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Olajide Oluwafunmisa Adeola

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Abstract

Rural households adopt several measures in order to deal with climate variations and related environmental damages. This brief discusses migration as an adaptation to climate change and the potentials that this could hold for Green Small and Medium Enterprises (G-SMEs) development and rural livelihoods improvement. The research was carried out using the farming and rural systems approach in the rural areas of Nigeria. The results suggest that failing to give attention to the implications of climate change-induced migration could pose a developmental challenge. This therefore requires various policy options including those that favour the development and establishment of green SMEs to meet the needs of farm families in different socio-economic contexts.

1.0 Introduction

The Green Economy Initiative looks promising for Africa because it focuses on green investments in priority sectors like natural resources. In the case of Sub-Saharan Africa, natural resources particularly land is the 'gold mine' from which over 60 percent of the population directly or indirectly makes a living. The use of land in production activities which lead to national food supplies and foreign exchange earnings is the center piece of rural livelihood. Several forms of small and medium scale processing and marketing activities form alternative income generating sources for rural households, particularly smallholder farmers. Smallholder farmers form the back bone of the agricultural economy in most SSA countries, but in most countries the sector is a struggling one even though it has a lot of potentials. For example, in Nigeria it was neglected for several decades while the economy depended on crude oil; yet during these years it supplied 40 percent of Nigeria's Gross Domestic Product (NBS, 2006a).

Apart from direct macro-economic planning neglect of the sort mentioned above, a major issue which the sector faces across Africa is climate change. Climate change was thought of in the past as a future occurrence; but the future is here today, the evidence and impact of climate change are reflected in extreme temperature, droughts, heavy rainfall, floods and severe weather storms. These shocks are becoming the norm in several African countries leading to loss of farm lands, livestock resources, homes and livelihoods. These translate to reduced food production, reduced income and reduced asset base. In other words, the poverty trap is tightened and the poverty cycle reinforced. This appears as a bi-directional cyclical relationship because most rural people not only live below their national poverty lines but also live in environments which lack proper amenities that can support a high standard of living; as such the level of vulnerability is high. The existence of climate variability and shocks threatens their very existence. It is important, however, to mention that people who depend on nature also have a wealth of experience and knowledge on its use and management and can often determine the possibility of it re-bouncing from a harsh condition. They have also developed uncanny ways, indigenous methods of reading the weather and noting changes.

The impact of climate shocks easily takes a severe effect on rural communities because production systems which include tree felling, bush burning, and other ecosystems unfriendly approaches are often practiced. As noted by

Edame et. al, (2011) climate change will negatively affect crop yield, stability of food supplies, and the ability of people to access and utilize food in many parts of the developing world. Climate change affects food and water resources that are critical for livelihood in Africa where much of the population especially the poor, rely on local supply systems that are sensitive to climate variation. The disruption of existing food and water systems will have devastating implications for development and livelihood (Aworemi et al, 2011). In the event of severe shocks households in rural communities tend to seek off-farm/off-household opportunities to tie them over difficult seasons. Traditionally, they diversify risks by planting several crops, developing a side-trade, taking on jobs with regular payment and migrating. It is however becoming more common to have more households opt for migration as a result of climate shock impact on the farm and other means of livelihoods (Machiori, 2012).

Migration may be defined as the movement of people from one location to the other for economic, social or political reasons (Sinha, 2005, Jolly and Reeves, 2005). Migration could be the end result of a process and it can be induced by an event such as extreme climate shocks. According to Marchiori et al, 2012, the analysis of the impacts of climate change has brought to light many inconvenient truths, part of which is the inducement of human migration as a result of climatic forces and fluctuations. Ravenstein (1889) was one of the first to suggest that various factors, including "an unattractive climate" tend to push persons from one area to another area. With regard to the effect of climate on migration, other things being equal, climate should operate as a "push" or as a "pull" factor, either attracting or repelling migrants (Lee, 1966). Although there are no assurances of economic success at the destination, it is often considered a viable option because the migrant, if successful, can support the family at difficult times while helping at least one other member to have an opportunity for a better life. Migration is a suitable and sustainable measure, especially in the absence of an alternative effective and efficient adaptation strategy; except that it leads to structural changes in rural communities which may not support community development or growth.

While the challenges associated with climate change are obvious one must not be oblivious of its many opportunities. The most notable opportunities are the call for natural resources and related services valuation, alternative energy sources and sustainable ecosystem based approaches to agricultural production and climate variability adaptation. This calls for a paradigm shift –Greening the Economy; the content of the Green Economy Initiative makes it suitable and adaptive to rural areas. The big question however is "how

should green growth be operationalized in rural Africa? This calls for an identification of opportunities and challenges for transitioning into a rural green economy to help diversify rural employment, develop green jobs and provide alternative sources of income other than the farm. The new drove of climate change–induced migration could be a major threat to the Green Economy Initiative. If the ‘future we want’ is truly to be created then Green Small and Medium Scale Enterprises (G-SMEs) need to be offered within a complete policy strategy which will be acceptable to rural people.

It is based on this premise that this study seeks to answer the question on how Green SMEs can be introduced as an alternative option to climate change adaptation and hence stem the tide of climate change induced migrants while enhancing rural livelihoods and development. This calls for a detailed understanding of the current development in order to offer future strategies that will lead to a successful transition to a Green Economy in rural Africa. In this context, the following research questions will be answered.

- What climate variability shocks are likely to induce migration in rural households within different socio- economic context?
- What is the nature and pattern of CC-IM migration experienced?
- What impact does climate change induced migration have on resource use efficiency of rural households?
- What impact does climate change induced migration have on the living standard of the households?
- What green SMEs opportunities are available and what possible impact could these have on family income hence sustainable livelihood?
- What future policy strategy options are required to make green SME opportunities a viable alternative to migration?

1.1 Research Objectives

The general objective of the research is to examine the occurrence of climate change induced migration and the implications it has for the development of Green SMEs in the study area.

In line with this and following from the questions in the previous paragraph, the research objectives are to:

- Characterize rural households based on demographic and economic variables and identify different drivers of CC-IM.

- Profile the nature and direction of climate change induced migration among rural households.
- Examine the effect of climate change induced migration on resource use-efficiency of migrants' household.
- Examine the effect of climate change induced migration the living standard of migrants' households.
- Identify, profile green SMEs options and the possible impact on family income.
- Suggest Green SMEs policy options that will enhance income and sustainable livelihoods.

The research is carried out in Nigeria- the largest populous African country, rich in natural resources but also very dependent on agriculture. The need for a transition is apt because it is traditionally a net-migrating country and the recent prognosis on climate variability indicates that current production trends will be severely affected with increases in temperature and rainfall (BNRCC, 2011). The challenge of climate change and global warming is enormous in Nigeria due to widespread poverty, prevailing slash-and-burn agriculture, erosion and burning of firewood and farm residues (Ajetomobi et al, 2010). The evidence of climate change in Nigeria is seen in the extreme and unusual weather events for example, weather-related disasters have become more frequent in the past four decades and the trend continues (NASPA-CCA, 2011). These extreme events have led to dislocation of families, destruction of farmlands, infrastructure and loss of lives as was experienced in some parts of the country in 2012.

The Green Economy Initiative includes activities that will lead to poverty reduction and sustainable agriculture-two key issues which are relevant to the country. Also several studies linking migration and climate change have been qualitative in nature (Kerry et al, 2012, Janssen and Ostrom, 2006); this study adds to the body of knowledge by taking a quantitative approach and by going a step further to simulate possible policy strategy options. Despite the development in quantitative approaches, climate change and migration are under researched; beyond adding to the body of knowledge on the link, this study includes implications for G-SMEs development and seeks to offer practical development options for rural livelihood. Often most studies use a partial approach focusing only on the production sector (Reuveny R, 2007, Boubacar, 2010; Fatuase and Ajibefun, 2013; and Ahmed et al 2016). Here, the Farming and Rural Systems Approach is used (Doppler, 2002). The approach puts the people at the center. Finally, this research is necessary for rural transformation and agricultural development not only in Nigeria but also in Africa (Nwajiuba and Ejiogu, 2008).

1.2 Literature Review

The Concept of Migration

Migration involves both distance and time dimensions. It may be defined as the movement of people over some distance or as the crossing of a spatial boundary by one or more persons involved in a change of residence. Sinha (2005) defined it as a ubiquitous process of movement of individual or a group of people from one spatial; unit or place of residence (known as origin place) to another (called as destination place) defined by any kind of commonly agreed geographical or political or administrative boundary. Migration involves moving internally within countries, or internationally between countries (Jolly and Reeves 2005). The move could be for the short or long term, for economic, political or social reasons; it may be regular (conforming to legal requirements) or irregular. The migrant may have varying degrees of choice over whether or not they move – the decision may be somewhere between "forced" and "voluntary.

Kosinsky and Prothero (1975) categorized migration according to time, for temporary or permanent migration; boundary crossed, for internal and external/international; distance, for long and short term migration; members involved, for individual or mass migration or; decision making, for voluntary or impelled migration; social organization, for family, class and individual migration; political organization, for sponsored and free migration; causes, for economic and non- economic; and aims, for conservative and innovative as the basis for migration classification. Migration can also be categorized depending upon the type of political boundary. The major difference is simply between internal and international migration (Ghosh, 1987). When migration takes place within a country by crossing either village or district or state boundary, it is known as national or internal migration and the persons associated with it are called in-migrants and out-migrants. When migrants cross international boundary, it becomes international migration (Sinha, 2005). According to length of time, migration could be classified as short-term and long-term migration as well as permanent, semi-permanent and temporary migration (Chandna, 1998). Depending upon length of distance migration may also be classified as short-distance or long-distance migration. However, Newman and Matzke (1984) states clearly that moves of greater distances cannot be taken as a criterion for classifying migration unless the moves cross a boundary. In other words, moves of small distances are regarded as migration as long as it crosses a boundary.

Spatial approach of classifying migration is done on the basis of local level (such as rural to rural, rural to urban and commuting population), regional level, national level and international level migration. Depending on rural-urban nature of the area migration becomes: rural to rural, rural to urban, urban to urban and urban to rural (Mabogunje, 1970, Sada, 1984). Depending on decision-making approach, migration is known as voluntary migration or free migration (usually small in number), instigated or forced migration (when the migrants have no choice in whether they go or stay), and impelled migration (when they retain some power of decision). Depending on the number, migration can be classified as individual or group of people. Similarly, migration could also be classified on the basis of occupational mobility. Persons especially workers generally move from one occupation to another (Sinha, 2005). For instance, migration may be from agricultural to industry.

Migration: The 'Push'-'Pull' Covariates

Migration has been a mechanism by which humans have tried to adapt to the effects of climate change. Environmental degradation, including desertification and coastal erosion, which are closely associated with increase in climate change, also exacerbates problems, such as loss of crops and fisheries, arising in largely rural, marginal economies that have had histories of migration. In Nigeria, for example, a large number of people are directly involved in agriculture and fishing which tends to make them sensitive to environmental changes. Martin (2010) argues that even without climate change, coming years are likely to witness continuing large-scale migration out of the agricultural sector, particularly in developing countries where farm incomes are significantly lower than non-farm incomes. Climate change is likely to accelerate this pace of migration. Several economic models (Olusina and Odumade, 2012; and Ezenkwe, 2013) project that climate change will have more effect on farm production as a result of higher temperatures. However, far more people who depend on agricultural production in the rural areas would be displaced than those likely to find jobs in the new farming areas. Gimba and Kumshe (2011) stated that in recent years, the rate of rural-urban migration has become alarming; in many developing nations, there had been a rapid growth of urban population far more than that of rural population. Nigeria is a typical example of this, where there had been a tremendous expansion of urban centers (Nnadi *et al.*, 2012).

In Nigeria, 1974 rural population was 75 percent of the total population but by 2001 urban population had assumed a high dimension of 44 percent of the country's population. This rapid urban growth portends serious implications

on the environmental and the well-being of the society. Rural-Urban migration in Nigeria became prominent during the Oil boom era of the early 1970s (Olatunbosun, 1975; Adepoju, 1979). The situation has become more intractable with the obvious dichotomy in access to modern facilities and living standards between rural areas and the urban centers (Fadayomi, 1992). This trend has continued unabated in spite of efforts at rural transformation. It is estimated that four of every five rural Africans are without reasonable access to safe water (Rimmor, 1988); and for Deavers (1992), most rural areas in developing countries especially in Africa, lack several social amenities such as electricity, good road network, secondary schools and post office, and human resources, which contrast sharply with what is obtainable in urban centers.

In Nigeria, the rural sector is distinguishable from the urban sector in terms of the respective volumes of agricultural and non-agricultural components of economic activity that take place in the two sectors. Thus, economic activity in the rural milieu revolves around the exploitation or utilization of land. It centers principally on farming, animal husbandry, poultry, fishing, forestry, food processing and cottage industry. It has been estimated that agricultural activity employs about 80 percent of the rural population in Nigeria (ADF, 2005). The unavailability of basic economic and social infrastructure such as water, roads, electricity, and health facilities due to rural-urban investment imbalance is one of the major causes of low rural employment, low agricultural productivity and low standard of living of rural people and these encourage rural dwellers to look for greener pastures believed to be in urban areas (Iruonagbe, 2009).

Although men have tended to dominate migration flows, women have not been left out of labor migration streams in Nigeria and other African societies; although they are less likely to migrate alone (Thadani and Todaro, 1984; Chant, 1992; Guilmoto, 1998; and Agesa and Agesa, 1999). In recent years, the volume and pace of rural-urban migration has greatly increased. The direction of the move has been unilateral, decided for the migrants who see the city as the only place where their aspirations for better living conditions can be satisfied (Iruonagbe, 2009).

Migration pattern has changed considerably over time, from the search for space, especially in the middle ages, to that of congestion in large cities in the modern age, especially in the last millennium (Iruonagbe, 2009). Generally, rural-urban migration has been explained as a function of several indicators which include income, socio-economic variables, gender factors, age and education among others (Hugo, 1998; Todaro, 1984; Greenwood, 1975;

Hausen, 1997; Callaway, 1967; Rempel, 1970; Caldwell, 1969 and Adepoju, 1974; Adepoju, 1977), and more important is the cost-benefit calculation between the point of sending and destination (Todaro, 1987; 1989). On this basis, the differentials in income levels between the sending and destination areas serve as the basis for such movements. The decision to migrate may involve contextual factors, such as ‘push factors’ which force migrants out of rural areas and ‘pull factors’ which attract migrants to urban areas. These factors typically reflect the relative strength of the local economies (such as the availability of public goods, or even institutional factors such as the introduction or enforcement of a system of land property rights which could act as push factors and encourage migration from rural areas for displaced workers (Katz and Stark, 1986). To Akangbe *et al.* (2006), the need for reliable fertile land, employment and steady income are the most important factors underpinning rural-urban migration.

Thousands of young men and women in search of job opportunities, better education and living conditions, and freedom from the restrictions of the more conservative way of life, migrate to the cities (Adesiji *et al.*, 2009). The fundamental condition for rural growth is that, the rural and urban sectors are regarded as aspects of the same community and that the rural areas are no longer isolated from the urban mainstream of political, economic and social activity (Iruonagbe, 2009). Iruonagbe (2009) further stated that it is mainly in the rural sector that much under-spending of planned expenditure occurs, as evidenced in the relatively low level of private and public investments in the rural areas. Unfortunately, rural dwellers bear the brunt of the incidence of fluctuating prices of their agricultural products on the world market. The consequent effect of this is the depreciating levels of income generated by rural dwellers. Thus, driven by the lack of opportunities for remunerative work, despairing of even the most minimal amenities, such as clean water, health care, good roads, electricity and fairly decent shelter and dreading the prospect of a life time of back-breaking labour for pitifully meager economic rewards, hundreds of thousands of young men and women abandon the countryside for the cities (Gimba and Kumshe, 2011).

The migration literature has come to regard rural-urban migration as “the major contributing factor to the ubiquitous phenomenon of urban surplus labour and as a force which continues to exacerbate already serious urban unemployment problems” (Todaro, 1976). According to the basic Harris-Todaro model (Todaro, 1969; Harris and Todaro, 1970), urban job creation programs are ineffective in solving the unemployment problem because they raise the expected payoffs to rural migrants and, as a result, lead to a higher, rather than lower, level of urban unemployment. Rural migrants are also

blamed for being a strain on urban infrastructures, such as transportation, healthcare and education systems, and for rising crimes and other social problems in urban areas (Liu, 2008). Gimba and Kumshe (2011) summarized some of the effects of rural-urban migration as: bringing pressure on urban housing and the environment; lessening of the quality of life due to high rate of population growth in the urban centers; overpopulation which encourages crime rate in the society and slowing down the pace of development of the rural areas.

Trends in Migration Studies

Traditionally, migration studies were devoted to investigating frequency, patterns and flows, distance and typologies of people's mobility and their assimilation in host societies. Recent explorations however, have begun to venture into studying the effects of migration and the various meanings of the migration for people themselves (Rigg, 2003). There is increasing interest in the 'migration process', which involves studying the lived reality of migrants; their migration, settlement, ethnic relations, public policies and identity construction as closely related and overlapping segments in a single process (Castles, 2000). The migration decision has been shown to be selective. Migration mainly concerns young adults who are more likely to have a positive net expected return on migration due to their longer remaining life expectancy, or because social norms require that young adults migrate in search of a better life (De Haan and Rogally, 2002).

According to Iruonagbe (2009) stated that like most themes in social change and development, the problem of rural-urban migration and its impact on agricultural development is a complex subject; agricultural development involves people, their available resources and institutions but its greatest problem has been that of low production worsened by several factors including the desertion of farming by the rural population for non-agricultural occupations in urban areas. Agricultural development cannot make any substantial progress if allowed to remain bereft of requisite human capital. In most rural areas in Nigeria, the potential labour force that could have contributed to the improvement of the rural economy has moved into the cities and nearby towns around them in search of better standards of living and benefits they presume could exist in urban centers (Aromolaran, 2013). Studies indicate that shortage in farm labour supply results in low farm productivity, this includes value, type, cost and availability of labour, farm age level of farm management (Adesiji *et al.,* 2009). This eventually culminates in poverty among rural farming communities (Anim, 2011). This situation has

been considered a major problem especially in developing countries (Gebremedhin and Switon 2001).

The impoverishment of rural areas in Nigeria is partly explainable by out-migration of able-bodied youths in search of white collar jobs in the cities. Migration of young adults from the rural to urban areas places a greater burden on the farmers (Adewale, 2005). This is attributed to the fact that farmers spend more time to cover the same area of land than when they had the assistance of the migrants, thereby being deprived of leisure time and involvement in many social activities (Ofuoku and Chukwuji, 2012). The impact of rural-urban migration is indeed a rapid deterioration of the rural economy, leading to chronic poverty and food insecurity (Mini, 2001).

The Nigerian government's efforts in agricultural development over the past three decades have failed to improve the country's economy. A review of the sector paints a gloomy picture. The poor performance of the sector is reflected in environmental degradation, mounting food deficits, and decline in both gross domestic product and export earnings, while retail food prices and import bills have been increasing. These effects have further impoverished the smallholder farmers, thereby placing them in a poverty web (Iruonagbe, 2009). The question therefore relates to, how to improve the general living conditions in rural areas in order to retain more youths who might otherwise migrate to the urban centre. In doing so, agricultural production in the country will be enhanced as labour is being retained instead of being drawn out (Nnadi *et al.*, 2012).

Climate Change and the Agricultural Sector

Climate change, once considered an issue for a distant future, has moved firmly into the present. Climate change is a long-term shift in weather conditions identified by changes in temperature, precipitation, winds, and other indicators. Climate change can involve both changes in average conditions and changes in variability, including, for example, extreme events. The earth's climate is naturally variable on all time scales. However, its long-term state and average temperature are regulated by the balance between incoming and outgoing energy, which determines the Earth's energy balance. Any factor that causes a sustained change to the amount of incoming energy or the amount of outgoing energy can lead to climate change (CACC, 2013).

Climate change has affected the earths' eco-balance. This change has been attributed to both human and natural causes with humans taking a larger portion of the blame. In its recently released Fourth Assessment Report, the

IPCC concluded there's a more than 90 percent probability that human activities over the past 250 years have warmed our planet (NASA, 2014). The anthropogenic action comes primarily from two activities: burning fossil fuels, and a smaller contribution from clear-cutting forests, known as deforestation (EDA, 2014). These human activities have increased substantially over the years with increased human population and conversion of land for agriculture purposes. These influence both the amount of incoming energy and the amount of outgoing energy and can have both warming and cooling effects on the climate. As these factors are external to the climate system, they are referred to as 'climate forcers', invoking the idea that they force or push the climate towards a new long-term state–either warmer or cooler depending on the cause of change (CACC, 2013). Climate change has far reaching environmental, social, and economic consequences.

Changing climatic conditions (especially those affecting rainfall and drought), combined with agricultural policies can reduce the sustainability of livelihoods. As livelihoods come under pressure – one part because of issues like declining soil fertility, erosion, deforestation, lack of water, greater than expected weather variability- internal and international migration have become coping mechanisms. Environmental degradation, including desertification and coastal erosion, which closely associated with increase in climate change, also exacerbates problems, such as loss of crops and fisheries, arising in largely rural, marginal economies that have had histories of migration. In rural areas, for example, greater number of people are directly involved in agriculture and fishing. This tends to make them sensitive to environmental changes. Climate change, specifically global warming, is likely to accelerate the pace of migration. Several economic models project that global warming will have more effect on the distribution of farm production than global farm output, with new areas becoming viable for farming as a result of higher temperatures. However, far more people who depend on agricultural production in the rural areas would be displaced by global warming than those likely to find jobs in the new farming areas, which are often located in developed countries where mechanization of new farm operations is probable (Martin, 2010).

Adejumo (2004) explained that rainfall is by far the most important element of climate change in Nigeria and especially in the south. Increased rainfall regime lead to flooding which in turn leads to erosion and surface run-off. Increased run-off over time causes the soil to lose a great amount of nutrient through leaching of the top soil. Finally, poor harvest is established and farm households who depend on their farm lands for sustenance look for alternative means of survival. Therefore, the impact of climate change could be measured

in terms of effects on crop growth, availability of soil water, soil erosion, incident of pest and diseases; sea level rises and decrease in soil fertility (Adejuwon 2004). Farm families therefore resort to migration since the challenge is seem as being beyond their control. The local climate variability which farmers have previously experienced and adapted to in the past is changing and the change seems to be observed and manifests in a relatively great speed.

A reduction in crop yield affects the standard of living of farm families especially those households with farming as a unilateral source of revenue. Since farmers usually sell a part of the crop yield to raise income, a reduction in crop yield affects the income and consumption expenditure thereby forcing the household to look for an alternative means to adapt. Migration again comes into the picture. Climate change according to Adejuwon (2004) has become more threatening not only to the sustainable development of socio-economic and agricultural activities of any nation but to the totality of human existence. Since many of people are relying heavily on agricultural production, even small changes in the local climates can have significant impacts on peoples' chances of survival (Machiori 2010). For rural families facing risks of weather anomalies such as drought, this strategy may imply the migration of family members to urban areas, where industry is not subject to the same risks (Stark and Lucas 1988).

