ANALYSIS OF SHOCKS AND COPING MECHANISMS IN CLIMATE SMART VILLAGES OF NYANDO, KENYA

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DECLARATION

This research project is my original work and has not been presented for any award of a degree in any other institution.

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SUPERVISOR'S DECLARATION.

This research paper has been submitted for examination with our approval as university supervisors.

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DEDICATION

I dedicate this work to the Almighty God for His grace during the entire period of my academic life and particularly in this demanding research paper.

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ABBREVIATIONS AND ACRONYMS

CBO’s	Community Based Organizations
CCAFS	Climate Change, Agriculture and Food Security
CSA	Climate Smart Agriculture
ILRI	International Livestock and Research Institute
KNBS	Kenya National Bureau of Statistics
NBR	Negative Binomial Regression
NGO’s	Non Governmental Organizations
RNF	Rural Non-Farm
SSA	Sub-Saharan Africa
TPR	Truncated Poisson Regression

ABSTRACT

Climate change is a global challenge that is hampering Africa's socio-economic improvement. The change has had a negative impact on agricultural production and subjected smallholder farmers in Africa to food insecurity, economic constraints and shocks. These farmers lack agricultural and weather guidelines. They often use indigenous techniques to cope with shocks. One of the coping strategies in this regard is diversification. In Nyando farmers face economic and climatic shocks. CCAFS, Vi Agro forestry and other organizations have been helping these smallholder farmers to diversify by adopting CSA practices of drought tolerant crops and animals. This paper used cross sectional data collected from Nyando through a structured questionnaire to establish the shocks that Nyando residents face, and their effects on diversification of CSA practices. Results from TPR and NBR show negative effect of death shocks on diversification while drought, pests and diseases positively influence diversification. This highlights the need to promote the uptake of CSA policies of water harvesting, and crop rotation seriously. Additionally, farmers should also consider weather index insurance to buffer against climatic shocks.

CHAPTER ONE: INTRODUCTION

1.1 Background Information

According to Adger et al (2003), climate change is a global challenge that is hampering Africa's socio-economic improvement. Changes in climate have had a negative impact on agricultural practices and have subjected smallholder farmers to food insecurity and economic constraints. According to United Nations Development report (2014), irrespective of the recent progress in poverty reduction, more than 2 billion people are either near or dwelling in multidimensional poverty. Many smallholder farmers in sub-Saharan Africa (SSA) are found in rural areas practicing agriculture that is highly dependent on rain. Harsh climatic conditions such as drought alter their livelihoods and subject them to shocks.

Shocks are events that trigger decline in the welfare of an individual, a household, community, or a region at large (KNBS, 2016). According to Dearcon, (2002) shocks can be classified as idiosyncratic or covariate. Idiosyncratic shocks are those that have an effect on an individual household, e.g., illness or death of a household member. Covariate shocks on the other hand have an effect on a large area at the same time, for example climatic effects and market price fluctuations. According to Goldstein (1990), households who are faced by recurrent shocks adopt strategies that minimize their risks and thus improve their long-term livelihood security. Coping to shocks refers to the households' response to an uncommon decline in access to their livelihoods. According to Hassan & Nhemachena, (2008) coping refers to actions taken by a household to survive in spite of prevailing conditions. Coping strategies are thus, a bundle of households' response to shocks. It is thus concerned with a household's survival rather than failure. The resilience of households is determined by its capacity to cope with shocks. According to Billing & Madengruber (2009), coping capacity refers to the resource endowments of households and their ability to utilize the resources and deal with the shocks.

Kurukulasuriya and Rosenthal (2013) rightly argue that most African countries face economic constraints that make them unable to cope with shocks and consequently hinder their ability to mitigate the effects of climate change. Sawada (2006) additionally points that the impact of shocks on GDP in developing countries is worse compared to developed countries. Fothergill & Peek (2004) argue that poor households are worst hit by natural disasters in either developed or developing countries. Smallholder farmers in Africa additionally lack precise guidelines and hence, use their indigenous techniques to cope with shocks (Kurukulasuriya & Rosenthal, 2013). According to Mortimore (1989), greater efforts are directed to empowering poor households to manage shocks and adapting to long-term variability in their livelihood situations. This is the approach of sustainable livelihood security. It raises understanding of rural communities.

According to Farrington, et al. (1999), household earnings require that families acquire different categories of capital that include social and physical capital. Unfortunately, the poor lack or have difficulties in accumulating. Focus is now directed to parameters that hamper human development. These include climate change and low income earnings. Ellis (1998) observes that through targeted interventions that prioritize farm activities, substantive change within the lives of the poor in rural areas can be achieved.

Governments have been urged to adopt climate change techniques and measures to reduce poverty and improve household welfare. One approach in this regard is enhancing agricultural productivity and intensification. Thirtle, Lin, and Piesse (2003) are of the view that agricultural boom could result in considerable reduction in poverty. Their rationale is that majority of low income groups practice subsistence farming with little marketing of their produce. Adger, et.al, (2003) argue that inability of smallholder farmers to cope with shocks is partly explained their low levels of incomes, illiteracy and poor transport networks.

The Kenyan government is developing national policies in an attempt to address the effects of climate change. One major policy in this regard is the response strategy (GoK, 2010), and Action Plan on Climate Change (GoK, 2013). The government is also partnering with several non-governmental organizations (NGOs) in adopting the Climate Smart Agriculture (CSA) policies and strategies.

1.1.1 Climate Smart Agriculture (CSA)

This is an economic development intervention of the United Nations geared towards mitigating and adapting to climate change. It is a policy intervention intended to provide sufficient food for the world population (Lipper *et al*., 2014). This is achieved through agricultural activities targeted to smallholder farmers. These activities enhance smallholder farmers' resilience to climate change and reduce green gas emissions. Some of the key CSA activities entail: water harvesting through construction of water pans; planting trees; growing of drought resistant crops and keeping drought tolerant animals together with introduction of new crop patterns and animal management practices for increased production. CSA also aims at development through forward-backward linkages created by the practices (FAO, 2010). By jointly addressing food security and climate-related shocks, CSAs promote economic, social and environmental development. Tscharntke et al (2015), points that the bona fide CSA thought is to embrace an environment based system. CCFAS, Vi Agro forestry and other organizations have been helping smallholder farmers in Nyando to diversify their incomes by adopting CSA practices such as drought tolerant crops and animals (CGIAR, 2018).

1.1.2 A Description of Nyando Basin

Nyando is named after the Nyando River flowing from the Hills of Nandi in the Rift Valley cutting its way through to the Lake Victoria. The area covers an approximate of 412.20 Sq. Kilometres with an approximate population of 141,037 persons who engage in a range of

human activities including farming, livestock keeping, fishing and other economic and social activities which are sources of livelihood (Raburu, Khisa & Masese, 2012). Nyando is bordered by Nyakach, Rachuonyo, Muhoroni, Kisumu East Districts, and the Rift Valley Province.

The climate of Nyando region is diverse due to altitude difference from the highlands of Nandi and Kericho to the lower plains of Lake Victoria (Muthusi, et al(2005). The lower plains has an average annual temperature of 22.6ºC while in the highlands has about 16.7 ºC with average annual rainfall of 1100mm near Lake Victoria to about 1800mm in the eastern highlands (Raburu, Khisa & Masese, 2012). Additionally, heavy rains are experienced between March and May while low rainfalls occur between October and December.

However, this rainfall pattern is changing and is increasingly becoming unpredictable. The rains start late and end early, dry spells are longer and more frequent (Raburu *et. al*., 2012). When the rains do fall, they are often intense and lead to flooding forcing farmers in the area to adjust quickly due to the severe floods that occur.

