welfare of risk-neutral farmers (de Janvry and Sadoulet, 1995).

According to Evans and Ngau (1991), farm households can raise their agricultural output, earnings and productivity by: increasing land under cultivation, applying more purchased inputs, hiring more labor and equipment, switching from subsistence to higher value cash crops, or by selling a greater proportion of crop yield. These methods, however, expose them to more risks since output or market prices may fall below expected levels. The farm household decision in such a situation will depend on its assessment of the risks involved and its capacity to withstand the losses should the outcome turn out bad (Evans and Ngau, 1991).

2.5 Off-farm Investment

The aim of the farmer is to increase income and to reduce its variability. Although many policy interventions are aimed at reducing price variability, de Janvry and Sadoulet (1995) report that the major concern of farmers is income variability and that stabilizing prices does not necessarily lead to income stability. Previous research shows that adding assets with higher levels of risk and higher expected rates of return can reduce risk because of the low correlation between farm and off-farm returns. Davis and Patrick (1999) found that education, net worth, age; livestock production and off-farm involvement influenced the level of off-farm investment by large scale farmers. They found that leverage had a negative effect while net worth, scale of the farming operation and off-farm involvement had a positive influence. Mishra and Morehart (2001) found that large farms were more likely to have off-farm investments than the smaller farms. Increased on-farm diversification and higher level of debt reduced the level of off-farm investment. Brown *et al.,* (2006) found that financial liquidity through access to credit and receipt of remittances was significant in livelihood choice and household welfare of farmers in Kenya's western and central highlands. A study in Ethiopia on determinants of off-farm participation by Bayene (2008) found that human capital in the form of health and training on non-farm activities as well as availability of credit and transfer income were significant.

A number of studies on off-farm investment as a risk reduction strategy have been carried out mainly in the developed countries. They include the work of Nartea *et al.,* (2003), Mishra and Morehart (2001) in New Zealand and Davis and Patrick (1999) in the USA. These studies focused on off-farm investments like financial assets, which include; equities, government bonds, and mutual funds. These are not well developed in low income countries. Off-farm investments in Uasin Gishu county may come in the form of rental property, posho-mill, shop, savings account and common stock.

2.6 Theoretical Framework

The theoretical framework for the study is based on literature on the farm household model and the investment theory. The farm household seeks to maximize utility subject to its limited resources and with a trade-off in its goal of minimizing risk. It does this by treating off-farm investment just like any other on-farm investment; it will only invest if the present value of the

benefits of the investment exceeds the present value of the associated costs of the investment (Mishra and Morehart, 2001). Given that the farmer is usually capital constrained, the farmer will choose the investment with the highest net present value (NPV). The NPV of the off-farm investment is given by;

$$NPV = \int_{t=0}^{T} e^{-rt} (R_t - C_t) dt,$$

Where T is time, r the discount rate, R_t the expected net returns of the investment and C_t represents the expected costs of the investment.

Economic research into risk attitudes is based on a set of axioms proposed by Von Neumann and Morgenstern (1947) and later developed by others. The axioms are used to demonstrate that an individual's risk attitude can be inferred if the preference ordering and distributional properties of the risky prospect are known.

The behavior of farmers under risk has been studied using two approaches. The first approach is an extension of the theory of consumer behavior. Consumers behave as if they have a utility function and make choices that maximize it. This approach gives the expected utility model (EUM). In the second approach, risk is defined as the probability that income will fall below a predetermined disaster level. This gives rise to safety first models (SFM). EUM is explained first then followed by SFM.

2.6.1 Expected Utility Model

In the Expected Utility Model (EUM), farmers are assumed to prefer an activity that has a certain return, Y, than that which has a risky return. A risk averter starting from a position of certainty is unwilling to take a bet which is actuarially fair (Arrow, 1970). The EUM is one of the most widely accepted models of individual behavior under risk. The household is assumed to have a utility function. It strives to maximize the expected value of a Von Neumann-Morgenstern utility function subject to an income constraint.

$$\boldsymbol{U = U(y, c)}$$

Where **y** is net farm income and **c** is consumption.

The utility function of a risk averse producer is illustrated in Figure 1. The expected utility of a random income that can take two values with equal probability can be calculated as:

$$y = \begin{Bmatrix} \bar{y} + \delta \; with \; probability \; {}^{1}/_{2} \\ \bar{y} - \delta \; with \; probability \; {}^{1}/_{2} \end{Bmatrix}$$

The expected utility is given by;

$$Eu\{y\} = \frac{1}{2}\{U(\bar{y} + \delta) + U(\bar{y} - \delta)\}$$

This is half way between the two utility levels. Due to the concave nature of the utility function, this $Eu(y)$ is less than the utility $u(\bar{y})$, which is the utility associated with the sure income of $\bar{y}$. The difference between the two is a measure of the cost of the risk in terms of the loss of the expected utility or producer welfare. The cost in monetary terms can also be measured by asking how much of the sure income the producer would be willing to give up to be in the same position as with the risky income. $\hat{y}$ gives the same utility and is thus referred to as the certainty equivalent income. It can be defined as: $u(\hat{y}) = Eu(y)$

The difference between $u(\hat{y})$ and $\bar{y}$ gives the risk premium or the cost of risk, which is the amount of average income that the producer is ready to give up to exchange random income for sure income. This is $\rho = \bar{y} - \hat{y}$ (de Janvry and Sadoulet, 1995).

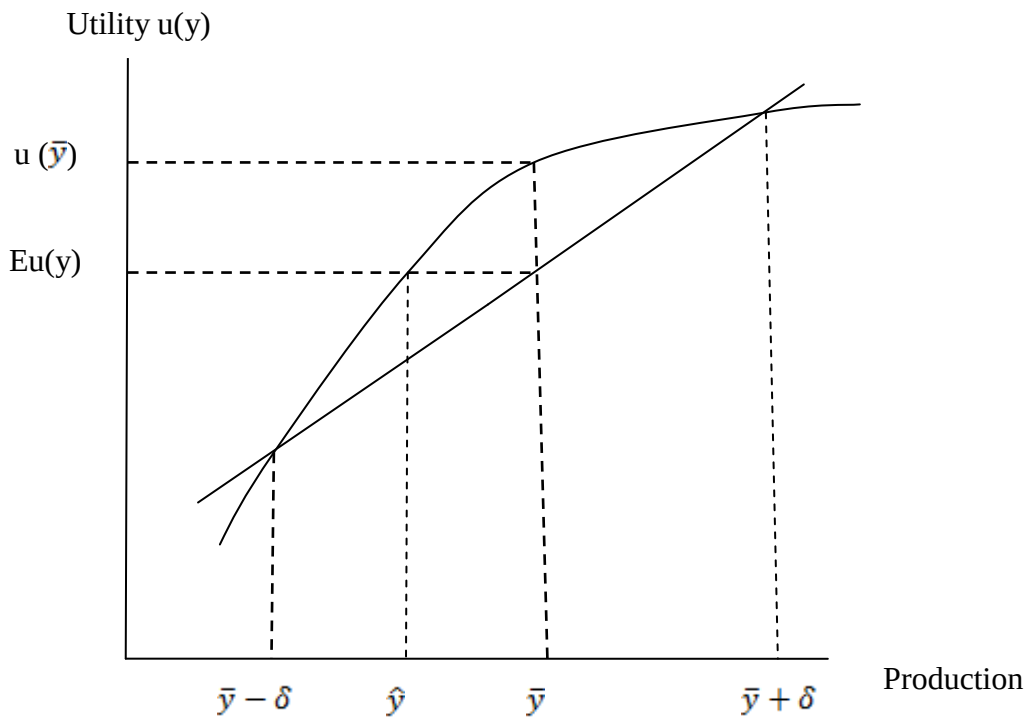

Figure 1: Risk aversion

Source: de Janvry and Sadoulet, (1995).

The magnitude of risk premium depends on the shape of the utility function and probability distribution of income. The more curved the utility function, the larger the risk premium. This curvature represents the level of risk aversion. If $Eu(y) > u(y)$ there is risk preference, if $Eu(y) = u(y)$ there is risk neutrality. When the expectation is calculated using subjective probabilities, it is called Subjective Expected Utility (SEU). SEU of a risky prospect tells all about an individual's risk attitude provided the expectation was calculated based on the individual's subjective probabilities and risk preferences (Hardaker *et al.,* 2004).

2.6.1.1 Measures of Risk aversion

The curvature of an individual's utility function reflects the individual's risk aversion. A utility function is defined only up to a positive linear transformation. A measure of curvature that is constant for that transformation is therefore needed. The simplest of such a measure is the absolute risk aversion function:

$$r_a(y) = -\frac{u''(y)}{u'(y)}$$

Where $u''(y)$ and $u'(y)$ are the second and first derivatives of the utility function respectively. $r_a(y)$ decreases with increases in *y* since people readily take risk as they get richer (Hardaker *et al.,* 2004). The $r_a(y)$ measure is, however, dependent on the currency units of *y*. This problem is overcome by using the relative risk aversion;

$$r_r(y) = -y\frac{u''(y)}{u'(y)}.$$

The absolute risk aversion can be categorized according to how it changes as wealth increases. It can be increasing, constant or decreasing. A constant absolute risk aversion for example means that preferences remain the same if a constant amount is subtracted or added to all payoffs. Utility functions can be elicited or inferred from observed behavior. Approaches based on observed behavior suffer from some weaknesses. Firstly, they assume that the probabilities used in the modeling, based on historical observations of uncertain phenomena are the same ones used in allocating resources or choosing enterprise mixes. Secondly, they suffer from specification errors (Hardaker *et al.*, 2004). This study applied the elicitation method.

