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Effect of the National Accelerated Agricultural Inputs Access Subsidy Program on Fertilizer Usage and Food Production in Kakamega County, Western Kenya

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Walden University
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Abstract

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M.Phil. (Agroforestry), Moi University, 2005

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Dissertation Submitted in Partial Fulfillment

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Abstract

Despite 25 years of concerted efforts by African governments to adopt consistent policies for increasing food production, hunger and poverty are still prevalent in the continent. Using Bernanke's conceptualization of the credit channel theory of monetary policy, the purpose of this correlational study was to investigate whether a subsidy program, the National Accelerated Agricultural Inputs Access Program (NAAIAP), affected the rates of fertilizer usage and food production in Kakamega County, Western Kenya. Purposive stratified sampling was used to select 114 participants consisting of 72 farmers in each of the 2 groups: NAAIAP beneficiaries and nonbeneficiaries. Participants completed a survey on fertilizer usage rates, income earned, and surplus maize yield. Data were analyzed using multiple regression to test whether there was a difference between the beneficiary and nonbeneficiary groups regarding income, surplus product, and the dependent variable of fertilizer usage. Results indicated that beneficiaries of NAAIAP credit program bought and prepared to use fertilizers significantly earlier than did their counterparts. Further, the results of multiple regression indicated significant positive correlation (p <.05) between income earned from sale of surplus maize yield and quantity of fertilizer used by farmers in Kakamega County. These findings suggest that NAAIAP improved food security and farmers' income in Kakamega Count. This study contributes to social change by recommending to subsidy program administrators in Kakamega County to consider policy changes. Such policy changes may improve program outreach to resource-poor farmers and improve income and product yield in the agricultural sector of Kenya.

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Dedication

This dissertation is dedicated to my beloved wife, Priscillah; and three children, Mwende, Katanu, and Jason; and my brothers and sisters for their moral support throughout my doctoral course.

Acknowledgments

First, I thank the Almighty God for His grace, providence and knowledge during the entire period of this doctorate course. Secondly, I thank Drs. Augusto Victor Ferreros, and Bethe Hagens, who accepted to guide me through the entire dissertation process. They were my dissertation chairperson and member, respectively. They have, in the last 24 months, worked tirelessly and enthusiastically with me, in every step of this dissertation creation. Thirdly, I acknowledge and take cognizance of the significant contribution of Dr. Patricia Ripoll, as my University Research Reviewer. I also acknowledge the participation of Mr. James Aucha and Geoffrey Mutuku in the data collection process. They played a significant role in translating the questionnaires and consent forms into local languages spoken by the participants.

Finally, I would like to thank my wife, Priscillah and children, Mwende, Katanu and Jason, for their moral support and encouragement during the entire study period, which started in March 2012.

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Chapter 1: Introduction to the Study

Despite abundant knowledge by policymakers that agriculture is the backbone of Africa's economy supporting about 70% of the continent's population, policies that are supposed to support the sector's growth have, for the last 6 decades, been haphazard and inconsistent, leading to slowed growth of the sector (Africa Union, 2016; New Partnerships for Africa's Development [NEPAD], 2016a). Since the formation of the Organization of African Unity (OAU) in May 1963, policies for increasing agricultural development in Africa have always been a priority for most African governments (Africa Union, 2016; NEPAD, 2016a). When OAU transitioned to African Union (AU) in September 1999, the agenda for revamping Africa's agriculture continued to be a priority for the African policymakers (Africa Union, 2016; NEPAD, 2016a). In the 1990s, like many other African governments, Kenyan policymakers devised policies that aimed at revamping the country's agricultural sector that employs at least 30% of all its workers in the formal sectors and 62% in the informal sectors (United Nations Development Programme, 2015; Republic of Kenya, 2013; World Bank, 2012; 2015; 2016).

The lack or insufficient use of fertilizers by smallholder farmers who produce over 80% of the food supplies in Africa have impeded the efforts by policy makers to fight hunger, malnutrition, and poverty (African Development Bank [AfDB], 2016). Consequently, in 2006, the African Heads of Agricultural Ministries held a fertilizer summit in Abuja, Nigeria, and adopted the Abuja Declaration on Fertilizer for a Green Revolution (African Union, 2006; World Bank, 2013). In the 2006 Abuja Declaration, the policymakers committed their governments to increase fertilizer usage by smallholder

farmers from a meager 11 kilograms (kg) per hectare (ha) to about 50 kg/ha by 2015 (NEPAD, 2016b; World Bank, 2013; Figure 1). In the Abuja Fertilizer Summit, the policymakers also made a recommendation to AfDB to establish the African Fertilizer Finance Mechanism (AfDB, 2016).

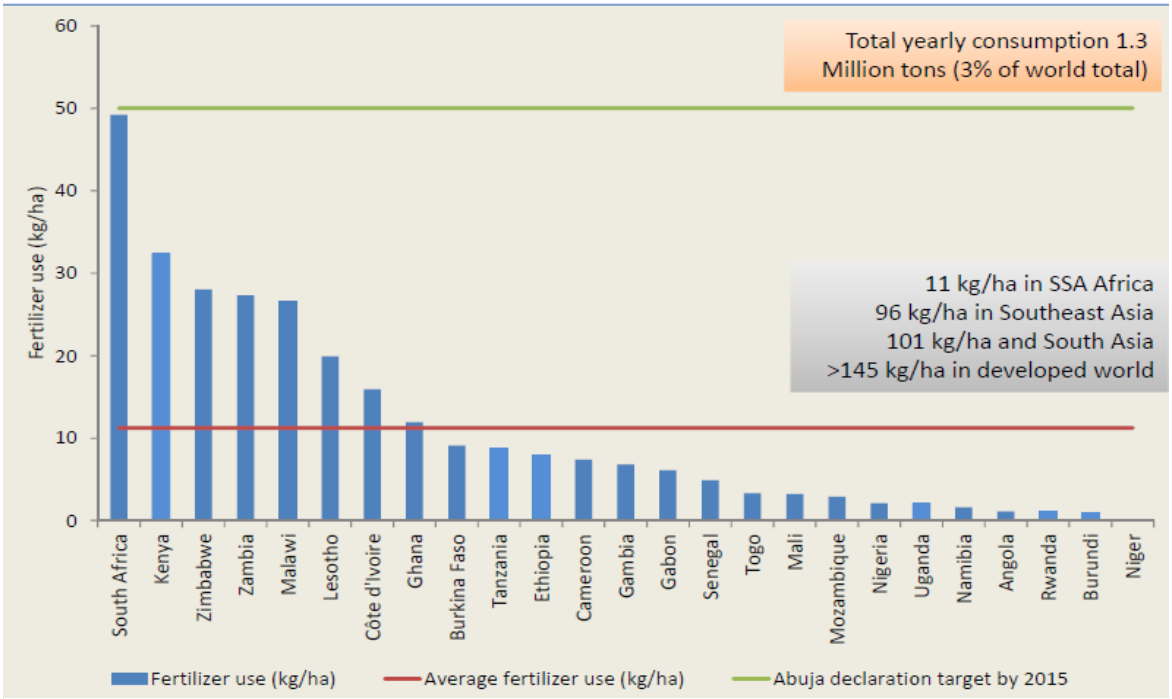

Figure 1: Fertilizer usage rates across various countries in Africa.

Note. From "Unlocking Africa's Agricultural Potential", by World Bank, 2013. Retrieved from https://openknowledge.worldbank.org/

The African Fertilizer Finance Mechanism (AFFM) of 2007 is a public private partnership policy tool for increasing fertilizer supply and demand in Africa through affordable financing to the fertilizer suppliers and users (AfDB, 2016). It was against this background that in 2007, the Kenyan government in partnership with the Alliance for a

Green Revolution in Africa (AGRA), International Fund for Agricultural Development (IFAD), and Equity Bank started the National Accelerated Agricultural Inputs Access Program (NAAIAP).

Through the implementation of NAAIAP, the Kenyan government introduced stringent measures aimed at improving the governance of the program. For instance, the subsidized fertilizer supplied through NAAIAP was supposed to be collected by resource-poor farmers only at the silos operated by the National Cereals and Produce Boards (National Cereals and Produce Board [NCPB], 2014). The farmers were allowed to collect the fertilizer after submitting a letter of eligibility proof from the approved government officials (Republic of Kenya, 2014). The sustainable implementation of this policy was constrained by multiple challenges.

For instance, besides corruption that characterized the issuance of the subsidized fertilizer, the NCPBs silos that served as collection centres were few and unevenly distributed (National Accelerated Agricultural Inputs Access Program [NAAIAP], 2014). In Kenya, there are only 98 NCPB silos and most of them are located far away from the farmers who desperately need to access government-subsidized fertilizers for increasing food production (NCPB, 2014). The implication of this constraint was that although NAAIAP made fertilizer cheaper than in the market price (NAAIAP, 2014), it was not readily available to most farmers (Sheahan, Black, & Jayne, 2013).

It is therefore not well known how effective NAAIAP was in terms of increasing the usage of fertilizers by farmers, especially in Kakamega County where a study by the Agricultural Sector Development Support Program (ASDSP) showed that over 70% of

the farmers use fertilizer but at rates of less than 10 kilograms (kg) per hectare (Agricultural Sector Development Strategy Programme [ASDSP], 2014). The prevailing fertilizer usage rate in the county is only 13% of the county's recommended rate of 75 kg/ha (ASDSP, 2014) and 31% of the Kenya's national average of 32 kg/ha (Sheahan et al., 2013; World Bank, 2013). The problem of low usage of fertilizers in Kakamega County is aggravated by high rates of nutrient losses through leaching and soil erosion since the county receives frequent rainfall ranging from 1,280 to 2,214 millimeters (mm) per year (ASDSP, 2014). Thus, with very low rates of fertilizer usage and continued land degradation, food insecurity in Kakamega County has remained a major problem for policymakers and agricultural stakeholders (Nambiro & Okoth, 2013).

The NAAIAP subsidy program that was implemented through two subprograms, *Kilimo Plus* and *Kilimo Biashara,* aimed at reversing food insecurity in the county and other parts in Kenya (NAAIAP, 2014). The Kilimo Plus subprogram was intended to catalyze a rapid awareness regarding using adequate fertilizer rates, improved seeds, and good agronomic practices for improved food production. The Kilimo Plus subprogram preceded the Kilimo Biashara subprogram and by design, it lasted for only one year, after which the farmers were supposed to graduate to Kilimo Biashara subprogram (Alliance for a Green Revolution in Africa [AGRA], 2011). Even with the glaring figures of low fertilizer usage in Kakamega County, proponents of NAAIAP argue that the program had great potential for increasing fertilizer usage had the Kilimo Plus phase been sustained for a period of more than one year (ASDSP, 2014; NAAIAP, 2014). Longer periods of Kilimo Plus would have made the resource-poor farmers financially stable, allowing

them to graduate to the Kilimo Biashara subprogram without much constraint. In the Kilimo Plus subprogram, resource-poor farmers benefited from a one-off supply of free fertilizers, seeds, and extension services in order to jumpstart them from stagnated agricultural productivity (NAAIAP, 2014). In the subsequent crop season, the beneficiary farmers were expected to approach Equity Bank to access affordable credit for purchasing agricultural inputs through the NAAIAP's credit program dubbed "Kilimo Biashara" (NAAIAP, 2014). Since AGRA and IFAD had deposited 5 million U.S. dollars (USD) with Equity Bank to serve as collateral for lending credit to the resource-poor farmers, the annual interest rate for the loans they borrowed was charged at 10% per annum, which was lower than the prevailing market interest rate of 18% per annum (AGRA, 2011).

To date, there has been little if any information to show whether NAAIAP was effective in increasing fertilizer usage rates and food production levels in Kenya. Therefore I envisioned that knowledge generated from this study will help to inform the general public in Kenya and the academic community of the effects of subsidy programs such as NAAIAP in increasing fertilizer usage and addressing the food insecurity problem. In addition, policymakers in Kakamega County and throughout Kenya will use knowledge generated from this study to streamline agricultural policies that aim to make fertilizers and other farm inputs accessible, available and affordable to farmers. This chapter provides detailed information on the background of the study problem, problem statement, purpose of the study, research questions and hypotheses, conceptual

framework, nature of the study, definition of terms, assumptions, scope and delimitations, limitations, significance, and a summary of the chapter.

Background of the Problem

While several agricultural policies on other continents have helped to increase food production, in Africa similar policies have yielded little gains in that area, especially with major staple cereals such as maize, rice, and wheat (Food and Agriculture Organization of the United Nations Statistics [FAOSTAT], 2015). The policies that led to a Green Revolution in Asia were successful in increasing the usage of fertilizers and improved seeds (Levin & Vimefall 2015). Such policies in Africa have yielded little gains compared to the food benefits they brought in Asia and America (FAOSTAT, 2015; Levin & Vimefall 2015). Further studies indicated that while the continued use of high rates of fertilizers in America and Asia (Figure 2) has deteriorated soil health and water reservoirs in multiple ways, the reverse holds for Africa (Borda, Celi, Zavattaro, Sacco, & Barberis, 2011; Xia, Liu, Ma, Yang, & Li, 2014).

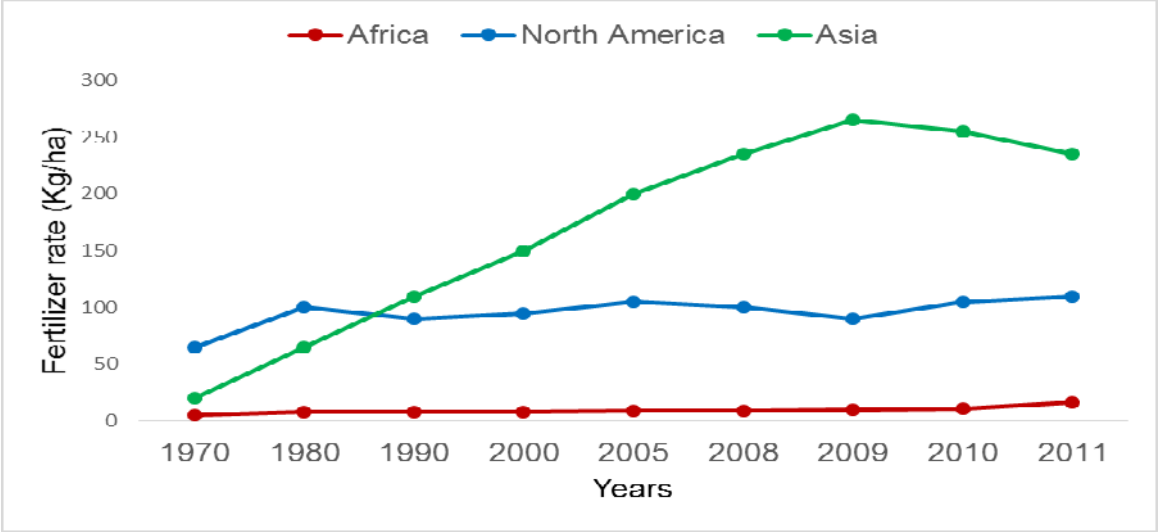

Figure 2: Trend of fertilizer usage in Africa, North America, and Asia.

Note. From "Africa Fertilizer Situation", by IFDC, 2013. Retrieved from http://ifdc.org/fertilizer-market-related-reports/

As shown in figure 2, it is the low rate of fertilizer usage in Africa that has deteriorated soil health (Beaman, Karlan, Thuysbaert, & Udry, 2013; Duflo, Kremer, & Robinson, 2011; 2008; Kiage, 2013; Lederer, Karungi, & Ogwang, 2015; NEPAD, 2009). Although African governments have implemented various policies for increasing fertilizer use among farmers, the average rates of 11 kg/ha (Figures 1 & 2) are still very low to cause a significant increase in food production (International Fertilizer Development Center [IFDC], 2013). The low rate of fertilizer usage by African farmers means that the rate at which plant nutrients are replenished in the soil is much lower than the rate at which they are removed (Beaman et al., 2013; Duflo, Kremer, & Robinson, 2008; Lederer et al., 2015; Sanchez, 2015).

To overcome declining soil health in Africa, researchers, development agencies, and policymakers have been advocating for the use of medium rates of fertilizers of at least 50 kg/ha (African Union, 2016; NEPAD, 2009). The fertilizers could be combined with organic inputs such as compost, green manures, and cattle manures for sustainable management of soil health (Mukuralinda et al., 2010; Vanlauwe et al., 2011). The low rate of fertilizer usage (Figure 2) coupled with other challenges that most African countries face have resulted in agricultural stagnation for the last three decades (Figure 3). This is contrary to other regions of the world where the use of adequate fertilizer rates (IFDC, 2013) has increased food production significantly (FAOSTAT, 2013; Vanlauwe et al., 2011; World Bank, 2015).

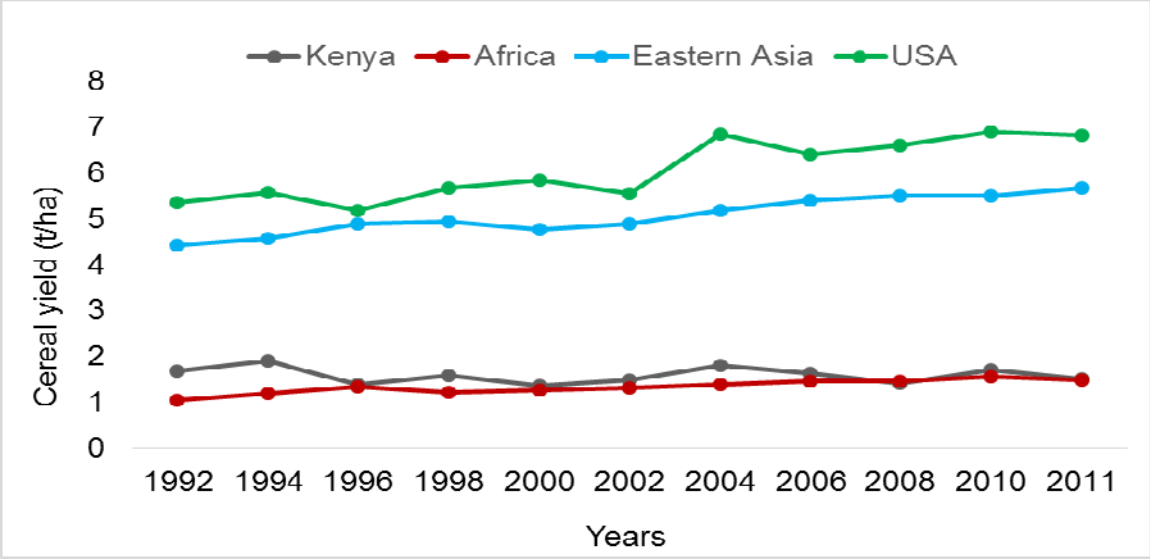

Figure 3: Trend of cereal food production in Kenya, Africa, Eastern Asia, and USA.

Note. From "Crop production trend in Kenya, Africa. Eastern Asia and United States of America", by FAOSTAT, 2015. Retrieved from http://faostat3.fao.org/compare/

In order to address the problems of low usage of fertilizers and food insecurity in Africa, policymakers, development agencies, and other stakeholders in the agricultural value chain have devised various policies for revamping the agriculture sector (Islam, Ahmed, & Debnath, 2013). Such policies include subsidy programs for farm inputs such as improved seeds and fertilizers (Duflo et al., 2011; Jayne, Mather, Mason, & Ricker-Gilbert, 2013; NEPAD, 2009). Others include the Millennium Development Goals (MDGs) of September 2000 which, among other development indicators, include reducing by half the number of people who suffered from hunger by 2015 (United Nations Development Programme, 2015; Republic of Kenya, 2013). The 2003 Maputo Declaration on Agriculture and Food Security added extra weight to the MDGs. Kenya, as with other African governments, committed to increasing its agricultural budgets to at least 10% of its national budget in order to increase food production (NEPAD, 2016a; Republic of Kenya, 2013). This was done under the policy framework of Comprehensive Africa Agricultural Development Program (CAADP) established in 2003 and housed by NEPAD (African Union, 2016). Other policy frameworks for increasing fertilizer usage and food production in Africa included the 2006 Abuja Declaration on Fertilizers and 2014 Malabo Declaration on Accelerated Agricultural Growth and Transformation (African Union, 2016; NEPAD, 2016a).