According to Eisten & Ochola (2006; 1), over 5000 people in Nyando are affected by floods during the rainy seasons. According to OCHA (2010), floods between march and may 2010 displaced 180 people and swept seven homes. This resulted to some schools and hospitals being submerged in water and as a result some schools were closed indefinitely. Roads and bridges are washed away making access to hospitals, schools, markets and other amenities impossible. Masese, Neyole, & Ombachi (2016) point out that the floods come with waterborne diseases and Malaria. This exacerbates the already devastated livelihoods of the Nyando residents. Inaccessibility of hospitals makes people resort to private clinics which then charge exorbitant prices.

Additionally, poor land use practices and deforestation in Nyando have resulted in increased run-off and erosion thus exposing the area to devastation (Macoloo et al., 2013). This poses a challenge on food security and household incomes. According to Ochieng, Charles, & Ang'awa (2017), the floods cause heavy economic losses averaging in monetary terms US$ 850,000 with another US$ 600,000 spent on interventions.

According to Verchot et al (2008), 65% of Nyando residents live below the poverty line. This explains the prevalence of prostitution and a high number of HIV/AIDs (GoK, 2010).

1.1.3 Climate Smart Agriculture in Nyando

CCAFS and partners have established Climate Smart Villages (CSVs) that train farmers on how to cope with climate change through Climate Smart Technologies (Ojango et al, 2015). New crops such as millet, sorghum, fodder trees and livestock breeds that are drought resilient have been introduced in Nyando. Livestock breeding was the entry point in sheep and goat upgrading intervention strategy (Ojango et al, 2015).Through the International Livestock Research Institute (ILRI), CCFAS introduced Galla goats to assist farmers' cross-breed their native breeds. The Galla breeds mature quicker and reach market weights faster compared to the local breeds. The Red Maasai sheep has also been introduced. It grows quickly and is mostly immune to drought and internal parasites (Ojango et al., 2016). Other intervention practices include construction of greenhouses, water pans to check erosion and provide irrigation water, tree planting for fodder, and related activities such as bee-keeping. CCAFS accomplishments have been through community based organizations (CBOs). Thorlakson (2012), points that farmers in Nyando are willing to receive information and advices on potential adaptation measures.

1.2 Problem statement

Climatic changes at times occasion natural disasters that cause physical and socio-economic damages (Thorlakson, & Neufeldt, 2012). According to Guha-Sapir, Hoyois, & Below (2013), natural disasters on average caused an estimated 107 thousand deaths between 2002-2012 around the world. Additionally, natural calamities affected over 260 million people and resulted in average economic losses estimated at $143 billion. World Bank (2010), estimated economic losses of natural disasters (1970-2008) to be around $2300 billion. They also lead to more economic losses in developing countries than developed nations (Luduing et al., 2007; Sawada 2006).

Natural disasters are not evenly distributed in the world (Van den Berg, 2010). UNDP (2008), estimates that over 84% of victims of natural calamities are located in developing countries. The poor are usually the most vulnerable (Fothergill & Peek, 2004). This is especially worse when it results to losses of incomes and assets (Van den Berg, 2010), making people resort to defensive desperate strategies in order to survive.

Off-farm labour is argued to be a coping mechanism to shocks (Heltberg, Siegel, & Jorgensen, 2009; Thorlakson, 2012), albeit not the only one. Diversification of farm activities could also help farmers cope with shocks (Howden et al, 2007; Maluccio, 2005). Diversification at farm level is an effective ex ante shock coping strategy and helps reduce the use of desperate coping mechanisms ex post (Fafchamps, 2003).

Farmers in Nyando are prone to different, socioeconomic and climatic shocks arising from droughts, floods and changing weather patterns, and which call for diverse coping mechanisms. CCAFS, Vi agro forestry and other organizations have been promoting on-farm diversification (CSA) and other complementary interventions (strengthening CBO's) to improve their resilience to shocks. However, it is not clear what shocks farmers experience and their effect on farm diversification. In addition, it is also not clear the different coping

mechanisms they adopt for specific shocks. It is against this background that this study sought to establish the different types of shocks and the corresponding coping mechanisms, and the effect of these shocks on diversification of CSA.

1.3 Research questions

This study was guided by the following research questions:

i. What shocks have smallholder farmers in Nyando experienced in the recent past?
ii. What coping actions have households in Nyando adopted to cope with what shock?
iii. To what extent have they diversified their CSA practices as a coping strategy?
iv. What factors influence diversification of the CSA practices in Nyando?

1.3 Objectives

General Objective

The general objective of this study was to examine whether shocks prompt diversification of CSA technologies in Nyando.

Specific Objectives

i. To establish the shocks that smallholder farmers in Nyando have faced in the past three years.
ii. To establish the coping strategies that households in Nyando have adopted in response to the either shock.
iii. To establish the extent to which farmers have diversified their CSA practices to cope with shocks.
iv. To establish the factors that influence diversification of the CSA practices.

1.4 Significance of the Study

Agriculture remains a fundamental source of livelihood for rural poor in developing countries (Jonasova & Cooke, 2012). Climate change endangers the livelihoods of the poor rural households that depend on agriculture (Beddington et al. 2012). Moreover, rural households are prone to other shocks that hinder their development efforts. CSA has been considered as an effective measure for enabling rural households adapt to climate change, as well as ensuring food security and coping to shocks. Despite recognition of CSA as a solution to myriad of challenges for the rural poor, studies on this topical issue remain scanty. Few studies in Nyando have focussed on the impact of CSA on household livelihoods, a detailed study on the prevalent shocks, coping mechanisms and determinants of diversifying CSA is equally important. As such, the study adds a new empirical body of knowledge on analysis of shocks and coping mechanisms in Nyando, which is important in designing policies on possible scaling-up and scaling-out CSA. Finally, the study acts as a basis for further research on shocks and on-farm diversification. Factors that emerge as influencing diversification can be further examined.

CHAPTER TWO: LITERATURE REVIEW.

2.0 Introduction

This research examined the effect of shocks on diversification of CSAs. This chapter briefly reviews the theoretical and empirical literature on factors that determine diversification of agricultural activities at household level. Section 2.1 provides the theoretical review with a focus on the theories of income diversification and theories used in the analysis of diversification of income portfolios. Section 2.2 provides the empirical review and the overview of the literature is highlighted in section 2.3.

2.1 Theoretical Literature

Some of the traditional and contemporary economic theories that relate to diversification of household incomes have been used in understanding effect of shocks. It is important to review the theories. A survey of the existing literature indicates that there is no conclusive agreement concerning the theories and models applied in diversification as this depends on the perspective from which these determinants are analysed. Specifically, this study digs into the effect of shocks on diversification of CSA technologies. This propagates the decision theory to provide a normative understanding of adoption and diversification of CSA practices.

2.1.1 Decision Making

The theoretical foundations of decision making dates back to the 1930's when Karanata (1932) proposed equal mean distribution as way of making decisions based on different investment portfolios under uncertainty. The theory was further built by Markovitz (1952); Markovitz (1959); Hanoch & Levy (1969); and Rothschild & Stiglitz (1970).

Uncertainty refers to situations where outcomes of an event are not known. Investment decisions are full of uncertainty and thus require critical evaluation before deciding on which investment to invest on. Decision theory is closely related to the prospect theory formulated by Tversky (1979). Prospect theory aims at describing how economic agents behave when they are faced with multiple choices and risk involved with outcome is unknown. This theory assumes that choices faced by economic agents are discrete and independent and the probability distribution of each choice is equal. The prospect theory postulates that individuals value gains and losses differently. Individuals faced with such a scenario will chose perceived gains over losses. Through evaluation of investment portfolios, people chose combinations of different portfolios with the highest gains. Risk averse individuals will diversify their choice sets in order to reduce the risk of losses in one choice set.