2.6.1.2 Utility Function Elicitation

Information is required from decision makers in order to encode their preferences into utility functions. The approaches used to elicit the information are; direct method and the certainty equivalents method. Under the direct method, the decision maker is asked to rate his or her relative preferences for consequences. If the utility value of the best outcome is defined as one and the worst outcome assigned a utility value of zero, this gives the range over which the decision maker can assess personal utility values for a sufficient number of intermediate points to define a utility function. There are two variants of the certainty equivalents approach; the Equally Likely Certainty Equivalent (ELCE) and the Equally Likely Risky Outcomes (ELRO). The most widely used method is the ELCE (Hardaker *et al.,* 2004). The study used the ELCE method.

In the ELCE method, certainty equivalents (CE) are derived for a sequence of risky outcomes and matched with utility values. An ordinal scale is imposed by assigning utility values of 1 to the best outcome and 0 to the worst outcome (Hardarker *et al.*, 2004). A risky prospect with discrete payoffs can be represented as (x_1,x_2,…; p_1,p_2,…), to indicate a set of possible payoffs x_1, x_2,… with corresponding probabilities p_1, p_2,…, summing to 1. Let the sign ~ mean 'is

indifferent between'. Table 1 shows an example of how the method is used. Assume the maximum income in a study area is KSh. 200,000 and the minimum is KSh. 0. The farmer is asked to specify the monetary value of a sure outcome that makes him indifferent between the two risky outcomes of KSh. 200,000 and KSh. 0 with equal probability. Assume the farmer's answer is 100,000. Thus, his CE is KSh. 100,000 for uncertain payouts of KSh. 200,000 and KSh. 0, each with a probability of 0.5. The farmer is again asked to specify the monetary value of the sure outcome that makes him indifferent between having uncertain payouts of KSh. 100,000 and KSh. 0 with equal probability. Assume the response is KSh. 50,000. The iterative process is continued until the farmer's sure income or CE reaches KSh. 1,000. At this point a sufficient number of data points have been obtained. To obtain data for the other half of the income distribution, the farmer is asked to specify the monetary value of the sure outcome that makes him indifferent between having uncertain payouts of KSh. 200,000 and KSh. 150,000 with equal probability. The iterative procedure continues until the CE reaches KSh. 199,000. Corresponding utility is calculated as shown in column 2 of the Table 1.

Table 1: Sequence of Elicitation of CEs for the ELCE Method (income in thousands of Ksh.).

Step	Elicited CE	Utility calculation
	Setting a scale	U(0)=0;U(200)=1
1	(100;1.0)~(0,200;0.5,0.5)	U(100)=0.5U(0)+0.5U(200)=0.5
2	(30;1.0)~(0,100;0.5,0.5)	U(30)=0.5U(0)+0.5U(100)=0.25
3	(5;1.0)~(0,30;0.5,0.5)	U(5)=0.5U(0)+0.5U(30)=0.125
4	(1;1.0)~(0,5;0.5,0.5)	U(1)=0.5U(0)+0.5U(5)=0.06245
5	(130;1.0)~(200,100;0.5,0.5)	U(130)=0.5U(200)+0.5U(100)=0.75
6	(170;1.0)~(200,130;0.5,0.5)	U(170)=0.5U(200)+0.5U(130)=0.875
7	(190;1.0)~(200,170;0.5,0.5)	U(190)=0.5U(200)+0.5U(170)=0.9375
8	(199;1.0)~(200,190;0.5,0.5)	U(199)=0.5U(200)+0.5U(190)=0.9875

Source: Own computation

2.6.2 Safety First Principle (SFP).

Under the SFP, it is assumed that the individual's objective is to minimize the probability of experiencing a shortfall in income below a certain initial level. Here the principle is to minimize the probability of a fall in income (π) below specified levels of disaster (E*) such that: Min P (π < E*) or Min F (E*), where P refers to probability and F is the cumulative distribution function (Sekar and Ramasamy, 2001).

Household income is risky due to the random price, yield and returns from investments. So the household maximizes expected utility of the outcome, which is income.

$\boldsymbol{E(y) = E(\bar{P})\varrho - C(\varrho) + E(\bar{R})I}$, where E(y) is expected income, $E(\bar{P})\varrho$ is expected income from the farm, $C(\varrho)$ is cost of farm production and $E(\bar{R})I$ is the expected return from off-farm investment.

2.6.3 Measurement of Risk

Generally, business risk can be measured by two methods; the standard deviation or the coefficient of variation (Alimi and Ayanwale, 2005). The coefficient of variation does not account for substantial skewness but other methods that include value at risk (VaR), tail value at risk, excess tail value at risk, expected policyholder deficit, and default value do (Powers and Powers, 2009). When enterprises have the same standard deviation but different mean, the standard deviation cannot help decide which enterprise should be chosen. The coefficient of variation becomes a better measure because it normalizes the standard deviation by dividing it by the corresponding mean (Penson and Lin, 1980).

2.6.4 Conceptual Framework

The problem is conceptualized in Figure 2. Biophysical factors, characteristics of transacting partners, international prices, commodity stock levels and institutional environment are factors that are out of control to the farmer. These factors introduce different types of risks to the farming activity; these are yield, price and transaction risks. These risks interact with farm and farm household characteristics to determine the type of risk management strategy. Some farmers opt for off-farm investments. The decision affects the outcome, which is stability of income and consequently the level of household utility.

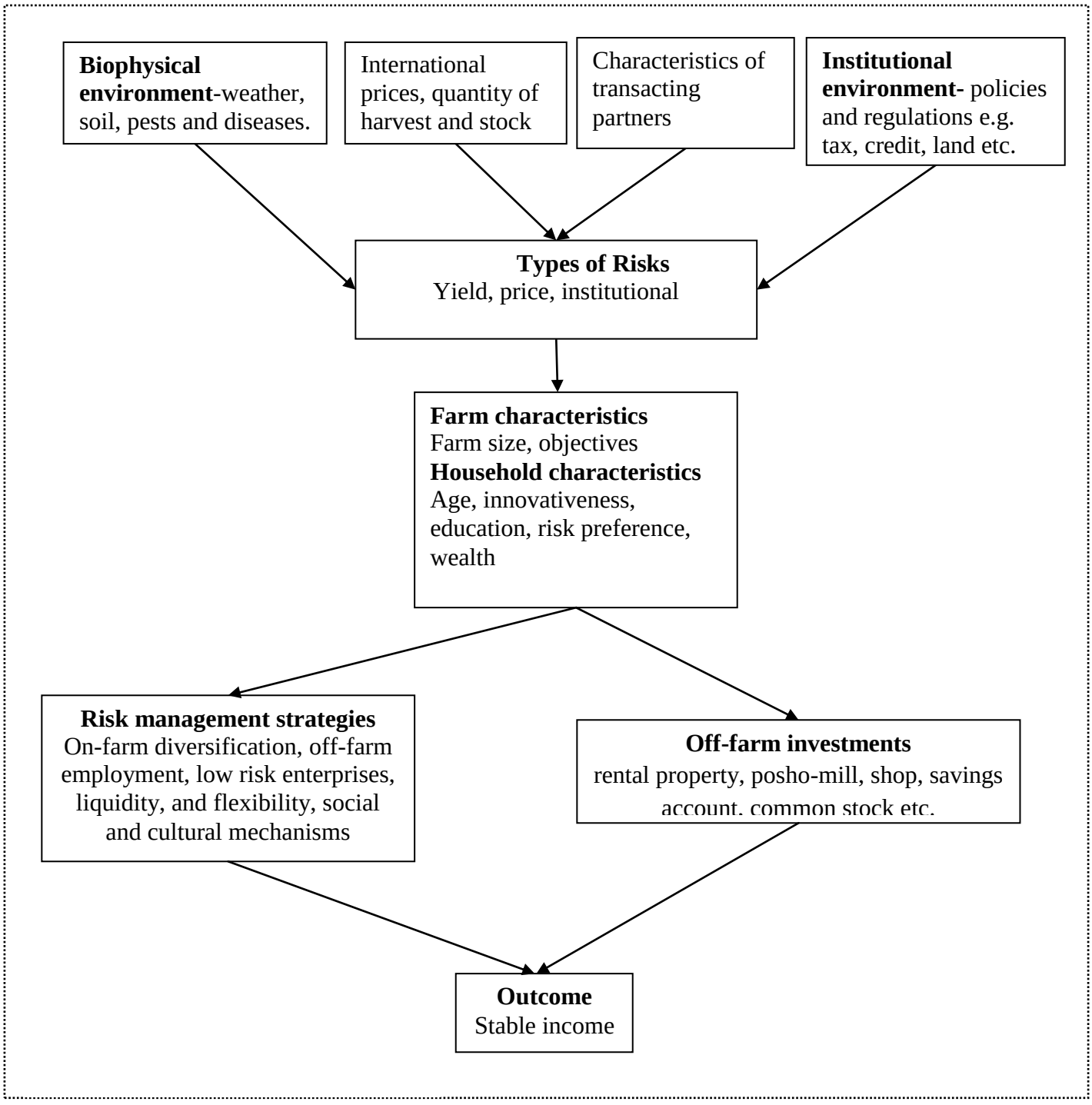

Figure 2: Conceptual Framework
Own conceptualization

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was conducted in the Uasin Gishu District, now Uasin Gishu County, before its sub-division. It is located in the Rift Valley province in Kenya and shares common borders with Trans Nzoia to the North, Keiyo Marakwet county to the East, Koibatek to the South East, Kericho county to the South, Nandi county to the South West and Lugari District to the North West. The county covers a total area of 3,327.8Km^2. It is a highland plateau with an altitude that fall gently from 2,700m above sea level at Timboroa in the East to about 1,500m above sea level at Kipkaren in the West. The county can roughly be divided into two broad physiographic regions, with Eldoret (2,085m) forming the boundary between the regions. The topography is higher in the East and declines towards the western borders. The plateau terrain in the county allows easier construction of infrastructure such as roads and the use of modern farming machinery. The average rainfall ranges between 900mm-1,200mm and occurs between the months of March and September with two distinct peaks in May and August. The wettest areas are found in Ainabkoi, Kapseret and Kesses Divisions. Turbo, Moiben and Soy Divisions receive relatively lower amounts of rainfall. The dry spells begin in November and end in February. Temperatures range between 8.4^{o}C and 26.1^{o}C. An estimated 90 percent of the land area in the county is arable out of which about 2,000 km^2 is classified as high potential and about 1,000 km^2 is medium potential. There are four major soil types in the county for agricultural production. These include red loam, red clay, brown clay and brown loam.