Climate Change Induced Migration

The analysis of the impacts of climate change has brought to light many inconvenient truths (Marchiori et al, 2010). Part of these is the inducement of human migration as a result of climatic forces and fluctuations. Ravenstein (1889) was one of the first to suggest that various factors, including "an unattractive climate" tend to push persons from one area to another area. With regard to the effect of climate on migration, other things equal, climate should operate as a "push" or as a "pull" factor, either attracting or repelling migrants (Lee, 1966). But social scientists have not given much attention to the extent to which attractive and unattractive climates, versus economic and other social and ecological factors, are pulling and pushing persons from certain areas to other areas (Dudly et. al). These concerns have been observed and raised recently by the IPCC. In 1990, the Intergovernmental Panel on Climate Change (IPCC) noted that the greatest single impact of climate change could be on human migration—with millions of people displaced by shoreline erosion, coastal flooding and agricultural disruption. Myers (1996) pointed out that more than 200 million people will be climate migrants by the year 2050.

In most cases, it is difficult to establish a simple and direct causal link between the movement of people and the environment. The environment, including climate change impacts, is usually one of multiple factors involved in a decision to move. Other factors such as levels of human and economic development, conflict, gender, livelihood strategies, demographic trends, access to networks as well as the availability of alternatives to migration, have an impact on whether or not a person migrates and the nature of migration (CCECM, 2010). In fact, Meekings (2013) argues that the forced migration of people and the factors that influence this displacement vary significantly within each nation and are highly dependent upon their political, economic and social position. Hence, climate change is only a 'stress multiplier' in a system of 'multiple stresses' which exacerbates the pre-existing and interwoven societal processes.

Nevertheless, when engaging in migration decision-making, therefore, to the extent possible, considerations involving climate are brought into the calculus (Dudlyet, al), and as confirmed by Brown (2005), migration is and has always been a mechanism to deal with climatic stress. This might be a plausible assumption especially where the climatic stress affects in a significant manner the livelihood of people in the area. Notwithstanding this, views differ on whether migration could even be considered as adaptation, and some characterize migration as a failure of, rather than as a form of, adaptation (Drabo and Mbaye, 2011)). On the other hand, others corroborate this view by inferring that migration is a maladaptive response because the migration may trigger an increased risk for those who move and also possibly for areas towards which migrants move (Oliver-Smith, 2009). Of course there are no assurances of good fortune in the place of destination - as researchers are also increasingly pointing to the vulnerability of migrants to adverse living conditions in their urban destinations.

Climate Change, Migration and Living Standard

A household living standard is a measure of their wellbeing which involves easy access to the basic necessities of life from clean water and air, food, shelter, sanitation, safety and freedom from disease. Climate and weather extremes can lead to physical injury, food insecurity, social disruption, population displacement and spread of communicable diseases (Rogers, 2011), and all of these will have strong implication for the wellbeing of farm families. Climate change can affect migration, and by extension standard of living of farming communities either directly or indirectly.

A primary dimension along which studies of the effects of climate change on migration vary is the degree to which they are able to identify the causal

channel through which climate affects migration decisions (Wibbenmeyer, 2014). In the extreme, bad weather events as well as seasonal flooding and drought can clearly lead to migration by sweeping off rural settlements thereby forcing communities to move to other locations. In this case climate change acts as a push factor in determining migration just as favorable climate could also pull people from adversely affected areas – or it may have direct effects on migration due to increased amenity differentials between source and host countries (Wibbenmeyer, 2014). Climate may influence migration through its effects on productivity and/or wages. Nevertheless, projected migration due to climate change varies in size, and whether directly or indirectly climate change will have implication on standard of living especially in a situation where the local economy is dependent of farm production in case of productivity.

Researchers have had mixed feelings about the perceived impact of migration on the overall livelihood of households. Generally, however, migration especially in sub-Saharan Africa is seen as a mechanism of adjustment by families and goes a long way to enhance the livelihood of the household through the factor of remittances through which households have the opportunity of increasing their sources of income. Seen from this perspective, migration even as a result of climatic stress may produce a cushioning effect on the migrants' sending households, as the migrants' send stuff back home to cool the tide. On the other hand, as literature suggests migration is selective. Therefore, in times of climatic stress households send their most educated and innovative adults out as a mechanism for survival inadvertently leaving behind the aged and the infirmed who are obviously non-productive. In this situation, the local economy is affected while household living conditions are impeded.

Climate Change Induced-Migration: Evidence from Nigeria

In a study examining the existence of migration as a result of climatic variations, in Ido Local Government Area of Oyo state, households indicated that members of the family migrated to other places as a result of changes in production activities caused by effect of climate change. Most of those who moved were young male adults and they moved to places like Kwara, Ilesha, Tewure etc. to learn either a trade or continue their education. The study showed that migrants were in their productive age which could have significant effects on agricultural development in the future (Ajibade, 2015). In a similar study in Abia state, Ejiba (2015) ascertained that young men migrated as a result of land/soil erosion but that the decision to migrate was made in most cases by the households or family members and not by the individuals. In both studies; the effects on resource-use efficiency and living standards were however could not be efficiently ascertained.

1.3 Theoretical Framework

The approaches to rural migration studies have revolved around some key models: the classical two-sector model, the neoclassical and expected-income (Todaro) two-sector models, human capital models and the New Economics of Labor Migration (NELM); the NELM is reviewed below for the purpose of this study.

New Economics of Labor Migration (NELM)

The fundamental view of the new economics of labor migration is presented in Stark (1991) and Stark and Bloom (1985). Under NELM, the decision to migrate is not taken by an individual but is agreed on by the household or family members. The NELM posits that people act collectively to minimize risks, loosen constraints created by market failures such as missing or incomplete capital, insurance and labor markets; and maximize income. Migration often generates remittances as such it is seen as an intermediate investment that facilitates the transition from familial to commercial production by providing the rural households with capital and a means to reduce their risks (Mensah-Bonsu and Burger, 2000). This perspective distinguishes the NELM from other theories of migration because it changes the unit of analysis from the individual to the household and brings about new motives for migration other than maximizing income.

Among other things, households want to minimize risk by diversifying their source of income (De Haan, 2011); they achieve this by sending some member(s) of the household to another place where the income from the place of origin and destination are uncorrelated or are negatively correlated. Hence, the migrant member will support the family during bad times (like crop failure) while the family covers her migration cost and also supports her during bad economic conditions at the destination (Stark and Bloom, 1985; Stark and Lucas, 1988; Taylor, 1999). Stark (1982, 1978 cited in Stark 1991) argues that an implicit contractual arrangement exists between migrant and household. Mutual altruism reinforces this implicit contract, as do inheritance motives (i.e., non-remitting migrants stand to lose their rural inheritance) and migrants' own aversion to risk, which encourages them to uphold their end of the contract in order to be supported by the rural household should they experience an income shock (e.g., unemployment) or other misfortune in the future. Fletcher (1997); and Rouse (1991) also points to the importance of rural households-of-origin as refuges for migrants who fall ill or suffer other sorts of misfortune (e.g., trouble with the law, substance dependence, etc.) that

prevent them from working or residing at the migrant destination for extended periods of time.

Though the NELM model has many noble contributions for the understanding of migration it is also criticized for totally ignoring the role of individuals in the migration process. While the situation of the household might affect the likelihood of individuals' migration, it is also worth noting that the individual can have an important role in the decision to migrate (Hoddinott, 1994).

NELM Theoretical Model[1]

Migration involves human beings who not only own 'labor' and move along with it but also possess feelings and independent wills; as such migration cannot be treated as traded goods. This is because the decision to migrate is borne out of several factors which includes interpersonal 'livelihood' measured by income) comparisons within own reference groups. The feeling of relative deprivation or satisfaction arrived at as a result of the cost-benefit comparison can trigger migration for the purpose of changing the relative position in the same reference group, changing the reference group and or showing preference for membership in a low relative deprivation reference group. The final decision to migrate is expected to be heightened by the extent of deprivation experienced by the individual as well as the degree of income inequality in a reference group. As migration occurs, the relative deprivation perceived by non-migrants may change, thereby inducing second waves of migration. If relative deprivation is gauged through a comparison with a reference group statistic such as average income, migration by low income-relatively deprived individuals will cause this statistic to increase and thereby induce migration by other individuals who become increasingly relatively deprived.

Migration behavior of individuals also differ based on skills level; it may be assumed then that skills differ and employers have imperfect skills information. For a given profession, workers with skill S receive wages $W_P(S)$ and $W_R(S)$ from employers at P and R assuming that skill follows a uniform distribution along a unit interval; that the functions $W_P(S)$ and $W_R(S)$ are non-decreasing and linear; and S is known by employers at P and R. Based on these, for levels of S below a threshold, S*, the wage at P will be higher than the wage at R. That is, if $S < S^*$, then $W_P(S) > W_R(S)$; for $S \geq S^*$, then $W_P(S) < W_R(S)$. There will be no incentive for the lowest skilled person to migrate. But if the assumption holds that R employers cannot observe the true skill

[1] Based largely on Stark and Bloom 1985.

level of individual P workers but know the distribution of S and will pay migrants from P a wage that is equal to average productivity of migrants groups; then the threshold S* is not required, it vanishes and one of 2 corner solutions occur: either no migration at all or migration by all.

This is because highly skilled workers who migrate under perfect information may not do so if the pooled wage is too low. If they do not, the pooled wage is lowered so that the next highly skilled group does not find it advantageous to migrate.

Climate change affects labor use on farm, output and income generated. Labor migration is a counter strategy to this, provided that from time to time, household members migrate. Migration confers benefits upon those who stay behind in addition to those associated with a left ward shift in labor supply curve. Employers, opportunities in other places and images of success attracts migrants. For as long as the alternative option is perceived to be better, migration response will be generated.

1.4 Conceptual Framework

The conceptual framework above indicates that the farm-family-households are in a system where the family makes the decision about the allocation of resources which they own in order to meet their goals and objectives. The system is governed by their norms and culture. It is within this system that the families' experience climate shocks which are as a result of climate variability in the locality or environment. The shocks include drought, flooding and heavy rains, and extreme temperature. The shocks affect the farm-family-household systems in different ways because they depend on nature and may find it difficult to insure their own food security and living standard (see figures 2 and 3). The situation presents both opportunities and challenges to the farm family. In the case of adverse situations families must re-evaluate their circumstance, make decisions that will ensure their continued survival. The process generally usually results in either a re-allocation of resources (labor quite often) to off-farm/non-farm activities or migration of some household members –the household head or someone who can be economically productive. It could also be a case of hedging for the future where young adults are sent to the city to be educated, learn a trade or get an employment to support him and perhaps, hopefully the family he left. These are the two traditionally documented options. However, Green SMEs (G-SMEs) development within the Green Growth Initiative presents a third possibility which could be offered to farm families as an economically viable option while adapting to climate change shocks and mitigating the effects of

climate variability. Since the family makes decisions over its own resources, introducing several G-SMEs alternatives through several policy varieties offer them more choices for resource allocation and use efficiency for a sustainable livelihood.

But, migration seems to be the choice option because of the continued effect of high temperature, drought and flood on agricultural activities, the family and the household. In extreme temperature cases, farm activities are delayed leading to loss of crop output; loss of birds, reduced income, reduced household food supply and reduced nutrition and ultimately a poor standard of living. This cycle of events will not enhance the development of Green SMEs. The appropriate setting however can be created with a proper understanding of how climate change drives migration through its direct and indirect effects on the family's goals and decision making.

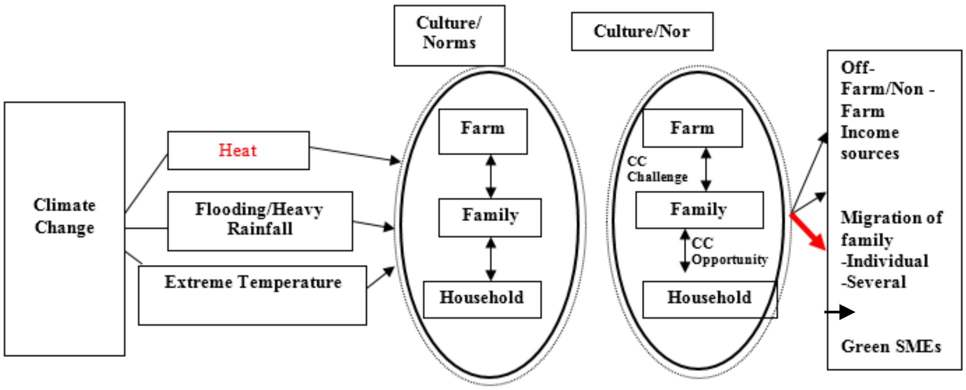
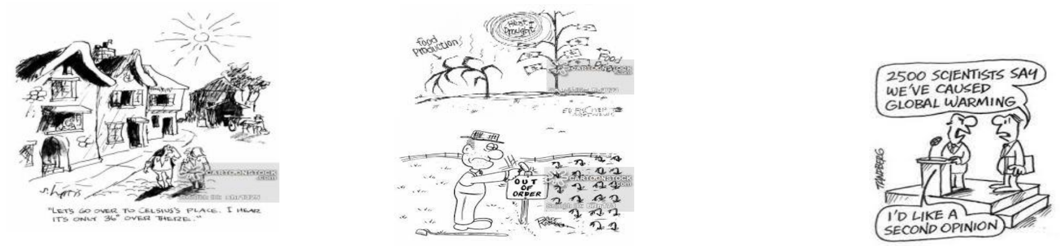


Figure 1. Flow of Climate Shock Effect within the Farm-Household-Family System.

Source: Author's Concept



CC Event

Production systems gender and vulnerable groups
Household Infrastructure Ripple effects
Direct and indirect

Policy, political will
Finance

Figure 2 Climate Change Impact Analysis Flow: Heat Stress. ***Source: Author's Concept***

CC Event

Production systems gender and vulnerable groups
Household Infrastructure Ripple effects
Direct and indirect

Policy, political will
Finance

Figure 3. Climate Change Impact Analysis Flow: Heavy Rainfall. ***Source: Author's Concept***

2.0 Research Methodology

The Farming and Rural Systems Approach (FRSA) was used in the study. The FRSA provides the philosophy, the concept and the strategy for developing and introducing solutions offered to families, communal and regional decision making bodies to solve problems at farm, household, family, village and regional levels (Doppler 2002). The research approach is based on the systems philosophy and is related to the development of farming as well as to rural development in general. It takes into consideration farmer's condition and development over time. Farming and Rural Systems Research deals with the philosophy, concepts and methodology development, testing and assessment, and lays emphasis on resource availability, their long term use and sustainability. It considers methodologies in the systems linkage and integrative potential; the strategies for farming and rural systems development; how local resources and local knowledge can contribute to this; and what roles institutions play in defining and implementing the strategies. The approach considers the farm-family-household as a system and ensures that the interventions offered are relevant to them.

A system is defined by its elements and their relations to each other. In the real world of rural and farming systems, there are clear boundaries of the systems, but at the same time comprehensive and intensive relation to the outside world. This often reaches a level where it is not easy to define the real boundary of the system. Finally, problems and objectives will define the boundary hence the type of system. The system at the family level can be considered as an open one. There are external relations which are centrally important for the survival of the system. Systems analysis as opposed to partial analysis is understood to deal especially with linkages and interrelationships within a defined complex system and its relation to the outside world (open systems).

Farming and rural systems are characterized by different problems, objectives and decision-making bodies and levels hence require different systems with relations to each other; there are vertical linkages between the hierarchies of systems. The vertical linkages between the levels and systems derive special relevance through the fact that the relations in decision making between those levels involves individuals as well as the society as a whole. At the different level of systems there is also a complex situation with respect to horizontal dimensions. Decision making takes place wherever individuals or decision-making bodies of a society will decide following their objectives and needs. At the family level (the lowest social unit in a society) the family decides on the allocation of the family resources for the best mix of activities in those units of action for which families are responsible. Since the objectives of a

family are not restricted to the farm only, but related to the needs of the family, decisions in a family with respect to resource allocation to improve living standard cannot be dealt with considering the farm only. Whether family labor or family capital goes into the farm, the household or into outside jobs depends on the expectation in each of the alternative and competing sectors of a family and the respective contribution to family objectives.

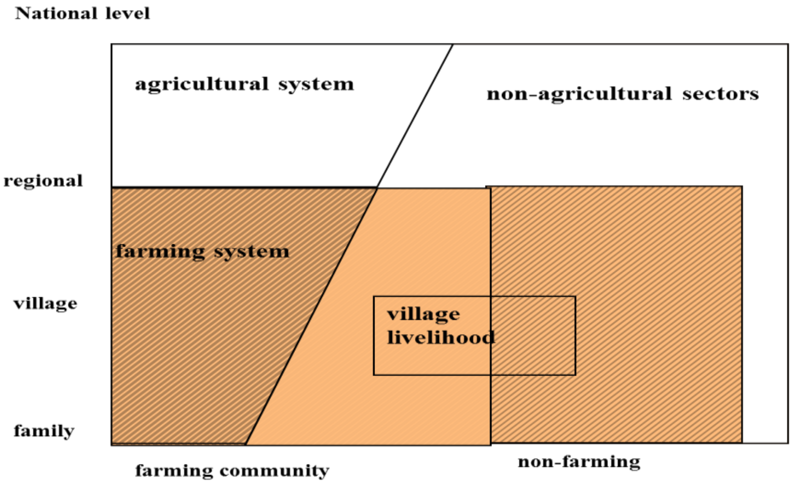


Figure 4. Agricultural, farming and rural systems.

Source: Doppler, W. (1998) p 5 cited in Doppler 2002

It is for this reason that a system approach has to include the farm (production and agricultural resource use); the household (consumption and general resource use such as capital, energy, water, services); storage, processing and transportation sector (adding value to the farm products for better market prices and preparing for consumption continuously over time); and off-farm/off-household alternatives (family resource in external use and cash income to the family). As a consequence, whenever the farming family and their problems, objectives and decision making is considered, it is not enough to focus on the farm as the production unit only. At the village level it could be the physical village infrastructure, social services and allocation of resources. The same applies for water shed or regional levels (Figure 4).

2.1 Farm family as a system

Decision-making oriented research considers the family, the farm and household as one system. Those who make the decisions about the farm and the household do so in light of their problems and objectives. The family's

own resources and allocation of resources follows the objectives and refers to use on the farm, the household or off-farm household activities (Figure5). The different sectors where the family makes decisions are defined by its internal relationships and spheres of influence. Furthermore, the family may be involved with the external environment through the resource market, for its purchase or sales. Inputs for production, processing, storage, household and family supply may come from the outside world and products and services may go out of the farm and family. In this regard, the G-SMEs innovation should be such that it has a positive impact on the needs of the decision makers and through it they are able to meet their long and short term goals. The horizontal relationship gives an indication of the sphere of gender interactions within the household. The complexities of these relations are defined by both social relations within the family; and institutions and socio-cultural norms. The activities in the different sectors could overlap significantly which also implies that the demarcation of gender roles and general relations fluctuates with changes in these sectors.

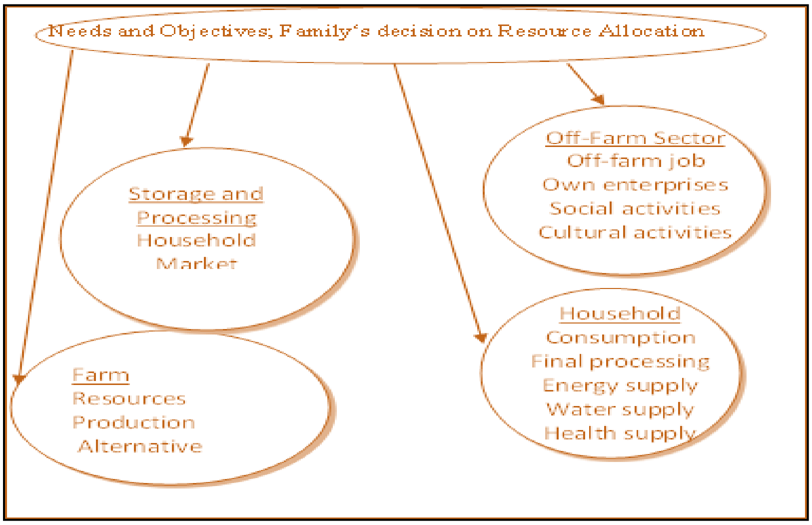


Figure 5 Horizontal Relationships in the Farm-Family-Household System.

Source: Doppler, W. (2000) p 14 cited in Doppler 2002

2.2. Criteria for living standard

Living standard is a complex parameter and is composed of several aspects (Doppler, 1997, cited in Akinsanmi, 2005). This is determined by a set of criteria which consists of family income, cash and liquidity, degree of independence from resource owners, food supply and food security, supply of housing, sanitary equipment, energy and clothing as well as health condition, education and qualification and social security. These criteria involve both social and economic aspects and both quantitative and qualitative values. The living standard criteria will be used to measure the economic success and security of the farming systems. A summary of these will give the final socio-economic context of the system.

Table 1. Living Standard Criteria:

S/N	Components	Description
1	Family income	This is the total of farm, household and off-farm/off-household income. Cash family income is the cash part of family income (excluding subsistence and imputed values)
2	Cash and liquidity	Ensuring that cash is available at the point in time when essential duties require cash, such as ensuring an existence minimum, ensuring payment for external resources (land, water, credit) if otherwise those needed resources would not be available in the future or own resources (e.g. land, livestock) would be lost; ability to make payment for health services.
3	Independency from resource owners	Dependencies of families on other individual persons, families or organizations are often related to provision of resources (land, water, credit), means of production (seed, fertilizers, pesticides) or to selling or processing of products.
4	Food supply and food security	This includes the amount and quality of supply of food from the farm as well as from the market over time.
5	Supply of water, housing, sanitary equipment, energy and clothes	Amount and quality of water as well as the resource required to ensure availability is central to the level of living standard. While housing and clothes are often of less importance, the sanitary conditions require attention.
6	Health conditions of the family	In insuring against minimal health problems, the amount and quality of food and water supply as well as the sanitary behavior are the main prophylactic sectors which will have to be related to curative measures using own or local knowledge and natural potential as well as modern medicine.

7	Education and qualification	Education and qualifications add to new dimensions and possibilities to experience, and knowledge from the family and own society. It is a long term issue and is relevant for decision making for all remaining in the farming business as well as for those seeking employment outside their farms.
8	Social security and safety	To ensure the survival or well-being of older people, widows, orphans and handicapped, many family decisions are made to provide the economic base for them. This is done by accumulating capital in different forms, higher education for children and social norms.

2.3. Survey design

The survey was designed to obtain information which would inform strategy or policy decisions and provide the kind of knowledge that will make interventions suitable to the conditions of respondents. The survey was carried out according to a statistical plan embodying random selection of households. The questionnaires were designed to give information on different aspects of respondent's lives and were administered using the participatory approach. A schematic representation of the survey plan is shown in Figure 6.