According to Gebru (2018), diversification is the maintenance of varied range of income sources by households to minimize variability in income. Mulwa (2017) argues that for farmers to manage natural disasters and deal with shocks, they ought to implement multiple practices in combinations. Diversification is also considered as a transition from subsistence agriculture to commercial agriculture, and also low income earnings to asset accumulation and wealth (Pingali and Rosegrant, 1995). This according to Bandyopadhyay and Skoufias (2013), is associated to push factors such as higher incomes and better returns of entrepreneurial activities.

According to Seo (2011), livelihoods in Africa take the form of either specialized livestock or crops systems or a diversified (integrated) system. Additionally, farmers have diversified their livelihood into both livestock and crop farming in order to offset loss of crops in severe drought and livestock death in periods of heavy rain fall. Howden et al, (2007) argues that farmers diversify in order to benefit from the ability of diverse crops to flourish under

different climate conditions. Second, farmers may adopt new technologies as a coping mechanism. For instance, Van den Berg, M. (2010) argue that farmers may invest their incomes on adopting new variety of drought tolerant crops as a way of coping with high risks of drought.

2.2 Empirical literature

The impact of climate change at farm level entirely depends on the adaptive capacity of farmers to new adaptive technologies. Adaptation to climate change at farm levels is an effective way of reducing the effects of climate change and improving food security (Smit & Skinner 2002; Di Falco 2014). However, resilience and adaptive capacity of smallholder farmers to climate change is unreliable especially when left to work alone (Ogada et al., 2018). It is thus important that they are supported and given necessary assets they can utilize in coping with climate variability. CCAFS has achieved this in various parts of the continent through establishment of Climate Smart Villages (CSVs'). This is aimed at providing suitable technologies at different ecological zones, mobilizing farmers to work in groups to leverage assets for adoption of CSA activities, and offering best possible recommendations at up scaling CSA (Aggarwal et al., 2018).

Several climate smart technologies have been embraced in different parts of the world as an approach geared towards transforming agricultural practices. According to Mauceri et al., (2005), excessive use of pesticides has had increased costs to farmers and health concerns in Ecuador. This resulted to negative impact on the ecology by killing beneficial insects. In an attempt to address these, farmers have been urged to adopt Integrated Pest Management (IPM). These practices include use of resistant varieties, practising crop rotation and use of different fungicides and altering them in different seasons to prevent build up of resistance.

South Asia agricultural sector is mainly dominated by rice and wheat (Gupta & Seth, 2007). However, rice-wheat farmers are facing a myriad of challenges including uncertain climate conditions, reduced profit margins due to high production cost, among others. To curb these challenges, CCAFS and other partners introduced conservation agriculture (CA), improved seeds, and precision agriculture. According to Jat et al., (2014), improved varieties of rice and wheat replaced the then existent varieties and resulted in increased margins where CA (minimum tillage and residue retention) was practised.

CCAFS village approach identified two sites (West and East) Africa. Soil degradation (Kamara et al., 2013), and rainfall variation (Jalloh et al., 2013; Recha et al., 2016) are the main challenges in these regions. Agriculture is the predominant livelihood source for most smallholder farmers.

The climate of West Africa is diverse ranging from arid to semi-arid, semi humid to humid regions, each with remarkable range of human activities (Zougmoré et al., 2016). Livestock make a tremendously important contribution to economies and food security in West Africa. Concerted efforts are directed to crop production and maintaining the riparian system (FAO, 2010).

Rising water levels has resulted to erosion and submergence of the coastal region leading to loss of biodiversity (McCartney et al., 2012). Additionally, increase in CO2 from fishing activities culminates the threats to the ecosystem. Collective action by different bodies are being directed on reducing emission of greenhouse gasses (GHG) resulting from fishing, adopting new aquaculture species together with supplemented better feeds and promoting insurance in the fishing industry (Zougmoré et al., 2016). Besides these, a number of CSA portfolios have been introduced in the crop production sector. These include; CA, agro

forestry, water management techniques among others. All these are meant to deliberately mitigate the effects of climate change.

CCAFS villages in East Africa were established in Kenya, Ethiopia, Uganda and Tanzania. All the CSVs' are characterised by crop-livestock production systems except in Ethiopia (Borana) where households mainly engage in livestock keeping. Across these villages, rainfall variability and rampant pests and diseases (for both crops and livestock) pauses a great challenge to the households' incomes and food stability (Recha et al., 2016).

Following the aforementioned challenges, CCAFS introduced drought tolerant, early maturing and disease resistant varieties of crops. Also introduced were small ruminants (Galla goats and Red Maasai sheep) which are resilient and mature fast (Ojango et al., 2016). Water pans and agro forestry were also introduced. Water pans were aimed at reducing the effects of run-off water on land and also providing water for irrigating crops. Agro forestry plan not only targeted beautification but also served as animal feeds. To reach the targeted populations, CCAFS mobilized people to form savings and lending groups; set up seed multiplication farms and demonstration sites (Zougmoré et al., 2016).

Recha et al., (2016) argue that there has been success in the uptake of CSA technologies in Nyando evidenced by households diversifying crops into improved varieties. Oganda et al., (2018) additionally finds evidence from Nyando that CSA technologies have had significant and positive impact on households' welfare. However, adoption of these technologies has been influenced by group membership (Recha et al., 2016), among others. These are discussed in the ensuing section.

2.2.1 Shocks, Coping Mechanisms and Livelihood strategies

Adverse natural shocks have negative impacts on agricultural activities which in turn affects household income through direct expenses of coping (Van den Berg, (2010). Households ex

ante preparation as well as ex post mitigation activities determine their welfare thereafter (Gröger & Zylberberg, 2016).

Empirical researches show that households face different shocks which significantly drain their incomes and resources. A study by Gröger & Zylberberg (2016) shows that 50% of victims of catastrophic typhoon in Vietnam lost up to 10% of their aggregate incomes. A study by Tongruksawattana, Schmidt, & Waibel (2009), finds that households in Thailand were affected by both idiosyncratic (inability to pay loans, sickness, and death of a household member) and covariate (crop pests, droughts and floods) shocks. The study further shows that, shocks lead to significant drop in household incomes and assets as most households use their savings while others sold off their resources in order to cope with the shocks. However, in the event of covariate shocks, majority (50%) had nothing to do, while hit by idiosyncratic shocks most households coped by borrowing, use of savings and adjusting labour. In Vietnam, households affected by typhoons send members of their family to seek employment in urban towns who then remit some incomes (Gröger & Zylberberg, 2016). Additionally, ex ante migrants remit fairly the same amounts of incomes as ex post migrants.

Thorlakson, & Neufeldt, (2012) carried out a research in Nyando to establish how farmers coped with drought conditions in 2009 and floods that occurred between March and May 2010. The study used data collected from community groups, government bodies and NGO's through focus group discussions. The study finds that with the drought like conditions, farmers lost up to 96% of their crops while during the floods, houses were submerged in water and people were displaced (OCHA, 2010) forcing them to engage in unsustainable coping strategies. The study finds that farmers sold their farm implements and also consumed seeds they had reserved for planting. They additionally relied on help from relatives, churches, and NGO's, borrowing, selling of livestock, moving to higher grounds of Kericho

to seek wage activities, and reducing the quantity and quality of meals. The study however, points that the farmers had not diversified crops and mainly engaged in maize and sorghum growing which were mainly local varieties.

Several studies; (Corral & Reardon, 2001; FAO, 2001; Malcow-Moller & Svarer, 2005; Van den Berg, M. 2010) have been conducted in Rural Nicaragua to assess the effects of the hurricane Mitch. These papers provide evidence that rural agricultural households were adversely affected by floods, landslides and strong wind currents. Corral & Reardon (2001) points out that most (98%) rural households in Nicaragua earn part of their income from agriculture. FAO (2001), argue that farmers lost their crops and rural roads were destroyed forcing households to sell off their properties in order to cope. Destruction of roads rendered roads impassable thus limiting intervention strategies. Van den Berg, M. (2010), equally finds that people who were dependent on agricultural wage work were affected. However, the study finds that even though the households were negatively affected by the hurricane Mitch, they did not alter their livelihood strategies.