Other policies that aimed at tackling food insecurity in Africa have included innovative finance programs that aimed at enabling farmers get access to affordable credit to buy farm inputs, especially improved seeds and fertilizers (AGRA, 2016). It was under the background of these policy frameworks that in 2007, Kenya initiated a farm

input subsidy program dubbed, NAAIAP. The goal of NAAIAP was to increase food production through increased access and usage of fertilizers among smallholder farmers (NAAIAP, 2014). The Republic of Kenya and its partners implemented NAAIAP through the subprograms called Kilimo Plus (farming plus) and Kilimo Biashara (farming as a business). The Kilimo Plus subprogram of NAAIAP was started in 2007 followed by the Kilimo Biashara subprogram in 2008. The subprograms were staggered in two phases in order to allow farmers some grace period to grow and sell their surplus crop yields, generate income and then open accounts with Equity Bank for easy access of financial loans (AGRA, 2011; Republic of Kenya, 2014).

Through the NAAIAP's Kilimo Plus subprogram, the government of Kenya aimed to benefit resource-poor farmers with landholdings of less than one hectare. These farmers were given free 10 kilograms (kg) of improved maize seeds, 50 kg of basal fertilizer in the form of Diammonium Phosphate (DAP), 50 kg of top-dressing fertilizer in the form of Calcium Ammonium Nitrate (CAN), and extension services on "best-bet" agronomic practices (Kiratu, Ngigi, & Mshenga, 2014). The rationale of distributing maize seeds only was because it is the main staple food crop in the country, and its productivity was declining due to poor soil fertility (Figure 2).

Some of the most important nutrient inputs for crop production include nitrogen, phosphorus, and potassium. In Kenya, nitrogen is the most limiting nutrient followed by phosphorus. It is for this reason that NAAIAP was designed to provide starter packages of free nitrogen and phosphorus fertilizers (AGRA, 2011; Republic of Kenya, 2014). The improved maize seeds promoted under NAAIAP were those produced through

conventional breeding and not through the biotechnology of genetically modified organisms (GMOs). This is because GMOs are not allowed in Kenya until the necessary bio-safety laws are enacted. In the NAAIAP's Kilimo Plus subprogram, the beneficiary farmers were expected to significantly increase their crop yields, mainly maize and wheat, in order to ensure food sufficiency and income for the farmers (Kiratu et al., 2014). NAAIAP targeted to promote the production of these staple cereals because they are the major food crops in Kenya. However, NAAIAP did not prevent farmers from intercropping or rotating these cereals with legume crops. In addition, although the program provided a "starter package" of improved maize seeds, it did not limit the farmers to mono-cropping.

A study by the ASDSP showed that most farmers in Kakamega County, on average, own about two hectares of land where they grow diverse crop types (ASDSP, 2014). These crops include maize, beans, sorghum, groundnuts, and fruit crops. Despite the various types of crops grown in the county, over 70% of the total cropland is occupied with maize, signifying the importance of the crop as a main food in the county (ASDSP, 2014). Although a study by ASDSP (2014) showed that NAAIAP created mass awareness of the benefits of fertilizer use, making over 70% of the farmers to use fertilizers, the rate of 10 kg/ha that is common in the county has been too low to improve soil fertility and reverse acute hunger among the farmers (Government of Kakamega County, 2013). In addition, this rate of fertilizer use is the least among all the counties in Western Kenya (ASDSP, 2014).

It is therefore, doubtful whether NAAIAP achieved its desired objectives in Kakamega County, where chronic food shortages are common, notwithstanding its adequate supply of rainfall that is evenly distributed throughout the year (ASDSP, 2014; Levin & Vimefall, 2015). Information on the effects of NAAIAP would be instrumental in helping the newly formed government of Kakamega County to locally adapt NAAIAP or devise other appropriate policies for increasing fertilizer usage and food production for its 1.6 million inhabitants (ASDSP, 2014; Government of Kakamega County, 2013).

Problem Statement

A key lesson emerging from the June 2014 Malabo Summit, Equatorial Guinea on Accelerated Agricultural Growth and Transformation, indicates that despite 25 years of concerted efforts by African governments to adopt consistent policies for increasing food production for its bulging population, hunger and poverty are still prevalent across the continent (Levin & Vimefall, 2015; NEPAD, 2016a). The problem being addressed in this quantitative study is that of food insecurity caused largely by very low usage of fertilizers in Kenya and Africa as a whole (Muyanga & Jayne, 2014; Ndirangu, Sachs, Palm, & Deckelbaum, 2013). Although there are many factors leading to food insecurity and poverty in Kenya and other African countries, the main one is lack of sustainable policies to promote the use of fertilizers by smallholder farmers (Duflo et al., 2011 ; Sheahan et al., 2013). Consequently, this problem has caused chronic suffering for smallholder farmers in Kenya and Africa as a whole for the last six decades (Ahlers, Kohli, & Sood, 2013; Sanchez, 2015).

The farm input subsidy programs of the 1960s to 1990s did not achieve their ultimate goal of food security because of disruption from the Structural Adjustment Programs (SAPs) introduced by the World Bank and International Monetary Fund (IMF) in 1990s (IMF, 2015; NEPAD, 2016a; World Bank, 2015). The 2003 Maputo Declaration in Mozambique on Agriculture and Food Security did not address the food insecurity problem largely due to lack of adequate financial resources (Levin & Vimefall, 2015; NEPAD, 2016a). The CAADP adopted under the auspices of NEPAD has demonstrated the role of public-private partnership in solving Africa's food shortage problems. This notwithstanding, the rate of food production in the continent (Figure 3), is still very low to match the rapidly increasing population (FAOSTAT, 2015; Levin & Vimefall, 2015; World Bank, 2016). As shown in figures 1 and 2, fertilizer usage in Africa, Kenya inclusive, has remained dismally low despite the adoption of the 2006 Abuja Declaration (AfDB, 2016; Tully, Wood, Almaraz, Neill & Palm, 2015).

In Kenya, the limited rates of fertilizer use have resulted in low fertility soils incapable of sustaining sufficient crop yields that can assure food security and income for the smallholder farmers who constitute over 70% of its 43 million citizens (Duflo et al., 2011; NEPAD, 2009). This study targets farmers in Western Kenya, a region that has not advanced sufficiently in improving food production in the last three decades (Figure 3) despite its high agricultural potential (FAOSTAT, 2015; Paul et al., 2015; Tully et al., 2015). The region's exponential growth in human population has not been mirrored in increasing food production. This is largely due to lack of sustainable policies that can

sufficiently address the interlinked problems of low soil fertility, poor farming methods, and infestation of *Striga hermonthica* weeds (Paul et al., 2015; Tully et al., 2015).

Although the adequate use of fertilizers has been shown to increase food production in many parts of the world (IFDC, 2016), most of the smallholder farmers in Western Kenya cannot afford unsubsidized fertilizers due to poverty (AfDB, 2016; AGRA 2016). In order to make fertilizers accessible, available, and affordable to the resource-poor farmers, the government of Kenya in 2007 collaborated with AGRA, IFAD and Equity Bank to start the subsidy program NAAIAP (AGRA; 2011, 2016; NAAIAP, 2014; Republic of Kenya, 2014). Although by design and implementation model NAAIAP was expected to increase fertilizer usage significantly and reverse chronic food shortages in Kenya (Pretty & Bharucha, 2014), the average national fertilizer usage rate of 32 kg/ha is still below the critical rate of 50 kg/ha agreed at the Abuja Summit of 2006 (IFDC, 2013; NEPAD, 2009; World Bank, 2013). Although the Kenya's national usage of fertilizer is about 32 kg/ha, in Western Kenya, the target of this study and where NAAIAP was promoted widely, the fertilizer usage rate is about 10 kg/ha (Paul et al., 2015; Tully et al., 2015). This low rate of fertilizer usage in the region is a main factor contributing to low crop yields, hunger, malnutrition, and poverty among women and children living in the rural areas (Paul et al., 2015; Tully et al., 2015).

Purpose of the Study

The purpose of this quantitative study was to explain the impact of NAAIAP on the usage of fertilizers for food production by farmers in Kakamega County, Western Kenya. With increased access to farm inputs, NAAIAP aimed at revamping the

agriculture sector in Kenya, which is the backbone of the country's economy. The sector supports the livelihoods of 80% of Kenya's 43 million people, provides formal employment to 30% of the population and contributes 25% of the Kenya's gross domestic product. The sector is a key foreign exchange earner with 65% of Kenya's exports coming from agriculture. This explains why sustainable agricultural policies are important pillars for socioeconomic development in the country. This study focused on Kakamega County because of its great potential to improve Kenya's agriculture and contribute to the country's socioeconomic stability through sufficient supply of food and revenue. The county that houses the only equatorial rain forest in Kenya lies at an altitude of 1,240 to 2,000 metres above sea level. It receives high amounts of rainfall that range from 1,280 to 2,214 mm per year. The rainfall is evenly distributed throughout the year allowing for two main cropping seasons in March to August and October to December (Ndirangu et al., 2013). Thus, policies that are geared towards increasing food production in Kakamega County could have multiple benefits of fighting hunger and poverty in Kenya.

The highest populated county in Kenya is Nairobi, but it is composed of mainly urban dwellers who depend on the rural population for food supplies. This study measured the impacts of a subsidy program in an important agricultural region, thereby providing important evidence for the adoption of sustainable policy programs for increasing fertilizer use, food production, and incomes. The independent variables for the study were the presence or absence of NAAIAP subsidy or credit program between the beneficiaries and nonbeneficiaries of NAAIAP. The dependent variables were the rates of

fertilizers used by the two groups of farmers, diversity of crops grown by the two groups and their yields, distances travelled to access fertilizers, and incomes from farm produce generated by the two study groups.

Research Questions and Hypotheses

The overall research question (RQ1) and subquestions (SQ2-SQ5) that guided this study and the hypotheses tested were:

RQ1: To what extent did NAAIAP programs affect the usage of fertilizers and food production in Kakamega County, Western Kenya?

$H_0$1: There is no significant difference between the rates of fertilizers used by beneficiaries and nonbeneficiaries of NAAIAP in Kakamega County.

H_a1: There is a significant difference between the rates of fertilizers used by beneficiaries and no-beneficiaries of NAAIAP in Kakamega County.

The independent variable for this hypothesis was NAAIAP participation while the dependent variable was the amount of fertilizer used by the two groups.

Through this study, I sought possible solutions to the following subquestions:

SQ2: How did NAAIAP's credit program affect farmers' preparedness to use fertilizer for food production in Kakamega County?

$H_0$2: NAAIAP's credit program did not significantly affect the preparedness of farmers to use fertilizers for food production in Kakamega County.

H_a2: NAAIAP's credit program significantly affected the preparedness of farmers to use fertilizers for food production in Kakamega County.

SQ3: How did NAAIAP's credit program affect fertilizer accessibility, availability, and affordability in Kakamega County?

$H_0$3: NAAIAP's credit program did not significantly affect the accessibility, availability, and affordability of fertilizers in Kakamega County

H_a3: NAAIAP's credit program significantly affected the accessibility, availability, and affordability of fertilizers in Kakamega County

The independent variable for this hypothesis was NAAIAP participation while the dependent variables were the distances travelled by the farmers to buy fertilizers, number of times that farmers missed to get the required type of fertilizers from the agrodealer shops and the preferred cost of a 50 kg bag of fertilizer for the farmers to afford.

SQ4: What is the relationship between farmers' rates of fertilizer usage and maize grain yield in Kakamega County?

$H_0$4: There is no significant relationship between the rates of fertilizer used by farmers, their income levels and maize grain yield in Kakamega County.

H_a4: There is significant relationship between the rates of fertilizer used by farmers, their income levels and maize grain yield in Kakamega County.

The independent variables (predictors) for this hypothesis were the rates of fertilizer and income levels of farmers while the dependent variable was the maize grain yield.

SQ5: How did the deliberate choice to promote maize under NAAIAP affect crop diversification in Kakamega County?

$H_0$5: The deliberate choice to promote maize crop under NAAIAP did not significantly affect farmers' crop diversification in Kakamega County.

H_a5: The deliberate choice to promote maize crop under NAAIAP significantly affected farmers' crop diversification in Kakamega County.

The independent variable for this hypothesis was NAAIAP participation while the dependent variable was the number of different crops grown by the farmers for food provision.

The rates of fertilizer usage were measured in terms of kilograms (kg) of nutrients applied per hectare per year. The preparedness of farmers to use fertilizers for food production was measured in terms of the number of days prior to planting season when farmers purchased the required fertilizers. In addition, the diversity of crops was measured by the number of different crops grown for food provision in the county while accessibility was determined by the distances travelled by farmers to buy fertilizers, which was measured in terms of kilometers (km) from the farm gate. Availability of fertilizers was measured in terms of frequency that farmers missed to get the required type of fertilizers from the agro-input shops. Crop yields were measured in terms of tons per hectare (t/ha).

Theoretical Base and Conceptual Framework for the Study

This study was guided by several concepts as illustrated in figure 4. These concepts were investigated under the lenses of the credit channel theory (Bougheas, Mizen & Yalcin, 2006). The main tenet of the credit channel theory is that when a central bank changes its policy, the amount of financial credit given to its clients to purchase commodities is also affected, subsequently affecting the overall economy of a country (De Fiore & Tristani, 2012; Jiménez, Ongena, Peydró, & Saurina, 2012). As described by

Madestam (2014) the credit channel theory can be viewed through two broad lenses, narrow and broad bank lending. As explained by Archarya, Almeida, Ippolito and Perez (2014) and Black and Rosen (2016), the narrow lenses of bank lending comes into play when monetary policies influence the supply of credit through the impact of loanable funds that can be provided by banks to certain categories of citizens. On the other hand, the broad lending lenses is where monetary policies affect interest rates only and not credit rationing (Madestam, 2014). Detailed literature relating to the credit channel theory can be found in Chapter 2 of this study.

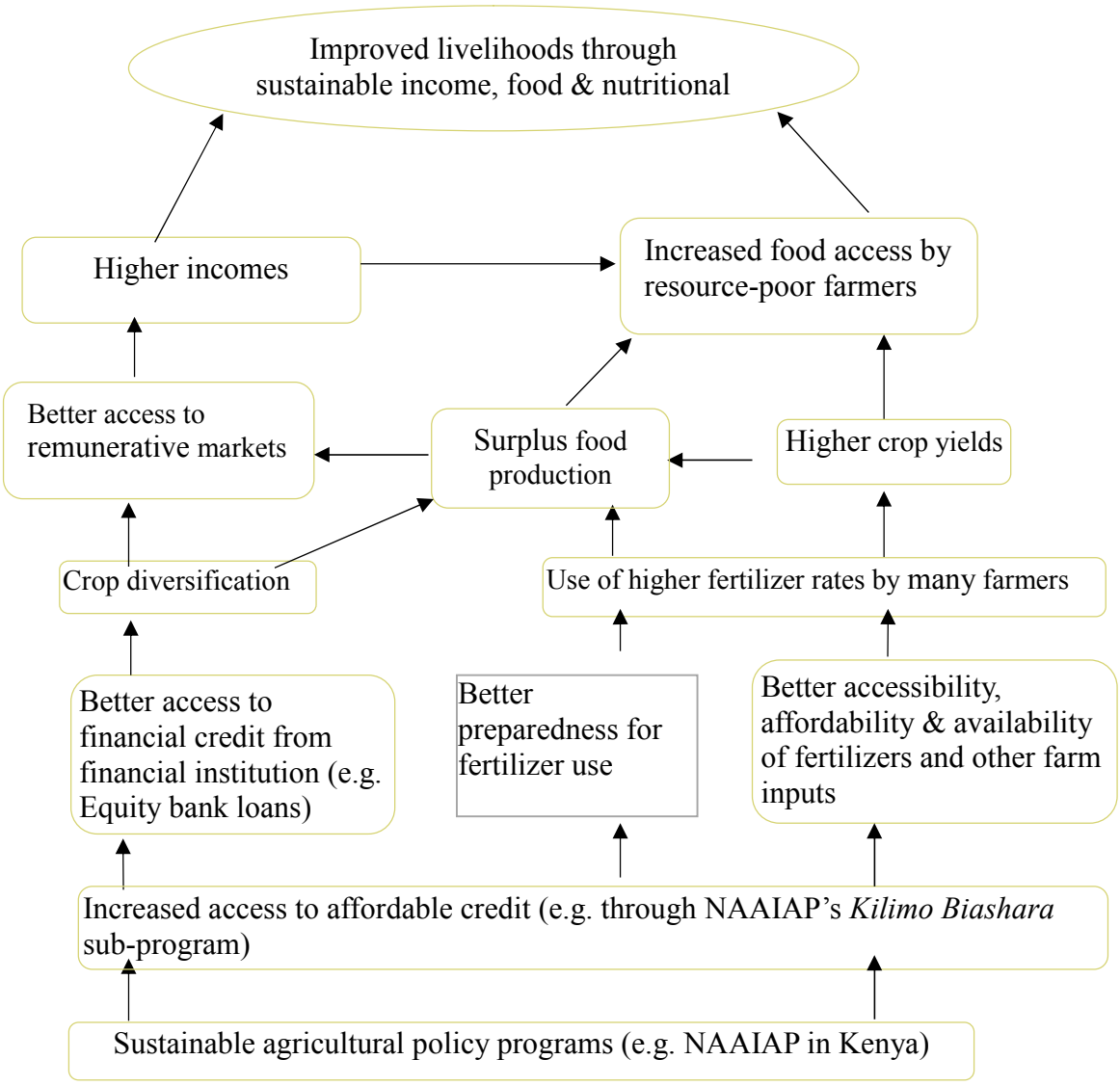

Figure 4: Conceptual framework for the study.

In this study, it was theorized that implementation of sustainable policy programs such as the NAAIAP's Kilimo Biashara would enable farmers and other value chain actors in Kakamega County to borrow higher amounts of loans (credit) from banks and use them to purchase higher amounts of fertilizers for farmers' use in increasing food

production (Figure 4). This is because the partners who started NAAIAP expected that its credit program known as Kilimo Biashara, would sustain improved incomes, food security and livelihoods of Kenyan farmers largely through access to affordable credit (AGRA, 2011). Several studies have shown that government and private sector initiatives that support the use of adequate rates of fertilizers and other essential farm inputs, such as improved seeds, lead to increased agricultural productivity and the ultimate achievement of food security (Duflo et al., 2011; 2008; Jain & Jha, 2015; Kerr, 2012).

The NAAIAP's Kilimo Biashara credit program had specific terms and conditions for applicants to meet before getting a loan. Therefore, the credit channel theory (Bougheas, Mizen & Yalcin, 2006) has been used to explain the extent to which the credit lending policy influenced farmers to borrow higher bank loans to invest in other crop diversification projects in order to increase food production and get surplus to sale for income generation. One of the objectives that made AGRA invest in NAAIAP was to encourage smallholder farmers in Kenya to use fertilizers by bringing it closer to them through the expansion of agrodealer networks in the rural areas. AGRA envisioned that the expansion of agrodealer networks in the rural areas would reduce the distances travelled by farmers to buy fertilizers thereby making it more available to them (AGRA, 2011).

According to Chinsinga (2011) and Duflo et al. (2011; 2008) the location of agro-input shops in urban centers, which are far away from farmlands restrains farmers from accessing and using fertilizers for increased crop production. The long distance travelled by farmers to agrodealer shops increases the cost incurred by farmers to access fertilizers,

hence a key contributing factor to low usage of fertilizers in many parts of Africa (Cultivating New Frontiers in Agriculture [CNFA], 2015). Thus, fertilizer usage by smallholders in Africa is limited by both supply and demand constraints (African Fertilizer Agribusiness Partnership [AFAP], 2015). The supply constraints can be addressed by making fertilizers affordable and available to the smallholder farmers, through innovative platforms that ensure sustainability (AFAP, 2015; CNFA, 2015). On the other hand, the demand constraints to fertilizer use can be addressed by creating mass awareness, through innovative extension models, on the agronomic and financial beneficial of using fertilizers (AGRA, 2016; CNFA, 2015).