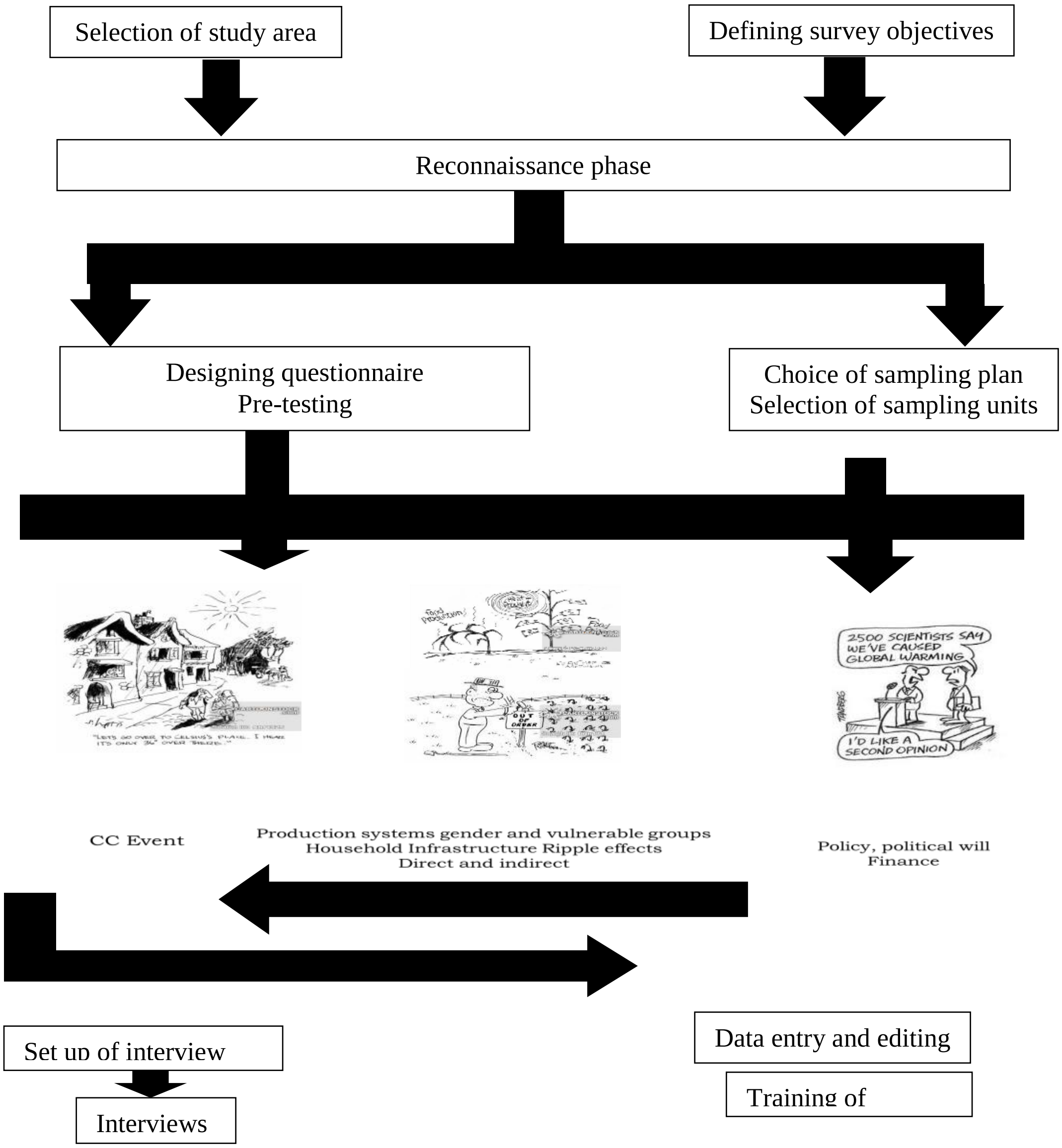
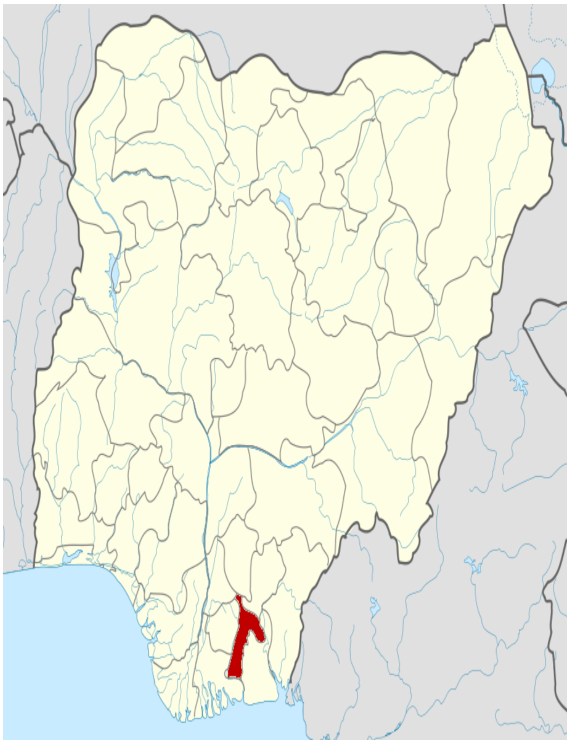


Figure 6. Planning a survey: sampling and questionnaire. **Source:** *Doppler,W.et al (2003) cited in Akinsanmi, p18*

2.4. Study Area

The study was carried out in Abia state. The state lies approximately within latitudes 4° 40' and 6° 14'north, and longitudes 7° 10' and 8° east (figure 7). It covers a land mass of 6,320 kilometers square, and has a population of 2,833,999 according to the 2006 population censors; the population density is 450/km^2. There are three Agricultural Development Zones namely Aba, Umuahia, and Bende. Over the years the State has witnessed increased manifestation of climate events including flooding and soil erosion. The worst affected areas include Umuahia, Ikwuano, Ohafia, Abariba, Nkporo, Igbere, Isiukwato, and parts of Arochukwu in Bende zone; others include Umuezeukwu and other surrounding villages like Umuodeche, Nbawsi, Umuogu, Ikputu, and Agburuike in IsialaNgwa North L.G.A. Since the people of the area are predominantly farmers and depend on their farmlands for subsistence, these events which may affect their crop productivity could ginger up the people to adjust, migrate or find alternative sources of livelihood. This study sought to empirically determine the event of households migrating in response to this climate change related events and how they interact with the people's living standards. The study was carried out in Abia state because of the knowledge of the prevailing environmental situation in the area. Also, although the per capita income is about ₦30,000, a large proportion of the population depends on the natural environment for their sustenance.



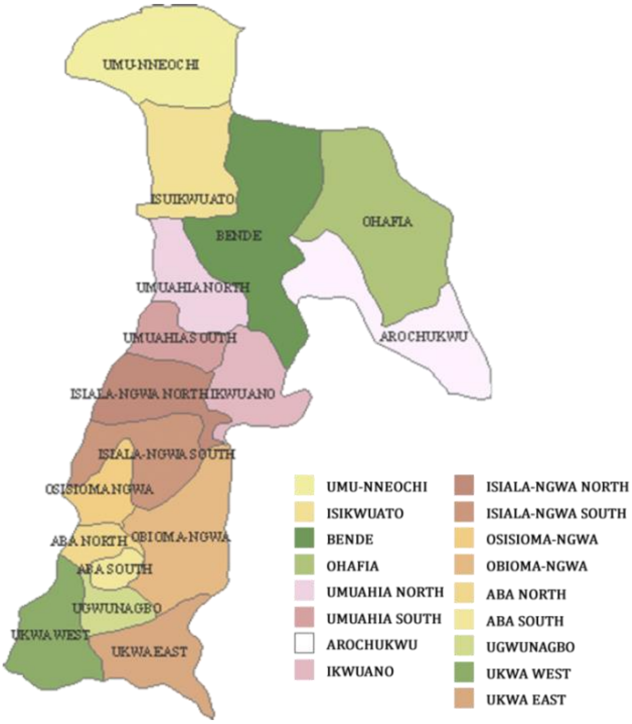


Figure 7. The Maps of Nigeria (top with Abia state inset) and Abia State (bottom) showing Bende ADP Zone.

Source: www.cometonigeria.com and www.abiastate.gov.ng

2.5. Data Source, Collection and Analysis

Primary data was used for the study. Primary data was sourced from households in the study area. Collection of data was through a structured questionnaire designed to collect information on the socio-economic characteristics of the households, household migration status, asset ownership etc.

2.5.1 Sampling Technique

Multistage sampling technique was used in the survey. Abia state and the ADP zone (Bende ADP zone) where the study was carried out were purposively chosen in the first stage based on the severity of the environmental issues in the areas; then in the second stage two Local Government Areas (LGAs Bende and Ikuwuano) were selected from the zone using simple random sampling

techniques. Simple random sampling technique was also applied to select 2 villages (Bende, Itunta, Ohafia and Abommri) from each LGA (making a total of 4 villages) and the 30 households who were interviewed from each village. In-depth interviews were conducted with the 120 households selected using structured questionnaires. The primary data consist of demographic information, production data, harvesting, sales and marketing data; consumption data on food and non-food items; evidence of climate change and migration.

2.6 Analytical Techniques

Based on the research approach and objectives, several analytical tools were employed in the analyses which covered resource availability and use, living standard, economic success of enterprises; climate shocks, migration profile, and decision making. The impact of continued development of the situation or changes on the farm-family level was assessed. The specific tools used and their implicit functional forms are discussed in the following paragraphs.

2.6.1 Principal Component Analysis

PCA is a multivariate statistical technique used to reduce the number of variables in a data set into a smaller number of 'dimensions'. In mathematical terms, from an initial set of n correlated variables, PCA creates uncorrelated indices or components, where each component is a linear weighted combination of the initial variables. Mathematically, the transformation is defined by a set of *p*-dimensional vectors of weights or loadings (1) that map each row vector $\mathbf{x}_{(i)}$ of **X** to a new vector of principal component *scores* (2) given by (3).

$$W_k = \left(\omega_1, \dots, \omega_p\right)(k) \quad (1)$$

$$t_{(i)} = \left(\, t_i, \dots t_p\right)(i) \quad (2)$$

$$t_{k(i)} = X_{(i)} \cdot W_{(k)} \quad (3)$$

in such a way that the individual variables of **t** considered over the data set successively inherit the maximum possible variance from **x**, with each loading vector **w** constrained to be a unit vector (Joliffe, 2006; Bro and Smilde, 2014).

For example, from a set of variables X_1through to X_n,

$$PC_1 = a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n$$

$$\vdots \qquad (4)$$

$$PC_m = a_{m1}X_1 + a_{m2}X_2 + \ldots + a_{mn}X_n$$

Where

a_{mn} represents the weight for the mth principal component and the nth variable (Vyas and Kumaranayake, 2006).

The uncorrelated property of the components is highlighted by the fact they are perpendicular, i.e. at right angles to each other, which mean the indices are measuring different dimensions in the data (Manly 1994, cited in Vyas and Kumaranayake, 2006). The weights for each principal component are given by the eigenvectors of the correlation matrix, or if the original data were standardized, the co-variance matrix. The variance (λ) for each principal component is given by the eigen value of the corresponding eigenvector. The components are ordered so that the first component (PC1) explains the largest possible amount of variation in the original data, subject to the constraint that the sum of the squared weights ($a^2_{11} + a^2_{12} + \ldots + a^2_{1n}$) is equal to one. As the sum of the eigen values equals the number of variables in the initial data set, the proportion of the total variation in the original data set accounted by each principal component is given by λ_i/n. The second component (PC2) is completely uncorrelated with the first component, and explains additional but less variation than the first component, subject to the same constraint. Subsequent components are uncorrelated with previous components; therefore, each component captures an additional dimension in the data, while explaining smaller and smaller proportions of the variation of the original variables. The higher the degree of correlation among the original variables in the data, the fewer components required to capture common information (Vyas and Kumaranayake, 2006).

The tool was applied in selecting the variables or components which were used to cluster the households. The initial variables were 9 and they were selected to cover the farm family household system. The initial variables were standardized before carrying out the Principal Component Analysis. After the PCA was applied 4 components were identified and the factor scores for 3 out of the 4 components were used to cluster the data using a hierarchical clustering procedure (see the Appendix I for the component scores and the rotation matrix of components). The PCA approach was also used to define climate change induced migration and living standard components; 4 components were identified for each. The 4 components identified for CC-IM are the Migrant component, the Remittance component, The Flood Shock component and the Erosion shock component. Those identified for living standard, derived from the 8 criteria set up are the Household Head Economic Viability component, the Asset/Income component, the Food Security component and the Vulnerability component. The CC-IM regression scores generated from the PCA were regressed against productivity measures, production outcome variables and each of the living standard components to estimate the effects on these.

2.6.2 Hierarchical Clustering

Cluster analysis or clustering is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). The first stage of the analysis involved a hierarchical clustering technique to group the sampled households into clusters of farming systems which are homogenous within but heterogeneous between one another. The selection of variables to be included in clustering analysis was done with regard to both theoretical/conceptual and practical considerations; only those variables that characterize the objects being clustered, and relate specifically to the objectives of the cluster analysis were included. The final set of variables used in the clustering procedure was selected through a Principal Component Analytical technique. The process yielded 4 components, 3 of which were used in the clustering procedure.

Ward's algorithm using the squared Euclidean distance was selected for the clustering algorithm. Ward (1963) proposed a clustering procedure seeking to form the partitions P_{n}, $P_{n-1,\ldots,}P_{1}$ in a manner that minimizes the loss associated with each grouping, and to quantify that loss in a form that is readily interpretable. At each step in the analysis, the union of every possible cluster pair is considered and the two clusters whose fusion results in

minimum increase in 'information loss' are combined. Information loss is defined by Ward in terms of an error sum-of-squares criterion, ESS. This procedure gave an idea of the number of clusters which would be reasonably formed from the data set.

Table 2. Descriptive of Cluster Variables for the 3 Farming Systems.

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. of mean diff.
Age	47.31 (11.05)	49.90 (11.10)	53.07 (12.77)	49.54 (11.63)	* b
Education (Years)	7.02 (3.81)	10.28 (3.04)	8.41 (3.98)	8.42 (3.86)	* a, c
Labor Hours allocated to farm	1244.42 (418.63)	1463.08 (320.35)	864.26 (465.35)	1223.61 (457.47)	*** a, b, c
Labor Hours allocated off-farm	121.85 (79.65)	170.46 (75.45)	129.10 (70.09)	139.40 (78.55)	*** a, c
Household size	4.19 (1.469)	7.03 (1.94)	7.24 (2.01)	5.85 (2.28)	***a, b
Asset value (₦)	78177.53 (170186.02)	115604.25 (148144.45)	65714.00 (105094.67)	87329.20 (149774.23)	***a, b
Farm Size (Hectare)	3.67 (4.94)	15.48 (39.84)	3.98 (3.10)	7.58 (23.45)	***a, c
Household Non Food (₦)	191289.70 (102059.91)	355382.36 (189594.53)	459596.41 (274882.53)	309460.61 (214494.57)	*** a, b
Household Food Expense (₦)	91254.23 (71443.95)	197300.51 (128820.44)	65453.79 (60954.68)	119484.17 (106794.7)	*** a, b

Note: ***significant at 1% based on Kruskall Wallis test. Values in parenthesis are standard deviation. ‘a’ significant between clusters 1 and 2; ‘b’ significant between clusters 1 and 3; ‘c’ significant between clusters 2 and 3.

The K-clustering approach was used in building the final clusters in order to have clear systems that are un-correlated. The resulting farming systems (clusters) were described and labeled based on the variables and components used. Three clusters were obtained; the description and differences are presented in table 2. The first cluster is the **Resource Poor Labor Intensive Farming System (RPLI-FS)**; the second one is the **Resource Rich Labor Intensive Farming System (RRLI-FS)** and the third one is the **Resource Poor Non-Labor Intensive Farming System (RPNLI-FS)**. All the farming systems identified derive their income mainly from farming but allocate their

resources differently. The RRLI farming systems has the highest level of education, labor, land and assets and is household food needs through market purchases better than the other two. The RPNLI has the least level of resources over all but has a slightly higher level of education and land resource compared with the RPLI. The clusters formed the basis for further analysis and the results were interpreted in a comparative manner.

2.6.3 Non-Parametric Tests

Apart from descriptive statistics using frequencies and percentages, the Kruskal-Wallis test was applied to examine the differences and compare the 3 clusters while the Mann Whitney U test was used to identify or locate specific cluster relations particularly with respect to the first and second research objectives.

The Kruskal-Wallis test: It is the most widely used nonparametric technique for testing the null hypothesis that several samples have been drawn from the same identical population. The Kruskal-Wallis test uses more information than the median test, it is usually more powerful and is preferred when the available data are measured on at least the ordinal scale. A significant Kruskal-Wallis test indicates that at least one sample stochastically dominates one other sample. The test does not identify where this stochastic dominance occurs or for how many pairs of groups stochastic dominance obtains.

Assumptions

- The data for analysis consist of K-random samples of sizes $n_1, n_2, \ldots, n_k$.
- The observations are independent both within and among samples.
- The variable of interest is continuous.
- The measurement scale is at least ordinal.
- The populations are identical except for a possible difference in location for at least one population.

The test statistic is given by

$$K = (N-1)\,\frac{\sum_{i=1}^{g} n_i(\bar{r}-\bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(rij-\bar{r})^2} \qquad (5)$$

Where:

n_i = the number of observations in group *i*
r_{ij} = the rank (among all observations) of observation *j* from group *i*

N = is the total number of observations across all groups

$$\bar{r_{i.}} = \frac{\sum_{j=1}^{n_i} r_{ij}}{n_i} \qquad (6)$$

$\bar{r} = \frac{1}{2}(N + 1)$ is the average of all the r_{ij}.
(Source: Wayne, 1990 and Macdonald, 1996)

The Mann Whitney U test: This was used to examine the location of the mean differences between the clusters. is a nonparametric test of the null hypothesis that two samples come from the same population against an alternative hypothesis, especially that a particular population tends to have larger values than the other. The assumptions for the test are:

- All the observations from both groups are independent of each other,
- The responses are ordinal (i.e. one can at least say, of any two observations, which is the greater)
- Under the null hypothesis H_0, the probability of an observation from the population *X* exceeding an observation from the second population *Y* equals the probability of an observation from *Y* exceeding an observation from *X*: $P(X > Y) = P(Y > X)$ or $P(X > Y) + 0.5 \cdot P(X = Y) = 0.5$.
- The alternative hypothesis H_1 is "the probability of an observation from the population *X* exceeding an observation from the second population *Y* is different from the probability of an observation from *Y* exceeding an observation from *X*: $P(X > Y) \neq P(Y > X)$." The alternative may also be stated in terms of a one-sided test, for example: $P(X > Y) > P(Y > X)$

The statistic is given by:

$$U_1 = R_1 - \frac{n_1(n_1 + 1)}{2} \qquad (7)$$

where n_1 is the sample size for sample 1, and R_1 is the sum of the ranks in sample 1.

(Corder and Foreman, 2014)

2.6.4 Regression Models

Several regression tools were used in achieving objectives 3, 4 and 5. The implicit models are described below. Objective 3 examined the effect of climate change induced migration on resource use-efficiency of migrants' household using binary logistic regression model. The effect of climate change induced migration the living standard of migrants' households Objective 4) was examined using logit models while GLM was used to identify, profile green SMEs options and the possible impact on family income. Linear programming was used to test the possible impact of future strategies.

Binary Logistic Regression

The model assumes that response takes 2 positive values representing success or failure. That is the presence or absence of an attribute of interest. The predictors can be made discreet factors viz
Y_i = binary 1 if the i^{th} household has a migrant and 0 otherwise. Y_i is the realization of a random variable y_i that can take the value one and zero with probabilities P_i and $1-P_i$; respectively. The distribution of y_i is called Bernoulli distribution with parameter p_i.

$P_r [Y_i-y_i] = p_i^{y_i} (1-p_i)^{1-y_i}$
$Y_i = 0,1$ $y_i = 1$ we obtain p_i, and if $y_i = 0$ we obtain $1-p_i$.

The mean and the variance depend on the underlying probability of p. Any factor that affects the probability will alter not just the mean but also the variance of the observation. The units understudy are classified according to the factors of interest into k groups in such a way that all individuals in a group have identical values/of all covariate/ homogeneous i.e 3 farming systems.

Let n_i = denote the number of observations in FS 1
Y_i = the number of units who have the attributes of interest in FS 1
Y_i = number of households with migrants in FS;
Y_i == realization of random variable y_i that takes value of 0,1…..n
If n_i observations in each groups are independent and have the same probability of having the attribute of interest then the distribution of Y_i is binomial with parameters p_i and n_i
$Y_i = B (n_i, p_i)$
The probability distribution function =
$P_r \{Y_i - y_i\} = (n_i/y_i) p_i^{y_i} (1-p_i)^{n_i - y_i}$

The above is the probability that y_i successes and n_i-y_i failures in some specific order. The combinatorial coefficient is the number of ways of obtaining y_i successes in n_i FS. Y_i is the individual variable that takes 1 or 0 if the y^{th} individual in the group is a success or failure respectively factors that affect the probability will affect both the mean and or variance of the observations $Y_i = \sum y_{ij}$

The model was applied to predict the presence or absence CC-IM based on a set of predictor variables. For example, what climate shocks and experience could lead to migration in different farming systems? The model was built to predict the presence or absence of climate change migrants based on selected variables**.** It gives the event probability of the outcome. The coefficients generated were used to estimate odds ratios for each of the independent variables in the model to tell, how much more those characteristics can lead to migration. The function is given as:

$$F(x) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}} \quad (8)$$

Where F (x) is interpreted as the probability of the dependent variable equaling a "success" or "case" rather than a failure or non-case. It is considered that there exists an unobserved continuous variable, which can be thought of as the “propensity towards” migration as a result of climate change issues, with larger values of F(x) corresponding to greater probabilities of migration.

The regression coefficients are estimated through an iterative maximum likelihood method. For each step in the analysis the variable(s) entered the –2 log-likelihood, goodness of fit, Hosmer-Lemeshow goodness-of-fit statistic, and the residual chi-square are given. Also for each variable in the equation the coefficient (*B*), standard error of *B*, Wald statistic, and estimated odds ratio (exp(*B*))are reported.

Assumptions:

- The data $x_1, x_2, ..., x_n$ are independently distributed, i.e., cases are independent.
- Distribution of X_i is $Bin(n_i, \pi_i)$, i.e., binary logistic regression model assumes binomial distribution of the response.

- It assumes linear relationship between the logit of the response and the explanatory variables; $logit(\pi) = \beta_0 + \beta X$.
- Independent (explanatory) variables can be even the power terms or some other nonlinear transformations of the original independent variables.
- The homogeneity of variance does not need to be satisfied.
- Errors need to be independent but not normally distributed.