The traditional image of rural farm households in developing countries is a sole farming entity with no non-farm activity (Reardon, et al, 1998). However, analysis from different developing countries has shown that besides animal rearing and crop production, rural households participate in varied forms of economic activities both on and off the farm. According to Malcow-Moller & Svarer (2005), non-farm activities constitute 50 percent of income portfolios of rural Nicaragua households. Tongruksawattana, Schmidt, & Waibel (2009), provide evidence from Thailand that households engage in both farm and mixed off-farm activities. However, agriculture is more dominant with most (61%) practising both crop farming and livestock keeping. Babatunde (2008) in a household survey to analyse income

disparities among rural households in rural Nigeria finds that whereas farming accounts for half of the full household's income, the other half is from off-farm activities.

2.2.2 Factors that Influence adoption/Diversification of new Agricultural Technologies

Natural disasters are push (Gröger & Zylberberg, 2016) and pull (Zawedde et al, 2014) factors for adopting new technologies for diversifying incomes. Arslan et al (2018) points that variation in rainfall patterns across seasons push farmers to diversify into livestock keeping and subsistence maize farming in Zambia. Additionally, Hassan& Nhemachena (2008) finds that increase in temperatures make farmers to diversify their farming practices and adopting new techniques.

Shocks could lead to loss of household incomes which farmers could otherwise use to adopt new techniques (Thanapackiam, Khairulmaini, & Fauza, 2012). Zawedde et al (2014) finds that loss of planting materials due to droughts, and limited land are key constraints to maintenance of local potato varieties in Ecuador. Diversifying into other activities like off-farm activities require skills which farmers could be competitively disadvantaged (Arouri, Nguyen, & Youssef, 2015).

Social capital explains proliferation in the uptake of new technologies (Bandiera & Rasul, 2006). Based on findings from Bayesian updating model of 198 sunflower farmers in Mozambique, the researchers argue that presence of many adopters in a social network increased the number of those who adopted new technologies. The study also found that having many adopters in a network increased the decisions by others to adopt a technology; technology is viewed as a public good. Social networks also integrate farmers with markets (Arslan et al., 2018). Arouri, Nguyen, & Youssef, (2015) adds that social capital is means through which households can cushion themselves against capital constraints and thus smooth consumption. Arslan et al (2018) adds that social capital is a channel through which

information is shared. The researcher argues that farmers who do not belong to community groups have limited chances of adopting new technologies due to lack of information. Oganda et al (2018), also argue that community groups are channels through which farmers are mobilized to adopt new technologies.

Households with better information pertaining the practice have higher chances of adopting new technologies (Koundouri, Nauges, & Tzouvelekas, 2006). A study by Stuart, Schewe, & McDermott (2014) to ascertain factors that limit farmers from reducing increased use of nitrogen fertilizer finds that information and the channels of information determine farmers' decision to reduce application of nitrous fertilizers. The study recommends that extension providers and universities are key channels of information dissemination to farmers. Similarly, Abdulai, & Huffman, (2005); Arslan et al (2018) find evidence that extension providers and community based organizations are key in influencing adoption of new farming practices. In Ecuador, Mauceri et al (2005), finds that farmer participation in field days influences farmer decisions to adopt new pest management practices.

Hassan& Nhemachena, (2008) analysed the determinants of strategies used by African farmers to cope with climate change. Findings of multinomial logit regression indicate that poor infrastructure coupled with inadequate resources limit most smallholder farmers' from adopting new technologies. Mertens et al. (2017), argue that households who depend on off-farm (commercial) activities highly depend on road networks in Uganda. Arslan et al (2018), also point out in Ethiopia that diversification of new potato varieties depends on road networks. Ease access to markets lowers transactional costs which influences adoption of better technologies (Hassan& Nhemachena, 2008). Distance to the markets has the largest effect on the adoption and intensity of fertilizer use (Croppenstedt, Demeke, & Meschi, 2003.

Oganda et al (2018), adds that access to markets and improved networks influences farmers to increase surplus production which in turn make them demand high yielding varieties.

Access to credit strongly and positively influences households decisions to abandon risky investments and adopting new technologies (Hassan& Nhemachena, (2008). These findings were affirmed by (Croppenstedt, Demeke, & Meschi, 2003) in a similar study to establish the role of credits in technology adoption. The study used cross sectional data collected from randomly selected 6147 agricultural households. Results from probit model indicated that household credit constraints resulted to lower chances of purchasing fertilizers by the households. More so, farmers with high incomes adopt new agricultural techniques as compared with farmers with low incomes (Suri, 2011). Arouri, Nguyen, & Youssef, (2015) adds that access to micro credit and remittances are additional incomes through which households cope to natural disasters. Oganda et al (2018), adds that investment in CSA technologies requires heavy capital investments and thus farmers need credits to enable them adopt the technologies. More so, high wage labour discourages adoption of CSA technologies.

Asfaw & Admassie, (2004) used data collected from 1295 households of 13 peasant associations in Ethiopia to analyse the role of education on adoption of fertilizer. Findings from probit regression indicate that education among the adult members of a household is key in driving adoption of fertilizer. Hassan& Nhemachena (2008) adds that education improves farmers' synthesis of information on new technologies and responding to new innovations in agriculture. Higher education among household heads increases diversity in meals among adopters and non-adopters of CSA practices (Oganda et al., 2018). Tongruksawattana et al (2009) finds evidence from Thailand that households with higher educational attainments

have diversified income portfolios and are more resilient to shocks and thus would not require coping mechanisms ex post.

Studies find negative relationship between age of household members and adoption of new technologies. According to Mauceri et al (2005), elderly people are risk averse and have little interest in long term investments in farms.

According to Arouri, Nguyen, & Youssef, (2015), households with high number of occupants tend to have low per capita incomes than small households. However, large families tend to venture into labour intensive techniques as compared to small sized households (Hassan& Nhemachena, 2008).

Gender of the household head has different influences on adoption. Whereas studies some studies (Hassan& Nhemachena, 2008; Oganda et al., 2018) find that male headed households adopt new farming technologies as compared to female headed households, other studies confirm otherwise (Tongruksawattana et al., 2009).

2.3 Summary of the literature Review

From this review, it is evident that there are several theories that can be used to understand the drivers of income diversification. More so, decision theory appears to be the most appealing framework for understanding the drivers of diversification. The review further provides empirical evidence of some of the factors that determine the diversification of income portfolios. Such factors include household demographic characteristics, socioeconomic factors, and social networks, among others. Studies (Arouri, Nguyen, &Youssef, 2015; Zawedde et al, 2014; Arslan et al., 2018; Mertens et al., 2017;Zawedde et al., 2014; Thanapackiam, Khairulmaini, & Fauza, 2012; Gröger & Zylberberg, 2016) on shocks and adaptive behaviours in different parts of the world do not find amicable