In addition, access to affordable credit can enable farmers to buy and use higher rates of fertilizers for increased crop yields and income from sale of surplus farm produce. Once the farmers generate sufficient income from the sale of surplus maize, which was largely supported under NAAIAP, they could buy other foodstuffs such as beans, cowpeas, fruits, and vegetables that ensure their nutritional security (Grace, Brown & McNally, 2014). They could also use the affordable credit borrowed from Equity Bank to diversify to other preferred crops that could assure them sufficient supply of diverse foodstuffs and incomes (Grace et al., 2014; AGRA, 2011). The outcome of all these interconnected value chain concepts is envisaged to be improved livelihoods through sustainable income, food, and nutritional security (Figure 4).

Nature of the Study

A cross sectional design in a quantitative method of inquiry was used where a survey was conducted using structured questionnaires to solicit responses from two

groups of farmers in Kakamega County beneficiaries and non-beneficiaries of the NAAIAP subsidy program. Purposive random sampling was used to select the two groups of farmers where randomization was stratified by sub-counties. This design was deemed necessary because it ensured that those farmers who benefited from NAAIAP and those who did not were selected representatively to constitute the study sample. Stratification ensured that farmers from each subcounty in the entire Kakamega County were given equal chances of being selected for the survey.

The subsidy (NAAIAP participation) was ,thus, the independent variable where various dependent variables were compared between the beneficiaries and non-beneficiaries of NAAIAP. Other independent variables like the distance to agrodealer shops, as well as demographic variables such as education, gender, and others were included in the survey instrument. The nonbeneficiary farmers served as a comparison/control group. The dependent variables compared against the independent variables included the rates of fertilizer usage, number of times that desired fertilizers were missed from the agrodealer shops, days prior to rain season when fertilizers were bought in preparation for use and number of different crops grown. The necessary data were collected through a survey using questionnaires that were administered to the beneficiaries and non-beneficiaries of NAAIAP. The collected data was analyzed using the Statistical Package for Social Sciences (SPSS), version 23 and then presented in form of tables and graphs.

Definition of Terms

African Fertilizer and Agribusiness Partnership (AFAP): A public private partnership organization with headquarters in Johannesburg, South Africa that was started in 2012, by the Alliance for a Green Revolution in Africa (AGRA) in partnership with the United States Agency for International Development (USAID), International Fertilizer Development Centre (IFDC), and others. Its main mandate is to address the supply constraints of fertilizer use in Africa (AFAP, 2015).

Alliance for a Green Revolution in Africa (AGRA): A not-for-profit international non-governmental organization that I work for and which was started in 2006, with initial funding from the Bill and Melinda Gates and Rockefeller Foundations, in order to catalyze an accelerated agricultural growth in Africa (AGRA, 2016).

Analysis of Variance (ANOVA): One of the data analysis method to test hypotheses postulated in this study (Nachmias, & Nachmias, 2008; Sage Publications, 2013).

Agricultural Sector Development Support Program (ASDSP): A program started by the Kenya's Ministry of Agriculture in 2011 to support the government's vision of a revitalized market-led agriculture as stipulated in the new constitution promulgated in August 2010 (Republic of Kenya, 2010). It also supports the alignment of the agriculture sector to the NEPAD's Comprehensive Africa Agriculture Development Programme (ASDSP, 2014).

International Fund for Agricultural Development IFAD: This is an agricultural development agency of the United Nations that collaborated with the Kenya government,

AGRA, and Equity Bank to start and support NAAIAP subsidy program (AGRA, 2011; IFAD, n.d.).

Kakamega County: One of the 47 counties in Kenya with the highest population of smallholder farmers (Government of Kakamega County, 2013).

Kilimo Biashara: One of the sub-programs of NAAIAP where the farmers were supposed to approach Equity Bank and obtain affordable credit to purchase farm inputs, mostly improved seeds and fertilizers (NAAIAP, 2014).

Kilimo Plus: One of the sub-programs of NAAIAP which targeted 2.5 million resource-poor farmers, country wide. They were supposed to get a 'jump-starter' package and then later graduate to Kilimo Biashara (NAAIAP, 2014).

Multivariate Analysis of Variance (MANOVA): One of the data analysis methods to test hypothesis (Nachmias, & Nachmias, 2008; Sage Publications, 2013)

Logistic Multiple Regression: One of the data analysis methods that was used with dummy variables (Nachmias, & Nachmias, 2008; Sage Publications, 2013)

National Accelerated Agricultural Inputs Access Program (NAAIAP): This refers to the fertilizer subsidy program started by government of Kenya in 2007, in collaboration with the AGRA, IFAD, and Equity Bank (NAAIAP, 2014).

NAAIAP beneficiaries: This refers to the farmers who benefited from either Kilimo Plus or Kilimo Biashara subprograms since 2007 (NAAIAP, 2014)

NAAIAP nonbeneficiaries: This refers to the farmers who did not benefit from either Kilimo Plus or Kilimo Biashara sub-programs (AGRA, 2011; IFAD, n.d)

Statistical Package for Social Sciences (SPSS): One of the statistical software for analyzing data collected for social studies such as the survey data under this proposed study (Nachmias, & Nachmias, 2008; Sage Publications, 2013).

Assumptions

One of the greatest assumptions made in this study was that the sampled farmers provided honest responses that related to the variables investigated. These included their annual rates of fertilizer usage per hectare and the yields of food crops gotten since the inception of NAAIAP. These assumptions were necessary in order to maintain a rapport with the farmers. This was because doubting the responses provided by the farmers would have destroyed the confidence that they had for confidentiality and usefulness of the study. A second assumption was that increasing the rates of fertilizer usage is a sustainable long-term soil fertility and economic strategy for smallholder farmers. This assumption was necessary for an agricultural based study like this one that targeted a region like Western Kenya where fertilizer usage has, for a very long time, been very low and the soil nutrient base has, for many years, been greatly degraded through soil erosion, leaching and poor agronomic practices. Studies have shown that crop responses to fertilizer nutrition follow the law of diminishing returns where crop yields will increase with increased rates of fertilizer application up to a given point where additional units of fertilizer becomes toxic to the soil leading to decline in crop yields (Sogodogo, Coulibaly, Coulibaly, & Sacko, 2016). In most African countries, Kenya inclusive, the optimal rates of fertilizer application for sufficient crop nutrition have yet not been

reached hence the reason why policy makers have been advocating for higher fertilizer rates to improve food production (AfDB, 2016; Africa Union, 2016).

Scope and Delimitations

This study addressed the intertwined problems of low usage of fertilizers and food insecurity due to failed implementation of sustainable agricultural policies, especially smart subsidy programs. These problems have led to severe hunger and poverty in Kakamega County, which has a great potential to produce surplus food for the entire Western Kenya region that consists of four other counties (Figure 5). The other counties in Western Kenya are Bungoma, Busia, and Vihiga (Figure 5). Among these counties, Kakamega is the most important one in terms of socioeconomic activities. It is the most expansive county covering 3033 km^2, while Bungoma, Busia and Vihiga cover 2207 Km^2, 1628 Km^2 and 531 Km^2, in that order (Thuweba, Diwani, Folkard, Becker, & Mussgnug, 2013). Kakamega is also the most populated county in the region with 1,660,651 inhabitants, compared to Bungoma, Busia and Vihiga whose populations are 1,375,063, 743,946 and 554,622, in that order. (Kenya Open Data, 2014)

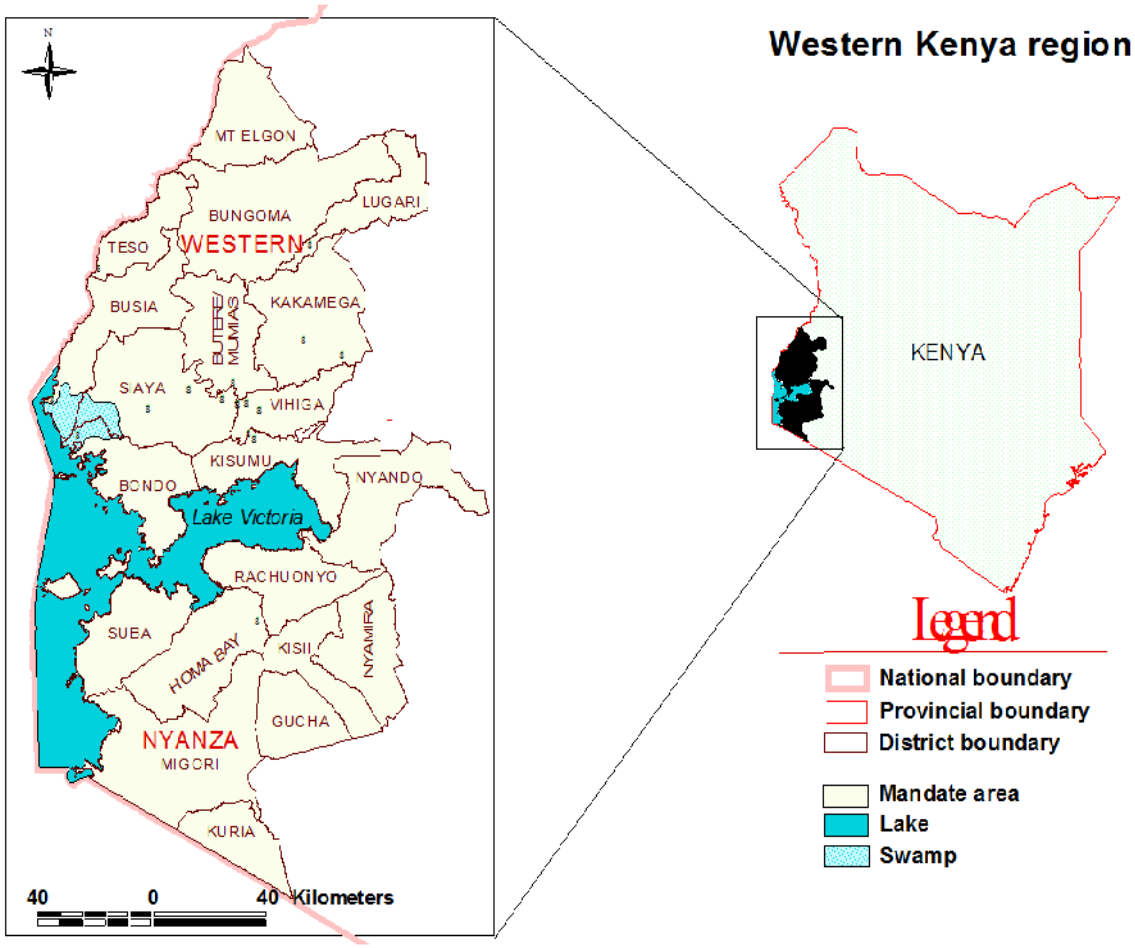

Figure 5: Western Kenya and neighboring regions.

The main economic activity in Kakamega County is subsistence farming of food crops, the main staples being maize, beans, and groundnuts. While these staple food crops are grown in the other three counties, subsistence farming is not the main activity (Thuweba et al., 2013). In Bungoma, the main economic activity is sugar cane growing, mainly for income generation, while in Busia, it is fishing in Lake Victoria. Vihiga is mainly dominated by tea and dairy farming (ASDSP, 2014). NAAIAP aimed at boosting

food production in various counties in Kenya through intensification of farm inputs such as fertilizers and improved seeds.

This study delimited the area of study to Western Kenya and specifically to Kakamega County, which is one of the four counties in the region. The other delimitation of the study was limited time and resources to enable me interview all the farmers who benefited from NAAIAP in Kakamega County. Therefore, only a representative sample of the farming population was considered in this study. Another delimitation was that maize was selected as the sole test crop in this study and the effect of the rates of fertilizer usage was based on maize grain yields and not on all the crops cultivated by farmers in Kakamega County

Limitation

The limitation of the study was that not all the farmers in Kakamega County were surveyed. Out of a population of about 400,000 farmers in Kakamega County, only 144 were sampled (Commission on Revenue Allocation, 2013; Kenya Open Data, 2014). Not all the farmers in the County could be interviewed due to limitation of time, human and financial resources. Thus, in the sampling strategy, there was a potential ethical issue of bias, since it was only a few farmers who were sampled from each of the twelve sub-counties in Kakamega County. The study was thus faced with an internal validity of generalizability because recommendations on the effect of NAAIAP subsidy program in Kakamega County were generalized based on the responses from 144 farmers (Janesick, 2011). However, in order to ensure justice in selecting the farmers that participated in the study, stratified random sampling was employed to pick a representative sample from the

twelve focal sub-counties. The study population exhibits homogeneity in terms of cultural and farming practices and therefore the sampled farmers fairly represented the larger population.

Significance

There has been an increasing call for 'smart' agricultural policies in Africa to address the problems of low usage of fertilizers, which has consequently led to declining soil fertility and low food production (Duflo et al., 2011; 2008; NEPAD, 2016). By describing the effect of NAAIAP on the rates of fertilizer usage by farmers in Kakamega County, this study added to the growing body of literature that highlights the effects of subsidy programs in Africa, in response to the 2006 AfDB (African Union, 2006; NEPAD, 2009). The results of this study has been documented and will be disseminated to all the 47 counties in Kenya and other stakeholders so that they can use it to devise smarter policy programs for enabling farmers to use appropriate rates of fertilizers for increased food production. It is envisaged that the information in this study would be used by the newly formed government of Kakamega County to increase the rates of fertilizers used by farmers in its county. In addition, since NAAIAP was effective in increasing fertilizer usage, accessibility and availability, similar policy programs should be devised to support farmers in transforming the agriculture sector in Kenya.

Summary

Chapter 1 provided background information on the effects of agricultural policies on the usage of fertilizers for food production in Africa and other parts of the world. It highlighted a number of policy frameworks that African governments, Kenya inclusive,

have devised to tackle the problem of low usage of fertilizers by their farmers. The inadequate use or no-use of fertilizers in Africa has largely contributed to low agricultural productivity, food insecurity and poverty among the rural folks most of whom are smallholder farmers. The Millennium Development Goals, CAADP, Maputo, Abuja and Malabo Declarations, are some of the policy frameworks that Kenya had ascribed to, with the goal of increasing fertilizer usage and food production. The achievements of these policies demonstrated that it is possible to reverse low agricultural productivity in the country but adequate financial resources and time are necessary for sustaining the benefits associated with such policies.

The chapter also highlighted how several agricultural stakeholders used these policies to create awareness of the need to increase agricultural productivity in order to match the food demands of the ever-increasing African population. It was against these policy frameworks that in 2007, the Kenyan Government in collaboration with AGRA, IFAD and Equity Bank initiated NAAIAP. It is now 10 years, since NAAIAP was launched yet Kenya continues to grapple with the problem of food insecurity. Thus, the effects of the 'NAAIAP' program in increasing fertilizer usage and food production, among Kenyan smallholder farmers, were not well-known. In addition, in 2013, Kenya changed its agricultural development policies by devolving agricultural functions to the County Governments. This was in response to recommendations contained in a new constitution that was promulgated in August 2010 (Republic of Kenya, 2010). Consequently, each of the 47 counties in Kenya was supposed to develop locally adapted policies to accelerate agricultural development in its region. The new agricultural policies

that the county governments have developed may not be able to tackle the problems of low fertilizer usage and food insecurity unless they are well anchored on empirical evidence of what works well and where. This underpinned the significance of this quantitative study that was carried out in Kakamega County, Western Kenya. The County is of great economic importance in Kenya because it has the highest number of food insecure rural people despite its high agricultural potential. Knowledge generated from this study supports the scaling out of adoption of subsidy programs similar to NAAIAP in order to increase fertilizer usage and food production in Kenya and elsewhere in Africa.

The following chapter provides a detailed description of publications and databases reviewed. Some of these databases include the Sage, Science Direct and websites of renowned agricultural development agencies and organizations such as AGRA, AFAP, IFAD, IFDC, IMF, NEPAD and World Bank. Some of the key journals that I reviewed included *Food Policy*, *Nature Plants, Environment & Urbanization, Geoderma, Agricultural Economics, Agroforestry Systems*, *Crop Science,* and *the International Journal of Agriscience*, among others. The chapter also contains a summary of what is known about the agricultural policy frameworks in Africa that have not been able to adequately address the problems of low usage of fertilizers and declining food production. In addition, the chapter provides a review of the credit channel theory and related concepts that served as basis for the conceptual framework for this study. The concepts provided under the credit channel theory and as applied in Kenya, provided a number of knowledge gaps that this study attempted to fill.

Chapter 2: Literature Review

Introduction

While conducive policies play a great role in driving agricultural development, policies that are not based on empirical data regarding what works where will not be adopted by the target population, will not be sustainable, and will not lead to achievement of the intended goal. For instance, various policies that include the Millennium Development Goals, CAADP, and declarations by African policymakers in Maputo, Abuja, and Malabo in 2003, 2006, and 2013, in that order, sought to increase the rate of fertilizer use in Africa but have achieved limited success.

On the other hand, studies have demonstrated that while organic inputs do improve soil fertility by increasing soil organic matter, they have limited ability to replenish certain essential macronutrients such as soil phosphorus (Mukuralinda et al., 2010; Vanlauwe et al., 2011). Without adequate presence of these essential macronutrients in the soil, plants are unable to complete their vegetative life cycle (Nash et al., 2014). The low contents of essential nutrients in organic inputs require that they are applied in large quantities in order to supply crops with the required amount of nutrients (Bvenura & Afolayan, 2013; Mukuralinda et al., 2010; Nash et al., 2014). Hence, their availability in the quantities required by farmers is a serious constraint to their use (Bvenura & Afolayan, 2013; Mukuralinda et al., 2010). Thus, the most efficient way to replenish soil phosphorus and other essential plant nutrients is through the application of inorganic fertilizers. It is against this background that sustainable policies are deemed

necessary to increase fertilizer usage and food production in Africa, where a majority of the rural people have suffered from hunger and poverty for a long time.

This section includes subsections of publications and databases reviewed as well as a summary of what is known about agricultural policies in Africa, Kenya inclusive, and gaps that this study attempted to fill. In particular, there are subsections that highlight relevant literature in the Sage database on policies that have been developed to increase the rates of fertilizer used by smallholder farmers in Africa and how the rates compare with those used by farmers in other continents. There is also literature on how various African governments and development partners have responded to the overarching problem of food insecurity. For instance, various Africa governments have devised certain agricultural policies that are geared towards decreasing the cost of farm inputs. Some of these policies include subsidy programs on fertilizers and improved seeds, which although they have helped alleviate the problem of low agricultural productivity, they have not addressed it in a sustainable way due to a myriad of challenges. The main challenges have been highlighted in the literature reviewed. For instance, the Kenyan Government introduced the NAAIAP subsidy program to provide affordable farm inputs to resource-poor farmers, but skeptics of the program still wonder whether it was a noble program for the government to invest in.

The proponents of the NAAIAP subsidy program argue that it was beneficial to the target farmers, and therefore, in the new era of the devolved agricultural sector, the various county governments in Kenya should adapt and adopt the program for increased fertilizer use to attain food security. The various literature in the following sections has

shown that for Kenya and other African countries to achieve step changes in crop yields and food security, both government and private sector need to have effective partnerships for facilitating farmers' access to quality seeds and fertilizers. In the process of reviewing literature related to agricultural policies, fertilizer use, and food security in African countries, Kenya inclusive, various knowledge gaps were identified. In this study, I have attempted to fill some of them.

Literature Search Strategy

In the literature review , I exhaustively describe the concepts that agricultural stakeholders, including African governments, have used to address the problem of soil infertility that has been reported to cause low food production and poverty among smallholder farmers. I had searched for constraints that impede smallholder farmers from using adequate rates of fertilizers necessary to boost the productivity of their farms. I highlight various studies that have shown that smallholder farmers in Africa are characteristically resource-poor and hence cannot afford the recommended rates of fertilizers for optimal food production and income generation. Consequently, African governments in partnership with their development partners have collaborated to devise and support innovative financial policies for helping farmers to access financial credit from banks that they can use to purchase fertilizers and other farm inputs. I describe the role of government policies conducive to helping farmers to increase their rates of fertilizer application for optimal crop production. I discuss these concepts through the lens of the credit channel theory. I also describe the tenets of the credit channel theory, its relevance to agriculture and its application to my study.