Multinomial Logistic Regression

This is an extension of **logistic regression**, which analyzes dichotomous (binary) dependents. This is used to classify the farming systems based on values of a set of predictor variables; to better understand factors that preselect the households in given clusters. The multinomial logit model assumes that data are case specific; that is, each independent variable has a single value for each case; that the dependent variable cannot be perfectly predicted from the independent variables for any case and there is no need for the independent variables to be statistically independent from each other; co-linearity is assumed to be relatively low, as it becomes difficult to differentiate between the impact of several variables if this is not the case. The regression model uses a linear predictor function *f* (k,i) to predict the probability that observation *i* has outcome *k*, of the following form:

$$f(k,i) = \beta_{0,k} + \beta_{1,k}x_{1,i} + \beta_{2,k}x_{2,i} + \cdots + \beta_{M,k}x_{M,i} \quad (9)$$

where $\beta_{m,k}$ is a regression coefficient associated with the *m*th explanatory variable and the *k*th outcome. The regression coefficients and explanatory variables are normally grouped into vectors of size *M+1*, so that the predictor function can be written more compactly:

$$f(k,i) = \beta_k \cdot x_{i,} \quad (10)$$

where $\beta_k$is the set of regression coefficients associated with outcome k, and X_i(a row vector) is the set of explanatory variables associated with observation *i*. The coefficients are estimated through an iterative maximum likelihood method (*Yu, Huang, and Lin,* 2011 and Green, 2003; 2012)

General Linear Model (GLM) Univariate Analysis

The GLM univariate procedure provides regression analysis and analysis of variance for one dependent variable by one or more factors and/or variables. The factor variables divide the population into groups. It is used to test null hypotheses about the effects of other variables on the means of various groupings of a single dependent variable. It is also used to investigate interactions between factors as well as the effects of individual factors, some of which may be random. The GLM uni-variate procedure is used to model the value of a dependent scale variable based on its relationship to categorical and scale predictors (*Rawlings, Pantula, Dickey, and David, 1998)* .The functional form is given as:

$$Y = XB + U \text{ or } Y = b_0 + bx + u \quad (11)$$

This can be expanded to give the following:

$$Y_1 = X_{11}\beta_1 + \cdots + X_{11}\beta_1 + \cdots + X_{1L}\beta_L + \varepsilon_1$$
$$Y_i = X_{i1}\beta_1 + \cdots + X_{i1}\beta_1 + \cdots + X_{iL}\beta_L + \varepsilon_i$$
$$Y_j = X_{j1}\beta_1 + \cdots + X_{j1}\beta_1 + \cdots + X_{jL}\beta_L + \varepsilon_j$$

The matrix is given by:

$$\begin{matrix} Y_1 \\ Y_i \\ Y_j \end{matrix} = \begin{matrix} X_{11} \ldots & X_{11} \ldots & X_{1L} \\ X_{i1} \ldots & X_{i1} \ldots & X_{iL} \\ X_{j1} \ldots & X_{j1} \ldots & X_{jL} \end{matrix} \begin{matrix} \beta_1 \\ \beta_i \\ \beta_j \end{matrix} + \begin{matrix} \varepsilon_1 \\ \varepsilon_i \\ \varepsilon_j \end{matrix} \quad (12)$$

where:

Y is a matrix of outcome variables (Observed data)
X is a matrix pre-program variables or co-variates
$\beta$is a matrix containing parameters to be estimated
U or ε is a matrix containing residuals/errors.
The errors are usually assumed to be uncorrelated across measurements, and follow a multivariate normal distribution.

Endogenous Switching Regression Model

The model was used to examine self - selection in migration as a result of several factors. The general form as described by Lokshin and Sajaia (2004)

is based on the behavior of an agent with two regression equations and a criterion function, I_i, that determines which regime the agent faces[1]:

$$I_i = 1 \; if \; \gamma Z_i + u_i > 0$$
(a)

$$I_i = 0 \; if \; \gamma Z_i + u_i \leq 0$$
(b)

Regime$_1$: $y_{1i} = \beta_1 X_{1i} + Q_{1i} \; if \; I_i = 1$
(c)

Regime$_2$: $y_{2i} = y_{1i} = \beta_1 X_{1i} + Q_{1i} \; if \; I_i = 0$
(d)

Here, y_{ji} are the dependent variables in the continuous equations; X_{1i} and X_{2i} are vectors of weakly exogenous variables; and β_1, β_2, and γ are vectors of parameters. It also assumes that u_i, ϱ_{1i}, and ϱ_{2i} have a trivariate normal distribution with mean vector zero and covariance matrix which equals

$$\begin{matrix} \sigma_ŋ^2 & \sigma_{ŋ1} & \sigma_{ŋ2} \\ \sigma_{1ŋ} & \sigma_1^2 & \cdot \\ \sigma_{2ŋ} & \cdot & \sigma_2^2 \end{matrix}$$
(e)

where $\sigma_ŋ^2$ is a variance of the error term in the selection equation, and σ_1^2 and σ_2^2 are variances of the error terms in the continuous equations. $\sigma_{1ŋ}$ is a covariance of u_i and ϱ_{1i}, and $\sigma_{2ŋ}$ is a covariance of u_i and ϱ_{2i}. The covariance between ϱ_{1i} and ϱ_{2i} is not defined, as y_{1i} and y_{2i} are never observed simultaneously. It can be assumed that $\sigma_ŋ^2 = 1$ (γ is estimable only up to a scalar factor). The model is identified by construction through nonlinearities (Lokshin and Sajaia and 2004; Difalco and Veronesi, 2014). The endogenous switching regression model is used to produce selection-corrected predictions of counterfactual states in the dependent variables.

$$E\,(y_{1i} \,|A_i = 1) = x_{1i}\beta_1 + \sigma_{1ŋ}\lambda_{1i}$$
(f1)

$$E\,(y_{2i} \,|A_i = 0) = x_{2i}\beta_2 + \sigma_{2ŋ}\lambda_{2i}$$
(f2)

$$E\ (\ y_{2i}\ |A_i = 1) = \ x_{1i}\beta_2\ +\ \sigma_{2\eta}\lambda_{1i}$$
(f3)

$$E\ (\ y_{1i}\ |A_i = 0) = \ x_{2i}\beta_1\ +\ \sigma_{1\eta}\lambda_{2i}$$
(f4)

Linear Programming Model

A family-farm-household model is developed to analyze income and labor allocation responses to the introduction of G-SMES in relation to migration using a static linear programming technique.

$$Max\ Z = \sum P_i X_i - \ C_i X_i$$
(13)

Subject to

$$X_i a_{ij}\ = \ \sum_{j=1}^{m} b_i\ \ all\ j = 1\ to\ m$$
(14)

X_i > 0 all i = 1 to n

Z = the objective function which is the family income,
n = the number of possible activities,
P_i= the price per unit of the output activity;
X_i= the level of activity I;
C_i= the cost per unit of I input activity,
M= the available number of resources and constraints,
a_{ij}= the required amount of resource j in producing one unit of I, and
b_j= the amount of the j resource available.

Three basic farm-household-off-farm models are constructed to represent the three farming systems in the study area namely:

- The Resource Poor Labor Intensive Farming Systems
- The Resource Rich Labor Intensive Farming System
- The Resource Poor Non Labor Intensive Farming Systems

The components of the objective function include:

- The variable cost of crop and livestock production per unit area or livestock units (excluding hired labor costs)
- The selling prices of crops and livestock products

- The consumption of crops and livestock products has a zero value in the objective function and has to be forced in by respective conditions in the right-hand side of the model. The value of home consumption which is an income component (in kind) is externally calculated using market prices.
- Hired labor is a cost. An average farming wage rate per man day is used.
- An average off-farm wage rate for each family group in the study areas is used for off-farm income.
- Credit cost resulting from formal and informal credit supply is used.

3.0 Results

3.1 Socio-economic Characterization and Analysis of Farm-Household- Family Systems

This section identifies the different types of resources which are available to the family and are used on the farm, the household and off-farm. Human, water, land and capital; resources are described and compared. The aim is to understand the scope of and the decision making process of the family for resource allocation and use in the system.

3.1.1 Human Resource

The family size determines the availability of labor for family use in the different sectors. The average family size in the system is approximately 6. The Resource Poor Farming Systems are at opposites in terms of family size, while the Labor Intensive branch has an average of 4 members, the Non Labor intensive one has 7. The number of males and females in the active working age group are not significantly different between the clusters which suggests that labor supply could be the same but the degree of dependency differ given that the Resource Rich and Resource Poor Labor Intensive Systems have more males and females who have either exceeded the active labor age or are yet to attain it.

A high dependency level can put pressure on scarce resources within the family. The proportion of female headed households is lowest in the RRLI-farming system. Female heads of households emerge where the male is deceased or left, but the structural change in the household could expose them to negative externalities like not having access and control over production resources like land. The RPLI represent the youngest family group while the oldest is the RPNLI. Age relates to experience and the ability to take up new innovations and translate them to viable enterprises; the level of formal education also counts towards these but more importantly towards economic viability through farm and off-farm activities. The educational levels in the systems differ which could account for differences in socio-economic status. Apart from the RRLI farming system where the couples have the same level of education (an equivalent of Junior School Certificate) the women in the other systems are more educated than their husbands. This indicates that the household head and the spouse in the RRLI have an advantage in terms of getting off farm income opportunities (Table 3).

Table 3. Human Resource Availability

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Family Size	4.19	7.03	7.24	5.85	***a, b
	(1.47)	(1.94)	(2.01)	(2.28)	
Mean Number					
Male	5.93	5.63	4.63	5.37	
	(4.22)	(4.90)	(4.88)	(4.63)	
Female	5.43	4.75	4.06	4.72	
	(3.96)	(5.12)	(4.23)	(4.42)	
14-60 years old male	6.29	5.50	7.38	6.39	
	(4.75)	(6.37)	(5.63)	(5.45)	
14-60 years old female	6.00	5.50	6.88	6.13	
	(4.58)	(6.61)	(4.39)	(5.11)	
<14,>60 years old male	5.57	5.75	1.88	4.35	** b, c
	(3.95)	(3.28)	(1.46)	(3.43)	
<14,>60 years old female	4.86	4.00	1.25	3.30	* b
	(3.49)	(3.34)	(1.04)	(3.11)	
% Female Head	25.00	7.70	24.10	19.20	
Age, Head (Years)	47.31	49.90	53.07	49.54	* b
	(11.05)	(11.10)	(12.77)	(11.63)	
Age Spouse (Years)	30.10	37.46	35.91	33.90	*, a, b
	(18.35)	(13.26)	(18.83)	(17.18)	
Education Head (Years)	7.02	10.28	8.41	8.42	* a, c
	(3.81)	(3.04)	(3.98)	(3.86)	
Education Spouse (Years)	9.11	10.13	9.62	7.77	*a
	(3.86)	(2.70)	(3.60)	(4.35)	

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3.

3.1.2 Family Labor Capacity and Use

The family size and structure translates to the quantity and quality of labor available in the farming systems. While there is no significant difference in the quantity of male and female labor available during the year, the absolute values show that the RPLI have more than the others and could experience labor down times when there will be excess labor during the season. A total of 300 days were assumed to be used in a year for farm activities. The allocation to the farm or off-farm activities differs between the systems. Household heads' labor capacity and that of the spouse are considered here. The least

supply of family labor to farm and off-farm activities is exhibited by the RPNLI which may be why farm production is not an intensive labor system; the RRLI household head and spouse invest more labor to the farm than followed by the RPLI. With respect to off farm activities, the RRLI allocate the largest quantity while the RPLI allocate the least hence the RPNLI are more off-farm oriented than the RPLI. This pattern of labor resource allocation and use is reflected in the man equivalent values (Table 4).

Table 4. Family Labor Capacity and Allocation

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Male	5.93 (4.22)	5.63 (4.90)	4.63 (4.88)	5.37 (4.63)	
Man days /family/year	1779	1689	1389	1611	
Female	5.43 (3.96)	4.75 (5.12)	4.06 (4.23)	4.72 (4.42)	
Man days /family/year	1629	1425	1218	1416	
H/ Head Labor Farm (man-days)	1964.88 (661.00)	2310.12 (505.81)	1298.55 (768.76)	1916.05 (743.55)	*** a, b, c
Spouse Labor Farm (man-days)	1071.26 (962.76)	1319.03 (1111.29)	901.63 (987.66)	1110.79 (1023.08)	c
H/Head Labor off Farm (man days)	192.39 (125.76)	269.15 (119.14)	203.85 (110.67)	220.11 (124.02)	*** a, c
Spouse Labor off Farm (man days)	3.64 (26.28)	29.15 (68.71)	7.84 (23.50)	12.95 (45.42)	** a
HH Man Equivalent Farm	245.61 (82.62)	288.77 (63.23)	162.32 (96.10)	239.51 (92.94)	*** a, b, c
HH Man Equivalent Off-Farm	24.05 (15.72)	33.64 (14.89)	25.48 (13.83)	27.51 (15.50)	*** a, c
Spouse Man Equivalent Farm	100.43 (90.26)	123.66 (104.18)	84.53 (92.59)	104.12 (95.91)	c
Spouse Man Equivalent Off-Farm	.34 (2.46)	2.73 (6.44)	.74 (2.20)	1.21 (4.26)	** a

Note: ***significant at 1% ; ** significant at 55; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. ‘a’ significant between clusters 1 and 2; ‘b’ significant between clusters 1 and 3; ‘c’ significant between clusters 2 and 3.

3.1.3 External Labor

External labor is often engaged to supplement family labor during the production season. Though the costs appear not to be significantly different between systems, they have common and different areas of spending. While they all engage external labor for clearing, and plowing, the RPNLI engage labor for weeding while the RRLI spend more on fertilizer application and harvesting. The RPLI and RPNLI spend about 50 percent of what the Resource Rich system spends. This expense is a reflection of the systems relations with the input and labor markets. The average man hour employed is highest in the RPLI. Both male and female labor is engaged for different activities; the average daily rate for male labor is N1500 while that of female is N800 (Table 5).

Table 5. Expense on External Labor for Farm Production Activities

Activity	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Clearing (₦)	**14723.08**	**27154.69**	**7869.24**	17107.01	
	(22514.30)	**(54860.05)**	**(15634.56)**	(35946.88)	
Planting (₦)	3551.92	6739.31	3869.24	4664.51	
	(11049.74)	(24213.97)	(13509.22)	(16870.12)	
Plowing (₦)	**5048.08**	**13970.08**	**5696.83**	8104.51	*
	(11471.30)	**(43192.04)**	**(15315.69)**	(26908.77)	
Weeding (₦)	4844.23	3226.49	**7234.76**	4896.18	
	(13630.48)	(8540.22)	**(18948.71)**	(13771.18)	
Fertilizer Appl. (₦)	2501.92	**8475.21**	3834.76	4765.34	*
	(8501.38)	**(21954.06)**	(13515.43)	15324.00	
Harvesting (₦)	3925.00	**8103.41**	4696.83	5469.51	
	(10154.80)	**(19874.63)**	(13990.28)	(14827.14)	
Man hours	5.31	2.95	.45	3.37	
	(26.13)	(7.87)	(2.41)	(17.82)	
Total Expense (₦)	36073.08	69899.95	33787.86	46514.55	
	44978.60	123357.89	78263.742	86219.85	

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.1.4 Land Resources

Land is the most important resource among rural households because the quantity available as well as the rights attached to its availability impact on the farm family's ability to generate income and have a sustainable livelihood. Members of the 3 systems depend on land as well as the forest. But the rights attached to the land differ. In the Resource Poor systems only about 40 percent

have full rights to the land being cultivated implying that long term investment in land or soil management may not be a priority to most (Table 6).

Table 6. Land Rights and Forest Dependence

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)
% with right to sell	38.50	53.80	44.80	45.00
% dependent on forest	**84.60**	**87.00**	**93.10**	87.50
Use of Forest				
% for fuel wood	**69.20**	**61.50**	**75.90**	68.30
% for fuel wood and Palm oil	5.80	10.30	0.00	5.80
% for fuel wood, fruits and vegetables	**3.80**	**2.60**	**3.40**	**3.30**
% for fuel wood fruits, vegetables and meat	0.00	**2.60**	0.00	0.80
% for fuel wood and meat	0.00	**1.00**	0.00	1.00
% for palm oil	**1.90**	**2.60**	**3.40**	2.50
% for vegetables and fruits	**3.80**	**7.70**	**10.30**	6.70

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3.

Land rental is a business as those who have lost interest in farming or are too aged to use up their land rent the land or plantations out to farmers in the community. The Resource Rich have better access to land through rentals which explains the average hectares of land available in the system it also implies a window of vulnerability to resource owners. The degree of dependence on forest is very high across board, but still higher in the Resource Poor systems. The items for which they depend on the forest indicate some level of vulnerability particularly among the Resource Poor. The forest is a source of vegetables, fruits and proteins particularly during the lean or food insecure months of the year (Table 7).

Table 7. Land Availability

item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Unit Rent price /plot (₦)	326.45 (884.07)	215.16 (725.71)	206.90 (491.30)	261.37 (750.47)	
Renton Land/Year (₦)	2326.92 (11201.75)	14251.28 (56376.92)	3568.97 (17694.70)	6502.50 (34231.27)	
Land size rented (Ha)	.52 (1.68)	2.02 (9.87)	.348 (.91)	.97 (5.745)	
Farm Size (Hectare)	3.67 (4.94)	15.48 (39.84)	3.98 (3.10)	7.58 (23.45)	***a, b, c

Note: ***significant at 1% ; ** significant at 55; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.1.5 Capital Resources

Next to land, the availability of capital in terms of farm equipment, cash and other physical assets is important. This determines the extent to which farm families can meet both family and production obligations. An examination of the systems shows that men have better access to cash or liquid capital through their involvement in cooperatives. Contrary to expectation no spouse in any of the system indicated that they belonged to any cooperative society. But traditionally in the society local or indigenous self-help groups exist which men and women participate in and from which they can get loans. An overall view shows that the RP NLI are more indebted to lenders (cooperatives, money lenders etc) than the other systems but they have the least number of household heads being involved in cooperatives; they also have the least number of people with own houses as well as the least value of assets (Table 8).

Table 8. Assets Ownership

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Loan**(₦)**	1029.23 (±5367.76)	769.23 (±3542.68)	1793.10 (±9278.93)	1129.33 (±6063.73)	
% Involved in cooperatives (HH)	19.60	30.80	6.90	20.20	
% Involved in cooperatives (Spouse)	0.00	0.00	0.00	0.00	
% with own house	44.00	34.00	27.00	86.00	
Other Asset value (₦)	78177.54 (170186.02)	115604.25 (148144.44)	65714.00 (105094.67)	87329.20 (149774.23)	***a, b

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.1.6 Production and Marketing

The essence of production is to insure own consumption as well as monetary income to meet other obligations. A close look at the crop and livestock production systems shows that the crops and livestock are common across the 3 systems; cassava is the most important crop in the systems. The RPLI can be described as Cassava-Rice-Cocoa based system; the RRLI as the Cassava-Cocoa-Yam/Rice based system and the RPNLI as the Cassava-Yam-Maize based system. Cassava, cocoa and rice are the main cash earning crops in the system. Cassava and yam serves as both food and market products; maize is mainly consumed at home (Table 9).

Table 9. Crops and Livestock Produced in the Different Systems

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)
	Percentage	**Percentage**	**Percentage**	**Percentage**
Cassava	**75.00**	**69.20**	**93.10**	77.50
Maize	26.90	20.50	**31.00**	25.80
Cocoa	**38.50**	**51.30**	17.20	37.50
Yam	25.00	**25.60**	**34.50**	27.50
Rice	**40.40**	**25.60**	24.10	31.70
Goat	25.00	17.90	20.70	21.70
Poultry	17.30	15.40	24.10	18.30

Cocoa is an export crop which has high value for cash income. Further analysis showed that the Resource poor in the systems depend more on own production to meet household food supply the revenue generated by the RPNLI is about one-third of that generated by the RRLI while the farm revenue of the RRLI is which is about three times more than that of the RPLI. The gross margin analysis shows that resource allocation to the farm is profitable and efficient bringing rewards per unit of resource used. The only resource productivity measure where there is a significant difference is gross margin per unit of labor (Tables 10 and 11).

The marketing costs show that the RRLI and RPLI relate with the market more than the RRNLI; the least efficient system is the RPLI. The market patronized for the sale of output is the village market or markets in nearby villages and towns. The average number of trips per month indicates the degree and intensity of the relationship of farm families with the output or products market that is external to the community in particular. The RPLI are more inclined towards the market than the RRLI and RPNLI. The RRLI have a good linkage with the local ministry representative for cocoa sales throughout the year (Table 12).

Table 10. Value of Farm Production

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
[1]Out Put (kg)	2475.14 (4507.50)	9276.95 (23456.29)	1954.64 (2590.54)	4559.94 (14029.45)	*, c
Home Consumption (₦)	92128.13 (252922.98)	47286.76 (57311.59)	170300.00 (501203.35)	95444.34 (290690.41)	
Crop Revenue(₦)	335462.50 (344459.60)	1134358.00 (1289240.00)	318746.40 (509005.20)	591063.70 (886530.30)	*** a, c
Livestock Value(₦)	12020.00 (8924.60)	38012.50 (40331.39)	31833.33 (29212.44)	25637.50 (29251.41)	
Farm Revenue (₦)	380294.70 (416193.30)	1162767.00 (1287139.00)	395801.60 (583113.20)	638345.80 (903795.40)	***ac

Note: Crops whose weight in Kg could not be easily determined were omitted; example includes banana, plantain and rubber. They did not play significant roles in the income generated in the systems. $1=NGN 183

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
	Percentage	**Percentage**	**Percentage**	**Percentage**	
Bende	40.40	25.60	32.10	33.60	
Umuahia	5.80	7.70	0.00	5.00	
Ndoro	7.70	7.70	10.70	8.40	
Itunta	1.90	7.70	0.00	3.40	
Uzoakoli	1.90	2.60	0.00	1.70	
Oboru	3.80	5.10	0.00	3.40	
Other Means	38.50	43.60	57.10	44.50	
Number of Trips Per Month	2.21 (4.37)	.49 (1.34)	.55 (1.40)	1.25 (3.15)	** b

Table 11. Farm Income and Gross Margin Analysis

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Farm size	3.67 (4.94)	15.45 (39.84)	3.98 (3.10)	7.58 (23.45)	***a b c
Farm Revenue(₦)	380294.70 (416193.30)	1162767.00 (1287139.00)	395801.60 (583113.20)	638345.80 (903795.40)	***a c
External Labor expense(₦)	36073.08 (44978.60)	69899.95 (123357.90)	33787.86 (78263.74)	26746.67 (86219.85)	
Other input expense(₦)	16476.92 (25269.17)	54541.03 (97921.73)	7782.76 (18702.68)	88731.22 (61683.02)	***b c
Marketing cost(₦)	11307.69 (27090.8)	25138.46 (93160.49)	993.10 (2975.37)	13310.00 (56325.82)	**b c
Total expense(₦)	26746.67 (66758.50)	63857.69 (208064.70)	42563.72 (84848.43)	86571.22 (139378.80)	**b c
Gross Margin(₦)	316437.00 (139378.80)	1013188.00 (396950.80)	353237.80 (122344.40)	551774.60 (849217.70)	***a c
Gross Margin/ Hectare(₦)	67759.53 (37977.83)	12883.78 (25692.61)	31741.21 (56782.01)	72793.48 (112033.99)	c
Gross Margin /Capital(₦)	27.95 (112.99)	49.02 (140.01)	238.16 (1186.92)	85.60 (592.26)	a
Gross Margin /Labor(₦)	178.30 (226.98)	461.44 (508.39)	243.83 (384.07)	286.16 (393.59)	***a c

Note: Crops whose weight in Kg could not be easily determined were omitted; example includes banana, plantain and rubber. They did not play significant roles in the income generated in the systems. $1=NGN 183

Table 12. Marketing Details

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
	Percentage	**Percentage**	**Percentage**	**Percentage**	
Bende	40.40	25.60	32.10	33.60	
Umuahia	5.80	7.70	0.00	5.00	
Ndoro	7.70	7.70	10.70	8.40	
Itunta	1.90	7.70	0.00	3.40	
Uzoakoli	1.90	2.60	0.00	1.70	
Oboru	3.80	5.10	0.00	3.40	
Other Means	38.50	43.60	57.10	44.50	
Number of Trips	2.21	.49	.55	1.25	** b
Per Month	(4.37)	(1.34)	(1.40)	(3.15)	

Note: ***significant at 1% ; ** significant at 55; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.2 Living Standard Analysis

3.2.1 Family Income: This is a sum of the income generated on the farm and off farm activities; the transfers from relatives and or children should be included. The value is a summation of what is generated by the household members in this case the household head and spouse are considered. It represents the income generating power of the family owned resources and reflects the decision making abilities of the family. In all the systems the farm income is higher than the off-farm income.