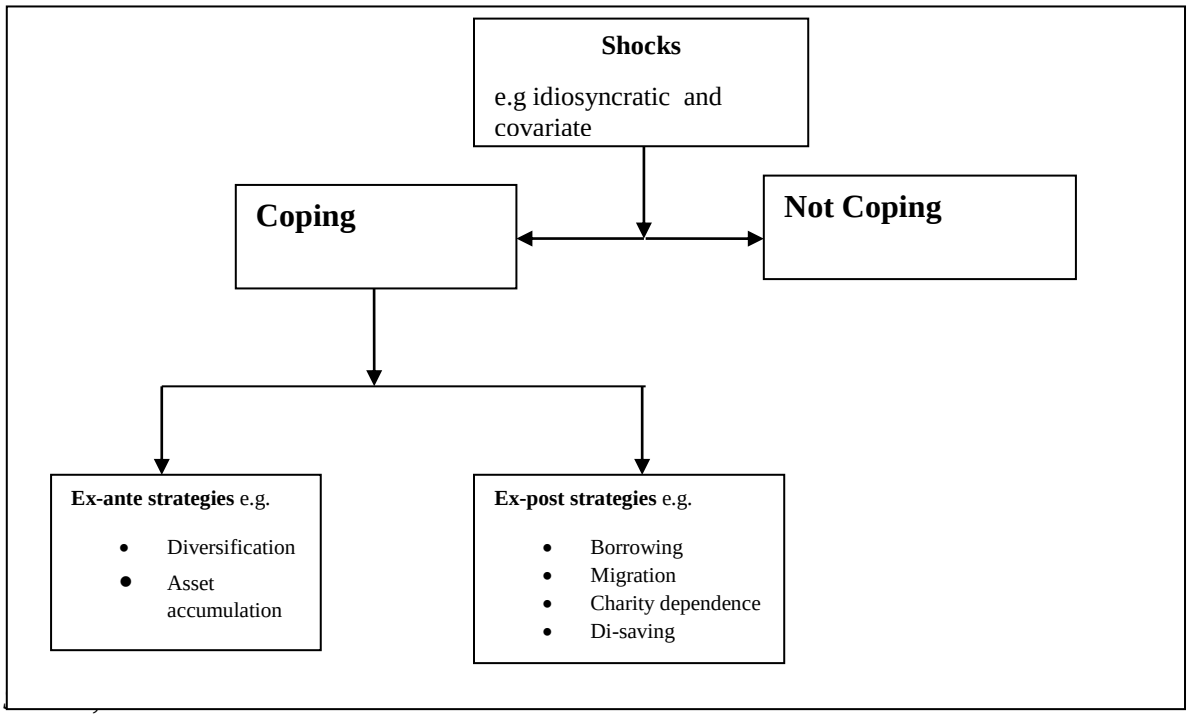
conclusions on how shocks influence household behaviours. Notably, Van den Berg (2010), points out that research finding of shocks in one location cannot draw macroeconomic conclusions due to for example geographical differences. Additionally, the study by Thorlakson (2012), used data collected in 2010 to assess how agro forestry cushions people against floods in Nyando. With the advent of CSA practices in Nyando since 2011, things could have changed overtime with (Recha et al 2016) showing that CSA in Nyando has been a success. From the literature, there is no study that has been conducted in Nyando regarding shocks and adaptive behaviours recent times. This paper therefore, sought to address this gap in literature by assessing the effect of shocks on diversification of CSA in Nyando and provide further insights into other socio economic and demographic factors that affect the diversification of CSA besides shocks.

CHAPTER THREE: METHODOLOGY

3.0 Conceptual Framework

Figure 1 presents a conceptual framework that underpins the relationship between shocks, and adaptive behaviours of households to shocks. The welfare status of a household ex post a shock, depends on the *ex ante* preparedness and *ex post* strategies adopted. According to OECD (2009), ex ante risk reduction/mitigation practices at household level include crop diversification, income diversification, and savings in the form of liquid assets, among other practices. Ex post coping strategies on the hand include borrowing, migration, dependence on intra-community charity, sale of assets among others. Both *ex-ante* and *ex post* coping strategies are influenced by information on environmental change, intrapersonal and interpersonal individual experiences (Floyd, Prentice-Dunn & Rogers, 2000).

Figure 1 Conceptual Framework



3.1 Theoretical Framework

According to OECD (2009), ex ante preparedness to shock strategies are more reliable and help cushion households against shocks in the long run. Kazianga and Udry, (2006) argue that farmers adopt new technologies in order to cope with the long term changes in climatic conditions. Newsham and Thomas (2009) add that for rural households to manage risks of climate change, they should engage in agricultural activities that are resilient to impacts of climate change. According to Ogada et al. (2018), farmers can adopt CSA technologies in order to improve their incomes, food security and resilience to climate change.

Households can either increase investments or divest as a response to climate change (Seo, 2012). According to Bandyopadhyay and Skoufias (2013), diversification at household level results to more income security, but lower average welfare status in the event of an extreme shock. In this sense, households diversify their farming practices to mitigate the risks of climate change and other risks (Ellis, 2004; Reardon *et al*., 2006). In this regard,

diversification can be said to be a calculated move by households to manage risks and improve food security, or it may be a reflex response to shocks. Ellis (1998) considers diversification as an insurance mechanism for rural poor, while for the rich is an asset accumulation strategy.

This study examines the effect of both idiosyncratic and covariate shocks on diversification of CSA practices. Following Barbieri and Mahoney (2009), we measure diversification index as the number of CSA practices practised by a household. Households could adopt a combination of different strategies (diversification). In this case, adoption can be captured as count data depending on the number of choices a household has adopted.

The number of CSA practices adopted by a household depends on factors like household assets, age of the household head, extension services, access to credit and credit facilities, access to markets, land size, gender of the household head, and household income. The CSA practices considered in this study are; land management practices, animal management practices, improved breeds of animals and agro forestry. Each of these categories has different practices.

The demand for a CSA practice can be formulated as;

$$y_i = f(s, x, \beta) + e_i \qquad \forall i = 1,.....,n, \tag{1}$$

y_i Is the number of CSA strategy adopted by the household, s is shocks associated with household i; x is a vector of household characteristics; β is unknown parameters to be estimated, and e_i is the error term.

3.1.1 Poisson Regression Model

The non-negative nature of the CSA technologies suggests use of count data models. The basic count data model is the Poisson regression model (Anderson, 2010; Parsons, 2003) which has a density function;

$$\Pr(Y = y_i) = F_s = \frac{e^{(-\lambda)\lambda^{y_i}}}{y_i!}, \quad (2)$$

Where y_i is the conditional mean of the distribution of the coping strategies.

The Poisson model assumes that

$$\left[E(y_i|x)\right] = \lambda_i = \exp(x_i, \beta), \quad (3a)$$

$$Var\left[(y|x)\right] = \lambda_i = \exp(x_i, \beta), \quad (3b)$$

This means the mean and variance of the distribution are equal, thus equal distribution of the coping strategies.

Data used in this study was collected from farmers who have at least one CSA practice. Therefore, the dependent variable is truncated at zero. The basic Poisson model does not take care of this truncation and this would lead to inconsistent estimates.

Shaw (1988), and Carson (1991), proposed a truncated Poisson distribution for equally dispersed data. For count y_i, truncated at zero, the density function is given as;

$$\Pr\left[Y = y|Y > 0\right] = \frac{e^{-\lambda} - \lambda^y}{y!}.\left[\frac{1}{1-e^{-\lambda}}\right] y = 1,....., n \quad (4)$$

Given heterogeneity of farmers, the assumption of equal distribution of the dependent variable may not hold. According to Berk & McDonald (2007), PRM ignores the fact occurrence of an event can influence its occurrence in the future. For example, if a household had adopted a certain practice and achieved their goals (maximized utility), then their chance

of adopting other practices would be lower. This situation can lead to under-dispersion in the dependent variable.

Additionally, if the practices are in such a way that occurrence of one influences occurrence of the other, leads to over-dispersion. For example, a household keeping the small ruminants (sheep/goats) can plant fodder trees that the residues can be used to feed the ruminants. In turn, the manure from the animals can be used in the farms.