The county is basically agricultural, producing about one-third of the total wheat produced in Kenya (DAO, 1996). Maize, a staple food for most Kenyans, is also produced in the county in large quantities, second to wheat (Lagat *et al.,* 2007).The county is divided into six administrative divisions namely Ainabkoi, Soi, Kapseret, Moiben, Kesses and Turbo. It is further divided into fifty-one locations and ninety-six sub-locations. Moiben is the largest division with an area of 778.2 km^2 with ten locations and twenty-three sub-locations while Kapseret Division, with an area of 297 km^2 is the smallest. The county's population was 622,705 in 1999. At an annual growth rate of 3.35% per annum, the county population growth rate is higher than the national average of 2.9% per annum.

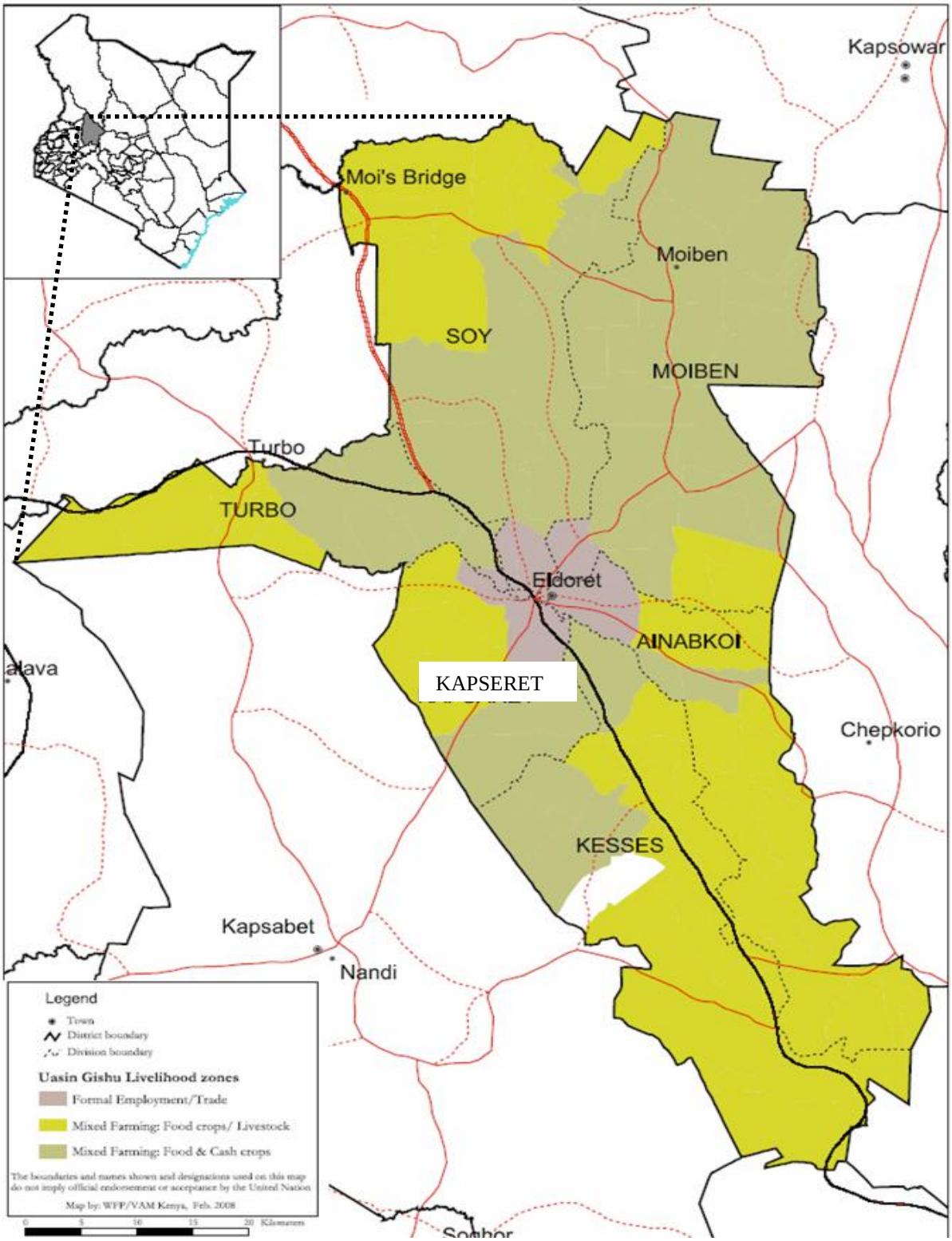

Figure 3: Map of Uasin Gishu County
Source: Baraza *et al.*, (2008).

3.2 Data Types and Sources

The study used primary data collected using structured questionnaire and observation. The data collected included household characteristics, farm characteristics, risks faced by households, risk management strategies employed and off-farm characteristics.

3.3 Sampling Design and Techniques

Multi-stage sampling was employed to select the sample for this study. The first stage was purposive selection of Ainabkoi and Turbo Divisions. This was done in order to capture differences in weather conditions, Turbo being drier than Ainabkoi division. The sampling frame consisted of all the farm households in Ainabkoi and Turbo Division. Both divisions were purposively selected because they have a mixture of both large scale and small scale farms. Ainabkoi division is representative of divisions that receive relatively more rainfall while Turbo is representative of those that are relatively drier.

Ainabkoi division has 10 locations while Turbo has 7. A random sample of 5 locations and 3 locations in Ainabkoi and Turbo divisions respectively were selected, an approximate target of half the number of locations in each division. These are Kaptagat, Kipsinende, Kipkabus, Chepkero and Plateau for Ainabkoi. In Turbo, Sugoi, Kosachei and Tabsagoi were in the sample. Simple random sampling was then used to obtain the households from each of the selected locations. There are 166,635 farming households in the county out of which 20,139 and 19,694 are found in Ainabkoi and Turbo Division respectively (Baraza *et al*., 2008). Sample size was determined by the use of proportionate to size sampling methodology as specified by Kothari (2004) as follows for a finite population;

$$n = \frac{z^2.p.q.N}{e^2(N-1)+z^2.p.q} \quad \text{..} \quad (1)$$

Where:

N = the population size,

n = sample size,

p = the sample proportion (q = 1-p),

Z= the standard variate at a given significance level ($\alpha = 0.05$) and

e= acceptable error (precision).

Using p=0.5 as the proportion of farmers with off-farm investments ('n' will be the most conservative sample and will give the desired precision).

Z=1.96,

p=0.5 and an acceptable error of 10% (e).

q= the weighting variable and is computed as 1-P.

The sample was determined as

n = $(1.96^2*0.5*\ 0.5*166{,}635)/(0.1^2\ *166{,}634)+(1.96^2*0.5^2)\approx 96$.

A sample of 47 households came from Ainabkoi division while 49 were picked from Turbo division. These were obtained as $\frac{20{,}139}{39{,}883} * 96 = 48.5 \approx 49$ for Turbo and 96-49=47 for Ainabkoi division.

3.4 Model Specification and Statistical Analysis

Descriptive statistics was used to characterize the risks that farmers face in the first objective as well as to identify their risk management strategies in the second objective. In order to determine farmers' risk attitude, the ELCE method was used to elicit CE for estimating a utility function. Utility functions for negative exponential functional form was then fitted. Although empirical evidence has shown that attitude towards risk arrived at through empirical analysis is sensitive to the functional form used (Bininci *et al.,* 2003). The negative exponential form was used in this study because it has been extensively used in decision analysis, mainly due to its convenience, for example, it can be estimated from a single certainty equivalent (Hardaker *et al.,* 2004). In addition, although other functional forms that exhibit more flexibility have been developed, experience has shown that the simpler forms serve equally well in most cases.

The expression for negative exponential is

$$U = 1 - \exp(-cy)\,, c > 0 \quad \text{..... (2)}$$

The coefficients obtained from the fitted equation 2 were used to calculate the coefficient of absolute risk-aversion. The coefficient was computed using equation 3.

$$r_a = -\frac{u^{''}(y)}{u'(y)} = c \quad \text{..... (3)}$$

The Arrow-Pratt coefficient is positive if the individual is averse to risk, zero if the individual is indifferent to risk, and negative if the individual prefers risk.