Farm Income is the economic ability of a farm to provide in one year an economic surplus to be used by the farm family. It is calculated as a residual after deducting all expenses from all revenues which are not directly related to the family resources. It contributes to meeting various objectives of the family such as subsistence supply. This occurs through interaction with markets for supplies and resources, accumulation of reserves and social network. Crop is the major contributor to farm income; the stock of livestock is low but has the potential of making considerable contribution if it is expanded. **Off-farm Income** refers to all activities which take place outside the family's own responsibility of farm business; it also includes labor and all household activities that generate. The relationship between the 3 is summarized in table 13.

Table 13. Sources of Family Income

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Farm Income (₦)	316437.00 (139378.80)	1013188.00 (396950.80)	353237.80 (122344.40)	551774.60 (849217.70)	*** a, c
Off-farm Income-HH (₦)	168384.20 (798883.90)	143323.08 (281338.86)	89379.31 (137209.02)	141146.50 (551547.60)	
Off-Farm Income-SP (₦)	5538.46 (39938.41)	32615.38 (87011.38)	24827.59 (81003.56)	19000.00 (69233.98)	** c
Total off-farm income (₦)	173922.70 (798929.50)	175938.46 (310356.43)	114206.90 (157814.85)	160146.50 (557538.60)	
Family Income (FI) (₦)	490359.70 (892864.70)	1189126.00 (189940.70)	467444.70 (563466.20)	711921.10 (988086.20)	*** a
% farm income to FI	65.00	85.00	75.50	77.50	
% off-farm income to FI	35.00	15.00	24.40	22.49	
% food expense to FI	18.61	16.59	14.00	16.78	
% non-food expense to FI	39.00	30.00	98.00	43.50	

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.2.2 Cash and Liquidity/Family's Annual Cash Balance

Liquidity is the situation where cash is available at the point in time when it is needed; implies that cash requirement differs at different periods over time and the availability of cash in these periods is important. It shows the difference between cash inflow and cash out flow. The ideal is to have the cash balance at different period such as harvesting, storage etc. but since the periods overlap it is not very easy to have clear cut points for cash transfer. An annual cash balance is used to give an indication of the family's financial situation at the start of a new season. The systems have positive cash balance at the end of each year. The RPNLI are more liquid than the RPLI but both have over 50 percent of members having negative annual cash balance (Table 14).

Table 14. Annual Cash Balance

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Inflow					
Loan (₦)	1029.23	769.23	1793.10	1129.33	
	5367.76	3542.68	9278.93	6063.73	
Livestock Revenue (₦)	12020.00	38012.50	31833.33	25637.50	
	(8924.60)	(40331.39)	(29212.44)	(29251.41)	
Crop Revenue (Sold) (₦)	367077.90	1856255.00	572884.33	900797.00	*** a
	(460464.40)	(3671652.00)	(950770.33)	(2249066.00)	
Crop Revenue (consumed) (₦)	92128.13	47286.76	170300.00	95444.34	
	(252923.00)	(57311.59)	(501203.40)	(290690.40)	
Farm Revenue (₦)	380294.70	1162767.00	395801.60	638345.80	*** a c
	(416193.30)	(1287139.00)	(583113.20)	(903795.40)	
Off-farm Income (₦)	173922.70	175938.46	114206.90	160146.50	
	(798929.50)	(310356.43)	(157814.85)	(557538.60)	
Total Inflow (₦)	586862.00	2061757.00	765939.50	1109480.00	*** a c
	(964654.90)	(3634652.00)	(1084635.00)	(2310729.00)	
Outflow					
Total Farm Expense (₦)	63861.36	149606.56	42567.71	86582.58	** b c
	(66759.80)	(208081.25)	(84848.91)	(139390.47)	
Food Expense (₦)	91254.23	197300.51	65453.79	119484.17	*** a, b c
	(71443.95)	(128820.44)	(60954.67)	(106794.69)	
Non-food Expense (₦)	191289.70	355382.36	459596.41	309460.60	*** a b
	(102059.91)	(189594.53)	(274882.53)	(214494.57)	
Total Outflow (₦)	346405.29	702289.43	567617.91	515527.35	*** a b c
	(152262.01)	(306946.49)	(284062.62)	(289134.87)	
Net Cash Balance (₦)	240456.70	1359468.00	198321.60	593952.60	** a c
	(959759.10)	(3600776.00)	(1047792.00)	(2253480.00)	
% with negative balance	**55.00**	**31.00**	**54.00**	**46.00**	

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.2.3 Independence from Resource Owners

Buying, renting, hiring and similar actions have to be considered in relation to resource market conditions and economic profitability; these are indicated by rent of land and debts owed by family members (Table 15).

Table 15. Degree of Resource Dependence

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)
% no rights to sell land	61.50	46.20	55.20	55.00
Rent on Land/Year (₦)	2326.92	14251.28	3568.97	6502.50
	(11201.80)	(56376.90)	(17694.70)	(34231.30)
Loan	1029.23	769.23	1793.10	1129.33
	(5367.76)	(3542.68)	(9278.93)	(6063.73)

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.2.4 Food Supply and Food security

The quantity and quality of food supply from farm as well as the markets over time are influenced by several factors which include family size, family cycle, and resources from subsistence, production, storage and preparation. In order to meet up the families' food supply, some purchases have to be made from the market. The expense on food supply is compared and the array of expense on each food group gives an indication of dietary diversity. The dietary pattern is similar but most of them do not expend money on fruits and vegetables which they can pick from the forest; the RRLI have the highest expense on food while the RPLI which has a smaller family size compared with the RPNLI spend more; the RPNLI appear to be the most insecure in terms of food supply (Table 16).

Table 16. Annual Food Expense

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Grains(₦)	20363.08	40786.67	18238.62	26487.33	****a c**
	(26354.810	(40782.58)	(19424.73)	(31899.07)	
Roots and Tubers(₦)	16001.92	24323.08	11824.83	17696.83	**c**
	(22383.61)	(29302.39)	(16474.04)	(24016.98)	
Vegetable Oils(₦)	**8063.85**	**11160.00**	**5328.28**	**8409.00**	**c**
	(9772.61)	**(913504.77)**	**(5729.48)**	**(10570.62)**	
Fruits(₦)	**1038.46**	**8784.62**	**914.48**	**3526.00**	*****a c**
	(4095.53)	**(17792.61)**	**(2910.98)**	**(11122.19)**	
Proteins-Legumes(₦)	**6371.54**	20107.69	9024.83	11477.00	*****a c**
	(10641.80)	(24191.72)	(16073.07)	(18261.29)	
Proteins-Fish/meat(₦)	**29584.62**	**60538.46**	**17797.24**	36796.00	*****a c**
	(35962.24)	**(57039.47)**	**(25561.47)**	(45192.55)	
Alcoholic beverage(₦)	6540.00	21092.31	1990.34	10170.00	****a c**
	(21401.79)	(44066.38)	(5488.94)	(29742.83)	
N-Alcoholic beverage(₦)	3290.77	10507.69	335.17	4922.00	*****a c**
	(10574.25)	(18432.50)	(1804.96)	(13179.38)	
Total Food Expense(₦)	91254.23	197300.51	65453.79	119484.17	*****a b c**
	(71443.95)	(128820.44)	(60954.68)	(106794.69)	

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.2.5 Supply of Water, Housing Sanitary Equipment, Energy and Clothes

The supply of water impacts food security, health and the sanitary situation of the families. The source, ownership of source can affect the availability and the quality of water used in the family. Water sources such as streams and rain are available and are used by most of the farm families but the dependence on borehole water facility is low with the RRLI and the RPLI. This however does not imply that those who have its own it; it could mean that it is the only source available for household use. This is reflected by the percentage of those purchasing drinking water in each system. The type of housing and the facilities available in it reflect the nature and availability of sanitary equipment for the family.

Though over 80 percent in all the systems own the houses they live in, pipe borne water is not made available and within the RRLI and RPLI systems, modern toilet facilities are available to 66 percent, implying that outhouses are still used. The proximity of the outhouse to the main building and own

borehole water facility holds some health hazards for the families. Short term health burdens such as malaria, is generally low but the percentage who opted for hospital treatment are about 50 percent of those with medical cases in the RR and RPNLI systems; a number of the ill people combined self-medication with visits to the chemist. Energy source for cooking is mainly fuel wood but 50 percent of households in the RR and RPLI have other alternatives such as kerosene stove while the RPLI depend mostly on firewood. Multiple lighting sources are also used which include local lamps, rechargeable lamps and generators (Table 17a). Expenses on non-food items indicate that the RPNLI has the largest spending on most variables; this could be associated with the location and absence of basic facilities (17b).

Table 17a. Supply of Water, Housing, Sanitary Equipment, Energy and Clothes.

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
% with own house	84.60	87.20	93.10	87.50	NA
% with modern sanitary facilities	66.70	66.70	100.00	77.10	NA
% depend on borehole **facility**	28.80	35.90	65.50	40.00	NA
% using multiple water **source**	1.90	10.30	6.90	5.80	NA
% purchasing drinking water	36.40	48.10	81.50	52.00	NA
% with short-term health burden	24.90	23.10	20.60	23.40	NA
% choosing hospital treatment	17.30	10.30	10.30	13.30	NA
% depending on electricity	15.40	23.10	24.10	20.00	NA
% dependent on multiple lighting	23.00	38.50	48.10	34.10	NA
% dependent on gas	0.00	2.60	0.00	0.80	NA
% dependent on fuel wood	76.90	51.30	51.70	62.50	NA
% dependent on multiple energy	7.60	28.20	17.20	16.70	NA

% purchasing clothing regularly	95.40	100.00	99.30	97.5	NA
Days lost to illness	66.38 (223.87)	2.72 (5.42)	128.97 (677.24)	60.62 (366.73)	
Water purchased/day (liters)	16.38 (41.15)	154.03 (495.31)	60 (58.53)	68.32 (276.59)	***b c
Health Expense (₦)	6697.08 (8719.84)	17770.97 (19293.37)	24229.66 (25325.09)	14533.13 (18855.78)	** a b

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

Table 17b. Household Non-Food Expenses

Item	**RPLI-FS (n=52)**	**RRLI-FS (n=39)**	**RPNLI-FS (n=29)**	**All (n=120)**	**Sig. Diff. of Mean**
Clothing	20007.15 (15119.65)	31614.46 (24523.06)	**35688.55** (24458.37)	27569.2 (21844.52)	***a b
Footwear	3570.05 (7645.63)	10497.13 (14863.49)	**21593.24** (26767.61)	10176.96 (17749.88)	**a b
Rent	5372.31 (14502.91)	3847.08 (9917.12)	1885.24 (7105.59)	4033.9 (11633.92)	
Cooking utensils	3082.00 (7080.48)	10446.56 (14836.28)	**19288.41** (27377.11)	9392.033 (17599.99)	**a
Water	7882.108 (13555.72)	14076 (18919.41)	**22703.59** (19166.48)	13476.98 (17720.98)	***a b c
Energy	27530.85 (31310.87)	50344.31 (39724.66)	43715.45 (33103.25)	38856.5 (35874.36)	***a b
Health	6697.08 (8719.84)	17770.97 (19293.37)	**24229.66** (25325.09)	14533.13 (18855.78)	**a b
Repairs	5701.85 (21516.31)	10238.15 (15219.20)	**17965.66** (27190.53)	10139.90 (21676.38)	*a
Transportation	15801.46 (14096.97)	28856.51 (46906.39)	**42728.41** (43857.13)	26551.70 (36828.59)	***b c
Communication	95644.85 (51029.96)	177691.20 (94797.26)	**229798.20** (137441.30)	154730.30 (107247.30)	***a b
Total Non-Food Expense	191289.70 (102059.90)	355382.40 (189594.50)	459596.40 (274882.50)	309460.60 (214494.60)	***a b

Note: ***significant at 1%; ** significant at 5%; * significant at 10%. All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.2.6 Education and Qualification

Educational level is generally low; there is no system where either the head or the spouse went beyond secondary school level. But the women have at least one year of formal education than their spouses on the average and within each cluster are some well-educated household members (table 18).

Table 18. Educational Status of Household Heads and Spouses in Farming Systems

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
% with primary education H-head	32.70	25.60	51.60	36.70	
% with primary education Spouse	17.30	12.80	6.80	13.30	
% with secondary education H-head	51.90	64.10	34.40	51.60	
% with secondary education Spouse	36.50	51.30	41.30	42.50	
% with tertiary education H-head	0.00	10.20	13.70	6.70	
% with tertiary education Spouse	1.90	2.60	3.40	2.40	
Mean years of Education H-head	7.02 (3.81)	10.28 (3.04)	8.41 (3.98)	8.42 (3.86)	***** a, c**
Education Spouse (Years)	9.11 (3.86)	10.13 (2.70)	9.62 (3.60)	7.77 (4.35)	*a

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3.

3.2.7 Social Security and Safety

This includes family decisions made to provide economic base for those who are currently at a disadvantage such as the disabled, widows, orphans and older people. This can be achieved by accumulating capital, investing in children's education and following social norms. The amount of remittance, net remittance and value of assets and number of CCIM are used to measure social security. There is the cultural side to it where it is expected that the aged be taken care of and in the future one's own children would do the same, this can however be hampered by the level of indebtedness and the migration status of the household (Table 19).

Table 19. Social Security and Safety

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
<14,>60 years old male	5.57	5.75	1.88	4.35	** b, c
	(3.95)	(3.28)	(1.46)	(3.43)	
<14,>60 years old female	4.86	4.00	1.25	3.30	* b
	(3.49)	(3.34)	(1.04)	(3.11)	
Remittance(₦)	3103.46	4004.87	9060.69	4836.08	*** b c
	(5874.70)	(7539.29)	(11106.01)	(8237.19)	
Net Remittance(₦)	1071.15	2012.82	5889.62	2541.66	b
	(9431.81)	(8069.18)	(12099.65)	(9855.60)	
Asset value(₦)	78177.54	115604.25	65714.00	87329.20	*** a, b
	(170186.02)	(148144.45)	(105094.67)	(149774.23)	

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

Summary of Living Standard: While some variables are generally poor, the RRLI system is better off on most measurement variables while the RPLI ranks second in terms of economic success. The RPNLI is the most vulnerable system, it has the lowest value of most of the relevant variables (Table 20).

Table 20. Summary of Living Standard Analysis of Farming Systems

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Family Income (FI) (₦)	490359.70	1189126.00	**467444.70**	711921.10	*** a
	(892864.70)	(189940.70)	(563466.20)	(988086.20)	
Farm Income (₦)	316437.00	1013188.00	353237.80	551774.60	*** a, c
	(139378.80)	(396950.80)	(1223444.00)	(849217.70)	
Total off-farm income (₦)	173922.70	175938.46	**114206.90**	160146.50	
	(798929.50)	(310356.43)	(157814.85)	(557538.60)	
Off-farm Income-HH (₦)	168384.20	143323.08	**89379.31**	141146.50	
	(798883.90)	(281338.86)	(137209.02)	(551547.60)	
Off-Farm Income-SP (₦)	5538.46	32615.38	**24827.59**	19000.00	** c
	(39938.41)	(87011.38)	(81003.56)	(69233.98)	
Annual Cash Balance					
% with negative balance	55.00	31.00	**54.00**	46.00	
Net Cash Balance (₦)	240456.70	1359468.00	**198321.60**	593952.60	**** a c**
	(959759.10)	(3600776.00)	(1047792.00)	(2253480.00)	

Independence-Res. Owner					
Debt Owed	1029.23 (5367.76)	769.23 (3542.68)	**1793.10** (9278.93)	1129.33 (6063.73)	
Rent on Land	2326.92 (11201.75)	**14251.28** (56376.92)	3568.97 (17694.70)	6502.50 (34231.27)	
Food Supply and Security					
Food Expenditure (Year)	91254.23 (71443.95)	197300.51 (128820.44)	**65453.79** (60954.67)	119484.17 (106794.69)	*** a, b
Home Consumption (₦)	92128.13 (252922.98)	**47286.76** (57311.59)	170300.00 (501203.35)	95444.34 (290690.41)	
Supply Non- Food Needs					
Non food Exp. (Year)	191289.70 (102059.91)	355382.36 (189594.53)	**459596.41** (274882.53)	309460.60 (214494.57)	*** a, b
Health Expense	6697.08 (8719.84)	17770.97 (19293.37)	**24229.66** (25325.09)	14533.13 (18855.78)	** a b
Days lost to illness	66.38 (223.87)	2.72 (5.42)	**128.97** (677.24)	60.62 (366.73)	
Education					
Education-Head	**7.02** (3.81)	10.28 (3.04)	8.41 (3.98)	8.42 (3.86)	*** a, c
Education Spouse (Years)	**9.11** (3.86)	10.13 (2.70)	9.62 (3.60)	7.77 (4.35)	*a
Social Security and Safety					
Remittance	**3103.46** (5874.70)	4004.87 (7539.29)	9060.69 (11106.01)	4836.08 (8237.19)	*** b c
Net Remittance	**1071.15** (9431.81)	2012.82 (8069.18)	**5889.62** (12099.65)	2541.66 (9855.60)	b
Asset value	78177.54 (170186.02)	115604.25 (148144.45)	**65714.00** (105094.67)	87329.20 (149774.23)	*** a, b

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.3 Climate Change Experience and Migration Profile

3.3.1 Climate Shock Experience

Several climate change shocks were reported in the systems, the most notable or common are heavy rainfall, floods and pests as a result of change in temperature or high humidity. Cocoa and cassava farmers in particular complained about the resurgence of the black of disease of cocoa and the cassava mealy bug. It should be noted that the awareness level is higher in the RPNLI system. The frequency of the experience was mainly seasonal and the effect on the different cops cultivated differed. The results show that pest and diseases attributed to the fluctuating temperature and levels of humidity as well as floods as a result of rain fall were the most destructive in the area. Also it should be noted that most of the major crops upon which they depended for livelihoods were affected. The cropping system is hardly mono-cultural as such multiple crops on the farm were destroyed. Several 'adaptation' strategies were mentioned but a critical assessment would show that these are coping strategies and are not environmentally sustainable or friendly (Table 21).

Table 21. Climate Shock Incidence and Experience

Items	RPLI (n=52)	RRLI (n=39)	RPNLI (n=29)	Total (n=120)
Climate Change Incidence Observed				
Nothing	15.30	12.90	3.40	10.50
Heavy Rainfall	38.50	30.80	27.50	32.70
Rainfall, Flood, Pest	13.40	12.80	38.70	21.63
Floods	17.20	15.40	6.80	13.13
Pests	3.80	12.90	6.90	7.87
High Temperature	9.60	12.80	10.30	10.90
Erosion	1.90	0.00	6.80	2.90
Frequency of Incidence				
Seasonal	11.50	7.70	20.70	12.50
Monthly	1.90	2.60	0.00	1.70
Weekly	1.90	2.60	3.40	2.50
Fluctuation	0.00	0.00	3.40	0.80
Occasionally	3.80	0.00	3.40	2.50
Crops Affected By Erosion				
Rice and cassava	5.70	7.80	3.40	5.90
Cocoa	0.00	2.60	3.40	1.70

Crops Affected by Drought				
Rice and cassava	9.50	2.60	0.00	5.10
Cocoa and Yam	3.80	5.20	0.00	3.30
Vegetables	1.90	2.60	0.00	1.60
Crops affected by pests and diseases				
Rice, cassava, Yams and Vegetables	15.30	10.40	20.60	15.10
Cassava and other minor crops	7.70	18.00	13.80	12.50
Cocoa	11.50	12.80	0.00	9.10
Vegetables	3.80	5.10	10.30	5.80
Yams	5.80	5.20	0.00	4.10
Crops affected by flood				
Rice Cassava, Cocoa and Yams	15.40	20.60	13.70	16.60
Rice and Cassava	1.90	10.30	3.40	2.50
Cassava	9.60	12.90	**34.40**	16.60
Cocoa	25.00	25.70	6.90	20.70
Yam and Vegetables	5.70	0.00	6.80	4.10
Adaptation				
Nothing	44.20	56.40	44.80	48.30
Water Supply and control	9.60	0.00	0.00	5.80
Chemicals	26.80	28.20	10.30	23.30
Cropping related	7.60	33.40	17.10	35.70

The irony of the situation is that even though 42 percent of the households have migrants as a result of the shocks related to the farm, none mentioned it as a strategy implying that the climate shocks induced the final decision which they view mainly as an overall economic, livelihood or development strategy (Table 22).

3.3.2 Migrants and Migration Profile

More male migrants than female, age wise are in the economically active bracket. Educational level is generally low, RPNLI has the highest proportion of the least educated as well as the largest of the well-educated migrants. Most migrants hold the first position in their families however, RPLI have about 8 percent of migrants being the household head or his spouse. The RPNLI have the higher of first born children migrating. Migrants are employed in different activities, the RRLI has the highest number of those who are self-employed or are trading and could remit substantial amount of money. A number of them

are employed in different jobs, not known to their family members. Typically, the migrants have remained within the state or regions in the city centers such as owerri and umuahia etc; they are relatively short distanced. The south west and south east regions are mainly represented by cities such as Lagos, and Port Harcourt; Africa region represented are Cameroon and Benin republic.

The RPNLI have a relative proportion of migrants distributed across different destinations except out of the country. The decision to have at least a member of the family migrate is made more often in the RPLI and RRLI systems while migrants in the RPNLI were self-motivated; but we see evidence of the family alone or family in conjunction with the individual making a decision on the strategy to take. The RPNLI have more migrants remitting food, money and other items to the families left behind. In all systems, at least 50 percent of the migrants care for their families by sending remittances to them. In the RPNLI food and money are the most common items remitted. The RPNLI have the best response in terms of remittance and its consistency (Tables 22 and 23).