To correct for both truncation and under/over dispersion, we adopt the zero truncated negative binomial model given as;

$$\Pr\left[Y = y|Y > 0\right] = \frac{\Gamma(y+\alpha^{-1})}{\Gamma(\alpha_i^{-1})\Gamma(y_i+1)}(\alpha\lambda)^{y}(1+\alpha\lambda)^{-(y_i+\alpha^{-1})}\left[\frac{1}{1-(1+\alpha\lambda)^{-\alpha^{-1}}}\right] \quad (5)$$

With

$$\left[E(y_i|x_i)\right] = \lambda_i + 1 + \alpha_i\lambda_i \quad (6a)$$

$$Var\left[(y|x)\right] = \lambda_i(1+\alpha_i+\alpha_i\lambda_i+\alpha_i^2\lambda_i \quad (6b)$$

Where Γ denotes the gamma distribution, and α represents the under/over dispersion parameter.

Given the functional form of the basic PRM,

$$\lambda_i = \exp(s, x, \beta) \quad (7)$$

Equation (5) can be extended to a regression framework, by conventionally modelling λ_i as a semi-logarithmic function of x_j explanatory variables,

$$\ln\lambda_1 = \beta_0 + \beta_1 S_i + \sum_{j=1}^{j}\beta_j x_{ji} + \varepsilon_i \quad (8)$$

The empirical model estimated in this study takes the form;

$$C_i = \beta_0 + \beta_1 Death + \beta_2 Crpfail + \beta_3 Floods + \sum_{j=1}^{J} \beta_j x_{ji} + \varepsilon_i \quad (9)$$

Where C_i is the number of CSA practices adopted by a household, *Death , Crpfail , Floods* are shocks experienced by the household considered in this study. βs Are parameters to be estimated.

3.2 Definition and measurement of Variables

Table1 Definition and Measurement of Variables used in regressions

Variable	Measurement	Source
Dependent Variable		
Number of CSA adopted	Number of CSA practices adopted by a household	Schmidt & Waibel, (2007)
Explanatory Variables		
Shocks		
Death	1= yes 0= No	Gröger & Zylberberg (2016),
Floods	1= yes, 0= No	
Drought	1= yes, 0= No	
Pests & Diseases	1= yes, 0= No	
Household Characteristics		
Distance to the market	Distance in Kilometres	Arslan et al (2018),
Road type to the market	1=Path,2=Earth,3=Gravel,4=Murram,5= Tarmac	
Farm size	Continuous and measured in approximate acres.	Hassan &Nhemachena, (2008)
Number of plots	Number of farming plots	
Education level of the household head	1= Primary, 2= Secondary, 3= tertiary	Asfaw & Admassie (2004)
Gender of the household head	1= male, 0= female	Hassan &Nhemachena, (2008)
Savings	Amount of savings	

Source: Author

3.3 Sample Selection

The study used data collected from a sample of 122 households who were randomly chosen from different strata of the CCAFS end line survey of 2017. The strata were based on two different groups of farmers, i.e "participating" Climate Smart Villages and non-participating (non-CSV) villages. The households in both the CSV's and the non-CSV villages have similar characteristics in terms of climate and soil conditions, and agricultural practices. Data was collected using Open Data Kit (ODK) by students of the University of Nairobi who had earlier been trained on data collection using ODK by ILRI staff.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 General Household Characteristics

Descriptive statistics of the population is presented in table 4.1. On average, the households' head were 54.033 years with the youngest aged 25 and the eldest aged 94 years. Households headed by male were 81.15 percent whereas the other 18.85 percent were female headed households. Average household size was made up of 6 persons with the smallest household having 1 person while the largest household having 19 persons. Female headed persons had an average of 5 people while those headed by male had an average of 6 people.

Majority (29.51 percent) of the household heads were primary school dropouts with another significant (27.87 percent) having completed primary education. Only eleven household heads had completed tertiary education. Moreover, 54.10percent of the household heads had crop farming as their main occupation while 8.20 percent reared livestock. Only 13.11 percent were on salaried employment while another same proportion participated in non-farm self employment.

On average, land holdings were 4.409 hectares with the smallest land size being 0.5 hectares while the largest land size was 70 hectares. Majority 120 of the households had one plot for farming while the other two had two and three plots of farming. These plots were either owned or rented by the households. Of those who owned the pieces of land and worked on them were 54.46 percent while 45.90 of the plots worked on by the households had been rented in. Only 1.64 percent had rented out part of their farming plots.

The households had different access to different markets. These were food markets and animal markets. The food markets were fairly nearer with a mean of 3.046 kilometers as compared to the animal markets with an average of 8.839 kilometers.

Table 2: Table of Descriptive Statistics of variables used in regressions

Variable Measurement/Category	Frequency	Mean	Percentage	Min	Max
Age of the Household head					
Age of household head		54.033		25	94
Gender of Household head					
Male	99		81.15		
Female	23		18.85		
Education level of Head					
No formal schooling	10		8.20		
Primary incomplete	36		29.51		
Primary complete	34		27.87		
Secondary incomplete	14		11.48		
Secondary complete	16		13.11		
Tertiary/university incomplete	1		0.82		
tertiary/University complete	11		9.02		
Occupation of the Household head					
farming crop	66		54.10		
farming livestock	10		8.20		
salaried employment	16		13.11		
self-employed off-farm	16		13.11		
casual laborer on-farm	2		1.64		
casual labored off-farm,	11		9.02		
household chores	1		0.82		
Household size					
Overall		6.008		1	19
Male headed	99	6.333		2	14
Female headed	23	4.609		1	19
Distance in Kilometers					
Dist to food market		3.046		.003	12
Dist to animal market		8.839		2	20
Land size in hectares		4.409		.5	70
Number of plots					
One Plot	120		98.36		
Two Plots	1		0.82		
Three Plots	1		0.82		
Plot Ownership					
owned and worked	64		52.46		
owned and rented out	2		1.64		
Rented	56		45.90		

Source: Author

4.2 Shocks and Coping Strategies

4.2.1 Shocks Experienced in Nyando in the past three years

Table 3 presents summary statistics of the shocks experienced by households in Nyando in the past three years. Five types of shocks were considered in this study. These are death of a household member, whether a household has experienced drought, whether a household has experienced flooding, whether a household has experienced cases of pests and diseases on either of their livestock or crops, and sickness of a household member.

Of these shocks, sickness of household member is the highly experienced by the households with 63.11 percent of the households reporting cases of sickness of a household member in the past three years. Seventy-two (59.02 percent) of the households reported having experienced drought like conditions whereas another 58.20 percent indicated that they had experienced cases of pests and diseases. Floods and death of household members were least experienced standing at 41.80 percent and 10.66 percent respectively.

Table 3 Shocks Experienced by Nyando Farmers last 3 years

Shock	Measurement	Freq.	Percent
Death	No	109	89.34
	Yes	13	10.66
Drought	No	50	40.98
	Yes	72	59.02
Floods	No	90	73.77
	Yes	32	26.23
Pests and diseases	No	51	41.80
	Yes	71	58.20
Sickness of a household member	No	45	36.89
	Yes	77	63.11

Source; Author

4.2.2 Shock Coping Strategies

There are different coping strategies for different shocks as reported in table 4.3. However, common practices that cut across the various shocks is de-saving, taking loans and doing nothing. Different coping strategies are adopted at different levels for the various shocks. For death shock, a major 61.54 percent of those affected reported dependence on contributions from relatives and neighbors, another 15.38 percent took loans to finance the funeral ceremonies. Other coping strategies were seeking divine interventions and doing nothing.

Households affected by drought coped by replanting their crops (2.9 percent), diversifying (2.9 percent) by growing other crops that are drought resistant, and divesting 4.35 percent. Divesting involves reducing the acreage of plating. Nonetheless, some (4.35 percent) households did not adopt any coping strategy, while others (13.04 percent) resorted to irrigating their crops. Most (31.88 percent) households however, coped by de-saving. Des-saving involved selling of household assets like animals in order to finance household expenses.