In order to identify the determinants of off-farm investments, a logit model was used to analyze the decision to invest off-farm or not. The logit model is given as,

$$log\frac{p_i}{1-p_i} = Z_i = \alpha + \beta X_i + \varepsilon_i, \quad \text{..... (4)}$$

Where $log\frac{p_i}{1-p_i}$ is the logarithm of the odds that off-farm investment is made, $\mathbf{Z}_i$ is a vector of farm operator characteristics; β is a vector of unknown parameters and ε_i is the residual error term, with mean zero and constant variance. The logit model is suitable when modeling which of two alternatives occurs. It is assumed that each alternative offers the farmer some amount of utility at the time of the choice and that the individual chooses the alternative with the highest utility (Lattin *et al.,* 2003). Mishra (2001) used it to analyze off-farm investment decisions of the USA farm households. The off-farm investment model is specified as;

$$P_t = \frac{1}{1+e^{-Z_t}} = \frac{1}{1+e^{-(\alpha+\beta_1 X_1+\beta_2 X_2+\ldots+\beta_n \beta_n)}} \quad \text{..... (5)}$$

Where $\mathbf{P}_t$ = the probability that the farmer will invest off-farm,

$\mathbf{Z}_t$ = a weighted sum of a vector of farm, operator and household characteristics ($\mathbf{X}_i$) that determine off-farm investments.

The model was used to test whether household resource endowment and socioeconomic characteristics influence the households' decisions to make off-farm investments or not. Household resources in the study included value of physical assets, credit access (financial capital), group membership (social capital), income, size of land (natural capital) and the level of schooling for the household head (human capital). The socioeconomic characteristics used were age, education level, income, size of land holding and gender. The variables included in the model are as shown in Table 2.

Table 2: Variables in the Logit Model

Variable	*Description*	*Unit*.	*priori assumptions*
Offminv	Probability of owning off-farm investments	0=owns no off-farm investments, 1= owns off-farm investments	Dependent variable
Age	Age of household head	Years	+
Humcap	Average number of completed years in school	Years	+
Socap	Social capital	Number of group memberships	+
Loglivscap	Log of per capita value of livestock	Ksh.	+
Landszca	Per capita land size	Acres	+
Logcoefabra	Log of coefficient of absolute risk aversion	Numerical number	+
Logemplicap	Log of per capita employment income	KSh.	+
Logfarmexpe	Log of number of years of farming experience	Years	+
Fincap	Financial capital	0=accessed credit in the last 2 years, 1=did not access credit	+
Gender	Gender of the household head	0=male, 1=female	Intermediate
Logfarmincap	Log of per capita farm income	KSh.	+

Unlike the approach taken by Goodwin and Mishra (2002) and Serra *et al.*, (2004), who used a proxy to represent farmers' degree of risk aversion, this study estimated the farmers' coefficient of absolute risk aversion.

The effectiveness of off-farm investments in risk control was assessed by the use of an OLS regression model proposed and applied by Kurosaki (1995). Households were asked questions on

all income and cost of production of all crop, livestock, off-farm investment and employment over a period of two years. Net income was then computed and aggregated into semiannual periods. In total, there were four time periods. Variability in income is analyzed since it is one of the major factors that affect household welfare under risk. Sources of household income were categorized into three; farm income (Y_F), labor income (Y_E) and off-farm investment income (Y_O). Y_F consists of livestock (Y_L) as well as crop income (Y_C). Y_F is composed of all farm revenues less all costs of keeping livestock and crop production. Total household income (Y_T), therefore, is given by the sum of Y_F, Y_E, and Y_O.

Following Kurosaki (2005), it was assumed that the mean of the observed values reflects the deterministic part and the residual term, which has a mean of zero, represents a transient shock due to income variability. The transient portion consists of two parts; an idiosyncratic risk and a covariant risk. Assuming an additive structure across the components, the model was specified as,

$$Y_{aht} = f_a(Z_{ht}) + u_{at} + \varepsilon_{aht}, \quad \text{..... (6)}$$

where

Y_{aht} = per capita income from activity *a* for household *h* in time *t;*

$f_a(\dots)$ = a function of a vector of household characteristics Z_{ht} and corresponds to the deterministic portion of income;

u_{at} = a covariant shock with mean zero;

ε_{aht} = an idiosyncratic shock with a mean of zero.

The portions of the transient part are independently distributed such that $E(u_{at}\varepsilon_{aht}) = 0$. $f_a(\dots)$ is a reduced-form equation of household production decisions. The function $f_a(\dots)$ is approximated linearly with the following variables: crop production assets (per capita acreage of owned and operated farm land), years of education of household head (as a proxy for human asset position), per capita adult equivalent of livestock (livestock assets) and household size. The actual variables used are presented in Table 3. The formulation gives,

$$E(Y_a) = f_a(Z) \quad \text{..... (7)}$$

Transient variation of income is expressed as,

$$e_a = u_a + \varepsilon_a \text{ ……………………………………………………………………….. (8)}$$

The data set covered a short time span and so market prices were not included but dummies were included as estimates for u_{at}. The actual OLS regression model estimated was:

$$Y_{aht} = \beta_0 + \sum_k \beta_{ak} Z_{hkt} + u_{a1}(D_1 - D_3) + u_{a2}(D_2 - D_3) + \varepsilon_{aht}, \text{ ……………… (9)}$$

Where β's, u_{a1} and u_{a2} are coefficients to be estimated.

With total household income Y_{ht} and removing t and h for simplicity, the coefficient of variation (CV_Y) is given by,

$$CV_Y = \sqrt{Var\left(\sum_a Y_a\right)} = \frac{1}{\bar{Y}}\sqrt{\sum_a Var(Y_a) + \sum_a \sum_{r \neq a} Cov(Y_a, Y_r)}$$

$$= \sqrt{\sum_a h_a^2 . CV_{Y_a}^2 + \sum_a \sum_{r \neq a} h_a . h_r . CV_{Y_a} . CV_{Y_r} . \rho\, Y_a, Y_r}, \text{ …………………………… (10)}$$

Where

h_a = activity composition weight defined as $E(Y_a)/E(Y)$, and

$\rho Y_a, Y_r$ = a correlation coefficient

CV_Y was calculated for each household observation.

In order to assess the effectiveness of off-farm investments in risk management, a simulation of the effect of a change in off-farm investment weight (h_O) on CV_Y in equation (10) was performed. CV_Y was approximated by the standard deviation of e_s generated from equation (8) divided by the value of $E(Y_a)$ from equation (7). Following Kurosaki, (2005) in the simulation, it was assumed that household income remained the same and that the sum of h_a was one, such that

E(Y) and $\rho Y_a, Y_r$ remained constant. If a drop in off-farm investment income increases the coefficient of variation, then off-farm investments stabilizes household incomes and vice versa.

Table 3: Variables in the OLS Regression Model

Variable	*Description*	*Unit*	*Priori assumption*
Dependent variables: Y_A	Crop, livestock, off-farm and employment income	Ksh	
Independent variables			
Hhldsize	Household size	Number	+
Humcapit	Human capital: Education level	Years	+
Livascap	Value of livestock assets per capita	Ksh	+
Builcapi	Value of buildings per capita	Ksh	+
Lanopcap	Land area operated per capita	Acres	+
Lanownca	Land area owned per capita	Acres	+
Valinvca	Value of off-farm investments per capita	Ksh	+
One, two, three	Dummy variables for periods 1, 2 and 3	Number	Intermediate

Data was analyzed by use of both descriptive and quantitative methods, by use of Excel spreadsheet, SPSS and STATA software.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 The Most Common Types of risks that Face Agricultural Households

In order to identify the most common types of risks that agricultural households faced, descriptive statistics were used and the results are presented in Table 4.

Table 4: Risks faced by farmers

	Frequency	Percent	Cumulative Percent
Weather (drought)	59	59.0	59.0
Price/market	34	34.0	93.0
Institutional	3	3.0	96.0
Pest attack	4	4.0	100.0
Total	100	100.0	

Source: Field Survey Data, 2009

Farmers reported production/yield risk as the most serious. This type of risk is compound composing of weather and pest attacks. It is becoming apparent that with the current global climate changes, drought risk is creating a great concern for many farmers and 59% reported this as a major risk. This is consistent with AERC (2009) which noted drought as a single largest risk. Similar findings were reported by Salimonu and Falusi (2009).

In situations where produce prices are liberalized as it is in Kenya, seasonal and regional fluctuations are expected. Therefore, market/price risk was the second major risk faced by farmers comprising 34%. Institutional risk was not major (3%) and this was mainly the unreliable weighing scales of buyers of farm products and sometimes non-payment for produce delivered to buyers. Pest attack was not a major problem being reported by only 4% of the farmers. With elaborate outreach programs by agrochemical dealers, any reported pest attacks may have been due to negligence or financial constraints by those concerned. These findings are comparable with those of Salimonu and Falusi (2009) who identified that between the year 2002 to 2003, 54.5%, 46.1% and 33.9% of sample households in Nigeria were affected by market failure, price fluctuation and pest and diseases respectively.

4.2 On-farm and Off-farm Risk Management Strategies Used by Agricultural Households

The study sought to establish the nature of on-farm and off-farm strategies used to manage risk among agricultural households. Both formal and informal strategies were assessed.

4.2.1: Formal Insurance Contracts

The responses to formal insurance contracts are shown in Table 5.