Table 22. Migrant Characteristics and Profile

Items	**RPLI (n=52)**	**RRLI (n=39)**	**RPNLI (n=29)**	**Total (n=120)**
	Percentage	**Percentage**	**Percentage**	**Percentage**
CCI Migrants	25.00	35.90	51.70	35.00
Sex				
Male	15.40	28.20	44.80	26.70
Female	9.60	5.10	6.90	7.50
Age				
<14	0.00	0.00	3.40	0.80
14-60	24.80	36.00	47.80	33.90
Education				
Primary Education	3.80	2.60	**20.60**	7.50
JSS	7.70	5.10	**13.80**	8.30
SSCE	**13.50**	**20.50**	**6.90**	**14.20**
tertiary	0.00	2.60	**10.30**	3.40
Position in family				
First	11.50	20.50	**42.90**	21.80

Second	5.80	10.30	0.00	5.90
Third	0.00	2.60	7.10	2.50
Household head/Spouse	**7.70**	0.00	0.00	3.40
Employment status				
Unemployed	1.90	5.20	**6.90**	4.20
Trading/Self-employed	3.80	**10.30**	6.90	6.60
Teaching/civil service	**5.70**	0.00	**10.30**	1.70
Schooling	0.00	2.60	6.90	2.50
Farming	**1.90**	0.00	0.00	0.80
Unknown employment	9.60	7.70	**20.70**	11.70
D**estination**				
Within Abia	**13.50**	**13.20**	**31.00**	17.60
South east	3.80	0.00	**10.30**	4.20
South west	0.00	**5.30**	**6.90**	3.40
South South	1.90	**5.30**	**3.40**	3.40
Africa	1.90	**7.90**	0.00	0.80
Decision to Leave				
Family	**19.2**	**18.00**	7.30	14.8
Self and Family	0.00	**7.70**	6.90	4.20
Self	3.80	10.30	**27.60**	11.70

Apart from receiving, migrant families also send money and food particularly to those migrants who are yet to find a footing. Remittance purposes differ between the systems, within the RPLI, it is used for family up keep and school fees, in the RRLI is mainly for family and household need while in the RPNLI it is for farming and family up keep. The benefits in the different systems also differ though they are all related to economic viability and food security. In the RRLI and RPNLI the supply of food, extra money and the independence of the individual are important benefits while in the RPLI, the supply of food and household needs are the most important and the fact that the migrant (s) become independent. The attitude towards migration is generally positive in the system though this does not imply that households are not mindful of the loss associated with it. Several sentiments in relation to the farm and

companionship were expressed however about 10 percent of the RPNLI did not see any disadvantage in it. This gives the impression that there could be a cultural expectation to migration.

Table 23. Interaction between Migrants and Migrants' Families

Items	RPLI (n=52)	RRLI (n=39)	RPNLI (n=29)	Total (n=120)
	Percentage	**Percentage**	**Percentage**	**Percentage**
Still in touch	25.00	35.90	48.30	34.20
Remittance Sending	13.50	20.50	28.60	19.30
Frequency of Remittance				
Monthly	7.70	5.10	**10.30**	7.50
Quarterly	0.00	0.00	**6.90**	1.70
Bi-monthly	3.80	5.10	**3.40**	4.20
Yearly	3.80	0.00	**6.90**	3.30
Occasionally	0.00	2.60	0.00	0.80
Item Sent by Family				
Food	5.70	12.90	13.70	10.10
Money	**13.50**	**20.50**	**34.40**	**20.80**
Frequency of Item sent				
Monthly	**11.50**	**15.40**	**17.20**	14.20
Quarterly	**3.80**	**5.10**	**20.70**	8.30
Bi-monthly	1.90	7.70	**3.40**	4.20
Yearly	0.00	2.60	**3.40**	1.70
Occasionally	5.80	0.00	**6.90**	4.20
Use of remittance received				
Farming and upkeep	0.00	0.00	**3.40**	0.80
Up keep	**5.80**	**15.40**	**17.20**	10.80
School fees	**1.90**	0.00	0.00	0.80
Other household needs	0.00	**2.60**	0.00	0.80
Migration Benefit				
Food	**3.80**	**5.10**	**6.90**	5.00
Food and money	0.00	**5.10**	**6.90**	3.30
Independence	**1.90**	**2.60**	**3.40**	2.50
Other Household needs are met	**1.90**	0.00	0.00	0.80
Migration disadvantage				
Farm labor loss	**3.80**	**12.80**	6.90	7.50
Farm and household labor loss	0.00	0.00	3.40	0.80
Nothing	**3.80**	**2.60**	**10.30**	5.00

Company	0.00	0.00	**3.40**	0.80
Net remittance				
Positive	25.00	23.30	47.90	29.70

The disadvantages also differ because in the RRLI, the loss of family labor support was reported while in the RPNLI nothing was seen as a disadvantage- they like their migrants to leave though a few percentages miss the company of those who left. The number of migrants per system is significantly different, with the RPNLI having the highest number; they also receive the highest amount of remittances while the net value of remittance does not differ in the system as a whole, it differs between the Resource Poor Systems (table 24).

Table 24. Remittance Value Differences

Item	RPLI-FS (n=52)	RRLI-FS (n=39)	RPNLI-FS (n=29)	All (n=120)	Sig. Diff. of Mean
Number of migrants	1	2	2	1	*** ab
Value of migrant remittance	3103.46	4004.87	9060.69	4836.08	*** b c
Value family remittance	1525.00	1653.85	1351.76	1525.01	
Net remittance	1071.15	2012.82	5889.62	2541.66	**b

Note: ***significant at 1% ; ** significant at 5%; * significant at 10% . All tests are Kruskall Wallis. Values in parenthesis are standard deviation. 'a' significant between clusters 1 and 2; 'b' significant between clusters 1 and 3; 'c' significant between clusters 2 and 3. $1=NGN 183

3.3.3 Climate Shocks That Induce of Migration

This is premised on the fact that families may not immediately make the decision to migrate or ask members of the household to leave based on a singular experience. The frequency of experience, the extent of damage or loss in terms of the types of crops destroyed (economic importance; all or some of the crops) due to the climate shocks experienced are factors that could drive the decision. Several variables based on the experiences shared and recorded in the survey instrument alongside some socio-economic variables which have strong linkage to climate change response (based on the survey) were selected as climate change migration inducing variables. These variables are: The number of shocks experienced, the crops affected, estimated quantity of output lost as a direct result of the shock, different shocks, pest and disease associated

with the shock, the farm size, household size, sex of household head, farm expenditure and value of assets. These were fitted to a binary logistic model using the Forward-Likelihood ratio approach. The a priori expectation is that the severity of shocks would have a negative impact on farm output, increase expense and the probability of migration. The sex of the household head could play a role in that male heads, particularly those with some level of formal education, could leave their families to seek off-farm income opportunity in the light of devastating effects on the farm.

The results indicate that different factors induce or lead to the probability of migration as a response to climate change shocks. In the system as a whole the types of crops lost to floods, and the sex of the household head could lead to families or some of its members migrating. The odds ratios indicate that the sex of the household head, and membership of a specific farming system have the largest likelihood of inducing a decision to migrate in response to climate issues. In the Resource Poor Labor Intensive System, the same variables are significant which implies that this effect dominated the factors that could drive it in the other two systems. In the Resource Rich Labor Intensive system only the crops affected was significant but in the Resource Poor Non Labor Intensive system two new variables in addition to crops lost to floods and sex of household head, the experience of pest and disease as an off shoot of floods or droughts was also significant (Table 25).

Climate change inducing variables were selected and used to develop 4 components using PCA. The first component relates to migrants' characteristics; the second one relates to remittance, the third relates to the flood shocks experienced and the forth to crops loss (due mainly to erosion shocks). These were tested with a binary logistic model to see if they could predict the probability of climate change migration in the system as a whole and in all the systems separately. The results show that components 1, 2 and 4 would increase the probability of CC-IM in the 3 systems as a whole, but have varied effects when tested on individual systems. In the RPLI, remittance related component was the most important factor while in RRLI the relevant component was the migrant characteristics (Table 26). As such the availability of an individual matured enough and economically viable will likely lead to out migration from the community.

Table 25. Climate Change Shocks Driving Migration in Different Farming Systems

	All			RPLI			RRLI			RPNLI		
Variables	**Wald**	**Sig.**	**Exp(B)**	**Wald**	**Sig.**	**Exp(B)**	**Wald**	**Sig.**	**Exp(B)**	**Wald**	**Sig.**	**Exp(B)**
Farming System	5.29	0.02	2.75		0.01	0.33				1	0.013	0.326
Crops lost to flood	5.77	0.02	1.43	7.46	0.01	1.55	4.732	0.03	1.41	4.732	0.03	13.568
Pest /Diseases Experience										3.32	0.068	32.187
Sex of Household Head	6.43	0.01	3.81	3.73	0.05	2.88	5.475	0.02	0.00	4.85	0.02	1497.1
Constant	12.82	0.00	0.05	3.10	0.08	0.51	5.471	0.02	0.49			
-2 Log likelihood	139.88			134.25			139.362c			17.459		
Cox & Snell R Square	0.12			0.16			0.12			0.543		
Nagelkerke	0.16			0.22			0.165			0.724		
Hosmer &Lemeshow Test												
Chi-square	6.19			4.80			6.185			4.956		
df	8			8			8			8		
Sig.	0.63			0.78			0.63			0.763		

Dependent Variable: dummy coded presence or absence of climate change migrants

Table 26. Components Based Drivers of Climate Change Induced Migration

	RPLI			RRLI			RPNLI		
	Wald	Sig.	Exp(B)	Wald	Sig.	Exp(B)	Wald	Sig.	Exp(B)
Migrant Components	17.76	0.00	230.22	17.76	0.00	230.22	17.76	0.00	230.22
Remittance Component	5.92	0.02	3.65	5.92	0.02	3.65	5.92	0.02	3.65
Erosion shock Component	6.93	0.01	2.70	6.93	0.01	2.70	6.93	0.01	2.70
Constant	1.26	0.26	0.59	1.26	0.26	0.59	1.26	0.26	0.59
-2 Log likelihood	31.54			31.54			31.54		
Cox & Snell R Square	0.64			0.64			0.64		
Nagelkerke R Square	0.89			0.89			0.89		
Hosmer and Lemeshow Test									
Chi-square	4.24			4.24			4.24		
df	8			8			8		
Sig.	0.84			0.84			0.84		

Dependent Variable: dummy coded presence or absence of climate change migrants

3.4 Climate Change-Induced Migration Components Effects on Productivity, Production Outcome Variables and Living Standard

3.4.1 Effect of CC-IM Components on Productivity

The four components of migration were used in the GLM model to test their effects on the productivity measures (margin per hectare, gross margin per capital and gross margin per labor) and production outcome variables (Gross margin, Farm expenses and family labor input). The expectation is that all the variables or components of CC-IM would have a negative effect on the independent variables; based on the fact that it had an obviously negative impact on the farms which is the main source of income for the families. The effect on productivity measures differ as shown in the table 30 below; the R-square measures for the gross margin per hectare model and the gross margin per capital model were marginal but the flood experience component (fac3-1) has significant effect on it and across the different systems while none of the components affect the unit return to capital 3 components (migrant characteristics, remittance and flood) significantly influence productivity per unit of labor. The low r-squares suggest that the relationships are not necessarily linear. With respect to the production outcome variables the 4 components have significant effects on them (Table 27).

Table 27. CCI Migration Component Effects on Farm Productivity

	GM/Hectare			**GM/Capital**			**GM/Labor**		
Parameter	**t**	**Sig.**	**Partial Eta^2**	**t**	**Sig.**	**Partial Eta^2**	**t**	**Sig.**	**Partial Eta^2**
Intercept	2.37	0.02	0.05	1.41	0.16	0.02	2.72	0.01	0.06
QCL_1c	**-1.79**	**0.08**	0.03	0.53	0.60	0.003	**2.29**	**0.02**	0.05
QCL_1b	-1.4	0.16	0.02	1.25	0.21	0.01	0.61	0.54	0.003
Migrants	0.01	0.99	0.00	0.80	0.42	0.01	**1.67**	**0.09**	**0.02**
Remittance	-0.21	0.84	0.00	0.67	0.50	0.004	**-2.15**	**0.03**	**0.04**
Flood Incidence	**1.68**	**0.09**	0.03	-0.62	0.53	0.003	**2.38**	**0.02**	**0.05**
Erosion	0.49	0.63	0.002	-0.27	0.79	0.001	-0.44	0.661	0.002
Sex-Head	0.54	0.59	0.003	-1.39	0.17	0.02	0.26	0.797	0.001
R-squared	**0.001**			**0.004**			**13.6**		

Table 28. Migration Component Effects on Production Outcome Variables-All

	Gross Margin			Farm Expense			Labor		
Parameter	**t**	**Sig.**	**Partial Eta^2**	**t**	**Sig.**	**Partial Eta^2**	**t**	**Sig.**	**Partial Eta^2**
Intercept	2.82	0.006	0.07	1.58	0.12	0.02	10.35	0	0.49
QCL_1c	-0.25	0.8	0.001	0.29	0.77	0.001	**-3.15**	**0.002**	**0.08**
QCL_1b	**3.11**	**0.002**	**0.08**	**2.56**	**0.01**	**0.06**	**1.63**	**0.11**	**0.02**
Migrants	**3.11**	**0.002**	**0.08**	**-1.16**	**0.25**	**0.01**	**0.76**	**0.45**	**0.01**
Remittance	**-4.62**	**0.00**	**0.16**	**-4.48**	**0.00**	**0.15**	**-1.36**	**0.18**	**0.02**
Flood Incidence	**3.48**	**0.001**	**0.10**	**2.12**	**0.04**	**0.04**	**1.13**	**0.26**	**0.01**
Crop loss	**-2.35**	**0.02**	**0.05**	**-1.50**	**0.14**	**0.02**	**-2.36**	**0.02**	**0.05**
Sex-H/Head	-0.28	0.78	0.001	0.85	0.40	0.01	**2.66**	**0.01**	**0.06**
R-square	**0.37**			**0.27**			**0.27**		

A further examination of each farming system shows that the flood incidence component has a positive impact on returns per hectare and labor and at the same time increases farm expense in the RPLI system; in the RPNLI system; migrant characteristic component and erosion negatively impact the returns per unit of land used; remittance component reduces farm expense and family labor. The RRLI system shows that crop loss due to erosion and remittance component both increase gross margin per hectare and labor respectively but in the long run reduces gross margin. Migrant characteristics and remittance have negative effect on farm expense (See appendix for details).

3.4.2 Effect of CC-IM Components on Living Standard

The climate change induced migration components were examined against family income and living standard components. Erosion and remittance have negative effects on family income and asset/income component of the farm families no significant effects were reflected in the other living standard components. However, strangely, the flood component seems to have a positive effect on Family income, Economic Viability of Household Head and Asset/Income components but negative on food security and vulnerability components. The other shock variables behave consistently except for crop

loss due to erosion which appears to have a positive effect on food security components. Some of these effects were not significant. The effects of the components were further investigated in each cluster separately. In the RRLI farming system, erosion component and remittance reduce family income while remittance and flooding worsens the assets and vulnerability context of the farm families; in the RPNLI, none of the components showed any significant effect on any of the living standard variables while in the RPLI, flood has a positive effect on the family income and in conjunction with the remittance component positively affects the asset/income component of the living standard index (See appendix for details).

The results exhibited imply that climate shocks and migration as a response catalyze some other behaviors in the different systems and as such the overall impact is not overwhelmingly negative.

The decision to migrate in the systems is mostly by the family or a joint decision with the individual; apart from it being induced by climate shocks, the final act of migrating or not migrating could also be as a result of unobservable differences between households; also the hypothesis that migrant households were not significantly more productive or better off in terms of living standard needed to be examined. As such an endogenous switching regression model was estimated using full information maximum likelihood. This indicates that climate shock experience is a key driver of migration as well as the farm characteristics and asset base. Also the coefficient of the farm revenue functions of those who migrated and those who did not are significantly different confirming the presence of heterogeneity in the sample; among those who migrated farm size, and asset base increase farm revenue from crops. Climate shocks have more significant negative effect on crop revenue among non-migrant households. More specifically crops affected by flood and the extent of damage of the farm reduce revenue while the farm size, and labor allocation to the farm increase revenue.

Table 29. Effect of Migration on Living Standard and its Components-All

	Family Income			Economic Viability H/Head			Asset			Income			Vulnerability		
Parameter	t	Sig.	Partial Eta^2	t	Sig.	Partial Eta^2	t	Sig.	Partial Eta^2	t	Sig.	Partial Eta^2	t	Sig.	Partial Eta^2
Intercept	2.68	0.01	0.06	-4.62	0.00	0.16	-0.64	0.53	0.004	0.26	0.80	0.001	-2.16	0.03	0.04
QCL_1b	2.44	0.02	0.05	2.98	0.004	0.07	1.87	0.06	0.03	-4.41	0.00	0.15	2.24	0.03	0.04
QCL_1c	-0.52	0.60	0.002	0.95	0.34	0.01	0.27	0.79	0.001	-0.85	0.40	0.01	3.19	0.002	0.08
Migrants	2.18	0.03	0.04	0.47	0.64	0.002	0.16	0.87	0.00	-0.97	0.33	0.01	0.54	0.59	0.003
Remittance	-3.64	0.00	0.12	1.04	0.30	0.01	-4.40	0.00	0.15	-0.56	0.58	0.003	0.46	0.65	0.002
Incidence	3.51	0.001	0.09	0.48	0.63	0.002	2.15	0.03	0.04	-0.11	0.91	0.00	-1.59	0.16	0.02
Crop Loss	-1.77	0.08	0.03	-1.54	0.13	0.02	-1.86	0.06	0.03	1.07	0.29	0.01	-0.28	0.78	0.001
Sex H/Head	0.36	0.72	0.001	3.96	0.00	0.12	-0.007	0.99	0.00	1.51	0.13	0.02	0.76	0.45	0.005
R-Squared	0.29			0.21			0.21			0.13			0.07		

Non migrants are more statistically affected by climate shocks but with respect to gross margin, migrant households suffer more from statistically significant climate shocks.

This indicates two things: it is the severely affected who migrate and secondly it underscores the fact that migration is not an appropriate response to climate change and the need to build rural households capacities to respond in a more ecosystems friendly way through Green Small and Medium Scale Enterprises. Migration is 'running away' and the risks are not significantly changed by migration. The opportunities open for G-SMEs are water recycling technologies; bio-chemicals for effective pest and disease control and alternative energy generation from farm waste but all of these should be offered within a complete ecosystems based adaptation strategy to separate it

from coping strategies. Some elements of these are already being practiced in the farming systems and would be easily acceptable to them. More specifically all the systems would benefit from the introduction of bio-chemicals but the RPLI are more likely to embrace water-related G-SMEs relatively faster than the others.

3.5 The Impact of Climate Change-Induced Migration on Productivity, Living Standard and Adaptation Decisions

The descriptive analysis in the previous sections revealed significant differences in some of the production, productivity and living standard indicators between the Farming Systems. Also, previous analysis shows potential effects of migration on these variables. To properly analyze the impacts of migration, an econometric technique the FIML ESR is used. The FIML ESR model involves a selection equation and separate outcome equations for migrants and non-migrants which are estimated simultaneously. The selection equation is about the determinants of migration decision, and the results have been discussed in previous sections. The exclusion restriction variable, the predicted probability of migration is statistically significant in all the models, thus satisfying the instrument relevance condition. The positive coefficient confirms the expectation that households with a high probability of migration, will migrate.

3.5.1 Crop Revenue and Gross Margin Effects

The results for each of the outcome indicators are discussed in the following sections. The second-stage estimates of the FIML ESR models for the crop revenue and gross margin equations are presented in Tables 30 and 31. The table shows how each of the explanatory variables affects the two income measures. $\rho 1$ and $\rho 0$, the correlation coefficients between the error terms of the selection and outcome equations reported at the bottom part of the table, provide an indication of selection bias. A statistical significance of any of them suggests that self-selection would be an issue if not accounted for. In all the two income models, the correlation coefficients for the migrant households ($\rho 1$) and non-migrant households ($\rho 0$) equations are both negative but only the $\rho 1$ coefficients is statistically significant in the crop revenue equation and both in the gross margin equation, suggesting that there is self-selection among migrants. Thus, farm households with lower than average crop revenue and Gross margin are more likely to migrate, while the non-migrants are not better

or worse off than a random farm household. The significance of the likelihood ratio tests for independence of equations also indicates that there is joint dependence between the selection equations and the farm income equations for migrants and non-migrants.

Table 30. Crop Revenue Effects

Log likelihood = -1783.137	**2**		**Number of obs = 120** **Wald chi^2(11) = 58.34** **Prob> chi2 = 0.0000**
	CC-IM	Migrant HH	Non-Migrant HH
Crop Revenue			
Farm Size (Ha)	-.0103589 (0.072824)	65977.28*** (20922.51)	7852.829*** (2349.27)
H-Head Labor-Farm	-.0006545 (0.002894)	660.6695 (1457.844)	1691.607** (791.6614)
Age	-.0160756 (0.020741)	-2614.334 (13952.44)	-12233.13** (5324.867)
Level of Education	.2073672 (1.385882)	798269.8 (633316.6)	258886.2 (278969.7)
Marital status	.5464154 (1.509863)	420354.2 (685561.8)	412123.9 (432523.7)
Net Remittance	.0000107 (0.000021)	-7.291119 (9.962814)	-.3435589 (7.775367)
Crops lost to Floods	.0001487 (0.000271)	-494639.3 (509365.7)	-220352 (166610.9)
pre_1	3.994055*** (0.686616)		
Farm Damage		533002.3 (510500.5)	645863.3*** (232268.4)
Pest/Disease Incidence		-605868.2* (309231.4)	-215081.6 (157173.5)
Type of Crop Affected		241794.6 (372653)	528066.6*** (153311.4)
Farm Assets		724779.2** (360094)	-155988.2 (152583.6)
Constant	-1.840044 (1.350281)	-807504.2 (1266910)	-378519.5 (378177.4)
sigma		193.91***	988.99***
rho		-1.93	-4.88***
LR test of indep. eqns.: chi2(2) =7.28		**Prob > chi2 = 0.0263**	

***, **, * represent 1%, 5%, and 10% significance level, respectively. Figures in parenthesis are standard errors

The estimation results show that farm size significantly affects the crop revenue of both migrant and non-migrant households. An increase in farm size results in an increase in crop revenue and gross margin. There are differences

between what determines crop revenue between migrants and non-migrants. For example, pest and or disease incidence and farm assets are significantly associated with the crop revenue of migrants, but the effects are insignificant among non-migrants. Conversely, age of household head, household head allocated to the farm, the extent of damage to the farm and the type of crop affected influence crop revenue of non-migrants. The results suggest that migrants and non-migrants may be experiencing climate shocks differently and that the severity also could differ.

The results for the gross margin model also indicate similar differences in the significance of the coefficients between migrants and non-migrants' equations. However, there are notable differences across the two income models. For instance, the education and crops lost to floods affect crop revenue but not gross margin. As such factors which significantly affect crop revenue may not necessarily influence gross margin, and this is expected since most of the households in the systems have different cost structures.