Most (34.78 percent) households that were affected by crop pests and diseases coped by using agro chemicals on their own, while another 28.99 percent sought the assistance of extension providers. Interestingly, a significant 20.29 percent did not adopt any coping strategy and left their crops to be affected by the pests. Some (8.7 percent) of the affected households did as a result of despair, resorted to using their savings to buy food items from the markets as they had harvested nothing from the farms. Only 2.9 percent of the affected households took loans to replace their animals that had died while another equal 2.9 percent used their savings to restock their animals.

Households affected by floods coped differently. 32.26 percent of those affected did nothing as they watched their farms being destroyed by the floods. Another 19.35 percent used their

savings to buy foods that they would have harvested from their farms. 16.13 percent coped by diversifying into agro forestry, while another equal 16.13 percent replanted their crops. One of the households that were severely affected had to relocate and build new houses.

Table 4 presents a summary of these coping strategies.

Table 4: Shock Coping Strategies in Nyando in order of prevalence

Shock	**Coping Strategy**	Freq.	Percent
Death	Contributions	8	61.54
	Loan	2	15.38
	De-saving	1	7.69
	Divine intervention	1	7.69
	Nothing	1	7.69
Drought	Nothing	28	40.58
	De-saving	22	31.88
	Irrigation	9	13.04
	Divesting	3	4.35
	Loan	3	4.35
	Replanting	2	2.90
	diversification	2	2.90
Pests and Diseases	Pesticides	24	34.78
	Extension service	20	28.99
	Nothing	14	20.29
	De-saving	6	8.70
	Loan	2	2.90
	Re-stocking	2	2.90
	Replanting	1	1.45
Floods	Nothing	10	32.26
	De-saving	6	19.35
	Replanting	5	16.13
	Diversification	5	16.13
	Loan	2	6.45
	Reporting to Gvt	2	6.45
	Relocating	1	3.23

Source: Author

4.3 The extent of Diversification of Farm Activities

Four major categories of CSA were considered in this study, these were animal management, land management, agro forestry and improved variety of animals. The different categories of animal management include using fodder crops to feed animals, growing of improved pastures, and cross breeding of animals with higher quality breeds, whereas the improved animal category included keeping drought tolerant and fast maturing breeds of animals like goats and sheep. Also considered were pure and improved varieties of animals like cattle, sheep, goats and chicken. Both the animal management practices and animal management techniques have an effect on improvement of yields from the farms.

Under the land management practices, different practices of Conservation Agriculture (CA) were considered. These include; mulching, intercropping, terracing, crop residue retention, ridges and burns, and water catchment. For the agro forestry category, both fruit trees and other non-fruit trees that flourish in the area were considered. Agro forestry enhances farm productivity and household incomes. Thorlakson, (2011) argues that trees provide a unique coping mechanism to shocks; fruits from the trees act as the only subsistence during flooding when crops are submerged in water.

An analysis of the adoption of these practices show that land management practices is the most (97.54 percent) adopted. Animal management practices and agro forestry have been equally (96.72 percent) adopted. However, keeping of either pure or improved livestock is the least (46.72 percent) adopted practice. Table 5 shows the summary of the practices adopted by farmers in Nyando.

Table 5: Summary of CSA practices adopted by Nyando farmers

CSA Practice	Percentage of users	Components
Land Management	97.54%	Crop residue retention, inter-cropping, planting cover crops, water harvesting, building ridges and burns, mulching, terraces, hedges, and contour ploughing.
Animal Management	96.72%	Stall keeping, growing fodder crops, growing improved pastures, storing fodder, and cross breeding animals
Agro Forestry	96.72%	Mango trees, banana plants, avocado trees, other fruit trees, and non-fruit trees
Improved breeds	46.72%	Red Masai sheep, Galla goats, improved breeds of cow, and improved chicken

Source: Author

Further analysis shows that farmers are at different levels of adopting and diversification these CSA practices. Diversification helps farmers optimize their income. Davies (2010) argues that diversification of farm practices is a norm. From the data, we find that the highest level of adoption is 23 with less than a percent of the farmers adopting, while the lowest level is one practice with less than a percent of the farmers adopting. Most (22.96) percent of the farmers have adopted eight to nine practices.

4.4 Factors that influence Diversification of CSA

Table 6 presents the econometric estimation of the effect of shocks on diversification of CSA practices in Nyando. Estimation results of the truncated Poisson regression and the negative binomial regression are presented.

Table 6: Regression Results of factors that influence diversification of CSA

	Number of CSA practices adopted	
	Truncated Poisson Regression	**Negative Binomial Regression**
Death shock	-0.288*	-0.286*
	(-1.80)	(-1.80)
Drought shock	0.339***	0.338***
	(3.39)	(3.39)
Pests & disease shock	0.175*	0.174*
	(1.71)	(1.71)
Age	0.033*	0.033*
	(1.92)	(1.92)
Age^2	0.000*	0.000*
	(-1.84)	(-1.84)
Gender	-0.083	-0.082
	(-0.66)	(-0.65)
Plot Ownership (owned and worked on)	0.000	0.000
owned and rented out	0.055	0.054
	(0.21)	(0.21)
Rented	0.132	0.132
	(1.29)	(1.29)
Log of Distance to food market	-0.022	-0.022
	(-0.48)	(-0.49)
Log of Distance to animal market	0.161	0.162
	(1.21)	(1.22)
Road type to food market (Path)	0.000	0.000
Earth	0.282	0.282
	(1.27)	(1.27)
Gravel	-0.584	-0.563
	(-1.37)	(-1.36)
Murram	0.498***	0.498**8
	(2.73)	(2.73)
Tarmac	0.444**	0.443**
	(2.04)	(2.04)
Road type to animal market (Murram)	0.000	0.000
Tarmac	-0.304**	-0.304**
	(-2.37)	(-2.38)
Log of Savings	-0.045*	-0.045*
	(-1.75)	(-1.75)
Log of Loan	0.013	0.013
	(0.36)	(0.37)
Group Size	-0.043	-0.044
	(-0.67)	(-0.68)
Constant	0.965	0.967
	(1.55)	(1.56)
Mean dependent var	9.938	
SD dependent var	4.216	
Pseudo r-squared	0.161	0.133
Chi-square	60.682	48.333
Prob > chi2	0.000	0.000
Akaike crit. (AIC)	354.057	356.207
Bayesian crit. (BIC)	395.371	399.695

*T-statistic in parenthesis *** p<0.01, ** p<0.05, * p<0.1*

Source: Author

The dependent variable (number of CSA practices adopted by a household) is truncated at zero. Basic Poisson model assumes no truncation, and thereby would be inappropriate in this case. We therefore, estimated the truncated Poisson regression which takes care of the truncation.

Due to the potential problem of over-dispersion, we also estimated the negative binomial regression, to choose the best model that fits the data. Summary statistics of the dependent variable shows a mean of 9.938 and a standard deviation of 4.216 (variance of 17.775). This indicates unequal-dispersion. From this, we expect differences in the coefficients of both models as shown in the model estimates.

To chose the best fitting model, we used the Akaike and Bayesian information Criteria (AIC & BIC). The model with the lowest value of these statistics is the best fit. From the results, the TPR has values of 354.057 & 395.371 for AIC and BIC, respectively, hence the best fit model.

Both TPR and NBR are linear-log in functional form for; distance to food market, distance to the animal market, amount of savings and group size, while the rest are linear. From the coefficient estimates, we find that death shock (death of a household member) has a negative influence on the number of CSA practices adopted by a household. This could be as a result of high capital incurred by households on funerals. Additionally, households could sell their agricultural resources in order to finance the funeral. This could especially be worse if the deceased succumbed to ailments while in hospital and the medical bills associated were high.