Table 5: Farmers who had formal insurance contracts

Response	Frequency	Percent
Yes	0	0
No	100	100.0

Source: Field Survey Data, 2009

In some parts of Kenya, private insurance companies have recently introduced crop and livestock insurance products. A good example is UAP Kenya whose crop insurance product targets commercial field crops including wheat, maize, barley, rice, tea crop, coffee, sugar cane, tobacco and all horticultural crops. Farmers are insured against crop losses caused by hail storm, fire, drought, excessive rainfall, frost damage, flooding and lightening (http://www.uapkenya.com). This is a fairly new product and it was not yet in the market in Uasin Gishu county when the study was carried out. That is why results in Table 5 show that none of the farmers had taken any formal insurance. However, other studies have registered low formal insurance cover in agriculture as reported by (Skees and Barnett, 2006), who attributed this to poor contract enforcement, asymmetric information, high transaction costs, and high exposure to spatially covariate risks. Formal insurance providers do not seem to have taken advantage of the risk averse attitude of the farmers and there being no formal insurance products means that farmers only rely on self insurance strategies.

4.2.2 Informal Risk Management Strategies

Informal risk management strategies involve the use of farmers' self insurance strategies. The most prevalent form of on-farm strategy was enterprise diversification. Table 6 shows that the number of farm enterprises ranged from a low of two to a maximum of 9. The mean number of enterprises was 4.62. Given the high risk environment in which rural farm households operate,

the households try to cushion their consumption by allocating their resources to different enterprises covering a number of crop and livestock enterprises. Luckert *et al.,* (2000) cited evidence from Zimbabwe on the role of on-farm diversification in risk management. Farm enterprise diversification works by selecting enterprises with low or negative returns and by buffering household consumption where crops and livestock products are realized at different times.

Table 6: Number of Farm Enterprises

	N	Minimum	Maximum	Mean	Std. Deviation
Number of farm enterprises	99	1	9	4.62	1.570

Source: Field Survey Data, 2009

One form of off-farm self insurance strategy for risk management was engagement in wage or salary earning activity. It was found to be common in the study area. Some household members worked as employees in the rural areas or away in urban areas with occasional visits to the household. Results in Table 7 indicate that more than half (51%) of the households had at least one member engaged in salary or wage income earning activity. Risks facing rural farm households have increased due to climate change that has led to more rampant drought risks. This combined with market risk and population growth has made agriculture appear less profitable and risky compared to wage and salary employment. In addition, rain-fed agriculture which is prevalent in the study area is seasonal in nature and households are left with surplus labor during the slack period. Households, therefore, find an incentive to send off some of their members for alternative sources of income. Beyene (2008) in a study in Ethiopia reported a lower prevalence rate, that 25.3% of sampled households had wage and salary employment. Oseni and Winters (2009) report this to be 7% in Nigeria which is still lower than the finding in this study.

Table 7: Household Members' Engagement in Wage or Salary Earning Activity

Response	Frequency	Percent	Cumulative Percent
No	49	49.0	49.0
Yes	51	51.0	100.0
Total	100	100.0	

Source: Field Survey Data, 2009

Another form of risk management strategy was off-farm investment. It is reported in Table 8 that 67% of households engaged in a diverse number of off-farm investments. Beyene (2008) found a higher percentage (79%) of sample households in Ethiopia participating in off-farm activities while Babatunde and Qaim (2009) found a lower percentage (50%). Oseni and Winters (2009) found that 17% of sampled households in Nigeria had participation in off-farm activities. The off-farm investments found in this study were mainly self employment business enterprises. Off-farm investments reduce risk because of the imperfect correlation between off-farm income and farm income.

Table 8: Household Engagement in Off-Farm Investments

Response	Frequency	Percent	Cumulative Percent
No	33	33.0	33.0
Yes	67	67.0	100.0
Total	100	100.0	

Source: Field Survey Data, 2009

The types of off-farm investments (Table 9) were composed of agricultural trading (18.6%) as the most prevalent, kiosks (13.7%), rental property (9.8%), posho mill and hair dressing/barber shops (each 5.9%), transport (4.9%), bicycle/motor cycle, livestock trading and sale of cooked food (each 3.9%), butchery, carpentry and dealers in herbal medicines (each 2%) and health clinic and lumbering (each 1%).

Table 9: Investment Types

Investment type	Frequency	Percent	Cumulative Percent
Posho mill	6	5.9	5.9
Kiosk	14	13.7	19.6
Transport	5	4.9	24.5
Rental property	10	9.8	34.3
Agricultural trading	19	18.6	52.9
Bicycle/motor cycle repair/transport	4	3.9	56.9
Butchery	2	2.0	58.8
Carpentry	2	2.0	60.8
Livestock trading	4	3.9	64.7
Hair dressing/barber	6	5.9	70.6
Health clinic	1	1.0	71.6
Traditional doctor	2	2.0	73.5
Lumbering	1	1.0	74.5
Others	22	21.6	96.1
Sale of coked food	4	3.9	100.0
Total	102	100.0	

Source: Field Survey Data, 2009

Households also participated in group membership as a risk management strategy. The groups that they participated in include rotating savings and credit associations. In these associations, members contribute a sum of money to individual members at periodic intervals after voting, eliminating those who have received the contribution until all members are covered. Slightly more than half (51%) (Table 10) of the households had membership in social groups. They had membership in between 3 to 4 groups. Levensen and Besley (1995) estimated that 80% of Taiwanese adults were members of these associations; this is higher than the finding in this study. Group membership works as a risk management strategy through the savings and borrowing the members make. Problems of information asymmetry and transaction costs are reduced because these associations use local information and enforcement mechanisms.

Calomiris and Rajaraman (1993) quoted in Besley (1995) report that these associations perform risk sharing functions when individual members suffer shocks to their income or health.

Table 10: Social Capital (Number of Household Group Memberships)

Number of group membership	Frequency	Percent
0	49	49.0
1	32	32.0
2	15	15.0
3	4	4.0
Total	100	100.0

Source: Field Survey Data, 2009

Risks associated with food shortage were similarly addressed using informal strategies and the most prevalent ones are shown in Table 11.

Table 11: How Households Cope with Food Shortage

Strategy	Frequency	Percent	Cumulative Percent
Sale of liquid assets	25	25.0	25.0
Redeploying labor	24	24.0	49.0
Self-sufficient	51	51.0	100.0
Total	100	100.0	

Source: Field survey data, 2009

It is becoming evident that with increase in population and rampant crop failures, food shortage is now common even among food crop producers that were expected to be self sufficient in food production. Maize shortage was taken as a proxy for food shortage. At the time of carrying out this study, 49% of all the households were dealing with food shortage. The most prevalent coping strategies were sale of liquid assets and redeploying labour. Off-farm employment involved selling labor by working for others for pay and was reported by 24% of households. An equal number of the households (25%) reported to cope with the food shortage by sale of liquid assets like eggs, chicken, sheep and vegetables. In Nigeria, Salimonu and Falusi (2009) reported

a higher value, that 69.7% coped by working off-farm and only 24.2% by disposing off their assets. In the study area, none of the farm households had reached the desperate situation of disposing off their fixed assets.

4.3 Risk Attitudes of Farm Households and its Effect on Off-farm Investment Decisions

In order to determine risk attitudes of farmers, the ELCE method of eliciting a utility function was used. A random sample of 100 farmers was interviewed in this study and after data cleaning 93 responses were suitable for this analysis. The negative exponential functional form of a utility function was then estimated by the method of nonlinear least squares. The parameter derived was the absolute risk aversion coefficient.

Table 12: **Summary of Negative Exponential Functions Estimated**

Parameter	Minimum	Maximum	Mean
C	.0000006182	.0001279930	.000009087303
R^2	.0132	.9993	.572552

Source: Field survey data, 2009

Table 12 shows that R^2 values for the fitted utility functions ranged from a low of 0.132 to a high of 0.999. These are consistent with findings of Torkamani and Rahimi (2001), but Hardaker *et al.,* (2004) cautions that goodness of fit measures such as R^2 does not have their usual meanings. This is because the purpose of fitting these curves is not to fit a curve to a scatter of points representing random deviations from underlying unknown relationship but to find the equation of a curve that is already partly defined by the elicited utility points.

The coefficient of absolute risk aversion as shown in Table 12 ranged from a minimum of 0.0000006182 to a maximum of .0001279930. This is almost similar to the findings of Torkamani and Rahimi (2001) who reported a range of between 0.0001203 and 0.001893 using the exponential utility function. Binici *et al.,* (2003) reported a higher range of between 0.0375 and 0.4920 with negative exponential utility function. There has been little consistency as to the magnitude of the coefficient of risk aversion. According to Musser *et al.,* (1984), Zuhair *et al.,*

(1992) and Raskin and Cochran (1986), the coefficient differs depending on many factors which include the study area, utility function and the procedure used to derive the risk coefficient.

Appendix II reports the absolute risk aversion coefficients for 93 farmers. The absolute risk aversion coefficient is positive if the individual is averse to risk, zero if the individual is indifferent to risk, and negative if the individual prefers risk. The results indicate that all the estimated absolute risk aversion coefficients were positive. This means all the farmers were risk averse. This finding is consistent with that of Bininici *et al.,* (2003) who found all farmers to be risk averse using the negative exponential utility function. Studies by Torkamani and Rahimi (2001) and by Binici *et al.,* (2003) that utilized different functional forms classified majority of farmers as risk averse.

4.4 Determinants of Off-farm Investment Decision

In order to identify the determinants of off-farm investments, the logit model was used. Table 13 below shows the logit results for the relationship between ownership of off-farm investments and the explanatory factors. The goodness of fit is measured by the level of correct prediction rate and chi-square test. There was a moderate correct prediction of 77.4% for the ownership of off-farm investments. The model Chi-square value of the 29.095 was significant at the 1% level (p-value = 0.002).