In addition, I examine literature that demonstrates the contribution of agriculture to Africa's economic and social development and how the various African governments have devised policies to revamp the agricultural sector for sustainable development. I detail how governments have used subsidies as a key policy tool for supporting agricultural development. Such subsidies have been implemented in different forms and strategies and some of them have failed to achieve their intended goals, necessitating a call for smart subsidies such as NAAIAP that Kenya launched in 2007. In the literature section, I have describe in depth the challenges and research gaps presented by NAAIAP that justified the importance of this study and its potential contribution to social change.

Foundational Research

In the search for literature on the various concepts highlighted in this study, I restricted my inquiries to websites of government departments, nongovernmental organizations, development agencies, and recent journal and online publications not more than five years old. On the websites of the African Union, FAOSTAT, IFDC, NEPAD, and World Bank, I searched for information on agricultural policies that have been proposed to increase fertilizer usage and food production in Africa. On the AGRA website (AGRA, 2016), I searched for information related to food insecurity, fertilizer use, access to credit for agricultural development, and the implementation of NAAIAP's Kilimo Biashara credit scheme that was executed by Equity Bank. This was after the bank got 5 million USD credit guarantee facility from AGRA and IFAD, which collaborated with the Government of Kenya in the implementation of the credit-lending program. As noted on its website, AGRA has a vision of having a food secure and

prosperous Africa, while its mission is to trigger a uniquely *green revolution* in Africa that transforms agriculture into a highly efficient, effective, and sustainable system that lifts millions of smallholder farmers from poverty (AGRA, 2016).

In responding to the problem of food insecurity in Africa, AGRA works with diverse partners along the entire agricultural value chain stretching from government departments to the private sector. Examples of these partners include the Bill and Melinda Gates Foundation (BMGF), Rockefeller Foundation (RF), USAID, IFAD, IFDC, nongovernmental organizations, and the Centres of the Consultative Group on International Agricultural Research. I therefore, reviewed various publications that I downloaded from the websites of these organizations.

When I searched for information on agricultural financing in the *International Public Management Review Journal*, I found a study by Ahlers et al. (2013) that provided information similar to what is postulated in this study, that favorable government policies that support sustainable agricultural growth can lead to a food secure and prosperous country. Ahlers et al., however, did not provide data on the outcomes or impacts of implementing certain government policies. They provided a vision for a prosperous Africa, which can be realized with increased use of fertilizers as had happened in Asia.

In order to get updated information and identify knowledge gaps on food security issues in Kenya, I reviewed journals such as *Food Policy* and *Nature Plants*. I also reviewed information on agricultural finance and implementation of NAAIAP from the *Environment and Urbanization Journal*. I reviewed literature on Kenya's agricultural

policies and governance from the Government of Kenya website and its 2010 Constitution.

In order to understand the food security situation and farming practices in Kakamega County where this study was carried out, I reviewed various reports published by the ASDSP, by the Government of Kenya, and those published by the County Government of Kakamega (ASDSP, 2014). I obtained information related to the use of fertilizers and their profitability from the following journals: *American Economic Review, International Journal of Agriscience*, *Agricultural Economics*, *Progress on Development Studies, Agroforestry Systems*, *Scientific Research & Essays*, *Geoderma* and various websites such as those of AFAP, NEPAD, and African Union. In the process of searching for literature, I identified various knowledge gaps as highlighted in the following sections.

A study by Jayne et al. (2013) provided a meta-analysis across various countries in Africa that showed the financial and agronomic benefits of using higher rates of fertilizers. They reviewed information on fertilizer usage rates in Africa and compared them with the rest of the world. They found that the rates of fertilizers used by farmers in Africa were very low, hence the reason why crop yields in Africa remained equally low. Jayne et al. (2013) identified the need to streamline some of the existing agricultural policies in order to come up with sustainable models for supporting increased food production and incomes in Africa. One of the greatest limitations of the article by Jayne et al. (2013) was that it relied on government subsidies as the main policy tool to reverse the low rates of fertilizers used by African smallholder farmers. The researchers did not

report on the effects of NAAIAP and how it affected the rates of fertilizers used by smallholder farmers in Kenya.

A similar study by Kiratu et al. (2014) provided a review of the perception of NAAIAP in Nakuru County, Kenya. They found that farmers are likely to adopt policies for which they have a positive perception about the socioeconomic benefits that would accrue from them. The main limitation of their study was that they did not investigate the socioeconomic welfare of the farmers who benefited from NAAIAP in order to recommend whether it was worthwhile for the Kenyan Government to invest in the program.

Mutoko, Hein, & Shisanya (2014) conducted a similar study in Western Kenya that provided information about the policies that should be put in place to ensure sustainable land management in such a region. In order to ensure adequate representation of the participants they selected, Mutuko et al. used stratified random sampling. Their method of sampling is consistent with the sampling strategy in this study. However, they remained silent about the benefits of NAAIAP, which was an important policy tool for increasing fertilizer usage and food production in Western Kenya.

In addition, a study by Ndirangu et al. (2013) provided information about some of the socioeconomic benefits of increased fertilizer use and food production in Western Kenya. They also provided information that showed farmers in Western Kenya are constrained by soils that are low in fertility, but if they could be supported to access affordable farm inputs that improve their soils, they would be able to produce enough food that would make Western Kenya a food secure region. However, they remained

silent on the role of NAAIAP in increasing fertilizer use for attainment of food security in Western Kenya.

Further, Jama and Kiwia (2009) conducted a study in Western Kenya that took the design of mixed methods involving both qualitative and quantitative data. In their study, Jama and Kiwia assessed maize yield with fertilizer application. They also conducted sensitivity analysis to assess the effect of change of fertilizer prices on the profitability of maize. The study showed that an increase in fertilizer prices adversely affects its profitability and rate of usage among resource-poor farmers. However, Jama and Kiwia remained silent on the "best-bet" agricultural policies that could be used by governments and agricultural stakeholders to make fertilizers affordable and more accessible for use by farmers to increase their food production.

Furthermore, Sheahan et al. (2013) provided information about the profitability of using fertilizers to grow maize crops across many agro-ecological zones in Kenya over a period of 13 years from 1997 to 2010. Their quantitative study involved 1,243 households in 120 villages from 24 districts in Kenya. Their findings were consistent with those of Jama and Kiwia (2009) and Jayne et al. (2013) in reporting significant crop yields with fertilizer application. In addition to Kenya, other countries quoted by Sheahan et al. (2013) that have benefited from increased use of fertilizers with appropriate policy support included Ghana, Tanzania, Malawi and Zambia. Sheahan et al. (2013), however, looked at the profitability of only nitrogen fertilizers, whereas farmers in Western Kenya plant their crops with phosphorus and potassium fertilizers and do top-dressing with

nitrogenous fertilizers. This gap was, however, addressed by Jama and Kiwia (2009), who looked at the profitability of nitrogen, phosphorus, and potassium fertilizers.

Theoretical Foundation and Conceptual Framework

Credit Channel Theory

The credit channel theory (Bougheas, Mizen & Yalcin, 2006) has been widely used in the developed and developing worlds to explain how changes in monetary policies by a central regulating bank affects the flow of money to commercial banks and how the commercial banks adjust their credit lending terms to borrowers. The credit channel theory (Bougheas, Mizen & Yalcin, 2006), whose basic tenet is recognition of imperfections caused by asymmetric information and enforcements of contracts in the credit market, explains how certain monetary policies passed by governments can affect the real economy of a country. For instance, a recent study by Black and Rosen (2016) showed that changes in monetary policies of federal funds in the United States of America affected the supply of loans to commercial banks which in turn affected the rate at which the banks loaned out their funds, the repayment period and general availability of credit to consumers. Black and Rosen (2016) reported that a small increase of only 1% in federal funds caused commercial banks in Chicago to reduce maturity of loan supply by 3.3% and subsequent decrease of 8.2% in the amount of loans available for borrowers to access from the banks.

A study by Archarya et al. (2014) executed through the lens of the credit channel theory showed that when commercial banks experience increased liquidity because of favorable monetary policies by the regulator, they tend to give out more credit to

borrowers at more relaxed and riskier terms. In addition, De Fiore and Tristani (2013) used the credit channel theory to explain how credit defaulters may lead into a banking crisis. De Fiore and Tristani (2013) explained that when producers of goods borrow money from financial institutions to pay for their factors of production such as labour and then they make a profit with the borrowed credit, they will deposit some of the profits with the financial institutions. Such deposits increase the bank's liquidity thereby, prompting them to give the extra liquidity to more credit seekers (Duff & Einig, 2015). On the other hand, though, if such producers fail to make the envisaged profits with the borrowed credit, they will default repayment of the loan and prompt the banks to initiate legal actions to recover their money from the defaulters (De Fiore & Tristani, 2013; Duff & Einig, 2015).

Such instances of loan defaulters will introduce a banking crisis and make banks unable to give out credit because of diminished liquidity supply (De Fiore & Tristani, 2013). If the banks have to give out the limited liquidity, they will only target a certain group of clients who are considered less risky to lend out credit (Duff & Einig, 2015). The majority of loan seekers will not be able to access formal bank credit (De Fiore & Tristani, 2013; Jiménez et al., 2012). Once the formal credit becomes inaccessible the loan seekers will turn to informal credit sources and borrow from there at perhaps exorbitant interest rates (Ferrando and Mulier, 2013; Madestam, 2014). The studies by Ferrando and Mulier (2013) and Madestam (2014) showed that resource-poor people in the rural areas prefer to borrow credit from informal sources compared to banks.

In the agricultural context, innovative finance policies that have supported farmers' access to affordable credit have been reported to cause increased use of farm inputs such as fertilizers and improved seeds, which have consequently resulted in increased food production and income (AGRA, 2016). For instance, the Government of Kenya collaborated with AGRA and IFAD to support the Kilimo Biashara sub-program of NAAIAP, which enabled farmers to access credit at Equity Bank without collateral and at interest rates lower than the market rates (AGRA, 2011). The credit that the farmers got from Equity Bank was supposed to help them buy fertilizers and other essential farm inputs for increasing food production. Thus, the credit channel theory served as lenses for investigating how NAAIAP facilitated farmers to acquire credit that was necessary for buying fertilizers to increase crop productivity and income.

There are several studies that point to the fact that where individual farmers made a decision to use fertilizers at the recommended application rates, there was mass use of higher rates of fertilizers, leading to higher crop yields, surplus food production and food and nutritional security (Government of Kakamega County; 2013; Mutoko et al., 2014; Nambiro & Okoth, 2013). Duflo et al. (2011; 2008) and Jain and Jha (2015) reported that the efficacy of agricultural production is directly related to the increased use of farm inputs such as fertilizers, improved seeds, herbicides, and pesticides, among others. Inaccessibility to affordable credit is a key constraint to the use of fertilizers and other farm inputs, especially among African resource-poor farmers (Cabannes, 2012; Duflo et al., 2011; 2008).

The credit channel theory can be viewed from two broad perspectives: narrow bank lending and broad credit channel (Madestam, 2014). From the viewpoint of bank lending channel, monetary policies such as the NAAIAP's Kilimo Biashara, influence the supply of credit through their impact on loanable funds that can be provided by the banks to certain categories of citizens. According to the bank lending channel theory, distortion of bank interest rates may result in more moral problems that can hurt a country's economy (Archarya et al., 2014; Madestam, 2014; Jiménez et al., 2012). According to this lending channel, certain investments or projects associated with lower risks may bring a moral hazard of crowding out the private-led investments associated with higher risks (Duff & Einig, 2015). As explained by Madestam (2014), the broad credit channel assumes that any imperfections of information that occur in the credit market is not caused by the banking sector and therefore, the effects of any monetary policy will affect interest rates and not credit rationing.

Although government subsidies and bank guarantee schemes help farmers navigate around the constraint of credit access to purchase farm inputs (Cabannes, 2012), studies in Zambia (Hanjra & Culas, 2011) and Malawi (Kerr, 2012) showed that government subsidies are normally faced with unreliability challenges that make fertilizers unavailable to farmers at planting time. Alkins (2009) argued that when governments or non-governmental organizations give money to financial institutions like banks to subsidize financial lending to a given group, there is normally a diversion of resources that should have been used to address other social problems. Thus, such

interventions might not be sustainable since they do not adequately address social problems (Alkins, 2009).

Harrigan (2008) suggested that the high cost of fertilizers hinders farmers from using them especially if the rate of return on investments is not profitable. Further studies suggested that farmers would be able to borrow loans from commercial banks if they are able to make profits from their farming enterprises (Harrigan, 2008; Jain & Jha, 2015).

Role of Policies in Promoting Fertilizer Usage

For the farmers to be provided with the prerequisites for increasing food production there must be favorable government policies that promote the demand and supply of fertilizers. There has been consensus to adopt favorable policies to encourage farmers to increase their rate of fertilizer usage (Jayne et al., 2013). The study by Jayne et al. (2013) showed that although fertilizer subsidy programs in Africa have played a crucial role in increasing fertilizer use by farmers, they are not sustainable in the long term due to corruption and poor administration. They recommended streamlining existing policies around fertilizer subsidies and coming up with sustainable models for supporting increased farm productivity and incomes. In the last decade, the Kenyan government put in place NAAIAP in order to streamline the fertilizer industry but the extent to which it affected the rates of fertilizer use in the country, particularly Western Kenya is not well documented.

Literature Review Related to Key Variables and/or Concepts

Agriculture is the economic backbone for most countries in sub-Saharan Africa and the sector will continue to underpin major economic activities in the region,

providing for food security, national employment and foreign exchange earnings (African Union, 2016). The major concern is the relatively low and variable growth rates of the region's agriculture sector, which has averaged 2.6% in the last decade (Ahlers et al., 2013; NEPAD, 2009), against a rising human population and the risks associated with climate change and variability. The current growth rate for agriculture is below the minimum target of 6% recommended by NEPAD (Ahlers et al., 2013; NEPAD, 2009). As reported by NEPAD (2009) the poor performance of the agriculture sector in sub-Saharan Africa, has been attributed to:

- under-investment in agriculture by national governments (often below 10% of national annual budgets),
- low levels of development and dissemination of agricultural technologies,
- lack of access to output markets, and
- lack of farmer access to production inputs, particularly seed and fertilizer.

Policy Frameworks to Revamp Africa and Kenya's Agriculture

The farm input subsidy programs of 1960s to 1980s showed great potential to increase agricultural production in many African countries (World Bank, 2015; IMF, 2016). However, the introduction of the SAPs by the World Bank and International Monetary Funds (IMF) in 1990s, disrupted the implementation of the subsidy programs (World Bank, 2012; 2016; IMF; 2016). Under the SAPs, the World Bank and IMF reduced the level of grants and loans that they were giving to the African governments (World Bank, 2016; IMF; 2016). Therefore, due to inadequate financial resources, the

governments could no longer continue implementing the subsidy programs (NEPAD, 2016).

In September 2000, like many other African countries, Kenya adopted the Millennium Development Goals (MDGs). The MDGs aimed to, between 1990 and 2015, reduce by half the number of people who suffered from hunger (United Nations Development Programme, 2015; Republic of Kenya, 2013). Although the MDGs caused a significant reduction of poverty, the number of people in need of adequate food and proper nutrition has increased due to rapid growth of population (Republic of Kenya, 2013). The Maputo Declaration of 2003 on Agriculture and Food Security, added extra weight to the MDGs where Kenya, like other African governments committed to increase its agricultural budgets to at least 10% of its national budget in order to increase food production (NEPAD, 2016a; Republic of Kenya, 2013). This was to be done under the policy framework of CAADP housed by NEPAD.

In the process of trying to grow Africa's agriculture the policymakers and agricultural stakeholders realized that the use of none or little rates of fertilizers by smallholder farmers, who produce over 80% of the food supplies in Africa, was impending their concerted efforts to fight hunger (AfDB, 2016). Consequently, in 2006, the African Heads of Agricultural Ministries held a fertilizer summit in Abuja, Nigeria, and adopted the Abuja Declaration. In the Abuja Declaration, the agricultural sector policymakers committed their governments to increase fertilizer use among its smallholder from 11 kg/ha to about 50 kg/ha by 2015 (NEPAD, 2016b). The policymakers agreed to remove cross-border taxes on fertilizers and to provide fertilizer

subsidies. The ultimate goal was to make fertilizers affordable by smallholder farmers (NEPAD, 2016b). In the Abuja Fertilizer Summit, the policy makers also made a recommendation to the African Development Bank (AfDB) to establish the African Fertilizer Finance Mechanism (AfDB, 2016).

The African Fertilizer Finance Mechanism (AFFM) of 2007 is a public private partnership policy tool for increasing fertilizer supply and demand in Africa (AfDB, 2016). Some of the main functions of AFFM include the provision of affordable finance to fertilizer manufacturers and credit guarantees for fertilizer suppliers, farmers and key stakeholders in the entire fertilizer value chain (AfDB, 2016). It was against this background that in 2007, the Kenyan government in partnership with AGRA, IFAD and Equity Bank started NAAIAP.

Genesis of NAAIAP Subsidy Program in Kenya

In 2007, the Kenyan government collaborated with the Alliance for a Green Revolution in Africa (AGRA), the International Fund for Agricultural Development (IFAD) and Equity Bank to roll out a smart subsidy program on fertilizers, seeds and extension services (Alliance for a Green Revolution in Africa, 2014; Kiratu, Ngigi, & Mshenga, 2014). It was known as NAAIAP.

In order to ensure sustainability of NAAIAP, the partners rolled it out in two sub-programs namely Kilimo Plus and Kilimo Biashara (Republic of Kenya, 2014). In the Kilimo Plus sub-program the government of Kenya supplied free fertilizers, improved maize seeds and extension services to farmers in order to kick-start their agricultural production. The government aimed to benefit 2.5 million resource-poor farmers across

the entire country, especially in the regions with high agricultural potential (Kiratu et al., 2014; Republic of Kenya, 2014). The partners of NAAIAP envisioned that its beneficiaries would be able to get surplus produce of maize from the use of improved seeds, fertilizers and best-bet agronomic practices so that they can sell the excess produce for income generation (Figure 4). They expected that the income generated by NAAIAP beneficiaries from the sale of the surplus maize, would be used to purchase essential farm inputs for sustainable food production. They also expected the beneficiaries of Kilimo Plus sub-program to graduate to Kilimo Biashara sub-program and get financial credit from Equity Bank to enable them purchase the necessary farm inputs (Kiratu et al., 2014).

Challenges and Research Gaps Presented by NAAIAP

Through the NAAIAP's Kilimo Plus sub-program, 494,000 metric tons of fertilizers reached farmers through the National Cereal and Produce Board (NCPB), which are operated by the Kenyan Government (Republic of Kenya, 2014). In Kenya, there are only 98 NCPBs and most of them are located far away from the farmers who desperately needed subsidized fertilizers for ameliorating their soils to increase crop yields (National Cereals and Produce Board, 2014). Consequently, the subsidized fertilizers were not readily available to most farmers due to the long distances that they had to travel to access them (Mutoko, Hein, & Shisanya, 2014). In addition, the subsidized fertilizers were available to farmers in specific seasons, some of which did not rhyme with the planting season, thereby, making the fertilizers unavailable to some farmers (Sheahan et al., 2013). Since the fertilizers stocked by the private agrodealers

near the rural resource-poor farmers were not subsidized, they remained inaccessible to most of them due to their high cost (Sheahan et al., 2013).

Farmers who qualified to buy the subsidized fertilizers under NAAIAP were supposed to submit a letter from their divisional extension and administration officers proving that they met the eligibility requirements. Although this was a strategy to avoid the resource-rich farmers from buying the subsidized fertilizer reports indicate that corruption was abundant. The resource-rich farmers corrupted the extension and administration officers who in turn issued them with letters cheating that they were resource-poor farmers and hence ended up buying the subsidized fertilizers. The consequence of this was that most of the targeted resource-poor farmers missed the subsidized fertilizer as supply was limited and the resource-rich farmers often bought the stock first.