Drought shock has a positive and significant effect on the number of CSA practices adopted by a household. These findings affirm Hassan, & Nhemachena (2008) arguments that low rainfalls make farmers to adopt irrigation techniques. Farmers could also diversify to take the advantage of different crops to thrive under different weather conditions. However, this

contradicts Martina, Smale, & Di Falco, (2016) findings that drought reduces chances of diversification of hybrid maize. Cases of pests and diseases on agricultural practices have a positive and significant influence of farmers' behavior to diversify their farming practices. This could stem from the fact that farmers wish to diversify so as to offset losses in either of the practices.

Age of the household head has a positive and significant effect on the number of CSA practices adopted. The higher the age of the household head, the higher the chances of diversifying to more CSA practices. This contradicts Roco et al, (2014) findings that younger household heads are more likely to adopt new farming technologies in Central Chile. Zilberman et al, (2012) argues that lower cognitive costs of younger farmers enable them to adopt new technologies and operate with longer planning horizon.

The distance to either animal or food markets have no influence on the number of CSA practices adopted by a household, rather the type of the road that significantly influence diversification of CSA portfolios. Access to food markets on Murram roads increases the likelihood of diversifying CSA as compared to use of foot path. Additionally, access to food markets via tarmac road increases the chances of diversifying CSA practices as compared to use of foot path. Access to animal market via tarmac road increases the likelihood of diversifying CSA practices as compared to use of Murram road.

The positive effect of the type of road to the food market could be due to reduced transactional costs which encourage diversification in order to produce sufficiently. These findings affirm Hassan, & Nhemachena (2008) findings that ease access of markets encourages farmers to diversify in order to take advantage of the market demand of agricultural outputs. The negative effect of type of road to animal market on diversification could be due to high demand for animal products like mattock and beef.

The study also finds a positive (e^-0.045=0.960) and significant effect of savings on the number of CSA practices adopted by a household. One percent increase in savings, increases the likelihood of CSA diversification by 4.5 percent. The higher the amount of savings, the higher the ability of households to finance more CSA practices.

CHAPTER FIVE

CONCLUSION AND POLICY RECOMMENDATIONS

The concept of CSA has been implemented in Nyando since 2012. Studies on impact assessment have indicated success on the project goals. However, studies on diversification and factors that influence diversification are equally important for policy purposes. Thus, this study used data collected from households sampled from CSV and non-CSV villages with similar ecological and agricultural practices. This aimed at establishing the extent of diversification of the CSA's and the effect of shocks on diversification.

Results show that farmers are at different levels of diversifying their farm practices. Different CSA practices have been adopted differently with land management being adopted by most (97.54 percent) farmers and adoption of improved animal breeds being least (46.72 percent) adopted. In spite of least adoption of improved breeds, proper animal management practices have been well adopted with 96.72 percent of farmers adopting practices in this category. This brings to light the willingness of farmers to improve their farming practices with either little knowledge or little access to artificial insemination (AI) services. Information dissemination through farmer groups and provision of extension services can go a long way in improving farmer's adoption and diversification into improved animal breeds.

Households cope differently to different shocks. The coping strategies employed include dependence on contributions and de-saving which involves selling of household assets. However, most of these coping strategies adopted are unsustainable. This indicates market failure or information asymmetry in Nyando especially on the part insurance firms. This cuts across both healthcare and crop insurance. This calls for strategies on improving the uptake of insurance cover to buffer Nyando residents against different types of shocks.

Moreover, different shocks have different effects on diversification of CSA practices. Whereas death of a household member has a negative effect, drought and cases of pests and diseases have positive effect on diversification. These could stem from the fact that households spend a lot of money on funerals which leads to financial barriers on diversifying their farm practices. The positive effect of both drought and pests and diseases could be because aggregate shocks increase the incentive for farmers to use modern farming practices to avert losses.

Additionally, age of the household head is found to positively influence diversification. This shows that elderly household heads are technology receptive and therefore, agricultural technologies can be promoted through information dissemination to household heads. Important to note is that, there is no age limit for diversification as indicated by the significant effect of age squared.

The difference in the effect of road type to either food or animal market on diversification could explain disparities in market demand. Whereas Murram road and tarmac road to food market has a positive influence, Murram road to animal market has negative effect on diversification. Despite these differences, of importance is improving road networks so as to reduce transactional cost to all actors in the different value chains. This will also encourage farmers to produce efficiently in practices in which they are comparatively advantaged.

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APPENDIX

Questionnaire

Household Demography

Name of the Respondent:

What is the age of the household head?

1. Male
2. Female

Age (years) .....

What is the highest level of education of the household head?

1. No formals schooling
2. Primary incomplete
3. Primary complete
4. Secondary incomplete
5. Secondary complete
6. Tertiary/university incomplete
7. tertiary/University complete
8. Adult education incomplete
9. Adult education complete
10. Don't know

What is the primary occupation of the household head?

1. farming crop,
2. farming livestock,
3. salaried employment,
4. self-employed off-farm,
5. casual laborer on-farm,
6. casual labored off-farm,
7. school/college,
8. non-school child,

Land Ownership

What is the size of the land owned by the household? [ ]

How many farming plots does the household have? [ ]

What is the ownership status of the plot?

1. owned and worked,
2. owned and rented out
3. rented in
4. communal land

Connectivity

What is the distance in km to the nearest.

- Local food market [ ]
- Cattle/goat/sheep market [ ]

What is the type of the road to the nearest

Local food market

1. Path
2. Earth
3. Gravel
4. Murram
5. Tarmac

Cattle/goat/sheep market

1. Path
2. Earth
3. Gravel
4. Murram
5. Tarmac

Savings

Who in the household has savings?

1. Husband
2. Wife
3. Joint husband/wife
4. Other

What is the amount of the savings in Kenya shillings?

Loans

Who in the household has an outstanding loan?

1. Husband
2. Wife
3. Joint husband/wife
4. Other

What is the amount of the loan? (KShs) [ ]

Social Capital

Who in the household is a member of a group?

1. Husband
2. Wife
3. Joint husband/wife
4. Other

How many people are there in your group? [ ]

What are the key activities of the group?

1. savings and credit,
2. Tree nursery,
3. soil improvement,
4. crop introduction,
5. fish farming,
6. small business,
7. marketing agricultural products,
8. women empowerment,
9. Other, specify

Shocks

Has the household experienced any of the following shocks in the past three years?

Shock	0= No, 1= Yes
Death of a household Member	
Drought	
Pests and Diseases	
Floods	
A member of the household falling sick	

Livestock Production

Please tell us about the livestock owned by the household as required in the table.

Livestock type	How many **animals of pure improved breed** does the household own?	How many **indigenous animals** does the household own?	How many **cross-bred animals** does the household own?
What kind of Livestock type?			
Cattle			
Sheep			
Goats			
Chicken			

Livestock Management

Please indicate which of the livestock management practice the household practices.

Livestock Management	*(0=No,1=Yes)*
Stall keeping	
Fencing	
Cut and carry	
Grow fodder crops	
Improved pastures	
Fodder storage (e.g. hay,silage)	
Cross-breeds indigenous animals with improved breeds	
Self-checks animal health	
Has animal health regularly checked by	

Land Management Practices

Please indicate which of the Land use and management practice the household practices.

Land use and management	*(0=No,1=Yes)*
Burns crop residues	
Intercropping	
Crop cover	
Micro-catchments	
Ridges or bunds	
Mulching	
Terraces	
Hedges	
Contour ploughing	

_ Agro-forestry

Tree type	number
How many mango trees does the household have?	
How many banana trees does the household have?	
How many avocado trees does the household have?	
How many other fruit trees does the household have?	
How many other (non-fruit) trees does the household have?	