Table 13: Determinants of off-farm investments

Offminve	Coef.	Std. Err.	Marginal effect	Std. Err.
Age	.0068622	.0321392	.0012716	.00596
Humcap	-.108611	.086272	-.0201258	.01577
Socap	.1895214	.3326771	.0351186	.06165
loglivscap	-.0698425	.5407933	-.0129419	.09987
Landszca	.2421584	.309432	.0448724	.05651
logcoefabra	-.8122696	.5926555	-.150515	.10922
logemplicap	-.8305341***	.25751	-.1538994***	.0412
logfarmexpe	-2.208014**	.9027599	-.4091489**	.16526
Fincap*	-.7459981	.6925344	-.1236476	.09988
Gender*	1.260155**	.6243682	.2279285**	.10644
logfarmincap	2.578638***	.9426553	.4778261***	.15753
Constant	-9.690833	5.508024		

N=93, percentage predicted correctly=77.4, chi-square=29.095***, -2 Log likelihood=89.297***

*** indicates significance at 1% and ** at 5%

(*****) marginal effect is for discrete change of dummy variable from 0 to 1

Source: Survey Data, 2009

The logit results for determinants of off-farm investments show that coefficients representing employment income, farming experience, gender and farm income were significant.

Employment income was significant and had a negative effect on off-farm investments. The marginal effect value for employment income was statistically significant at the 1% level. This may suggest that households that had employment income had more stable incomes and so found no necessity to diversify into off-farm investments. This suggests that the role of wage and salary income in financing non-farm activities in the study area is not significant. A possible explanation for this finding is that people who were employed in salary or wage earning activity devoted their time to this activity, hence less likely to engage in off-farm investment activities. Mishra (2001) found a positive effect of off-farm income on off-farm investment. The reason for the difference lies in the nature of off-farm investments. This study involved off-farm

investments that require direct day to day running of the business while his study focused on investments in financial assets; which earn dividends and interest and do not need direct management by the investor.

Years of experience in farming had a significant and negative effect on the probability of owning off-farm investments. This could be explained by the fact that older farmers are not very active economically to seek off-farm investment opportunities. They therefore prefer to depend on farming only. The marginal effect value for years of experience in farming was statistically significant at 5% significance level.

The coefficient on farm income per capita was significant and positive. The marginal effect value for total income per capita was statistically significant at the 1% level. This suggests that farm income is important through provision of capital for making the necessary investments. This is critical in the study area where credit use and liquidity is low. The failure in credit markets means that households have to look for alternative financing sources. Limited financial resources at the disposal of households act as barriers to entry into off-farm investments. The fact that farm income determines participation in off-farm investments implies that entry into lucrative off-farm investment opportunities could be more difficult for the poor households with little income. This could fuel inequality where the poor are exposed to high risks.

The coefficient on gender turned out positive and significant. This means that the probability of having off-farm investments increases when a household head is female. This could be due to unequal access to and control of land resources by male and females in the study area, leaving the females to seek off-farm income. In addition, the most prevalent activity was found to be agricultural trading and kiosks which were mostly operated by female members. This finding concurs with findings of van de Berg and Kumbi (2006) who found females dominating food and drinks business activities in rural Oromia, Ethiopia. The finding that being a female headed household increases the probability for off-farm investments corresponds with findings by Oseni and Winters (2009). The marginal effect value for gender was however, not statistically significant.

4.5 The Effectiveness of Off-farm Investments in Risk Management

4.5.1 Calculation of Coefficients of Variation

In order to assess the effectiveness of off-farm investments in risk management in objective five in a descriptive way, households were categorized into three groups: first, those who had farm income only, secondly, those who had farm income and employment income and finally those who had farm and off-farm investment income only.

Coefficients of variation for these categories of farmers were then calculated and are reported in Table 14. The findings show that households that had farm income only (composed of crop and livestock) suffered more income variability, represented by a higher coefficient of variation. The coefficient of variation for households that had off-farm income was lowest at 0.279591. This suggests that off-farm investments reduce household income variability.

Table 14: Coefficient of Variation of Household Income

Enterprises	**Crop and livestock**	**Crop, livestock and employment**	**Crop, livestock and off farm**
Mean	1.523124	1.468708	0.279591
Standard deviation	3.080924	0.341358	6.119309

Source: Field Survey, 2009.

4.5.2 Estimates of correlation coefficients

A further analysis was done by estimating correlation coefficients among the different components of household income streams based on the results of OLS regression results reported in Appendix III.

Table 15: Inter-household Deterministic Variation of Income

	Min.	Max.	Mean	Std. Deviation
$E(Y_C)$: Crop income (1)	-21,4560.00	816,500.00	12,450.54	72,926.50
$E(Y_L)$: livestock income (2)	-27,200.00	147,591.00	7,122.36	18,126.09
$E(Y_F)$: Farm income (3)=(1)+(2)	-149,310.00	964,091.00	19,572.90	80,312.63
$E(Y_O)$: Off-farm investment income (4)	-100.00	625,000.00	25,804.82	53,586.99
$E(Y_E)$: Employment income (5)	.00	55,8000.00	36,860.50	81,419.00
$E(Y_T)$: Total household income (6)=(3)+(4)+(5)	-110,830.00	1,099,991.00	82,238.21	131,609.60

Source: Field Survey, 2009.

A summary of the deterministic portion of household income are shown in Table 15 while detailed regression output is presented in Appendix III. In general, the coefficients of the regression had the expected signs. Land area operated per capita and value of livestock assets per capita were significantly positive in determining crop income. This is consistent with Mifimisebi (2008) finding. Human capital was significantly positive in determining off-farm investment income. Human capital and livestock assets per capita were significantly positive in determining employment income. This is consistent with the findings of Kurosaki (1995). The table shows that the incomes were widely varied; this is indicated by the large standard deviations, in addition, some made losses as demonstrated by the negative incomes.

Table 16: Correlation between deterministic incomes

	$E(Y_C)$	$E(Y_L)$	$E(Y_O)$	$E(Y_E)$
Crop income (1)	1	-0.147	-0.071	0.142
Livestock income (2)		1	0.084	-0.090
Farm income (1)+(2)			-0.047	0.117
Off-farm investment income (3)			1	0.312**
Employment income (4)				1

** Correlation is significant at the 0.01 level (2-tailed).

Source: Field Survey, 2009.

The correlation results among the deterministic portion of household income are presented in Table 16. There is a negative correlation between off-farm investment income and farm income of -0.047. This finding is consistent with that of Kurosaki (2005). Although this is not significant, it suggests that off-farm income contributes to the smoothing of household income through the negative correlation with farm income. Livestock income has a -0.147 correlation with crop income and also plays a role in household income stability. The correlation between employment income and off-farm investment income is significantly positive suggesting that employment income supplements off-farm investments.

Table 17: Descriptive Analysis of Transient Portion of Income

	Minimum	**Maximum**	**Mean**	**Std. Deviation**
e_C :Crop income	-29,438.66	23,286.34	0.00	7,186.37
e_L :Livestock income	-7,415.39	4,711.94	0.00	2,075.71
e_F: Farm income	-28,938.05	18,936.95	0.00	7,191.80
e_O: Off-farm investment income	-34,872.37	7,127.63	0.00	7,864.27
e_E: Employment income	-40,307.29	10,692.71	0.00	10,675.45

Source: Field Survey, 2009

Table 17 presents a summary of descriptive analysis of transient income. A correlation among the transient portions of the various income streams was also done and is presented in Table 18.

Table 18: Correlation between Transient Incomes

	$\boldsymbol{e_C}$	$\boldsymbol{e_L}$	$\boldsymbol{e_F}$	$\boldsymbol{e_O}$	$\boldsymbol{e_E}$
e_C :Crop income	1	-0.142	0.958(**)	-0.084	0.144
e_L :Livestock income		1	0.147	0.110	-0.071
e_F: Farm income			1	-0.052	0.124
e_E: Employment income				1	0.226
e_O: Off-farm investment income					1

** Correlation is significant at the 0.01 level (2-tailed).

Source: Field Survey, 2009

Table 18 shows that there is a negative correlation between the residuals of $e_{L\ and}\ e_C$ of -0.142 and of -0.084 between residuals of e_O and e_C. This indicates a smoothing effect of crop income by both livestock and off-farm investments. Although not significant, the correlation between e_O and e_C is more negative than that between e_L and e_C. The correlation between e_O and e_F is also negative, showing that off-farm investments smoothes farm income more than does livestock income.

4.5.3 Simulation of the Effect of Changes in Off-farm Investment Weight on Risk

In order to determine the effectiveness of off-farm investment in risk management analytically, the effect of a change in off-farm investment weight h_o in equation (9) on CV_Y was simulated. CV_{Ys} was approximated by the standard deviation of *es* from Table 18 divided by the value of $E(Ys)$ from Table 16 and assumed constant, and h_o and h_F were changed while their sum was restricted to one. Following Kurosaki (2005), it was assumed that mean household income remained the same and that households did not adjust crop choices such that $E(Y)$ and $\rho Ys,Yr$ remained constant. The assumptions mean that the simulation shows a very short run effect of CV_Y of changes in off-farm investment weight.

Figure 4.1 plots the outcome of the effect of a change in off-farm weight, (h_O) as evaluated at sample mean of farmers who had farm, off-farm and employment income. The vertical axis shows an index of CV_Y with a starting value equal to 100. The curve represents a scenario in which the change in the off-farm weight replaces farm weight (h_F). The simulation was done by use of Excel spreadsheet and graphed by use of SPSS software. The results are reported in table 20. The values in Table 19 were used to graph Figure 4.