These challenges and others mentioned in several studies left many doubts on whether NAAIAP achieved its objectives (Sheahan et al., 2013). Currently, it is not well known whether the farmers who benefited from the NAAIAP's Kilimo Plus sub-program were able to graduate to the Kilimo Biashara sub-program as anticipated. It is also not clear whether the farmers who benefited from Kilimo Plus sub-program formed a critical mass to enable the Kilimo Biashara sub-program to operate sustainably as an agribusiness model. It is also not well known whether farmers who are currently benefiting from Kilimo Biashara are using adequate rates of fertilizers that can cause a significant increase in crop yields, especially maize that is the main staple food in Kenya. It is also not well known whether the NAAIAP program was able to attract agrodealers to open

agro-input shops near the farmers so that the distance travelled by the farmers to access fertilizers and other farm inputs were reduced.

Fertilizer Usage and Agricultural Productivity

The use of inorganic fertilizers has been shown to reverse the trend of declining soil fertility and food production in many parts of the world (Beaman et al., 2013; Duflo et al., 2011; 2008; Kiage, 2013; Sanchez, 2015). Several studies have shown that there is no country in the world that has been able to increase its food production significantly, without significant usage of inorganic fertilizers (Beaman et al., 2013; NAPAD; 2009). Inorganic fertilizers are able to increase the production of both cereal and legume crops through the quick replenishment of essential macronutrients such as nitrogen, phosphorous, and potassium, among others (Beaman et al., 2013; Ndirangu et al., 2013; Islam et al., 2013). Recent studies in Africa have shown that even after a single cropping season, the application of average rates of fertilizers (60 kg of nitrogen and 20 kg of phosphorus per hectare), increased the yields of major staple foods such as maize, rice, sorghum, millet, and wheat by more than threefold, compared to where fertilizers were not applied (Beaman et al., 2013; Camara, Camara, Berthe, & Oswald, 2013; Duflo et al., 2011; 2008; Muyanga & Jayne, 2014).

Despite the enormous agronomic and financial benefits of using fertilizers to grow crops, their rate of usage in Africa has, for many decades, remained as low as 10 kilograms (kg) of nutrients per hectare (ha) compared to 110 kg per ha in Latin America and over 130 kg per ha in Asia (Ahlers et al., 2013; Beaman et al., 2013; Jayne, Mather, Mason, & Ricker-Gilbert, 2013; NEPAD, 2009; Islam et al., 2013). Studies have shown

that the use of either very high or low quantities of inorganic fertilizers have negative effects on the soil base (Lederer, Karungi, & Ogwang, 2015; Xia et al., 2014).

The addition of inorganic fertilizers in combination with organic inputs, commonly referred to as integrated soil fertility management (ISFM), ensures a healthy soil, capable of sustaining high crop yields, subsequently leading to food security and income generation for farmers (Mukuralinda et al., 2010). Unfortunately, the high cost of fertilizers and lack of awareness among African smallholder farmers on the benefits of using inorganic fertilizers, are some of the factors responsible for low usage of fertilizers in sub-Saharan Africa (Duflo et al., 2011; 2008; Sanchez, 2015).

Fertilizer subsidies implemented in various African countries such as Nigeria (Takeshima & Nkonya, 2014), Ethiopia (Uraguchi, 2012), Malawi (Jayne et al., 2013), and Zambia (Hanjra & Culas, 2011) were reported to result in more farmers using higher rates of fertilizer than the continental average of 10kg/ha (NEPAD, 2009). However, their strategies of implementation were not sustainable due to several loopholes that included political interference, mismanagement, and corruption among the policy implementers (Jayne et al., 2013).

The unavailability of subsidized fertilizer also limited the success and sustainability of the subsidy programs (Jayne et al., 2013). Often, the supply of subsidized fertilizer did not match the quantities demanded by farmers. In addition, subsidized fertilizers were not regularly available at the time when farmers needed to use them (Takeshima & Nkonya, 2014; Uraguchi, 2012). Furthermore, most of the governments, which implemented fertilizer subsidy programs, did not have sustainable

exit strategies for such subsidies and therefore, farmers ceased to use fertilizers when their governments stopped the subsidy programs (Jayne et al., 2013).

Constraints Faced by Farmers in Accessing Fertilizers in Kenya

The main factors that limit fertilizer use in Kenya, and Africa in general, are affordability, accessibility, and availability (Jayne et al., 2013; Sheahan et al., 2013). Most of the fertilizers that are used in Africa are imported from oversees countries and when they reach the African seaports, they are transported further through long distances to reach farmers' fields. Although the cost price of the fertilizers from their source might not be expensive, the additional cost incurred by the fertilizer supply companies to transport the fertilizers to their distribution centres within a country makes the commodity rather expensive for resource-poor farmers to afford it (Muyanga & Jayne, 2014). In addition, the agrodealers who sell fertilizers are located in cities and other big towns that are far away from the farmers' fields hence making fertilizers inaccessible to farmers (Jayne et al., 2013; Sheahan et al., 2013). In addition, the agrodealers sometimes fail to stock the required types and quantities of fertilizers needed by farmers, especially at the start of planting seasons (Republic of Kenya, 2014; Islam et al., 2013).

Measures for Addressing Fertilizer Supply and Demand Constraints

In order to address the constraint of fertilizer accessibility to the rural resource-poor farmers, many African governments such as Malawi, Ghana, Zambia, Nigeria, Ethiopia, and Kenya, among others, have in the last decade rolled out several policies in favour of increasing fertilizer use by the farmers. One of the most popular policies on this matter has been the fertilizer subsidy program, which has been reported to cause an

increase in the rate of fertilizer use in several African countries (Hanjra & Culas, 2011; Jayne et al., 2013; Takeshima & Nkonya, 2014; Uraguchi, 2012). However, several researchers have reported that most of the subsidy programs in Africa will not be sustainable due to a number of factors, the major one being lack of 'a smart strategy' to sustain the increased use of fertilizers, once the subsidy programs come to an end (Jayne et al., 2013; Takeshima & Nkonya, 2014; Uraguchi, 2012).

Summary and Conclusions

It is evident from various studies that most of the countries in Africa rely on agriculture for their livelihood as well as the main source for their income. Therefore, policymakers should devote more resources to grow the sector. One way to do this is to support smart subsidy programs to enable farmers access farm inputs that are necessary for increasing agricultural production and food security. In Kenya, various policies have been enacted to increase agricultural production through fertilizer use that is essential for reversing soil infertility. In 2007, the government of Kenya, AGRA, and IFAD started NAAIAP mainly to increase the rate of fertilizer usage among smallholder farmers. A decade after introduction of NAAIAP, the rate of fertilizer usage is still below the 50 kg/ha target recommended by African policy makers in the 2006 Abuja Fertilizer Summit.

One of the main reasons why farmers in Kenya and Africa in general, do not use the recommended rate of fertilizer is inaccessibility constraint of the fertilizers (Jayne et al., 2013; Sheahan et al., 2013). This constraint exists because fertilizers in the region are expensive for the farmers to afford (Muyanga & Jayne, 2014). In addition, the

agrodealers who sell fertilizers are located in cities and other big towns that are far away from the farmers hence making fertilizers inaccessible to farmers (Jayne et al., 2013; Sheahan et al., 2013). Another factor contributing to this constraint is that the agrodealers sometimes fail to stock the required types and quantities of fertilizers needed by farmers, especially at the start of planting season (Republic of Kenya, 2014). Thus, the factors of affordability and availability work well to make fertilizers inaccessible to farmers in Kenya as well as in other parts of Africa (Jayne et al., 2013; Islam et al., 2013).

In order to investigate the extent to which NAAIAP subsidy program affected the rates of fertilizer usage for improved food production in Western Kenya, this study was conducted in Kakamega County from October 5 to November 11, 2016. I first pre-tested the questionnaire (Appendix A) in a reconnaissance survey from October 5 to 11, 2016 using a representative sample of 36 farmers (18 beneficiaries and 18 non-beneficiaries of NAAIAP). The farmers who participated in the reconnaissance survey were purposively and randomly picked across the 12 sub-counties of Kakamega County. After clarifying all the questions in the questionnaire and after getting a fair understanding of the target population, I started collecting the data used for this study from October 17 to November 11, 2016. I administered the questionnaire attached as Appendix A, to 144 farmers after seeking their consent to participate in the study. The participants that consisted of 72 beneficiaries and 72 non-beneficiaries of NAAIAP were chosen purposively and randomly across the 12 sub-counties of Kakamega County. Details of the research design, its rationale, population of the 12 sub-counties, sampling procedures and the recruitment of the participants are provided in Chapter 3 below. In addition, details on the method of

data collection, data analysis, threats to validity and ethical procedures are provided in Chapter 3 below. The chapter ends with a summary of the entire methodology used in this study.

Chapter 3: Research Method

Introduction

Kenya, which is located in eastern Africa, covers an area of 582,650 square kilometres (km^2) of which 8,361 km^2 (1.4%) is in Western Kenya. This small area supports about five million (12%) out of the 42 million Kenyans, signifying the socioeconomic importance of the region. Western Kenya consists of four counties, Kakamega, Bungoma, Busia and Vihiga. This study focused on Kakamega County because of its agricultural importance in Kenya. Kakamega County borders Vihiga County to the south, Siaya and Busia Counties to the West, Bungoma and Trans Nzoia Counties to the north and Nandi and Uasin Gishu Counties to the east. This chapter describes the research design and rationale of the study and defines the study population and how it was sampled. The chapter also describes how the data in this study was collected and analyzed and highlights some of the ethical issues and how they were addressed.

Research Design and Rationale

I used a quantitative method to investigate how NAAIAP subsidy program affected the usage of fertilizer and food production in Kakamega County, Western Kenya. I administered the questionnaires with the help of two local enumerators who I engaged to help explain the purpose of my study to the illiterate farmers using local Luhya language. This arrangement was important because I do not speak the Luhya language that is spoken by most farmers in the study area. The farmers sampled in this study were selected randomly, thereby presenting equal opportunities for the literate and

illiterate farmers to be selected as study participants. As explained by Creswell (2013), this design is appropriate since the study helped to investigate structural changes that NAAIAP subsidy program brought. This design is also appropriate in studies such as this one that aim to produce macrobenefits to a larger community (Creswell, 2013). The use of questionnaires provided an opportunity for the study participants to expound on the questions asked and to provide detailed information that was useful for analyzing the collected data. They also helped me to conduct a reconnaissance survey that was helpful in improving some vague questions before commencement of the actual study. This helped to increase validity and reliability of the collected data (Creswell, 2013).

These steps showed how the farmers who benefited from NAAIAP were faring in terms of food security and income levels and how they compared with those who did not benefit from the program. Through the study, I was able to compare the rates of fertilizer used by farmers, food production, income levels, and fertilizer affordability, accessibility, and availability before and after implementation of NAAIAP.

Population

This study focused specifically in Kakamega County because of its socioeconomic, agricultural, and environmental importance. As shown in Table 1, the county has twelve subcounties, Butere, Ikolomani, Khwisero, Likuyani, Lugari, Lurambi, Malava, Matungu, Mumias East, Mumias West, Navakholo, Shinyalu (Government of Kakamega County; 2013; NAAIAP, 2014).

Table 1

Administrative Subcounties of Kakamega County

Subcounty	Area (Km²)
Butere	210.5
Ikolomani	143.6
Khwisero	145.6
Likuyani	301.9
Lugari	367
Lurambi	161.8
Malava	423.3
Matungu	275.9
Mumias East	135.5
Mumias West	165.3
Navakholo	257.9
Shinyalu	445.5
TOTAL	3033.8

Note. From **"**First county integrated development plan 2013–2017", Government of Kakamega County, 2013. Retrieved from https://kakamega.go.ke/

Kakamega is the second most populated county in Kenya after Nairobi County but the most populated by rural dwellers, most of whom are resource-poor farmers (ASDSP, 2014; Commission on Revenue Allocation [CRA], 2016; Kenya Open Data, 2014). Over 75% of the population lives in the rural areas and are engaged with smallholder farming activities in less than two hectares of land for their livelihood (CRA, 2016; Thuweba et al., 2013).

Sampling and Sampling Procedure

I used purposive, stratified random sampling to select the farmers surveyed across the twelve subcounties of Kakamega County. Purposive sampling was deemed fit in

order to sample the farmers who benefited from NAAIAP and those who did not, across the twelve subcounties of Kakamega County. They provided information related to fertilizer usage and food production levels before and after NAAIAP. The office of the County Director of Agriculture, Kakamega County, in liaison with the Ministry of Agriculture, provided the lists of the farmers who benefited from NAAIAP. Following the devolution of the agriculture sector in Kenya in 2013, all the agricultural activities within a given county were controlled by the county governments in consultation with the national government to avoid duplication of efforts and wastage of resources. Stratified random sampling is used in population studies where a researcher is interested in describing population characteristics and doing so using inferential statistics (Creswell, 2013; Nachmias & Nachmias, 2008). It is used where the population has different groups (strata) and the researcher wants the groups to be fairly represented in the sample to be studied.

The number of participants sampled in the county was determined using G*Power software (Faul, Erdfelder, Bucher, & Lang, 2009). This was based on the type of analysis, effect size, and statistical power required. For instance, in this study, an independent *t* test, two-tailed, with two independent means (two groups: beneficiaries and nonbeneficiaries of NAAIAP) was conducted with the aim of achieving a medium effect size of 0.5, statistical power of 80%, and alpha = 0.05. This allowed for a sample size of 128 participants (64 beneficiaries and 64 nonbeneficiaries of NAAIAP).

I also conducted logistic multiple regression to see how fertilizer usage between the beneficiaries and nonbeneficiaries of NAAIAP in Kakamega County was predicted

by a number of factors such as distance to agrodealer shops, number of times that desired fertilizer was missed after NAAIAP, and preferred affordable price for a 50 kg bag of DAP and CAN fertilizers. I used multiple regression with dummy variables where omnibus chi-square (χ^2) tests and contingency tables were applied. The inputs for this test were a medium effect size of 0.3 to achieve 80% power at alpha = 0.05 with 1.0 as the degree of freedom. This allowed for a sample size of 88 participants using G*Power software (Faul et al., 2009). In order to ensure that my sample size was sufficient for all the analysis that I deemed necessary while taking care of good representation across the 12 subcounties of Kakamega County, I sampled 72 farmers in each of the two groups, giving a sample size of 144. The targeted farmers belonged to the same tribe and hence they exhibited homogeneity in cultural and economic behavior that largely influences their farming practices. Due to this homogeneity of the target population, it was possible to generalize the results of a sample population with high degree of accuracy (Creswell, 2013).

Procedure for Recruitment, Participation, and Data Collection

Before starting data collection, I got permission from the Institutional Review Board (IRB) of Walden University. My IRB approval number was 09-14-16-0347050. I also got an introduction letter from my employer AGRA, and permission from the County Government of Kakamega. I hired two local enumerators who understood the geography of Kakamega County well and who were proficient in English, Kiswahili, and the local Luhya language so that they could help me in administering the questionnaires. Although over 90% of the sampled participants were literate with either primary or

secondary education, the local enumerators mostly used the local Luhya language to introduce me to the participants. This was a necessary measure for identifying ourselves with the farmers and for instilling trust with the participants. In Kenya, people trust one another based on tribal affiliations. The use of local enumerators added great value to my study because they developed a quick rapport with participants so that they could identify with me. Thus, my local enumerators used their local language to clearly explain to the participants the purpose of my study and the information sought in the questionnaires. This made them to open up with us, thereby providing accurate responses to the questions in the questionnaires.

Instrumentation and Operationalization of Constructs

I used a questionnaire (Appendix A) to provide an opportunity for the farmers in Kakamega County to expound on the issues of fertilizer usage and food production as influenced by NAAIAP subsidy program. The questionnaire also provided an opportunity to conduct a reconnaissance survey and then improve on some vague questions before undertaking the actual study. The sampled farmers were requested to participate in this study voluntarily, and anyone who declined to participate for reasons unknown or known, such as old age, was not coerced to participate. The question in the questionnaire that asked about the participant's age helped to determine the elderly people so that pressure was not exerted to them during discussions that hardly extended beyond 45 minutes. In cases where we engaged the participant beyond 45 minutes, we sought their consent for the extension. I used the responses provided by such farmers during such discussions to

complete the questionnaire. I protected each individual's privacy by assigning a unique code to the questionnaires.

During the data collection period for this study, I adequately planned for flexible and ample time that accommodated all participants. For instance, there were some participants who agreed to participate in the study voluntarily but requested that I leave the questionnaire behind with them and allow them one or two days to complete it. I assigned a unique code to each participant so that I could always get in touch them for clarification of any vague question in the questionnaire at a time and place convenient to them. This provision minimized participants risks associated with time pressure and respected stakeholder welfare. The data collected from the participants was triangulated through secondary data and relevant reports from the Ministry of Agriculture and County Government of Kakamega. This increased the reliability and validity of the data. I also coded the data source so that names of individual participants were not disclosed in the questionnaire and study findings.

Operationalization. Information on the number of farmers who benefited from NAAIAP's subprograms is stored by the Government of Kakamega County at the Office of the County Director of Agriculture. I discussed my proposed study with the Ministry of Agriculture officials as well as the officers in the County Government of Kakamega who voluntarily agreed to provide me with the necessary secondary data. Therefore, I visited the Kakamega County director of agriculture before the start of data collection where I gathered the necessary secondary data. This included the total number of farmers who benefited from NAAIAP's subprograms and those who did not. It was from these

two lists of NAAIAP beneficiaries and nonbeneficiaries that I drew my participation sample.

I conducted the reconnaissance survey from October 5 to 11, 2016, using a representative sample of 36 farmers (18 beneficiaries and 18 nonbeneficiaries of NAAIAP). The farmers who participated in the reconnaissance survey were purposively and randomly picked across the 12 subcounties of Kakamega County. After clarifying all the questions in the questionnaire and after getting a fair understanding of the target population, I started collecting the data used for this study from October 17 to November 11, 2016. The data was collected through a survey using questionnaires. I was assisted by two local enumerators to navigate the county and administer the questionnaires to 144 farmers after seeking their consent to participate in the study. From November 14 to November 30, 2016, I coded and entered the data into SPSS spreadsheets that I cross-checked to correct for human errors that occurred during entry. I conducted data analysis during the month of December, 2016.

The NAAIAP participation defined by beneficiary or nonbeneficiary of subsidy served as the main independent variable for this study. This independent variable was compared against a number of dependent variables such as education levels of the farmers, gender, marital status, age, and other attributes that were included in the survey instrument. The nonbeneficiary farmers served as a comparison/control group for other dependent variables such as the rates of fertilizer used, amount of credit accessed by the two groups of farmers, preparedness for fertilizer use, and diversity of crops grown. The

data were subjected to inferential statistics to test the hypotheses of no significant differences between the dependent variables mentioned above.

Data analysis plan. I used the Statistical Package for Social Sciences ([SPSS], version 23), computer software, to code and analyze the data. I then conducted descriptive statistics to check whether the assumptions of the intended statistical analysis were met. I screened the data to remove typographical errors and I did the necessary cleaning to ensure that the appropriate assumptions were met.

After screening and cleaning the data, I proceeded to test the various hypotheses using inferential statistics such as univariate and bivariate analysis.

The overall research question (RQ1) and subquestions (SQ2-SQ5) that guided this study and the hypotheses tested were:

RQ1: To what extent did NAAIAP programs affect the usage of fertilizers and food production in Kakamega County, Western Kenya?

$H_0$1: There is no significant difference between the rates of fertilizers used by beneficiaries and non-beneficiaries of NAAIAP in Kakamega County.

H_a1: There is a significant difference between the rates of fertilizers used by beneficiaries and non-beneficiaries of NAAIAP in Kakamega County.