Table 31. Gross Margin Effects

		Number of obs = 120	
Log likelihood = -1783.1873		Wald chi2(12) = 40.54 Prob > chi2 = 0.0001	
Gross margin	**CC-IM**	**Migrant**	**Non Migrant**
Farm Size (Ha)	-.0393943 (0.088172)	55189.42*** (21793.24)	6678.382*** (2318.02)
H-Head Labor-Farm	-.0012079 (0.003018)	837.573 (1589.329)	1563.473** (784.264)
Age	-.0186907 (0.019652)	-117.4793 (15001.25)	-7886.911 (5402.20)
Level of Education	.4727183 (1.6636)	1263074* (688858.2)	172335.2 (278826.6)
Marital status	.6159078 (1.620183)	44834.95 (826950)	202315.7 (456098.3)
Net Remittance	9.25e-06 (1.98E-05)	-5.0321 (10.75974)	1.347332 (7.79667)
Crops lost to Floods	.0002244 (0.000285)	-1210979** (552019.5)	-110918.2 (173444)
Pre_1	.170466*** (0.678283)		
Farm Damaged		1226212**(570099.1)	513779.2** (236084.8)
Erosion Impact		-194792.5(431533.9)	-83877.51 (134355.1)
Pest/Disease Incidence		-556431.5*(321815.3)	-195758.2 (159492.3)
Type of Crop Affected		189071.3(389937.2)	421923.9***(154059.8)
Farm Asset		707451.4*(383772.5)	-176680 (152423.5)

Constant	-1.87 (1.73)	-911024.6 (1385747)	-269739.5 (376304.7)
sigma		388.81	1,378 (410.9)
rho		-3.30***	-5.33***
LR test of independent. eqns chi2(2) = 9.82 Prob > chi2 = 0.0074			

***, **, * represent 1%, 5%, and 10% significance level, respectively. Figures in parenthesis are standard errors

The estimates of the treatment effects of migration on crop revenue and gross margin are presented in Table 40. The predicted crop revenue and gross margin from the ESR models are used to compute both the ATT and ATU. The ATT measures the difference between the mean income of migrants and what they would have earned if they had not migrated, while the ATU indicates the difference between the mean revenue of non-migrants and what they would have obtained if they had migrated. The results show that migration has a positive and significant effect on both crop revenue and gross margin of the migrating households. Migration increased

Crop revenue and gross margin of migrants by about 90 per cent and 100 percent respectively, and this is statistically significant. The positive and significance of the ATU estimates suggests that households that did not migrate would have realized an even higher revenue and gross margin benefits had they migrated. Specifically, if farm households that did not innovate had innovated, they would have increased their farm and household income per AE by 51 percent and 28 percent, respectively. Overall, that migration could derive income benefits from migration.

3.5.2 Productivity and Adaptation Effects

Table 32 and 33 shows the estimation results of the productivity and adaptation models. The results show that farm size significantly increases gross margin per labor but the effect is more pronounced for non-migrants. Also, input expense and migration related variables significantly influence gross margin per labor for migrants but are not statistically significant for non-migrants. Pest and disease incidence has a significantly negative effect on gm/labor in the migrant model while crop loss and type of crops affected has appositive effect on it among non-migrants. This is contrary to expectation and can only be explained by the fact that these incidences lead to a re-allocation of labor to a more economically rewarding crop in the system and or a reduction of intensive use or over use of labor on the farm.

Table 32 Gross Margin Per unit of Labor Effect

	Wald chi2 (14) = 60.09		**Number of obs 120 Prob > chi2 0.0000**			
Log likelihood -848.251		76				
Gross Margin/Labor	CC-IM		Non Migrant		Migrant	
Under Aged Labor			-2.42	(18.43)	-74.44*	(39.08)
var45			-1.43	(14.21)	-1.54	(23.93)
Farm Expense			-8.5E-05	(0.0002)	0.001	(0.001)
Herbicide Exp./Ha			-0.0001	(0.006)	0.04	(0.05)
Seed Exp/Ha			-0.0006	(0.003)	0.15*	(0.09)
Farm Size (Ha)	0.001	(0.013)	2.76**	(1.13)	-22.27*	(12.14)
H-Head Labor-Farm	0.001	(0.003)	-0.043	(0.38)	0.52	(0.67)
Age H-Head	-0.02	(0.02)	.84	(0.56)	1.70	(6.86)
Level of Education	0.32	(1.40)	-92.44	(130.06)	339.63	(214.73)
Marital status	0.44	(1.60)	104.05	(206.87)	300.03	(243.60)
Net remittance	6.55E-06	(0.00002)	-0.001	(0.004)	0.011**	(0.01)
Quantity of crops lost	-0.0002	(0.00013)	0.13***	(0.04)	0.06	(0.05)
Type of crops Affected			252.06***	(78.98)	-25.42	(142.36)
Pest/ Disease incidence			30.35	(63.48)	-379.85***	(115.28)
Migration Perception (-ve)					-584.58***	(115.36)
Number of CCIM					101.12***	(28.78)
pre_1	4.03***	(0.76)				
Constant	-2.06	(1.47)	44.68	(182.57)	-345.35	(430.66)
sigma			8.42***		12.46***	
rho			2.28**		-3.6**	

LR test of independent. eqns. : chi2(2) 5.9 Prob > chi2 = 0.0518	

***, **, * represent 1%, 5%, and 10% significance level, respectively. Figures in parenthesis are standard errors

The extents of damage on the farm and farm size have significant influence on the choice of adaptation strategies in both models. The age of household heads, the labor allocated to farm by the H-head and the marital status are significant in the non-migrant model alone. The statistical significance of the correlation coefficient (ρ_1) suggests that there is selection effect; hence, unobserved factors affect both the migration decision and choice of adaptation strategy. In particular, there is negative selection bias but only for migrants as ρ_1 is negative and significant while ρ_0 is not statistically significant. Thus, farm households who choose to migrate have a better adaptation choice or strategy while those who choose not to migrate are not better or worse off than a random farm.

Table 33. Adaptation Decision Effect

			Number of obs = 120
			Wald chi2 (3) = 47.57
Log likelihood = -65.455501			Prob > chi 2 = 0.0000
Adaptation Choice	CC-IM	Non-Migrant	Migrant
Under aged Labor		0.07***	0.01
Farm Asset		-0.04	0.33*
Farm Output (Kg)		1.84e-06	7.27e-06
Farm Damage		.32***	.52***
Farm Size (Ha)	-0.004	0.003**	0.022*
H-Head Labor-Farm	0.004	0.001*	0.001
Age H-Head	-0.02	0.01**	-0.01
Level of Education	.59	.16	-.61**
Marital status	0.15	-0.98***	0.07
Net remittance	.00001	-4.30e-06	6.44e-06
Yield related 'strategy'	-.0002	.72***	
Total Quantity of Crops lost	4.50	-.00006	-.0001
Gross margin		-2.24E-08	-1.23E-07
Constant	-3.001	0.12	0.61
Sigma		12.24***	8.92***
Rho		-1.17	(-3.33)***
LR test of independent eqns chi2(2) = 4.9 Prob > chi2 = 0.0865			

***, **, * represent 1%, 5%, and 10% significance level, respectively

3.5.3 Living Standard Effects

This was examined through the ESR model using family income and the vulnerability component of the living standard variables (Tables 34 and 35).

Family income is significantly influenced by farm output in both migrant and non migrant models. Other factors which influence it differ in both systems; remittance and household size positively affect it in the migrant households while in the non-migrant households, climate shock variables, other economically viable adults and farm size have a positive effect. The factors which have a negative influence are age in the non-migrant systems and pest and disease incidence in the migrants' system. The fact that climate shock variables have a positive influence on family income suggest that the two groups of people experience climate shocks differently and cope in different ways; more importantly it suggest that climate shock trigger some economic flows which the non migrants may be an a position to harness better than the non migrants. This could also be the reason behind the choice not to migrate.

The statistical significance of the correlation coefficient (ρ0) suggests that there is selection effect; hence, unobserved factors affect both the migration decision and family income. In particular, there is negative selection bias for both non migrants and migrants as ρ0 is negative and significant while ρ1 is not statistically significant. In the vulnerability model, household size of both migrants and non- migrant models have significantly negative effect on vulnerability, meaning an increase would make the households more vulnerable. In addition to these, the age of the household head in the migrant model also has a negative influence while in the non-migrant model it is the increase in the allocation of female (spouse) labor to farm that negatively impacts vulnerability.

This suggests a miss-use of the resource. The statistical significance of the correlation coefficient (ρ0) suggests that there is selection effect; hence, unobserved factors affect both the migration decision and vulnerability of farm families. In particular, there is negative selection bias for non-migrants as ρ0 is negative and significant while ρ1 is not statistically significant.

Table 34. Family Income Effect

Log likelihood =-1701.83	**1**	**Wald chi2(13) =61.08**	**Prob > chi2 = 0**
Family Income	**CC-IM**	**Migrant**	**Non-Migrants**
Ext. lab Hours		2934.094 (6876.11)	5514.835 (7967.51)

Flood/erosion Incidence		-128692	367104.5*
		(234821.7)	(195265.2)
H-Head Labor Farm	-3.5E-05	1020.39	775.9735
	(0.002718)	(1332.162)	(984.41)
Farm size Ha	0.00157	-32103.1	5342.345*
	(0.016654)	(24553.13)	(3132.10)
Age (H-Head)	-0.02527	-5513.09	-11590.7*
	(0.020007)	(12392.28)	(6612.21)
Level of education	0.594329		
	(1.283832)		
Marital Status	0.472697		
	(1.395315)		
Net Remittance (N)	1.26E-05		
	(1.78E-05)		
Total Quantity of crops lost	-7.5E-05		
	(0.00017)		
pre_1	3.856337***		
	(0.775199)		
Off-Farm Income		312172	282931.9
		(221392.2)	(182420.3)
Pest/Disease Incidence		-472325.8**	-257702
		(213460.4)	(179507.6)
CC-I Migrants' Remittance (N)		24.53732**	18.46662
		(9.958247)	(14.26)
Value of Asset (N)		0.259375	0.302606
		(0.807033)	(0.67)
Type of Crop Affected		16946.09	651006.2***
		(305134.9)	(190485.4)
Farm Output		26.95058***	26.29709***
		(7.347509)	(9.14)
Household Size		117907.5**	-17919.2
		(46290.28)	(37926.53)
Other Economically Viable Adults		126063.9	440123.7**
		(201071.6)	(201689)
constant	-1.69163	-35175.3	85946.42
	(1.341062)	(636647.6)	(439472.1)
sigma		303.24	736.18
rho		-1.5	-4.44***
LR test of indep. eqns.: chi2(2) = 4.83 Prob > chi2 = 0.0892			

***, **, * represent 1%, 5%, and 10% significance level, respectively

Table 35. Vulnerability Component Effect

Number of obs	**=**	**120**			
Wald chi2(17)	**=**	**27.33**	**Prob > chi2**	**=**	**0.0534**

Log likelihood = -216.9606	9		
Vulnerability component	**CC-IM**	**Migrants**	**Non-Migrant**
Under Aged Labor		.71	.053
		(0.72)	(0.046)
Farm Expense		-1.68e-06	6.90e-07
		(1.84E-05)	5.44E-07
Farm Asset		-2.39	.259
		(3.15)	(0.17)
Ext Labor Man-hours		-.169	-.004
		(0.17)	(0.0034)
Cooperative membership		.65	-.32
		(2.71)	(0.22)
Sex H-Head		3.95	.2928663
		(2.96)	(0.26)
Spouse Labor-Farm		-.02	-.002**
		(0.01)	(0.0009)
Household Size		-.98**	-.07-**
		(0.38)	(0.03
Age H-Head	-.006	.20*	.009
	(0.02)	(0.118)	(0.01)
Level of Education	.14	.22	-.013
	(4.84)	(0.27)	(0.024)
Off-farm Income		.0002	2.35e-07
		(0.0001)	(1.34E-06)
Farm size (Hectares)	.0009	-.07	-.002
	(0.014)	(0.22)	(0.003)
H-Head Labor Farm	-.0008	-.02	-.001
	(0.0034)	(0.01)	(0.001)
Marital Status	1.30	1.43	-.18
	(1.38)	(5.49)	(0.49)
Net Remittance (N)	.000016	-.000068	.0000103
	(2.04E-05)	(9.07E-05)	(8.93E-06)
Total Quantity of Crops Lost	-.00018	.00078	-.000095
	(0.00016)	(0.001)	(8.23E-05)
Other Economically Viable Adult		.039	.009
		(2.669)	(0.18)
Predicted Probability of Migration	4.75*** (0.87)		
Constant	-3.08	-2.79	.744*
	(5.22)	(7.40)	(0.41)
sigma		8.55	11.81
rho		1.76	-2.09***
LR test of indep. eqns.: chi2(2) = 5.9 Prob > chi2 = 0.0523			

***, **, * represent 1%, 5%, and 10% significance level, respectively

3.5.4 Counterfactual Analysis: Effect of CCIM on Production, Productivity and Living Standard

The study also investigated the effect of having migrated in response to climate change on production, productivity, living standard and adaptation decision. In other words, to estimate the treatment effect (Heckman et al. 2001). As already mentioned, unobserved heterogeneity in the propensity to migrate in response to climate change creates a selection bias that should not be ignored. The endogenous switching regression model is used to produce selection-corrected predictions of counterfactual states in the dependent variables. It can be used to compare the expected states of migrant households (a= f1) relative to the non-migrants (b = f2), and to investigate the expected states of the dependent variables in the counterfactual hypothetical cases (c = f3) that the migrant households did not migrate, and (d = f4) that the non-migrant households migrated. The conditional expectations for the different dependent variables four cases are defined as follows:
The endogenous switching regression model is used to produce selection-corrected predictions of counterfactual states in the dependent variables.

$$E\ (\ y_{1i}\ |A_i = 1) = \ x_{1i}\beta_1\ +\ \sigma_{1\eta}\lambda_{1i} \qquad \text{(f1)}$$

$$E\ (\ y_{2i}\ |A_i = 0) = \ x_{2i}\beta_2\ +\ \sigma_{2\eta}\lambda_{2i} \qquad \text{(f2)}$$

$$E\ (\ y_{2i}\ |A_i = 1) = \ x_{1i}\beta_2\ +\ \sigma_{2\eta}\lambda_{1i} \qquad \text{(f3)}$$

$$E\ (\ y_{1i}\ |A_i = 0) = \ x_{2i}\beta_1\ +\ \sigma_{1\eta}\lambda_{2i} \qquad \text{(f4)}$$

Cases (f1) and (f2) represent the actual expectations observed in the sample. Cases (f3) and (f4) represent the counterfactual expected outcomes. In addition, following Heckman et al. (2001), the effect of the treatment "to migrate" on the treated (TT) is calculated as the difference between (f1) and (f3),

$$TT = E\ (\ y_{1i}\ |\ A_i = 1) - E\ (\ y_{2i}\ |\ A_i = 1) = \mathbf{x_{1i}}\ (\boldsymbol{\beta_1} - \boldsymbol{\beta_2}) + (\sigma_{1\eta} - \sigma_{2\eta})\ \lambda_{1i}\ , \qquad \text{(f5)}$$

which represents the effect of climate change Induced migration on the dependent variables of the farm households that actually have migrants in response to climate change. Similarly, the effect of the treatment on the untreated (TU) is calculated for the farm households that actually do not have migrants in response to climate change as the difference between (f4) and (f2),

$$TU = E(y_{1i} \mid A_i = 0) - E(y_{2i} \mid A_i = 0) = \mathbf{x_{2i}}(\boldsymbol{\beta_1} - \boldsymbol{\beta_2}) + (\sigma_{1\eta} - \sigma_{2\eta})\lambda_{2i} \quad (f6)$$

The results show that migration made migrants' households better in terms of production and selected productivity variables while it made them worse off in terms of family income and living standard variables. Also it showed that non migrant households were better off not having migrants with respect to productivity variables; also if they had migrated they would have had a lower family income and they would have been more vulnerable. The choice of adaptation strategy was better in the migrants' household while it would have been poor if the non-migrant households had migrated (Table 36).

Table 36. Average Expected States of Outcome Variables

	Decision Stage		
Sub-Samples	**Migrate**	**Not migrate**	**Treatments Effects**
Crop Revenue			
Migrant Households	603417.2	588335.7	15081.57***
Non Migrant Households	282606.8	1133275	-850668.13***
Gross margin			
Migrant Households	642778.7	507462.2	135316.49***
Non Migrant Households	252573.3	1310563	-1057989.58***
Gross Margin Per Labor			
Migrant Households	323.1869	267.3851	55.81***
Non Migrant Households	183.4353	513.0395	-329.60***
Adaptation Decision			
Migrant Households	0.368201	0.320304	0.05***
Non Migrant Households	0.20689	0.624109	-0.42***
Family Income			
Migrant Households	640622.2	724442.1	-83819.95***
Non Migrant Households	406045.2	573712.7	-167667.56***
Vulnerability			

Migrant Households	2.015504	0.453649	1.56***
Non Migrant Households	0.248885	4.391289	-4.14***

***, **, * represent 1%, 5%, and 10% significance level, respectively

3.6 Impact of Future Resource Use and Management

The farming systems were examined in different aspects in the preceding sections. An ideal farming systems is a complex one and is best modeled using a farm-household- family model to portray the multi-dimensional interactions between the farming system components in quantitative terms (Wightman, 1990). An understanding of the situation of each farming systems with respect to the hypothesis tested was used to formulate the basis for future development strategies and scenarios which should have a possible influence on the living standard of the family through the improvement in earning opportunities or income variables. As such the scenarios are tested in order to assess the socio-economic impact of future strategies at the family level.

A family model was used as a tool; linear programming algorithm was selected to find model solutions. The basic model describing the current situation without any strategy is compared to the models without strategies. The difference between the results with and without the strategies is interpreted as the impact of the strategies tested. The scenarios tested can be implemented at the village or community level because they are oriented by the concept of farming development as an integral of regional development. The strategies selected emphasize the quantification of the potential impact of the reallocation of excess labor to an alternative income generation opportunity like the Green-SMEs in the absence and presence of migration.

A single period static model was selected. The basic model of each group was built by applying the average families of each group, not an existing family with the smallest deviation of the sum of parameters. This implies that all parameters in the model represent average values. The basic model of each group describes the farming system of the group through technical coefficients, resource constraints and a set of activities. The results of the model were calculated using the Excel Solver. The estimated basic models are validated by comparing the results of the basic model with the empirical results of the farm off farm and family income. The differences between the estimated model and the basic model are attributed to the complexity of the real world while the estimated process assumes perfect knowledge on the part of the farm family.

Parameters of the Basic Model
The activities on the farm and household level included make the model close to reality but the structure of the models of the farming systems differs.

Constraints:
Land: The constraint in the use of land is the average owned land.
Labor: This is available as family labor or as external (hired) labor for specific purposes.
Family labor: This is computed as the average family labor used on the farm for a season of production. It was measured in man-days for both male and female between ages 14-60 Off-farm activities and wage rate constraints were restricted to the average in the farming systems.
Hired labor: This is unrestricted in the model; access to it is limited only by cash. Labor activities are depicted in man-days.
Home consumption and household expenditure: This is based on the survey results, home consumption values were constrained by the average value of each item. Crops and livestock output can be sold to the market or consumed in the household of the farming system.
Credit: Working capital is required to finance purchases and other direct inputs. It may be available in the basic model, not only from the farm family's own savings but it can often also be supplemented by informal or formal credit.
Activities

Crop production: This is the main form of farm activity in the area.
Livestock production: This is not a major sector of farm production for all the families, but some farms keep livestock such as goats and chicken.
Household: This includes buying, selling and storage and processing activities. Activities are mainly linked through labor demands with other opportunities. Family members either contribute through on-farm work to the household supply or may decide to contribute to the household returns through external activities.
Capital: Capital can come from two sources: internal (family) and external (borrowed). Borrowed capital and additional funds in the form of loans are subjected to annual interest rates and in the model's objective function are charged as an additional cost on capital borrowed.
G-SMEs: water harvesting, bio-gas generation for lighting and cooking energy and organic chemicals for the farm

Migration: number of people who moved because of climate shocks experienced over time but who also relate with their households by sending and or receiving remittances.

Transfer activities: Any cash surplus at the end of each month or each season can be transferred to the next month or next season in the financial year through cash transfer activities.

Validation of the Model

The criterion for the validation of the model is the closeness of selected parameters between reality and model results. It is assumed that the model quality can be accepted if the model results are close to reality. The parameters selected for comparison are the farm income, off-farm income and family income; and the allocation or use of family owned and external resources (land, labor, and capital). In the RPLI system, apart from farm income, other variables were over estimated by over 50 percent; in the RRLI, the off farm income and farm income are over estimated by over 50 percent while in the RPNLI none of the variables was over estimated by above 30 percent. The estimated model assumes perfect knowledge and immediate decision hence the reason for the differences. None of the variables were under estimated. Owned resources had optimal solutions under each system but the distribution or use was slightly different. All the activities in the model were selected but carried out to different degrees in the systems.

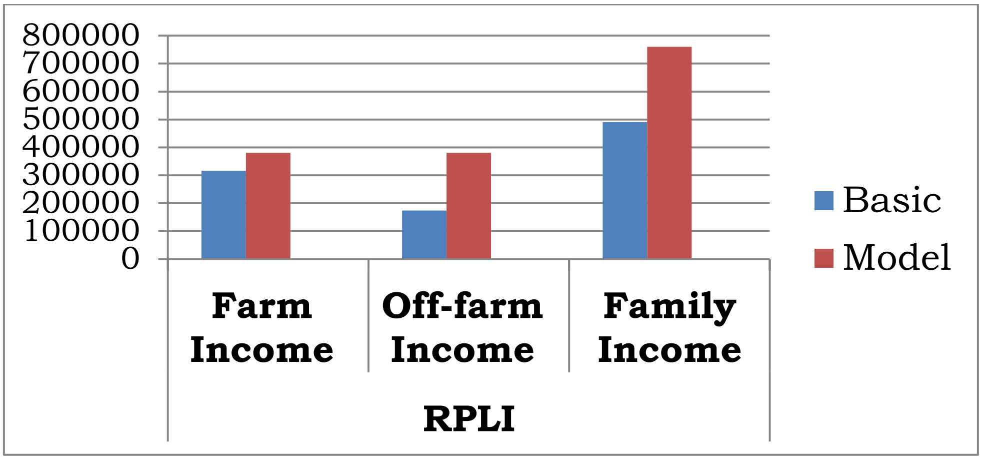


Figure 8. Validation of Farm-Household-Family Model-RPLI

The differences in the use of family resources can be explained by the fact that in reality, farmers may react depending on the updated information. Risk behavior might influence the farmers not to reach the optimal solution. Farmers may prefer farm plans that provide a satisfactory level of security even if it means sacrificing income on average. This creates a gap between model results and real practices (Sattarasart, 1999). Based on this explanation, the model could be accepted and used to test future development and impact strategy.