Table 19: Simulation Results for Changes in Off-farm Investment and Farm Income Weights

CV	96	96	97	100	104	109	114
Change in h_o	30	20	30	0	-10	-20	-30

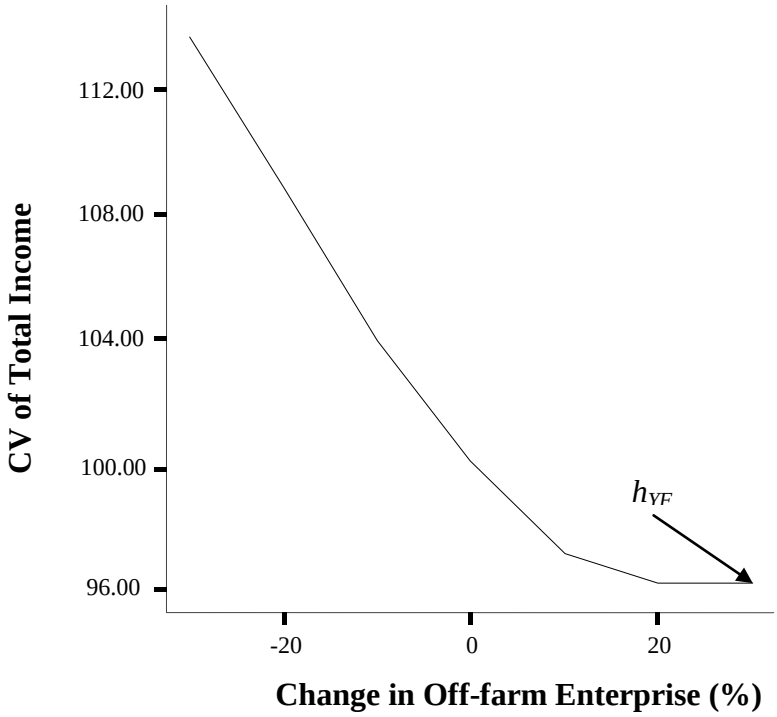

Figure 4: Effects of Changes in Off-farm Investment Weight

Source: Field Survey, 2009.

The curve is downward sloping, indicating that a marginal increase in off-farm investment income stabilizes income, while a decrease in off-farm investment income weight increases variability of total income as measured by the coefficient of variation. For example, a shift in the share of off-farm income in total household income to the farm sector of 6.3 points increases the coefficient of variation of household income by 9 per cent. This is obtained by subtracting the default coefficient of variation from the coefficient of variation when off-farm investment weight decreases by 20 per cent. This can be computed from the vertical axis in Figure 4 or obtained from Table 20 (109-100 in Table 20). The explanation for this is as follows: the starting value of h_O is 0.314. The weight becomes 0.251 after a 20 per cent decrease in off-farm weight. This is equivalent to a shift of 6.3 points (= 31.4 per cent − 25.1 per cent) of expected income from the off-farm sector to the farm sector. The slope of the curve is horizontal beyond the 20 per cent mark, this suggests that a further increase in h_o beyond 20 percent does not reduce farm income variability. Off-farm investments therefore help households to reduce their exposure to risk, thus improving their welfare through an improvement in agricultural productivity. This finding is consistent with Evans and Ngau (1991) and Oseni and Winters (2009).

CHAPTER FIVE

CONCLUSION AND RECCOMENDATION

5.1 Conclusion

This study focused on identifying the most prevalent risks facing agricultural households, their risk attitudes, the risk management strategies they employ and the role of off-farm investments in farm household risk management. Most agricultural households (59%) reported drought risk as the most serious. This could be as a result of the climate change that is expected to increase incidences of drought. No household that had taken any formal insurance contract but households utilized self insurance techniques including both on-farm diversification and off-farm diversification. A majority of the households derive their income from a combination of farm and non-farm activities. Farm households utilized on-farm diversification by operating several farm enterprises covering both livestock and crop enterprises. On-farm diversification was common with a mean number of enterprises standing at 4.62. Off-farm diversification included the use of group participation, wage and salary employment and off-farm investment. A majority of the households (67%) had off-farm investments. Using the ELCE method of eliciting utility functions and utilizing the exponential function, all the farmers in the study were found to be risk averse. The findings suggest that there is room for insurance products that are tailored to meet farmers needs while addressing potential problems of transaction costs and moral hazard.

Four variables were significant in household decisions concerning off-farm investments. Households which had employment income in the form of wages and salaries were less likely to have off-farm investments. Being a female headed household also increased the likelihood of off-farm investment. Farmers with a high experience in farming were less likely to invest in off-farm investments. Farm income per capita was also found to positively affect off-farm investment decisions, implying that household with income are likely to be excluded from enjoying the benefits associated with off-farm investments, thus raising the level of inequality.

In order to determine the effectiveness of off-farm investment in risk management, household income was categorized into three: farm, off-farm investment and employment income. Per capita income was decomposed into the deterministic part, representing the mean of observed values and the residual portion which represented transient shock. An analysis of the correlation

coefficients between the deterministic portions of these incomes showed that off-farm investments were negatively correlated with farm income with a coefficient of -0.047. This implied that it contributed to smoothing household income. Livestock income was negatively correlated with crop income and thus plays a role in reducing farm income variability. The correlation between employment income and off-farm investments was 0.312; this means that employment income complements off-farm investments. A consistent conclusion was arrived at by analyzing correlation between the transient portions of the income. A simulation of the effect of an increase in the weight of off-farm investments weight from the farm enterprise showed that household risk measured by the coefficient of variation of total income reduced. Off-farm investments therefore represent an effective risk management strategy.

5.2 Policy Recommendations

The farmers were found to be risk averse implying that they were not fully insured by their self insurance strategies. In order to improve their welfare, policies that enhance access to insuring farm activities should be put in place.

The study demonstrated the risk reduction benefits of off-farm investments. In order to improve farmers' welfare, diversification into off-farm investments should be encouraged since it reduces risks by increasing resilience and offsetting the seasonal nature of agricultural income. As long as there are weak credit and insurance markets, diversification should be encouraged because households are willing to trade-off income that would arise from specialization as a form of self-insurance. Off-farm investments are encouraged by certain factors like access good income to allow for savings.

A vibrant agricultural sector can encourage the development of an equally successful non-farm sector. The livestock sector should also be promoted as it contributes to income stability. Access to credit should be enhanced and supported in order to finance rural investments that includes both farm and off-farm investments. There is need to improve rural infrastructure such as roads, electricity and telephone coverage. Policies that support the development of rural non-farm enterprises should be directed at farmers in their earlier years of their careers since this category are more interested off-farm investments than the experienced farmers. The development of rural

trading centers should be encouraged and supported since it creates rural-urban linkages which are important in presenting opportunities for off-farm investments and markets for farm produce. This study has shown that farm households that have low income are excluded from participation in off-farm investments by lack of investment capital. Policies that encourage commercialization of smallholder farms are needed in order to encourage the poor households to access surpluses for sale in order to get resources to finance off-farm investments. In this way, the households can be able to manage their risks.

5.3 Further Research

This study dwelled on the role of off-farm investments in risk management. Although a reduced risk situation increases household welfare, this study did not look at whether off-farm investments significantly contributed to poverty reduction. In addition, the scale of off-farm operation and the constraints to their success was not covered. It would be beneficial to identify the circumstances under which rural non-farm rural enterprises can emerge into commercially viable ventures that can contribute to commercialization of small scale agriculture.

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APPENDICES

Appendix 1: Questionnaire

EGERTON UNIVERSITY

This study is conducted under Egerton University. We are studying the risks that farmers face in their agricultural activities and the role of off-farm investments. Your help in answering these questions is highly appreciated. Your responses will be confidential. They will be pooled together with responses of many other households and analyzed.

QUESTIONNAIRE IDENTIFICATION

Date (day/month/year) ____/___/2009

Enumerator name: _____

Location: _____

Sub-location: _____

Village: _____

SECTION A: BACKGROUND INFORMATION/ FARM ACTIVITIES AND FACILITIES

A1. (a) Farmer's name: _____

(b) Respondents' name: _____

(c) Farmer's marital status (A) married (B) single (C) divorced (D) widowed (E) other (specify)

A2. How much of your land ***(****owned, rented or free access land)* is under

(i) Cultivation _____acres (ii) Pasture _____acres

(iii) Homestead _____acres (iv) Others (specify_____ _____ Acres

A3. Did you have any extension contact? (tick) Yes ☐ No ☐

A4. Did the household use inorganic/chemical fertilizers?_____If not, why? _____

A5. Did the household use hybrid seed? _____ If not, why? _____

A6. (a) Where did you sell your maize? _____ Distance from the farm _____

(b) What problems did you face?

(i)

(ii)

A7. (i) Did the household run out of maize for consumption? ……

(ii) How does the household feed itself in such a case? List in order of priority

(A) Sale of liquid assets such as chicken, sheep, cows, depleting cash savings etc.

(B) Redeploying labor (C) Sale of farm equipment like wheelbarrows, jembes etc (D) Sale of productive assets like land.

A8. What are your farming objectives? ……

(A) Food supply (B) income/profit (C) other (Specify)

A9. Tell us whether you performed the following activities on your maize field in time.

Activity	**Was the activity done in time?**	**If no, why not?**	**Input**	**Did you buy enough?**	**If no, why?**
Ploughing			Seed		
Harrowing			Fertilizer		
Planting			Top dressing fertilizer		
Top dressing					
Weeding					

Ploughing Reasons examples

1. Money not available
2. Bad weather
3. Domestic problem
4. Other, specify

Amount Reasons

1. Money not available
2. Anticipated high prices
3. Anticipated lower prices
4. Bad weather
5. Other, specify

SECTION B: ELICITATION OF CERTAINTY EQUIVALENTS

B1. How much money will make you indifferent between the two risky outcomes of KSh. 200,000 and KSh. 0 with equal probability?