The independent variable for this hypothesis was NAAIAP participation while the dependent variable was the amount of fertilizer (measured in kilograms) that was used by the beneficiaries and non-beneficiaries of NAAIAP. I first conducted descriptive statistics where I determined the mean, mode, median and standard deviation of the data. This was important in establishing whether the sampled farmers were a good representation of the

target population (Creswell, 2013). For instance, data with small value of standard error from the mean that follows the normal distribution curve depicts that the study sample was representative of the entire population (Creswell, 2013). I then conducted independent *t* test, set at 95% confidence interval (alpha = 0.05), two-tailed, with two independent means (NAAIAP participation), to achieve a medium effect size of 0.5 and statistical power of 80%. As reported by Creswell (2013) a high statistical power of 80% or more, helps a researcher to draw conclusions that are not only by chance but are indeed, a true reflection of real issues under investigation. I also conducted an analysis of Covariance (ANCOVA) to test whether there was significant differences between the rates of fertilizer used by the two groups before and after implementation of NAAIAP and whether the rate of fertilizer used before NAAIAP, affected the rates of fertilizer used after NAAIAP.

SQ2: How did NAAIAP's credit program affect farmers' preparedness to use fertilizer for food production in Kakamega County?

$H_0$2: NAAIAP's credit program did not significantly affect the preparedness of farmers to use fertilizers for food production in Kakamega County

H_a2: NAAIAP's credit program significantly affected the preparedness of farmers to use fertilizers for food production in Kakamega County

The independent variable for this hypothesis was NAAIAP participation while the dependent variable was the number of days prior to planting season when the farmers purchased fertilizer. After conducting descriptive statistics, I conducted independent t-test to either accept or reject this hypothesis.

SQ3: How did NAAIAP's credit program affect fertilizer accessibility, availability, and affordability in Kakamega County?

$H_0$3: NAAIAP's credit program did not significantly affect the accessibility, availability, and affordability of fertilizers in Kakamega County

H_a3: NAAIAP's credit program significantly affected the accessibility, availability, and affordability of fertilizers in Kakamega County

The independent variable for this hypothesis was also NAAIAP participation while the dependent variables were the distances travelled by the farmers to buy fertilizers, number of times that farmers had missed to get the required type of fertilizers from the agrodealer shops and the preferred cost of a 50 kg bag of fertilizer for the farmer to afford. To test this hypothesis, I used linear multiple regression with dummy variables first to determine the impact of the independent variables on the dependent variables and then I used the independent variable to predict fertilizer accessibility, availability and affordability in a logistic regression. This test was set at a medium effect size of 0.3 to achieve a statistical power of 80%, at alpha = 0.05 with 1.0 as the degrees of freedom. I also used a chi-square test where NAAIAP participation was the independent variable and their opinions on the effect of NAAIAP on fertilizer accessibility, availability and affordability was the dependent variable.

SQ4: What is the relationship between farmers' rates of fertilizer usage and maize grain yield in Kakamega County?

$H_0$4: There is no significant relationship between the rate of fertilizer used by farmers, their income levels and maize grain yield in Kakamega County.

H_a4: There is significant relationship between the rate of fertilizer used by farmers, their income levels and maize grain yield in Kakamega County.

The independent variables (predictors) for this hypothesis were the rate of fertilizer used by farmers and their income levels. The dependent variable (criterion) was maize grain yield realized by the farmers. I used correlation and linear multiple regression at 95% confidence interval, two tailed, to accept or reject this hypothesis (Faul et al., 2009). A correlation test is suitable in describing relationships between two or more naturally occurring variables while linear multiple regression allows a researcher to assess the relationship between one dependent variable (criterion) and several independent (predictors) variables (Creswell, 2013)

SQ5: How did the deliberate choice to promote maize under NAAIAP affect crop diversification in Kakamega County?

$H_0$5: The deliberate choice to promote maize crop under NAAIAP did not significantly affect farmers' crop diversification in Kakamega County.

H_a5: The deliberate choice to promote maize crop under NAAIAP significantly affected farmers' crop diversification in Kakamega County.

The independent variable for this hypothesis was NAAIAP participation while the dependent variable was the number of different crops grown by the farmers for food provision. I also used a chi-square test where NAAIAP participation was the independent variable and their opinions on the effect of NAAIAP on crop diversification was the dependent variable. A chi-square test calculates the difference between observed and expected frequency values where two independent nominal variables are under

investigation and the researcher wants to test if the values of one variable are related to the values of the second variable (Creswell, 2013).

Threats to Validity

The recommendations made from this study are based on a sample of 144 farmers instead of the entire population of 400,000 farmers. The study is thus, faced with an internal validity of generalizability (Janesick, 2011). In order to ensure reliability and validity of the scales used in this study, I used triangulation where my empirical data was compared with what is written in literature. I also used references for some of the information from Kenya's Ministry of Agriculture since the Ministry, had been, before devolution of agriculture in 2013, the main custodian of agricultural data in the entire country. I ensured content validity by picking a representative sample of farmers from each of the sub-counties and then probing to ensure that they provided valid information. I also compared the information they provided with that in literature. I ensured empirical validity with a questionnaire that was pre-tested in a reconnaissance survey before the actual study commenced.

Ethical Procedures

In the sampling strategy, there was potential ethical issue of bias, since it was only 144 farmers who were sampled in Kakamega County. In order to comply with the ethical principle of beneficence (Creswell, 2013), the questionnaires filled by the participants were coded so that analysis was based on the assigned codes and not the name of the study participants. This ensured that the farmers' sensitive information was protected and

held confidentially. I first sought the consent of the participants and I explained the purpose of the study including the intended use of the collected data.

Summary

In summary, this study was conducted in Kakamega County, Western Kenya that has a population of about 1.6 million people that consists of 400,000 farmers. Due to financial and time constraints, not all the farmers were sampled but a manageable and representative sample size consisting of 144 farmers from all the 12 sub-counties of Kakamega County were picked to participate in this study. The sample consisted of 72 farmers from each of the two groups of farmers– those who benefited from NAAIAP and those who did not. I collected the data using a questionnaire and analyzed using SPSS, version 23. I tested five key hypothesis at 95% confidence interval, two-tailed, using independent *t* test, analysis of Covariance, correlation and linear multiple regression aiming to achieve a medium effect size and statistical power of 80%. These tests helped to answer the main question of this study that sought to determine whether the beneficiaries and non-beneficiaries of NAAIAP exhibited differences in the rates of fertilizer usage and the yield of major staple crops, especially maize that they got from their farms. Each of the sampled farmers was requested to participate in the survey voluntarily and when they agreed, I requested them to voluntarily sign a consent form.

After data analysis, I compiled chapters 4 and 5 of this dissertation in the Month of January 2017. In Chapter 4 below, I have presented the results of the various statistical analyses. The chapter starts with a summary of the analyses that I conducted to check whether the assumptions of the various tests were met and results of descriptive analyses.

The inferential tests that I conducted were Independent t-test, Linear Multiple Regression, Logistic Regression, Correlations and Chi-square. The chapter also provides a write up on the timeframe used to collect the data and demographic characteristics of the sample. It also presents results on the effect of NAAIAP on fertilizer usage, effect of NAAIAP credit on farmers' preparedness to use fertilizers and effect of NAAIAP's credit programs on fertilizer accessibility, availability, and affordability. In addition, the chapter presents results on the relationship between rates of fertilizer usage and maize grain yield, effect of maize promotion on food crop diversification and food security. The chapter ends with a summary of the results that provide answers to the various research questions.

Chapter 4: Results

Introduction

This chapter presents the results of a study the purpose of which was to explain the effects of a subsidy program in Kenya known as NAAIAP on the usage of fertilizers for food production by farmers in Kakamega County, Western Kenya. The subsidy program was initiated in 2007 but was rolled out in 2008 by the government of Kenya in collaboration with AGRA, IFAD, and Equity Bank of Kenya. The government of Kenya provided the necessary policy environment to roll out the subsidy program. It also provided either free or subsidized fertilizers, improved seeds, and extension services to jumpstart the program under a subprogram known as Kilimo Plus. On the other hand, AGRA and IFAD gave a grant of 5 million USD to Equity Bank to provide cheaper credit to farmers under a program known as Kilimo Biashara. This study focused on Kakamega County because of its great potential to improve Kenya's agriculture and contribute to the country's socioeconomic stability through sufficient supply of food and income.

The overall question that guided this study was:

RQ1: To what extent did NAAIAP programs affect the usage of fertilizers and food production in Kakamega County, Western Kenya?

The study also sought to answer the following subquestions:

SQ2: How did NAAIAP's credit program affect farmers' preparedness to use fertilizer for food production in Kakamega County?

SQ3: How did NAAIAP's credit program affect fertilizer accessibility, availability, and affordability in Kakamega County?

SQ4: What is the relationship between farmers' rates of fertilizer usage and maize grain yield in Kakamega County?

SQ5: How did the deliberate choice to promote maize under NAAIAP affect crop diversification in Kakamega County?

In order to answer the above questions, the following null and alternative hypotheses were postulated and tested:

$H_0$1: There is no significant difference between the rates of fertilizers used by beneficiaries and non-beneficiaries of NAAIAP in Kakamega County.

H_a1: There is a significant difference between the rates of fertilizers used by beneficiaries and non-beneficiaries of NAAIAP in Kakamega County.

In order to test this hypothesis, I conducted descriptive statistics to determine the mean, mode, median and standard deviation of the data. I then conducted an independent *t* test, set at 95% confidence interval (*CI*), two-tailed, with two independent means, to achieve a medium effect size of 0.5 and statistical power of 80%. The independent variable for this hypothesis was NAAIAP participation (beneficiaries and nonbeneficiaries) while the dependent variable was the amount of fertilizer used by the two groups.

$H_0$2: NAAIAP's credit program did not significantly affect the preparedness of farmers to use fertilizers for food production in Kakamega County

H_a2: NAAIAP's credit program significantly affected the preparedness of farmers to use fertilizers for food production in Kakamega County

After conducting descriptive statistics, I conducted independent *t* test to either accept or reject this hypothesis.

$H_0$3: NAAIAP's credit program did not significantly affect the accessibility, availability, and affordability of fertilizers in Kakamega County

H_a3: NAAIAP's credit program significantly affected the accessibility, availability, and affordability of fertilizers in Kakamega County

In order to test this hypothesis, I first conducted a linear multiple regression in a stepwise model after ensuring that all the necessary assumptions for the analysis were met. The six assumptions that were met were as follows:

- There were no outliers since all the data had been screened for accuracy and completeness, there was homoscedasticity of errors (normal distribution of variables).
- There was adequate ratio of cases to predictors ($N = 144$) which exceeded $104 + M$ where our M was six (number of independent variables used in the multiple regression).
- There was no multicollinearity since the predictors were not too highly correlated because none of the correlation values exceeded ± 0.8 (Tables 2 and 3).
- There was independence of errors since the Durbin-Watson statistics which was 1.328 for the DAP usage model and 1.257 for the CAN usage model were within the allowable limits of 1 to 3, indicating that the errors were reasonably independent.

Table 2

Correlations Between Variables That Predicted Rates of DAP Fertilizer Usage

Variables	Quantity of DAP currently used	Shortest distance travelled to access fertilizer after NAAIAP	Number of times that desired fertilizer was missed after NAAIAP	Preferred price for a 50kg DAP fertilizer bag to be affordable	Maize surplus yield (tons) for sale	Income (Ksh) earned from sale of surplus maize yield per year	Average annual income (Ksh) after start of NAAIAP
	Pearson Correlation						
Quantity of DAP currently used	1.000	.041	-.155	.080	.269	.367	.167
Shortest distance travelled to access fertilizer after NAAIAP	.041	1.000	.043	.026	.089	-.004	.149
Number of times that desired fertilizer was missed after NAAIAP	-.155	.043	1.000	-.052	-.030	-.082	-.071
Preferred price for a 50kg DAP fertilizer bag to be affordable	.080	.026	-.052	1.000	-.029	.066	-.115
Maize surplus yield (tons) for sale	.269	.089	-.030	-.029	1.000	.743	.549
Income (Ksh) earned from sale of surplus maize yield per year	.367	-.004	-.082	.066	.743	1.000	.370
Average annual income (Ksh) after start of NAAIAP	.167	.149	-.071	-.115	.549	.370	1.000

Table 3

Correlations Between Variables That Predicted Rates of CAN Fertilizer Usage

Variable	Quantity of CAN currently used	Shortest distance travelled to access fertilizer after NAAIAP	Number of times that desired fertilizer was missed after NAAIAP	Preferred price for a 50kg CAN fertilizer bag to be affordable	Maize surplus yield (tons) for sale	Income (Ksh) earned from sale of surplus maize yield per year	Average annual income (Ksh) after start of NAAIAP
	Pearson Correlation						
Quantity of CAN currently used	1.000	.029	-.143	.053	.140	.242	.195
Shortest distance travelled to access fertilizer after NAAIAP	.029	1.000	.043	.018	.089	-.004	.149
Number of times that desired fertilizer was missed after NAAIAP	-.143	.043	1.000	-.046	-.030	-.082	-.071
Preferred price for a 50kg CAN fertilizer bag to be affordable	.053	.018	-.046	1.000	.116	.192	.012
Maize surplus yield (tons) for sale	.140	.089	-.030	.116	1.000	.743	.549
Income (Ksh) earned from sale of surplus maize yield per year	.242	-.004	-.082	.192	.743	1.000	.370
Average annual income (Ksh) after start of NAAIAP	.195	.149	-.071	.012	.549	.370	1.000

In the linear multiple regression analysis, the dependent variable was the quantity of DAP fertilizer used for planting and CAN fertilizer for top-dressing. The independent variables (predictors) that I entered in the first model were shortest distance travelled to access the fertilizers after NAAIAP, number of times that the desired fertilizers were missed after NAAIAP, and preferred affordable price for a 50 kg bag of fertilizer. The predictors that I entered in the second model were maize surplus yield (tons) for sale, annual income (Ksh) earned from sale of surplus maize, and average annual income (Ksh) after start of NAAIAP. This analysis was necessary to determine the impact of the independent variables (predictors) on the dependent variables. Further, I conducted logistic regression with the above independent variables to predict their relationship with the dummy variable codes of NAAIAP's subsidy and credit groups. Finally, I used a chi-square test where farmers' participation in NAAIAP was the independent variable and their opinions on the effect of NAAIAP on fertilizer accessibility, availability and affordability was the dependent variable.

> $H_0$4: There is no significant relationship between the rate of fertilizer used by farmers, their income levels and maize grain yield in Kakamega County.
>
> H_a4: There is significant relationship between the rate of fertilizer used by farmers, their income levels and maize grain yield in Kakamega County.

In order to test this hypothesis, I used correlation and linear multiple regression at 95% confidence interval, one tailed, to accept or reject this hypothesis. The independent variables (predictors) for this hypothesis were the rate of fertilizer and income levels of farmers while the dependent variable was maize grain yield.

$H_0$5: The deliberate choice to promote maize crop under NAAIAP did not significantly affect farmers' crop diversification in Kakamega County.

H_a5: The deliberate choice to promote maize crop under NAAIAP significantly affected farmers' crop diversification in Kakamega County.

The independent variable for this hypothesis was NAAIAP participation while the dependent variable was the number of different crops grown by the farmers for food provision. I conducted a chi-square test where the group of farmers was the independent variable and their opinions on the effect of NAAIAP on crop diversification were the dependent variable.

Timeframe for Data Collection

Data collection was started on October 5, 2016, with a reconnaissance survey that lasted for one week. The questionnaire was improved based on lessons learned from the reconnaissance survey. After the reconnaissance survey, I commenced data collection on October 17 and continued for three weeks until November 14, 2016. I spent the rest of November, 2016, entering the data into SPSS spreadsheets. I analyzed the research data in the month of December, 2016. Although I had initially proposed to recruit 128 participants as respondents for this study, lessons learned from the reconnaissance survey led me to increase the sample size to 144. This resulted in recruitment of 72 NAAIAP beneficiaries and 72 nonbeneficiaries. The participants were selected representatively across the 12 subcounties of Kakamega County so that 6 beneficiaries and 6 nonbeneficiaries were recruited from each subcounty. The sampled participants consisted of both male and female farmers of different ages, education, family backgrounds, and income levels.

Demographic Characteristics of the Sample

The sampled farmers who participated in this study consisted of 60% females and 40% males. Only 19% of the participants were youthful farmers of below 35 years. A majority of the participants (37%) were aged between 36 and 45 years while another 27% were aged between 46 and 55 years (Figure 6). About 17% of the participants were elderly farmers aged over 55 years (Figure 6).

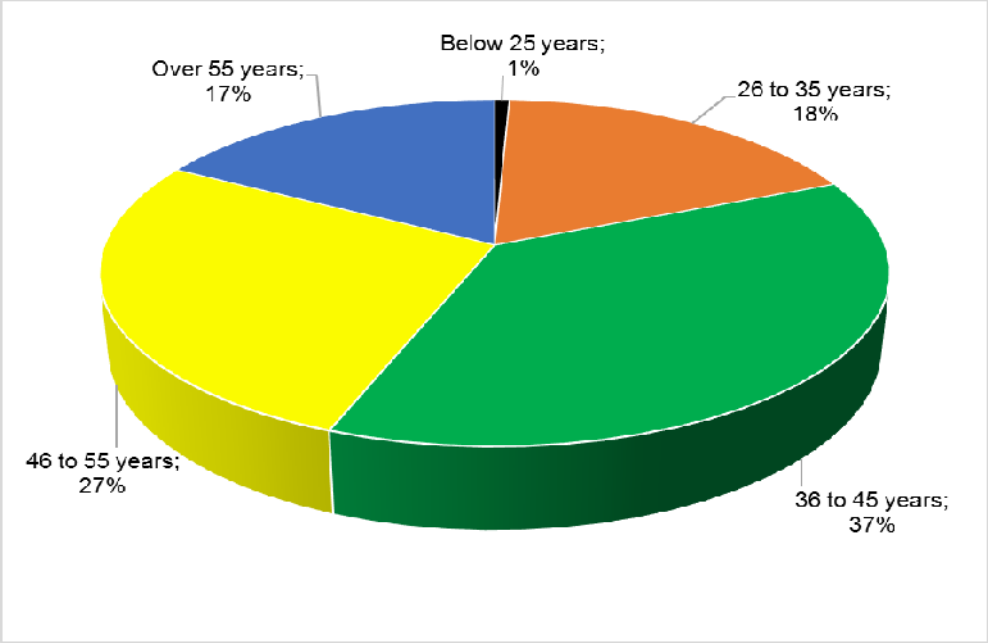

Figure 6: Age of participants in NAAIAP evaluation study, in Western Kenya.

Over half of the participants (53%) had secondary education while 40% had primary education (Figure 7). Only 7% of them had middle level and university education.

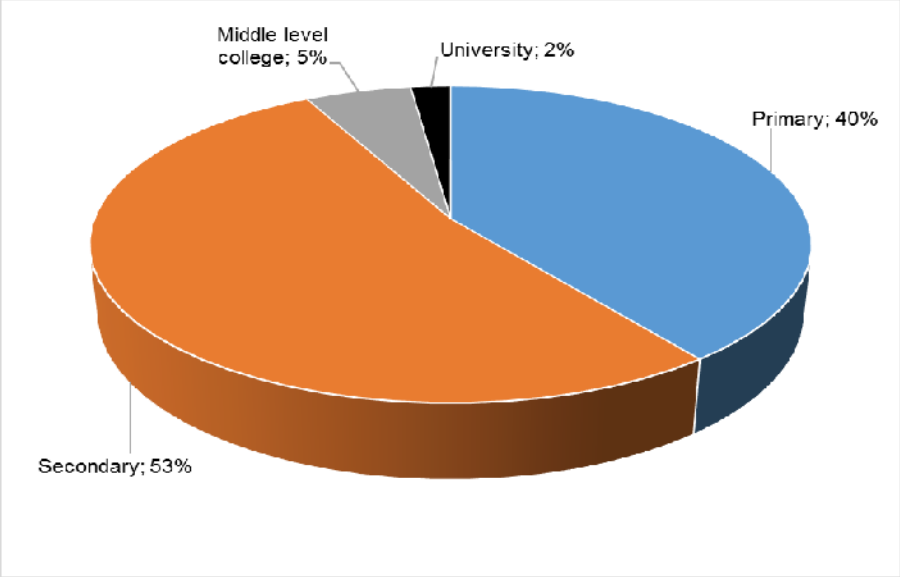

Figure 7: Education background of participants in NAAIAP evaluation study, in Western Kenya.

About 82% of the participants were married while about 5% were single (Figure 8). Another 13% of them were once married and either got divorced or their spouses had died (Figure 8).