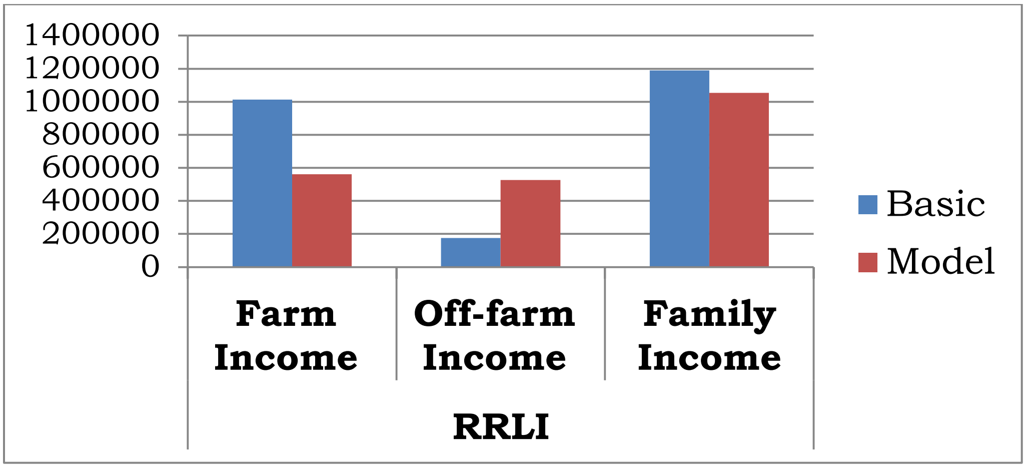


Figure 9. Validation of Farm-Household-Family Model-RRLI

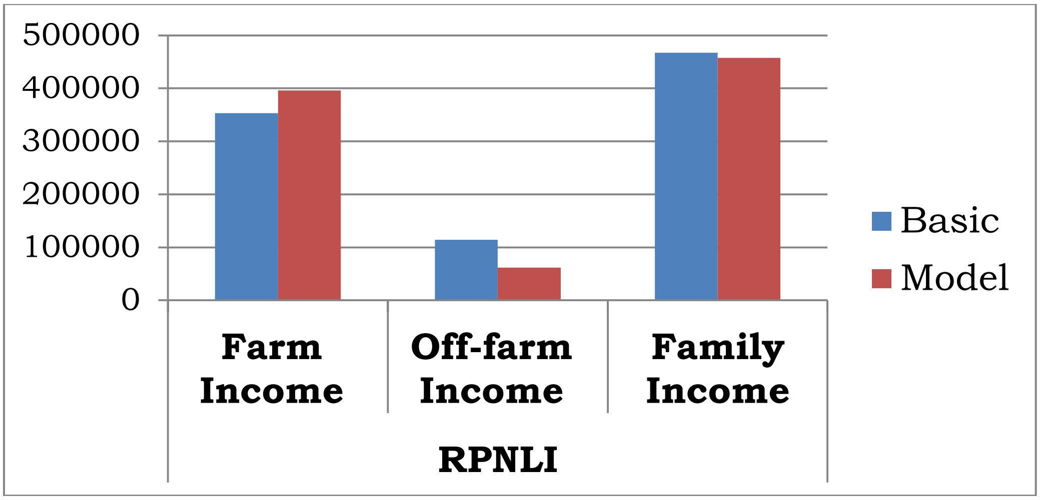
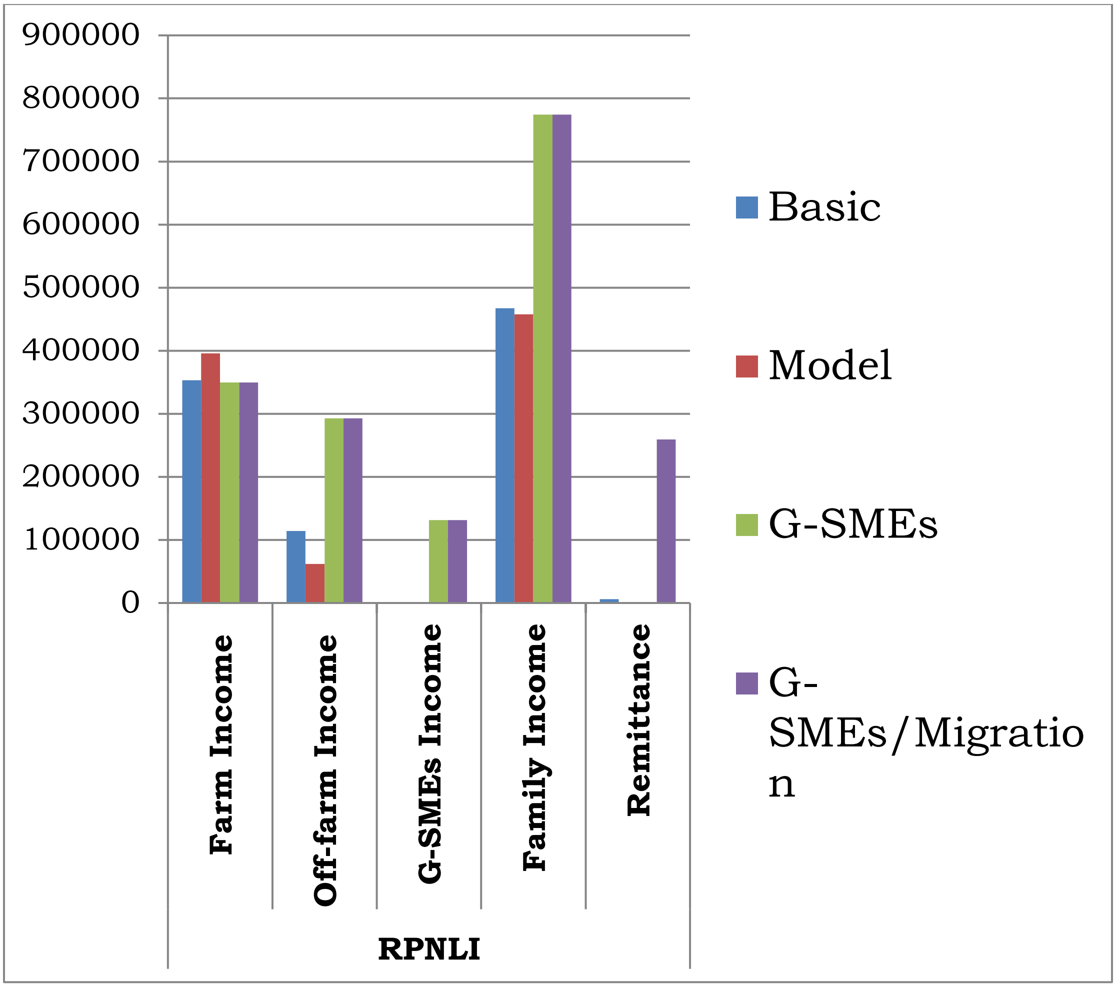


Figure 10. Validation of Farm-Household-Family Model-RPNLI

3.6.1 Impact of Introduction of G-SMEs Without and With Migration taking place

Based on the analysis in the previous section, the need for an alternative income source that is friendly to the eco system is apt. It is expected that the introduction of G-SMEs with an attractive wage rate and relevant to the need or vulnerable points identified in previous section will absorb excess labor lead to income and discourage out migration particularly among vulnerable households. The results are presented in the figure below. The results show that a new income generated through SME leads to an increased family income, though farm and traditional off-farm income sources remain the same. When the migration component was introduced in the presence of a G-SME, the previous variables remained the same, that is there was no reduction, but a new variable which is the remittance value generated increased.



900000
800000
700000
600000
500000
400000
300000
200000
100000
0
Farm Income
Off-farm Income
G-SMEs Income
Family Income
Remittance
RPNLI
Basic
Model
G-SMEs
G-SMEs/Migration

4.0 Discussion

The research findings present different perspectives on the challenges and opportunities presented by climate shocks which farm families tend to respond to by seeking off-farm income or asking economically viable members of the household to migrate. The different farming systems identified had significantly different resources and their allocation and use differed as well. But more importantly, it signifies the differences that need to be taken into consideration in the process of introducing an intervention. The findings with respect to the research questions are discussed below.

4.1 Characteristics of Farming Systems

The Resource Poor Labor Intensive system has a high dependency ratio which can be traced to the percentage of female headed households in the system. However, the family labor availability is high enough for farm, household and off farm/household activities; except that significant part of labor is allocated to farm activities. External labor is employed for specific activities such as clearing and plowing. The system is the least dependent on the forest for firewood and other resource owners like land-owners but its capital base is relatively low. It is a cassava-cocoa-rice based system though some goats and chicken are raised. A reasonable proportion of the items produced are consumed at home, the deficit in food supply is made up from market purchases. The households experience rainfall, floods and pest on all crops and respond through water supply and control practices as well as use of chemicals. The decision to migrate in response to these shocks is made mostly by the families; 25 percent of the households in the system have at least one CCI migrant. Crops lost to floods drive the propensity to migrate. Also, remittance, migrant and crop loss (erosion) components of CC-IM are significant drivers of migration.

The Resource Rich labor Intensive System equally has a high level of dependency ratio from having under or over aged family members who are not earning income. The system has the highest level of education for both household head and spouse; but despite this most of the male and female labor is allocated to farm; family labor is supplemented with external labor for clearing, plowing, fertilizer application and harvesting. The system depends

on land owners, 50 percent of the land in the system is rented but has a low dependence on consumption loan. It has the highest capital assets, farm and family income. It could be defined as a cassava-cocoa- Yam/Rice base system with a high degree of market orientation. It is easily identified as the most economically successful of the three systems. The households in the system describe their experience of climate shocks mostly based on a specific event; rainfall and floods are the most common but the frequency of these experiences are not well described. All the major economic and minor crops are affected by these shocks but only 44 percent are making effort at adapting to the situation. The most common ‘adaptation’ strategies are the use of chemicals and crop related activities such as repairing damaged crops or replanting. The decision to migrate is made mostly by the family but sometimes in conjunction with the migrant. Flood experience or damage done as a result of floods leads to migration; with respect to the components, remittance, migrant and crop loss (erosion) are significant drivers.

The Resource Poor Non labor Intensive system has a large family size but low male and female member which translates to a relatively low labor availability and capacity. It also has the highest number of female heads; low level of education for household heads but relatively high levels for women. The system allocates labor to the farm and off farm; earning the second highest off-farm income in the system. Family labor is supplemented with external labor for clearing, plowing and harvesting. About 40 percent of the households own land, most of them are not dependent on land owners; they are the most dependent on consumption loans. It is the most dependent on forest for fuel but the least dependent on it for food. Compared with the other systems, it has the lowest asset and income but the highest non-food expenses particularly on health. It can be described as a cassava-yam-maize system, with the lowest degree of market orientation as well as value of food market purchases. It is the least economically successful of the three systems although it is most efficient in the use of labor. The climate shock experienced by the system is mainly rainfall, floods and pest; and these affect both major and minor crops on the farm. About 45 percent of those who experience these shocks respond by doing nothing. The most common ‘adaptation’ strategy is the use of chemicals. Over 50 percent of the households in the system have at least one CC-I migrant. Over 40 percent of the migrants are holding the first position among children; hence age and educational level might play a role in the choice of who should migrate. The decision to migrate however is taken most of the time by the individual. The most important climate change shocks which

drive migration in the system are flood and pest incidence and with respect to the component it is the migrant characteristic, remittance and erosion shock.

4.2 Climate Shocks That Induce Migration in Farming Systems

That climate change leads to migration has been confirmed by several studies. For example, Meeking (2013) posited that factors influencing the migration of people and the factors that influence this displacement vary significantly within each nation and are highly dependent upon their political, economic and social position. His reference was to forced migration and in particular his study was on Somalia where conflict interacted with climate issues to drive migration. But the fact is that climate migration drivers differ from one system to another (Adger, 2009; Mertz et al 2009) in their findings on the social dimensions of climate change indicated that climate change would lead to migration but not of whole communities and household. Suggesting that individuals or members of household could migrate; but mainly as part of the households' income diversification strategy. Other related studies include Burkett (2011), Martin (2013), Warn and Adamo (2014). These focused on the national level and large scale migration very few examined the specific drivers at the micro level and in different socio-economic contexts.

While all households in the different systems experience rainfall, floods and pest on all crops, the emphasis on the crop affected differs and the responses differ. For example, the Resource Poor Labor Intensive system indicates that flooding, pest and diseases are the most severe shocks experienced. In some cases, all the crops on the farm are affected and the farm is damaged while in others just one or two are severely affected. But the main factors which drive migration in the system are: crops lost to floods, remittance, migrant characteristics and crop loss (erosion) components. The sex of the household head and crops lost to flooding have the largest odds ratio that migration would occur if the incidence continued; and male headed households are thrice as likely to migrate or have a migrant as a female headed household in the system. This is expected since more males migrate and in some cases the male household heads are the migrants. The situation is similar in the Resource Rich Labor Intensive system, where the households have relative flexibility in terms of resources and are more economically successful. In this system, Cocoa, Cassava, yam and Rice are the most important crops for consumption and income generation and have been affected by droughts, floods and pest and diseases in recent times. In the Resource Poor Non Labor Intensive System cassava which is the major economic crops has been affected severely by

floods, pest and diseases; apart from the effect of the flood incidence on crops and the sex of the household head, the incidence of pest and diseases show a high probability of driving migration. Of the 3 systems, the odds ratios of the drivers are highest in this system. Incidentally, the system is made up of the most vulnerable households.

4.3 Migration and Migrants' Profile in the Farming Systems

Reuveny, (2007) suggests that people leaving in lesser developed countries are likely to leave environmentally degraded environments and that this would be the most probable response to climate change as well. This will not only happen at the national level but within different communities those who have low adaptive capacities are likely to leave. The RPNLI has the highest percentage of households with migrants followed by the RRLI. The large percentage of households with migrants among the RRLI is unexpected, but could be interpreted in the light of the fact that migration is a 'silent' response to the shocks they experience although over 50 percent claim to do 'nothing'. Apart from this, the general pattern follows other research output: the most educated leave, in some cases the household heads or the spouse but in most cases the oldest child or oldest male child. Migration is in most cases short distance to a more urban or environmentally friendly environment where off-farm income opportunities are higher. It is mainly a rural-urban pattern of migration (Ayinde et al 2014; Glaeser, 2013 and IOM 2015). The decision to migrate is seen to be made mainly by the family and in some cases with the migrant in a joint process; however, in the RPNLI, most of the individuals made the decision themselves. Also remittances received from migrants are used to meet different family needs which are not farm related and as such may not lead to the commercialization of production activities (Sanders and Maimbo, 2003; Kifle, 2007 and Ajaero and Onokala, 2013). Households also encourage migration to insure that a generation of relatively prosperous members evolves; migration is a strategy to give the next generation a better chance at life. Families may not always be in a position to fund the cost of migration but would give the emotional and psychological support required for the decision to translate into action. The migration pattern follows the NELM theory except that the high percentage of individuals making the decision to migrate in the RPNLI indicate that the decision making process could be influenced by the socio-economic context of the households and of the individual.

4.4 Effects of CC-IM Components on Production and Productivity

Climate change induced migration components have differentiated effects on production and productivity. The initial hypothesis was that it should significantly decrease production and productivity. The effect is more significant with respect to gross margin, farm expenses, labor and gross margin per unit of labor. It showed marginal effect on gross margin per hectare. The relationship with these variables is not necessarily linear. The components behave as expected with gross margin per capital; migrant characteristics and remittance have a positive but non-significant effect while the flood incidence and crop loss component had non-significant negative effects. With respect to the other productivity variables, the reverse is the case with flood incidence and remittance. This implies that there are unobserved influences which cause it to play out in the opposite direction; it also suggests that the effect of remittance is a function of where the households stand in terms of net remittance and initial resource base. The effect of climate change on land use, agriculture and crop output is well documented (Lambin et al 2003; Ladger et al 2003; McMichael et al 2007 and Olajide, 2014); also the effect of migration on place of origin and place of destination is well documented (Adepoju, 1984; Ratha and Shaw, 2007; Olajide and Udoh, 2012; and Olajide, 2013); but how these two interact together to impact production and productivity has been paid little attention in literature (Adger, 2009; Mertz et al 2009). Thus this study presents some firsthand information in this regard.

4.5 Effects of CC-IM Components on Living Standard

With respect to living standard, the hypothesis was that the overall living standard should increase. But when the components are examined against family income and living standard components, the output suggests unobservable interactions which cause remittance to have a negative effect on family income and the flood incidence component has a positive impact on it. With respect to the economic viability of the household head and asset/income component, it reduces both when the crop loss due to erosion incidence is high. They however increase with increased flood incidence. All the components apart from erosion reduce food security while flood and erosion worsen the vulnerability component. As such different aspects of the living standard are affected differently by CC-IM components. Effects of migration and those of climate change on health, livelihoods and income as a measure of living standard are well documented (Adger, 2009; Mertz et al 2009) but this

research presents a different perspective to the effects considering core living standard components.

4.6 Effects of CC-IM on Production, Productivity, Adaptation and Living Standard

The direct of migration was further examined based on the indications of unobservable patterns or reaction using ESR model. Further investigations using the ESR showed that the effect of migration on gross margin may not equal a better off position for migrant households but does improve their income. Also for GM/Labor, it does not lead to a better off position for migrant households but improves their returns to labor. With respect to family income, migration improves family income and places the migrant household in a better position. But with respect to vulnerability component of the living standard, migration does not lead to a better vulnerable position for migrants'. The decision to migrate also affects the choice of adaptation strategy; migrant households are less likely to choose or have ecosystems friendly adaptation strategies.

As such CC-IM may be the 'opium' of the vulnerable. This presents a clear picture; CC-IM migrant households would have been worse off if they had not migrated and those who did not migrate were better off not migrating. This is a confirmation that the vulnerable households in each system were the ones with migrants. The research in this wise also presents first hand results with respect to the effect of migration on different aspects of rural livelihoods. The vulnerable points and sink holes of possible interventions were better identified.

4.7 Strategy for Green SME Options

The strategy tested introduced G-SMEs in the absence and presence of migration and it showed that Green SME is a potentially viable alternative for labor use, migration and income generation, particularly in the most vulnerable farming systems.

5.0 Conclusions

The overarching question was to examine how Green SMEs should be implemented in Africa in the presence of increasing migration induced by climate change.

One may safely conclude that farming systems can be identified and defined by characteristics or variables such as the level of education particularly of the household head and spouse; the resource base which they have ownership and control over; assets owned both durable and non-durable which can easily be converted to cash; relations within the household as defined by resource allocation and use decisions and market relations defined by external purchase of resources, inputs and services as well as the sales of own resource such as labor and products or service. These variables summarized as **Education, Resources, Assets, Household and Market relations (ERHAM) define** the degree of independence from resource owners, income generation, living standard and innovation adoption. The study identified the RPNLI as the most vulnerable FS based on the 8 criteria of living standard. Through the criteria, multiple vulnerable points were identified in the FS; these are the dependence on other resource owners for consumption loans and productive resource such as land; health burden typified by the number of days lost to illness and average amount spent on cure; a bi-directional dependence on remittance by

both migrants and their households; the lack of security in access to water, energy, food supply and the negative annual cash balance experienced by at least 50 percent of the Resource Poor Farming Systems.

Migration as a response to climate shocks is more common among males who are usually the household head or eldest child in the home. The receiving location is mainly within the state of the study area or south east zone; as such migration here may be characterized as being short distanced. Migrants relate with the sending household through remittance, which is bi-directional. This is an indicator that migrants could be used as potential market development strategy for green SMEs. Different climate change (CC) shocks are experienced and the way it is experienced also vary as such several coping strategies were developed; most of which are environmentally unfriendly. Ecosystem friendly chemicals, water harvesting/recycling techniques are needed. Holistic Ecosystems Based Adaptation strategies (EBAs) should be developed for all the CC shocks experienced and the farm situation.

CC-IM was defined through its components to avoid ambiguity. The components are Migrant characteristics, Remittance, Flood Incidence and Crop Loss (driven by erosion); through these, potential sink holes of G-SMEs at farm and family levels were identified. The effects of remittance, crop loss (erosion) on production and living standard variables indicate that they could harm the growth and development of a G-SMEs. It is important to note these and have them factored into any Green SMEs innovation strategy to ensure their survival. Most SMEs die between 1-5years of their establishment thereby not serving the purpose of livelihood enhancement for which they were set up. This suggests that projects with positive NPV, B/C and IRR within 2 to 3 years would be best for the farming systems. Also, the potential economic impact of CC-IM was identified–flood incidence, which has a positive effect on gross margin signifying a trigger of economic variables which lead to increased prices and hence increased income, most likely through the effect of scarcity.

Further investigations through the ESR model using the Full Information Maximum Livelihood approach confirm that unobservable characteristics influence the decision to migrate. The effects on production, productivity and living standard variables vary but suggest that migration will not necessarily make migrants' household better off than non-migrant households but it does improve the situation of the migrants; that is, they could have been worse off if no one migrated.

The result strongly indicates that migrants' households are more likely to be the vulnerable households in the different farming systems; as such migration is not a sustainable solution to the problems or risks associated with climate variability or shock. The strategy tested introduced G-SMEs in the absence and presence of migration and it showed that Green SMEs is a potentially viable alternative for labor use, migration and income generation, particularly in the most vulnerable farming systems. Policy interventions using G-SMEs as an alternative should take the following points into consideration:

- Crops of household and economic importance
- Work in conjunction with male dominated cooperative societies
- Innovations with credit and thrift content for women
- Focus on the entrepreneurial and economically viable FS
- Should not be labor demanding, should fit into current labor resource capacity
- Input related G-SMEs for the economically viable
- Zero initial capital or develop a cooperative business model
- Locally sourced inputs- markets are rural and localized
- Baskets/cohorts of G-SMEs should be developed to serve multiple needs
- Water and Energy situation have promising opportunities for success if G-SMEs related to them are developed and introduced.
- Having a compulsory savings content in schemes
- Turning the 'flood economic' opportunity to an advantage. It is a market driver

The results provide G-SME spaces and suggest the use of a value chain approach. Several spaces for G-SMEs include energy (bio fuel), water recycling, and organic chemicals within the context of a full eco-systems based adaptation strategy.

6.0 Policy Considerations

In light of the findings of the study, the following recommendations are made:

- Identify climate change shock prone crops of households which are of economic importance such as cassava, cocoa, yam, rice and develop Green SMEs around them;
- Develop G-SMEs with credit and thrift content particularly for women.
- Pilot phase should focus on the economically viable and entrepreneurial farming systems - (but it should be noted that dependency ratio could be high for such systems);
- Develop several "baskets" of SMEs for different farming systems;
- Target migrants at popular migrant receiving locations as possible market agents;
- Seasonal introduction of associated products to harness the market drive potential of climate chocks;
- A value chain approach should be considered in the G-SMEs introduction.

Future Research Challenge

- The cost of adaptation with and without G-SMEs
- Perception and awareness of G-SMEs
- Willingness of Farm Families to adopt Green SMEs

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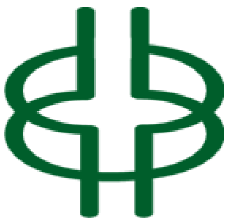

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