(Fill in the farmers' response in the table below and then ask the subsequent question based on the farmers' response. Proceed until all iterations are completed).

Step	Elicited certainty equivalent	Utility calculation
	Setting a scale	U(0)=0; U(200,000)=1
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		

SECTION C: FARM/FARMER CHARACTERISTICS

C1. How many acres in **total land holdings** do the household own? **TACRES** _____

C2. Does the household have title to the land? _____

C4. How many acres do you hire in/out? _____

A5. What is the rent per year? _____

C5. Did the household borrow any cash in 2008? _____ ?

i) If yes, how much? _____ Where was it borrowed? _____

ii) Was the credit given? _____ If not, why? _____

iii) Did the household buy inputs on credit? _____

iv) If yes, where from? _____

C6. What is the travel time to the nearest market? _____

C7. Tell us about the members of your household.

Mem No.	NAME	Sex :F , M	Age in years	Years of schooling	Was the person employed in formal or informal business? Y/N	Did the person receive salary from employment, wage or pension? Y/N
1.						
2.						
3.						
4.						
5.						

C8. Is there any household member who participates in group activities?

Person name	Type of group	For ROSCAS frequency of contribution	Amount of contribution	Reason for participation

Reason for participation codes: 1. Share information 2. Mutual help in time of distress 3. Access credit 4. Generate income 5. Development 6. Access market

D: ROLE OF OFF-FARM INVESTMENTS

D1. D5. I would like to know about all income from off-farm investment business activities.

Name	No.	Investment type	Startup capital	Value of investment	Net income in 2008											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Investments codes; (1) posho mill (2) kiosk (2) lumbering (3) transport business (5) savings account balances (6) common stock (8) rental property (9) land in urban area (10) brewing traditional beer (11) agricultural trading (12) bicycle repair/transporter (13) brokerage (14) butcher (15) carpentry (16) charcoal burning (17) livestock trader (18) earning dividends (19) Hair dresser/barber (20) traditional doctor (21) school business (22) animal health

Name	No.	Investment type	Startup capital	Value of investment	Net income in 2007											
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

D2. Let us now talk about salaried employment and informal labor activities, pensions and remittances of household members.

Person name	Person code	Employment	Average monthly earnings			
			2008		2007	

D3. Tell us about the costs you incurred in land preparation, seeds, fertilizers, planting, weeding, chemicals and harvesting your crops.

Crop	Acres	Costs incurred in 2008											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maize													

Crop	Acres	Costs incurred in 2007											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maize													

D4. Let us know about your crop sales.

Crop	Sales in 2008											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maize												

Crop	Sales in 2007											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maize												

D5. I would like to know about the costs you incurred in your livestock activities in tick control, vaccination, veterinary, de-worming, AI, salaried farm workers, feed and minerals.

Livestock	Costs in 2008											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cattle												
Sheep												
Poultry												

Livestock	Costs in 2007											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cattle												
Sheep												
Poultry												

D6. I would like to know about the sales of livestock you had.

Livestock	Sales in 2008											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cattle												
Sheep												
Poultry												

Livestock	Sales in 2007											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cattle												
Sheep												
Poultry												

D7. Household assets

ASSET	NUMBER	UNIT VALUE	TOTAL VALUE	ASSET	NUMBER	UNIT VALUE	TOTAL VALUE
1. Cows				16. Sprayer pump			
2. Sheep				17. Posho mill			
3. Goats				18. Tractor			
4. Chicken				19. Tractor trailer			
5. Bank savings				20. Vehicles			
6. Wheelbarrow				21. Buildings			
7. Bicycles				22. Maize grain			
8. Power saws							
9. Motorcycles							
10. Water pump							
11. Television							
12.Radio							
13.Solar panel							
14. Panga							
15. Jembe							

C11. Do you have any outstanding credit (formal and informal)? …… If yes, how much? ……

THANK YOU VERY MUCH FOR YOUR COOPERATION AND TIME.

Appendix II: Absolute risk aversion coefficients

Farmer number	Absolute risk aversion coefficient	Farmer number	Absolute risk aversion coefficient	Farmer number	Absolute risk aversion coefficient	Farmer number	Absolute risk aversion coefficient
1	0.000005492	26	-	51	0.000002704	76	0.000001367
2	0.000006351	27	0.000001816	52	-	77	0.000003747
4	0.00000316	28	0.000007238	53	0.000002791	78	0.000008019
4	0.000006382	29	0.000001456	54	0.00000102	79	0.000002234
5	0.000010683	30	0.00000733	55	0.000001809	80	0.000002234
6	0.000004446	31	0.00000117	56	0.000002322	81	0.000024024
7	0.000027571	32	-	57	0.000002378	82	-
8	0.000011852	33	0.00000733	58	0.000003081	83	0.000002523
9	0.000013935	34	0.000003667	59	0.000002405	84	0.000006371
10	0.000005931	35	0.000003806	60	0.000001812	85	0.0000336
11	0.000015203	36	0.000007329	61	0.000006923	86	0.000005005
12	-	37	0.000007329	62	0.000006327	87	0.000007963
13	0.00000462	38	0.00000671	63	0.000004924	88	0.000006374
14	0.000099474	39	0.00000733	64	0.000002228	89	0.000006366
15	8.102E-07	40	0.00000117	65	0.000007924	90	0.000007809
16	0.000008099	41	0.000000965	66	0.000011521	91	0.000007322
17	0.000011667	42	0.000005174	67	0.000001804	92	6.964E-07
18	0.000013159	43	9.094E-07	68	0.000127993	93	0.000006366
19	0.000102005	44	0.000004956	69	-	94	6.182E-07
20	0.000007892	45	0.000007325	70	0.000001475	95	6.964E-07
21	0.000003426	46	0.000002277	71	0.000012222	96	0.000003688
22	0.000001473	47	0.000002347	72	9.552E-07	97	0.000002882
23	0.000002244	48	0.000002561	73	0.000003782	98	6.362E-07
24	0.000002598	49	0.000001481	74	0.000023774	99	0.000007322
25	9.862E-07	50	0.000001852	75	0.000002094		

Source: Field survey data, 2009

Appendix III: OLS Regression for determinants of household income

	Dependent variables (Y)					
Independent variables	Crop Income	Livestock Income	Farm Income	Off-farm Investment Income	Employment Income	Total Household Income
	(1)	(2)	3=(1)+(2)	(4)	(5)	6=(3)+(4)+(5)
hhldsize	399.154	-45.139	354.016	-551.924	31.937	-165.971
	(0.892)	(-0.442)	(0.805)	(-1.245)	(0.075)	(0.833)
humcapit	224.516	-65.464	159.052	831.753**	2,037.054***	3,027.859***
	(0.701)	(-0.895)	(0.505)	(2.621)	(6.715)	(0.000)
livascap	0.198*	-0.001	0.197*	0.100	0.660***	0.956***
	(1.838)	(-0.034)	(1.862)	(0.933)	(6.471)	(0.000)
builcapi	-0.085**	-0.005	-.089**	-0.027	0.047	-0.069
	(-2.391)	(-0.569)	(-2.564)	(-0.757	(1.387)	(0.269)
lanopcap	6,305.847**	798.956	7,104.803**	3,769.430	-16,772.457***	-5,898.224
	(2.073)	(1.150)	(2.377)	(1.251)	(-5.820)	(0.273)
lanownca	-5,884.350	131.319	-,753.031**	-2,158.050	11,200.530***	3,289.448
	(-2.373)	(0.232)	(-2.360)	(-0.878)	(4.767)	(0.453)
valinvca	0.024	0.000	0.024	-0.014	0.048***	0.057*
	(1.451)	(-0.093)	(1.455)	(-0.879)	(3.060)	(0.053)
one	-772.037	-533.892	-1,305.929	-4,710.284	-2,710.462	-8,726.675*
	(-0.294)	(-0.889)	(-0.506)	(-1.808)	(-1.088)	(0.063)

Appendix III (continued)

	Dependent variables (Y)					
Independent variables	Crop Income	Livestock Income	Farm Income	Off-farm Investment Income	Employment Income	Total Household Income
	(1)	(2)	3=(1)+(2)	(4)	(5)	6=(3)+(4)+(5)
two	302.078	-790.152	-488.074	-4,684.924*	878.121	-4,294.877
	(0.130)	(-1.491)	(-0.214)	(-2.039)	(0.400)	(0.295)
three	-1,579.530	-507.600	-2,087.130	-170.319**	25.417	-2,232.032
	(-0.681)	(-0.958)	(-0.916)	(-0.074)	(0.012)	(0.585)
cons	-4,426.680	737.936	-3,688.743	2,489.011	-13,826.519***	-15,026.251*
	(-0.935)	(0.682)	(-0.793)	(0.531)	(-3.083)	(0.075)
Mean of Y	394.6739	650.6057	1,045.2796	7,127.6333	10,692.7087	18,865.6216
Std. Dev. of Y	7,186.36940	2,075.71395	7,191.80122	7,864.27191	10,675.45492	16,693.82265
R-squared	0.195	0.496	0.224	0.340	0.673	0.541
Adj. R-squared	0.063	0.414	0.096	0.232	0.619	0.465

Notes:

1. Source: field survey data, 2009.
2. OLS is used in the regression; the number of observations is 72.
3. Dependent variables are given in Ksh in per capita defined by household size.
4. t-statistics are given in parentheses.
5. * indicates the coefficient is significant at 1%, ** at 5% level and *** at 1% level (two-sided test).