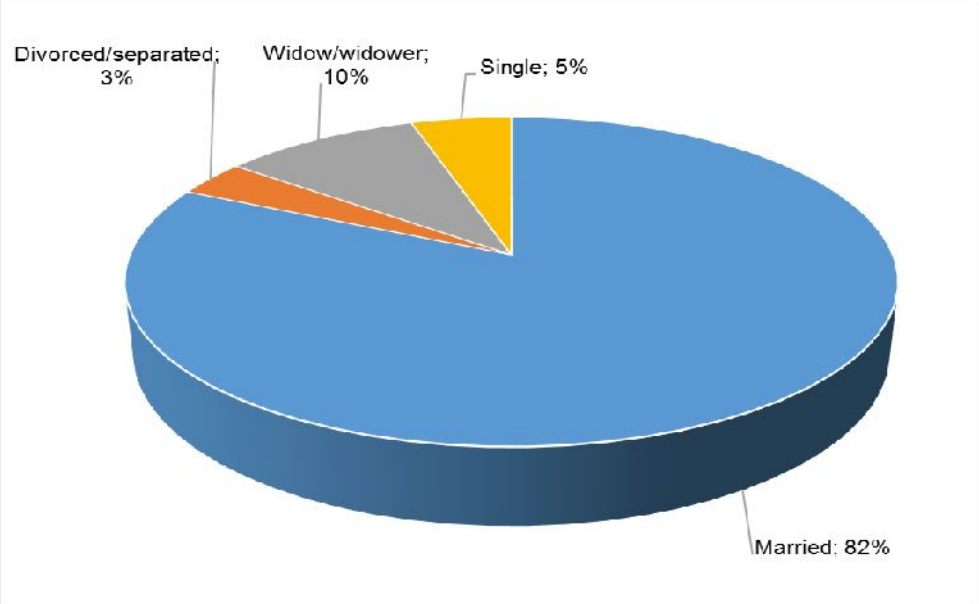

Figure 8: Marital status of participants in NAAIAP evaluation study, in Western Kenya.

More than half of the participants (56%) had 4 to 6 children while a small proportion of 2% did not have any children (Figure 9). The single participants who were yet not married were among this category.

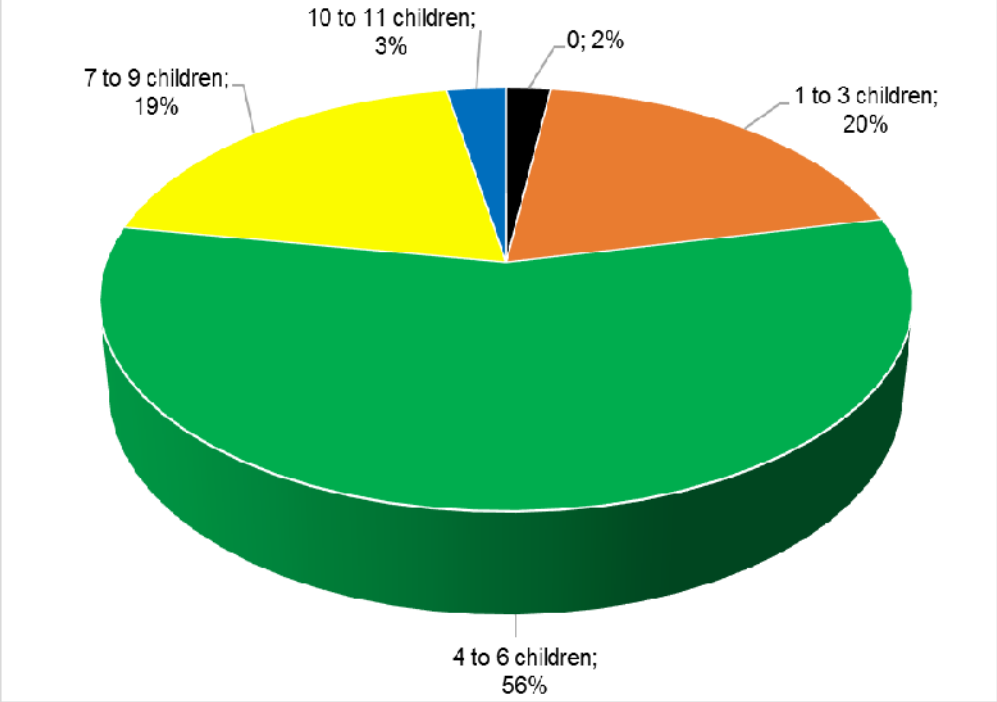

Figure 9: Number of children for participants in NAAIAP evaluation study, in Western Kenya.

The annual incomes of participants ranged from Ksh. 5,000 (50 USD) to Ksh. 420,000 (4,200 USD). Their mean annual average before NAAIAP was about Ksh. 39,000 390 USD, but after NAAIAP, it increased by more than twofold to Ksh. 950,000 (950 USD). All participants quoted crop farming as the main source of income (Figure 10). This was followed by livestock and poultry rearing which was mentioned by 89% of the participants, off-farm enterprises (64%), and job salary (34%).

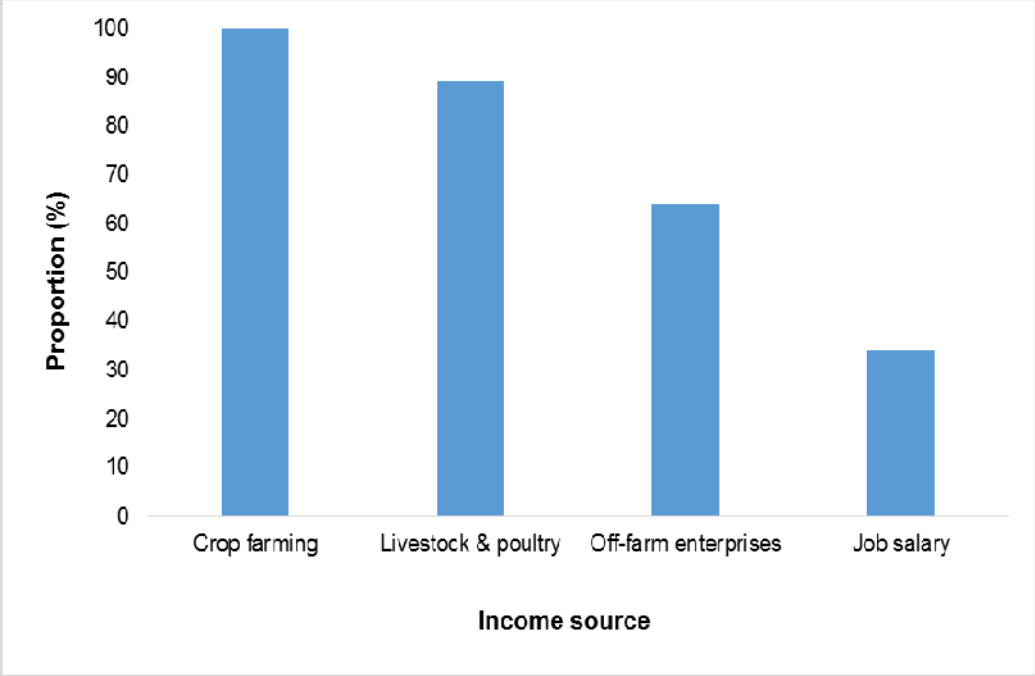

Figure 10: Income sources of participants in NAAIAP evaluation study, in Western Kenya.

Effect of NAAIAP on Fertilizer Usage

The farmers in Western Kenya mostly use DAP fertilizer as basal fertilizer for planting compared to other types of basal fertilizers such as NPK. As at the time of this study in October 2016, the average rate of DAP usage was 37 kg/ha per annum. The farmers in Western Kenya mostly use CAN fertilizer for top-dressing compared to urea. As of October 2016, the average rate of CAN usage was 34 kg/ha per annum. Over half of the participants do not use any fertilizer including DAP and CAN that are commonly used by farmers in Western Kenya (Figure 11). It was only a quarter of the participants that were, at the time of this study, using 50 kg of the fertilizer per annum. This was the 2015 target set by African governments in the Abuja Declaration of 2006 (Figure 11).

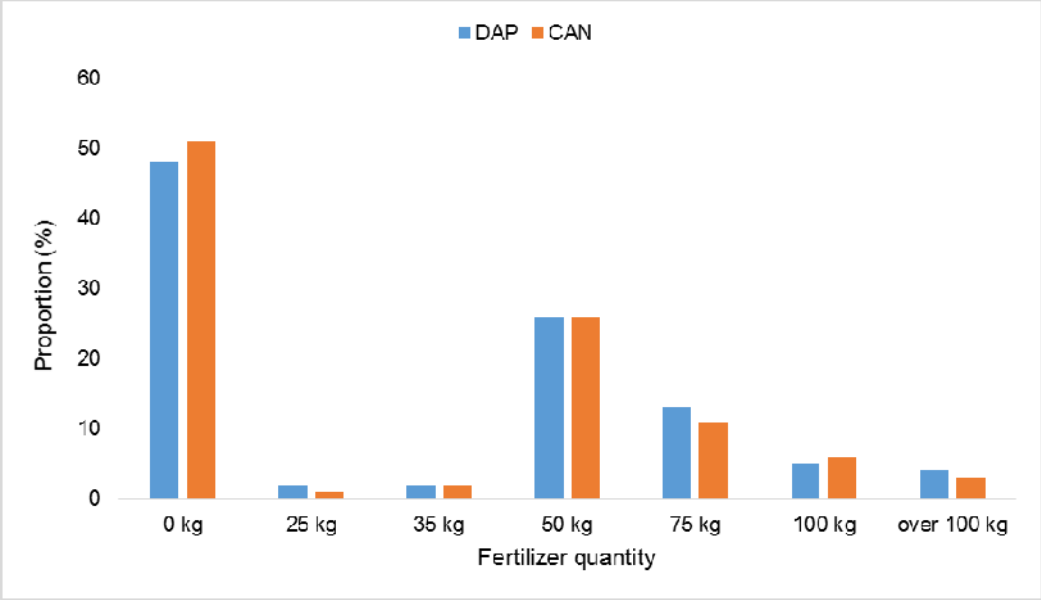

Figure 11: Quantity of fertilizer used by farmers in Kakamega County by October 2016.

The combination of the first three predictors, namely, shortest distance travelled to access fertilizer after NAAIAP, number of times that desired fertilizer was missed after NAAIAP, and preferred affordable price for a 50 kg bag of DAP fertilizer, accounted for 3.1% of the variance in DAP fertilizer usage (Table 4). This variation was not significant ($p > 0.05$). When the other three predictors namely maize surplus yield (tons) for sale, annual income (Ksh) earned from sale of surplus maize, and average annual income (Ksh) after start of NAAIAP were added into the regression model, they brought an additional variance of 12.5% in the usage of DAP fertilizer (Table 4). The combined set of predictors in the second model accounted for 15.5% of the variance in the current usage of DAP fertilizer (Table 4) and it was a significant fit to the data (F (4,139) = 6.374, $p < 0.001$) (Table 5). The adjusted R^2 shows some shrinkage in variance from 15.5% to 13.1% meaning that the model may not cross-generalize well (Table 4).

Table 4

A Summary Table Showing the Variance in DAP Fertilizer Usage that is Accounted for by the Model[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.177[a]	.031	.010	48.137	.031	1.502	3	140	.217	
2	.394[b]	.155	.131	45.118	.124	20.365	1	139	.000	1.328

a. Predictors: (Constant), Preferred price for a 50 kg DAP fertilizer bag to be affordable, Shortest distance travelled to access fertilizer after NAAIAP, Number of times that desired fertilizer was missed after NAAIAP

b. Predictors: (Constant), Preferred price for a 50 kg DAP fertilizer bag to be affordable, Shortest distance travelled to access fertilizer after NAAIAP, Number of times that desired fertilizer was missed after NAAIAP, Income (Ksh) earned from sale of surplus maize yield per year

c. Dependent Variable: Quantity of DAP currently used

Table 5

ANOVA Table Indicating the Model's Significance of Fit to the DAP Fertilizer Usage

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10442.760	3	3480.920	1.502	.217[b]
	Residual	324403.724	140	2317.169		
	Total	334846.484	143			
2	Regression	51897.307	4	12974.327	6.374	.000[c]
	Residual	282949.177	139	2035.606		
	Total	334846.484	143			

a. Dependent Variable: Quantity of DAP currently used
b. Predictors: (Constant), Preferred price for a 50 kg DAP fertilizer bag to be affordable, Shortest distance travelled to access fertilizer after NAAIAP, Number of times that desired fertilizer was missed after NAAIAP
c. Predictors: (Constant), Preferred price for a 50 kg DAP fertilizer bag to be affordable, Shortest distance travelled to access fertilizer after NAAIAP, Number of times that desired fertilizer was missed after NAAIAP, Income (Ksh) earned from sale of surplus maize yield per year

Among the six main variables that were hypothesized to predict the rate of DAP usage, it was only the income earned from the sale of surplus maize yield that predicted DAP usage rate significantly, $N = 144$, $R = 0.394$, Adj $R^2 = 0.131$, $B = 0.001$; $\beta = 0.001$, $Sr^2 = 0.0.124$, $t\ (139) = 4.513$, $p < 0.001$. The other five predictors were not significant ($p > 0.05$). There was a significant positive correlation between the income earned from the sale of surplus maize yield and the annual quantity of DAP fertilizer used by the farmers (Table 4).

In terms of CAN fertilizer usage, the combination of shortest distance travelled to access fertilizer after NAAIAP, number of times that desired fertilizer was missed after NAAIAP, and preferred affordable price for a 50 kg bag of CAN fertilizer, accounted for 2.4% of the variance in CAN fertilizer usage (Table 6). When the other three predictors namely maize surplus yield (tons) for sale, annual income (Ksh) earned from sale of surplus maize, and average annual income (Ksh)

after start of NAAIAP were added into the regression model, they brought an additional variance of 5.1% in the usage of CAN fertilizer. The combined set of predictors in the second model were a significant fit to the data (F (4,139) = 2.825, p < 0.05) (Table 6). Among the seven main variables that were hypothesized to predict the rate of CAN usage, it was only the income earned from the sale of surplus maize yield that predicted CAN usage rate significantly, N = 144, R = 0.274, $Adj\ R^2$ = 0.049, B = 0.001; β = 0.001, Sr^2 = 0.051, t (139) = 2.783, p < 0.05.

Table 6

ANOVA Table Indicating the Model's Significance of Fit to the CAN Fertilizer Usage

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6985.853	3	2328.618	1.131	.339[b]
	Residual	288373.479	140	2059.811		
	Total	295359.332	143			
2	Regression	22204.278	4	5551.070	2.825	.027[c]
	Residual	273155.053	139	1965.144		
	Total	295359.332	143			

a. Dependent Variable: Quantity of CAN currently used
b. Predictors: (Constant), preferred price for a 50kg CAN fertilizer bag to be affordable, shortest distance travelled to access fertilizer after NAAIAP, number of times that desired fertilizer was missed after NAAIAP
c. Predictors: (Constant), preferred price for a 50kg CAN fertilizer bag to be affordable, shortest distance travelled to access fertilizer after NAAIAP, number of times that desired fertilizer was missed after NAAIAP, income (Ksh) earned from sale of surplus maize yield per year

The combined set of predictors in the second model accounted for 7.5% of the variance in the current usage of CAN fertilizer (Table 7). The adjusted R^2 shows some shrinkage from 7.5% of the unadjusted value to 4.9% (Table 7). There was a significant positive correlation between the income earned from the sale of surplus maize yield and the annual quantity of CAN fertilizer used by the farmers (Table 7).

Table 7

A Summary Table Showing the Variance in the Usage of CAN Fertilizer That is Accounted for by the Model[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.154[a]	.024	.003	45.385	.024	1.131	3	140	.339	
2	.274[b]	.075	.049	44.330	.052	7.744	1	139	.006	1.257

a. Predictors: (Constant), Preferred price for a 50kg CAN fertilizer bag to be affordable, Shortest distance travelled to access fertilizer after NAAIAP, Number of times that desired fertilizer was missed after NAAIAP

b. Predictors: (Constant), Preferred price for a 50kg CAN fertilizer bag to be affordable, Shortest distance travelled to access fertilizer after NAAIAP, Number of times that desired fertilizer was missed after NAAIAP, Income (Ksh) earned from sale of surplus maize yield per year

c. Dependent Variable: Quantity of CAN currently used

Effect of NAAIAP's Credit on Farmers' Preparedness to Use Fertilizers

The days prior to rain season when farmers purchased fertilizer, especially DAP and CAN that are commonly in the study area, did not differ significantly between the beneficiaries and non-beneficiaries of NAAIAP F (1,142) = 3.547, p = 0.062 (Table 8).

Table 8

ANOVA Table Showing the Effect of NAAIAP Subsidy Group on the Days Prior to Rain Season When Farmers in Western Kenya Purchased Fertilizer

Dependent Variable: Days prior to rain season when DAP and CAN fertilizers are bought					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1083.507[a]	1	1083.507	3.547	.062
Intercept	75121.674	1	75121.674	245.927	.000
NAAIAP subsidy group	1083.507	1	1083.507	3.547	.062
Error	43375.819	142	305.464		
Total	119581.000	144			
Corrected Total	44459.326	143			

a. R Squared = .024 (Adjusted R Squared = .018)
b. Computed using alpha = .05

However, the days prior to rain season when farmers purchased fertilizers, differed significantly between the beneficiaries and non-beneficiaries of NAAIAP's credit program known as Kilimo Biashara F (1,142) = 7.135, p = 0.008 (Table 9).

Table 9

ANOVA Table Showing the Effect of NAAIAP Credit Group on the Days Prior to Rain Season When Farmers in Western Kenya Purchased Fertilizer

Dependent Variable: Days prior to rain season when DAP and CAN fertilizers are bought					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2127.115[a]	1	2127.115	7.135	.008
Intercept	74553.448	1	74553.448	250.084	.000
NAAIAP credit group	2127.115	1	2127.115	7.135	.008
Error	42332.212	142	298.114		
Total	119581.000	144			
Corrected Total	44459.326	143			

a. R Squared = .048 (Adjusted R Squared = .041)
b. Computed using alpha = .05

The beneficiaries of NAAIAP's subsidy purchased fertilizers much earlier (*M* = 25.61, *SE* = 2.051) than the non-beneficiaries (*M* = 20. 07, *SE* = 2.051) in preparation for planting (Table 10).

Table 10

Days prior to rain season when DAP and CAN fertilizers are bought by the groups of NAAIAP subsidy program

Dependent Variable: Days prior to rain season when DAP and CAN fertilizers are bought				
NAAIAP group of participant	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
NAAIAP beneficiary	25.605[a]	2.051	21.549	29.660
Nonbeneficiary	20.076[a]	2.051	16.021	24.131

a. Covariates appearing in the model are evaluated at the following values: Shortest distance travelled to access fertilizer after NAAIAP = 2.010.

Similarly, the beneficiaries of NAAIAP's Kilimo Biashara credit program purchased fertilizers much earlier (M = 28.36, SE = 2.519) than the non-beneficiaries (M = 20.17, SE = 1.753; Table 11).

Table 11

Days Prior to Rain Season When DAP And CAN Fertilizers are Bought by the Groups of NAAIAP's Credit Program

Dependent variable: Days prior to rain season when DAP and CAN fertilizers are bought				
NAAIAP's credit program group	Mean	Std. error	95% confidence interval	
			Lower Bound	Upper Bound
Kilimo Biashara beneficiary	28.362	2.519	23.383	33.340
Nonbeneficiary of Kilimo Biashara	20.165	1.753	16.699	23.630

The main effect of NAAIAP subsidy on the number of days prior to rain season when fertilizers were purchased did not differ significantly between the beneficiaries and non-beneficiaries of NAAIAP F (1,141) = 3.632, p = 0.059, partial η^2 = 0.025 (Table 12). The distance travelled by the two groups of NAAIAP program was not a significant covariate for this analysis F (1,141) = 2.181, $p > 0.05$, partial η^2 = 0.015, power = 0.311 (Table 12), meaning that the distance travelled by the groups of the NAAIAP subsidy program to access fertilizer after NAAIAP had no significant effect on the number of days prior to rain season when they bought DAP and CAN fertilizers.

Table 12

Effect of Distance Travelled after NAAIAP's Subsidy Program on the Preparedness of Farmers to Use Fertilizer

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared	Observed power[b]
Corrected Model	1744.31[a]	2	872.15	2.88	.060	.039	.556
Intercept	10833.84	1	10833.84	35.76	.000	.202	1.000
Distance to access fertilizer after NAAIAP	660.80	1	660.80	2.181	.142	.015	.311
NAAIAP subsidy group	1100.26	1	1100.26	3.63	.059	.025	.473
Error	42715.01	141	302.94				
Total	119581.0	144					
Corrected Total	44459.31	143					

a. R Squared = .039 (Adjusted R Squared = .026)
b. Computed using alpha = .05

The main effect of NAAIAP's Kilimo Biashara credit on the number of days prior to rain season when fertilizers were purchased differed significantly between the beneficiaries and non-beneficiaries of the credit program, $F(1,141) = 7.564$, $p = 0.007$, partial $\eta^2 = 0.051$ (Table 13).

Table 13

Effect of NAAIAP's Credit Program on Preparedness to Use Fertilizer

Dependent Variable: Days prior to rain season when DAP and CAN fertilizers are bought							
Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared	Observed power[b]
Corrected Model	2875.00[a]	2	1437.50	4.87	.009	.065	.796
Intercept	12041.62	1	12041.62	40.83	.000	.225	1.000
Distance to access fertilizer after NAAIAP	747.89	1	747.89	2.54	.114	.018	.353
NAAIAP Credit group	2230.95	1	2230.95	7.56	.007	.051	.780
Error	41584.33	141	294.92				
Total	119581.0	144					
Corrected Total	44459.33	143					

a. R Squared = .065 (Adjusted R Squared = .051)
b. Computed using alpha = .05

The average annual income after NAAIAP was not a significant covariate for the days prior to rain season when DAP and CAN fertilizers were purchased (F (1,141) = 1.895, $p > 0.05$, partial $\eta^2 = 0.013$, power = 0.277 (Table 14).

Table 14

Effect of Income Level on Preparedness of Farmers to Use Fertilizer

Dependent Variable: Days prior to rain season when DAP and CAN fertilizers are bought

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	1658.842[a]	2	829.42	2.73	.069	.037	5.465	.533
Intercept	21774.177	1	21774.18	71.73	.000	.337	71.732	1.000
Annual income after NAAIAP	575.335	1	575.34	1.89	.171	.013	1.895	.277
NAAIAP group	1100.072	1	1100.07	3.62	.059	.025	3.624	.472
Error	42800.485	141	303.55					
Total	119581.000	144						
Corrected Total	44459.326	143						

a. R Squared = .037 (Adjusted R Squared = .024)
b. Computed using alpha = .05

Effect of NAAIAP's Credit Program on Fertilizer Accessibility, Availability, and Affordability

Fertilizer Accessibility. Fertilizer accessibility was measured in terms of the distance that farmers travelled to the nearest agrodealer shops to buy it. Before start of NAAIAP subsidy program, there was no significant difference F (1,142) = 0.071, p = 0.79 in the distance the beneficiaries and non- beneficiaries of NAAIAP travelled to access fertilizer (Table 15).

Table 15

ANOVA Table Showing the Effect of NAAIAP Group on the Shortest Distance Travelled By Farmers to Access Fertilizer Before NAAIAP Subsidy Program

Dependent Variable:	Shortest distance travelled to access fertilizer before NAAIAP				
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.502[a]	1	.502	.071	.790
Intercept	3075.627	1	3075.627	436.032	.000
NAAIAP group	.502	1	.502	.071	.790
Error	1001.622	142	7.054		
Total	4077.750	144			
Corrected Total	1002.123	143			

a. R Squared = .001 (Adjusted R Squared = -.007)
b. Computed using alpha = .05

There was no significant difference F (1,142) = 0.014, p = 0.906 in the shortest distance travelled by the beneficiaries and non- beneficiaries of NAAIAP to access fertilizer after the subsidy program (Table 16).

Table 16

ANOVA Table Showing the Effect of NAAIAP Group on the Shortest Distance Travelled By Farmers to Access Fertilizer After NAAIAP Subsidy Program

Dependent Variable:	Shortest distance travelled to access fertilizer after NAAIAP				
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.02[a]	1	.02	.014	.906
Intercept	582.02	1	582.02	520.709	.000
NAAIAP group	.02	1	.02	.014	.906
Error	158.72	142	1.12		
Total	740.75	144			
Corrected Total	158.73	143			

a. *R* Squared = .000 (Adjusted *R* Squared = -.007)
b. Computed using alpha = .05

The main effect of NAAIAP subsidy did not differ significantly between the beneficiaries and non-beneficiaries of the program F (1,141) = 0.081, p = 0.777, partial η^2 = 0.001 (Table 17). However, the distance travelled by both groups to access fertilizer before NAAIAP reduced significantly from 4.62 km (SE = 0.220) to 2.0 km (SE = 0.087) after implementation of NAAIAP. As shown in Table 17, the distance travelled before NAAIAP was a significant covariate for this analysis (F (1,141) = 44.421, $p < 0.001$, partial η^2 = 0.24, power = 1.00.

Table 17

Effect of Distance before NAAIAP Subsidy Program on the Distance Travelled to Access Fertilizer After NAAIAP

Dependent variable: Shortest distance travelled to access fertilizer after NAAIAP

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared	Noncent. parameter	Observed power[b]
Corrected model	38.04[a]	2	19.02	22.22	.000	.240	44.440	1.000
Intercept	43.58	1	43.58	50.92	.000	.265	50.915	1.000
Distance to access fertilizer before NAAIAP	38.02	1	38.02	44.42	.000	.240	44.421	1.000
NAAIAP group	.07	1	.07	.08	.777	.001	.081	.059
Error	120.69	141	.86					
Total	740.75	144						
Corrected total	158.73	143						

a. R Squared = .240 (Adjusted R Squared = .229)
b. Computed using alpha = .05

After the implementation of NAAIAP, the distance travelled by the beneficiaries was almost the same ($M = 1.98$, $SE = 0.109$) as that travelled by the non-beneficiaries ($M = 2.03$, $SE = 0.109$) (Table 18).

Table 18

Distance Travelled by Farmers in Western Kenya to Access Fertilizer After Implementation of NAAIAP

Dependent variable: Shortest distance travelled to access fertilizer after NAAIAP				
NAAIAP group of participant	Mean	Std. error	95% confidence interval	
			Lower bound	Upper bound
NAAIAP beneficiary	1.988[a]	.109	1.773	2.204
Nonbeneficiary	2.032[a]	.109	1.817	2.248

a. Covariates appearing in the model are evaluated at the following values: Shortest distance travelled to access fertilizer before NAAIAP = 4.622.

A logistic regression model at step 1 was significant, Omnibus $\chi^2(3) = 15.38$, $p < 0.05$*),* $R^2 = 0.101$ (Table 19). Thus, the model including the predictors was significantly better than without the predictors. The predictors entered at step 1 were number of times that a farmer missed the desired type of fertilizer after NAAIAP, shortest distance travelled to access fertilizer and the preferred affordable cost of DAP fertilizer.

Table 19

Omnibus Tests at Step 1 of Model Coefficients of Benefiting From NAAIAP Subsidy

		Chi-square	df	Sig.
Step 1	Step	15.38	3	.002
	Block	15.38	3	.002
	Model	15.38	3	.002

Similarly, a logistic model on NAAIAP Kilimo Biashara credit program was significant Omnibus χ^2 (3) = 76.54, $p < 0.001$*),* $R^2 = 0.412$. Thus, the model including the predictors was significantly better than without the predictors (Table 20).

Table 20

Omnibus Tests at Step 1 of Model Coefficients of Benefiting From NAAIAP's Credit Program

		Chi-square	df	Sig.
Step 1	Step	76.54	3	.000
	Block	76.54	3	.000
	Model	76.54	3	.000

The current quantity of DAP fertilizers used significantly predicted whether a farmer benefited from NAAIAP's credit program or not, Ward = 14.34, $p < 0.001$ (Table 21). However, the current quantity of CAN fertilizer used did not significantly predict whether a farmer benefited from NAAIAP's credit program or not, Ward = 0.502, $p > 0.05$ (Table 21). A farmer who used higher quantities of DAP fertilizer was less likely to have benefited from the NAAIAP's credit program B = - 0.07, (Exp (B) = 93, $CI_{0.95}$ = [0.899, 0.967]). This is perhaps caused by the possibility of the farmer getting surplus maize yield for income generation, with higher usage of DAP fertilizer. He therefore uses the generated income to buy DAP fertilizer instead of borrowing a Kilimo Biashara loan to buy the fertilizer.

Table 21

Relationship Between Rates of Fertilizer Usage and NAAIAP's Credit Program

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Step 1[a]	Current quantity of DAP used	-.07	.02	14.34	1	.000	.93	.90	.97
	Current quantity of CAN used	-.01	.02	.50	1	.478	.99	.96	1.02
	Current quantity of CAN by current quantity of DAP	.00	.0020	11.31	1	.001	1.00	1.00	1.00
	Constant	3.44	.63	30.33	1	.000	31.27		

$R^2 = 0.412$, N = 144

a. Variable(s) entered on step 1: Current quantity of DAP, current quantity of CAN, current quantity of CAN * current quantity of DAP.

The number of times that desired fertilizer was missed after NAAIAP significantly predicted whether a farmer benefited from NAAIAP subsidy program. However, the shortest distance travelled to access fertilizer and the preferred affordable cost of DAP fertilizer did not significantly predict whether a farmer benefited from NAAIAP subsidy program (Table 22).

Table 22

Variables Not Included in the Logistic Equation for Groups of NAAIAP Subsidy Program

Variables not in equation at step 1	Score	df	Sig.
Shortest distance travelled to access fertilizer after NAAIAP	.007	1	.935
Preferred affordable cost of DAP fertilizer	1.677	1	.195
Overall Statistics	1.679	2	.432

A logistic regression model at step 2 was significant, Omnibus χ^2 (4) = 24.60, $p < 0.001$, $R^2 = 0.157$ (Table 23). Thus, the model including the predictors at step 2, was significantly better than without the predictors (Table 23). The predictors entered at step 2 were quantity of maize surplus yield (tons) for sale, income (Ksh) earned from sale of surplus maize yield per year, and average annual income (Ksh) before start of NAAIAP.

Table 23

Omnibus Tests at Step 2 of Model Coefficients of Benefiting from NAAIAP Subsidy

		Chi-square	df	Sig.
Step 1	Step	15.379	3	.002
	Block	15.379	3	.002
	Model	15.379	3	.002
Step 2	Step	9.223	1	.002
	Block	24.602	4	.000
	Model	24.602	4	.000

As opposed to the case with preferred affordable cost of DAP fertilizer, the preferred affordable cost of CAN fertilizer significantly predicted whether a farmer benefited from NAAIAP subsidy program, Omnibus χ^2 (1) = 9.22, $p < 0.05$, R^2 = 0.157 (Table 24).

Table 24

Effect on the Logistic Model of NAAIAP Subsidy if Significant Predictors Were Excluded

	Variable	Model log likelihood	Change in -2 log likelihood	df	Sig. of the change
Step 1	Number of times that desired fertilizer was missed after NAAIAP	-99.81	15.38	3	.002
Step 2	Number of times that desired fertilizer was missed after NAAIAP	-95.20	15.38	3	.002
	Preferred affordable cost of CAN fertilizer	-92.12	9.22	1	.002

Fertilizer affordability. The views shared by both NAAIAP beneficiaries and non-beneficiaries on fertilizer affordability did not differ significantly (χ^2, 3 = 2.0, *NS*, two-tailed). Over 85% of the farmers from both groups shared a common view that NAAIAP subsidy program made fertilizers fairly affordable (Figure 12). A similar view was shared by the beneficiaries and non-beneficiaries of NAAIAP's credit program (Kilimo Biashara). About 80% of the Kilimo Biashara beneficiaries felt that NAAIAP made fertilizers fairly affordable while over 90% of the Kilimo Biashara non-beneficiaries held a similar view (Figure 13). It was only about 10% of the Kilimo Biashara beneficiaries and less than 5% of the non-beneficiaries who opined that NAAIAP's credit made fertilizers easily affordable (Figure 13). The views of the Kilimo Biashara beneficiaries and non-beneficiaries on fertilizer affordability level were not significantly different (χ^2, 3 = 4.75, *NS*, two-tailed).

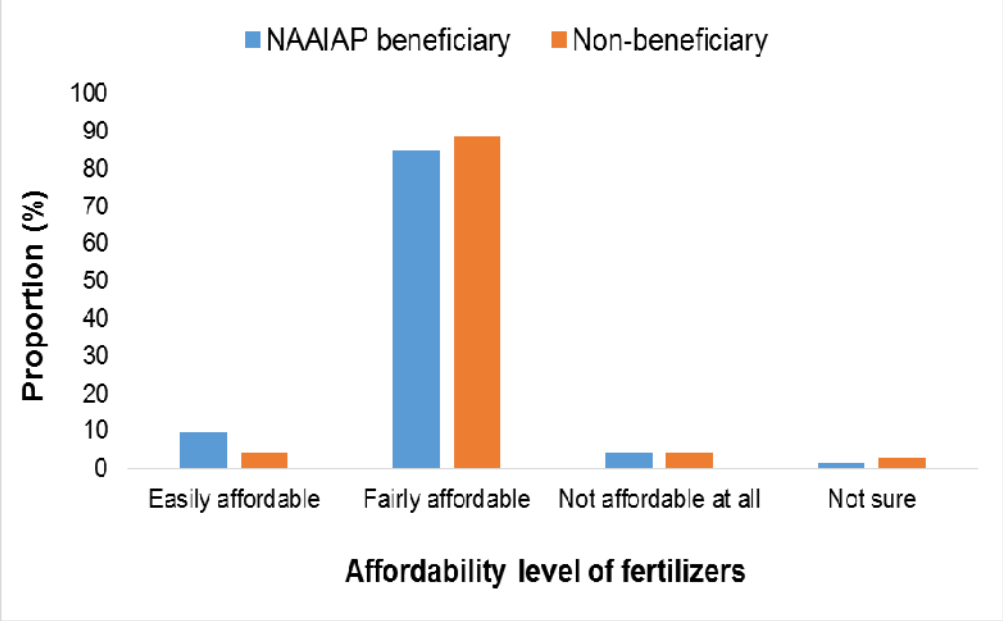

Figure 12: Effect of NAAIAP's subsidy on affordability level of fertilizers.

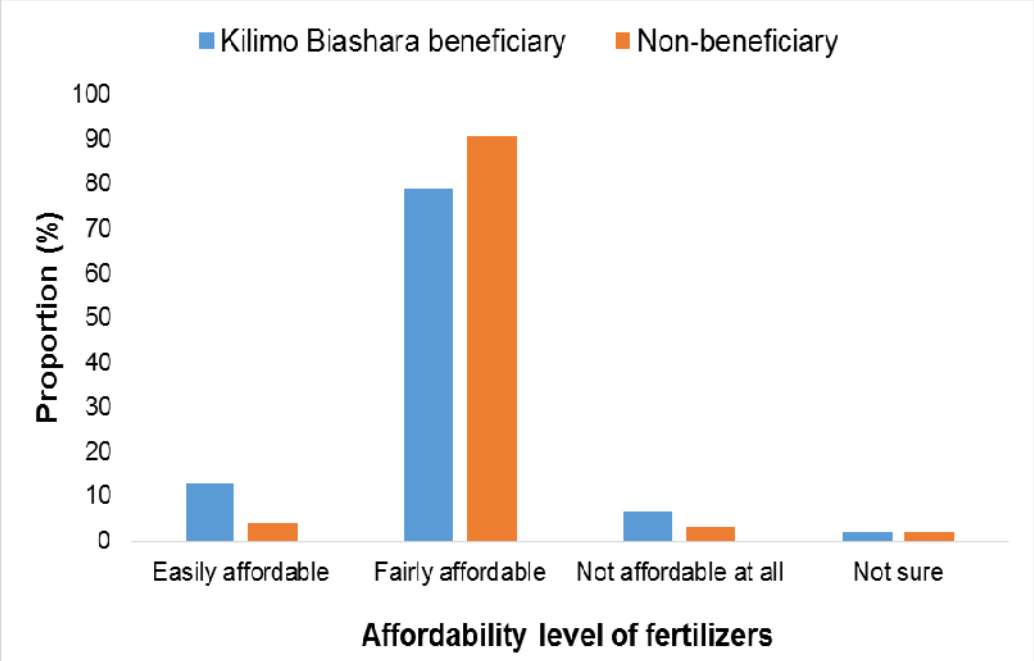

Figure 13: Effect of NAAIAP's credit on affordability level of fertilizers.

Over 55% of the credit beneficiaries were not satisfied with the interest rates charged on the credit facility while about 90% of the non-beneficiaries shared the same opinion. Their opinions on the interest rates charged on the NAAIAP's credit facility differed significantly (χ^2, 1 = 33.43, $p \leq 0.001$) where non-beneficiaries felt that the facility was out of their reach due to high interest rates.

Fertilizer availability. The opinions on fertilizer availability expressed by both the beneficiaries and non-beneficiaries of NAAIAP did not differ significantly (χ^2, 2 = 1.0, *NS*, two-tailed). Over 80% of them opined that NAAIAP subsidy made fertilizers more available (Figure 14).

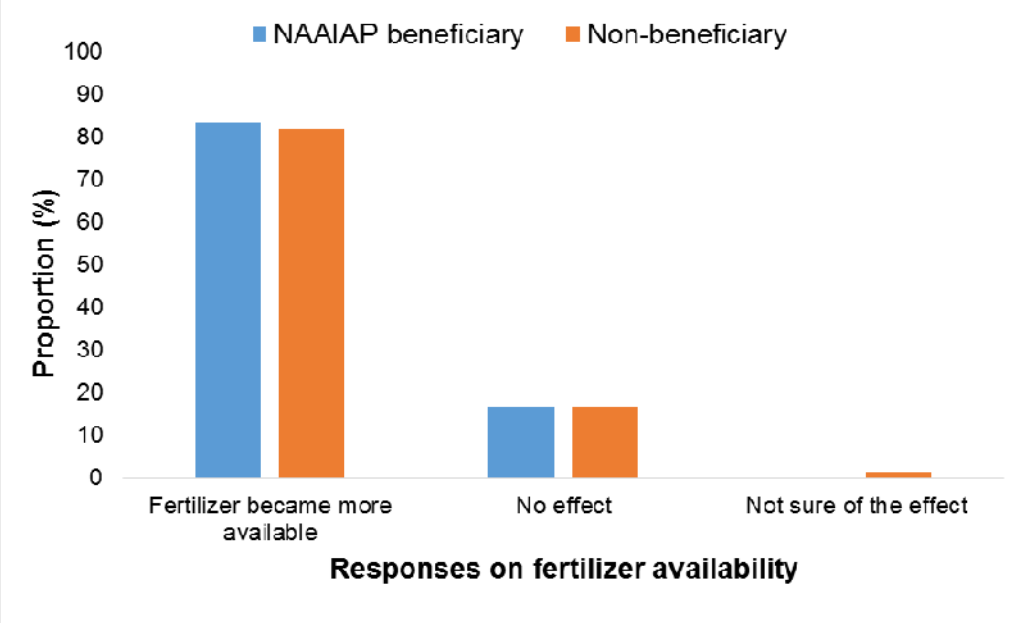

Figure 14: Participant's responses on effect of NAAIAP subsidy program on fertilizer availability.

Before introduction of NAAIAP in 2007, there was no significant difference in the frequencies at which the desired fertilizer was missed by the beneficiaries and non-beneficiaries (χ^2, 4 = 6.39, *NS*, two-tailed). However, after introduction of

NAAIAP, there occurred significant differences in the frequencies at which the desired fertilizer was missed by the beneficiaries and non-beneficiaries of NAAIAP (χ^2, 3 = 13.29, $p \leq$ 0.05). The frequency of missing the desired fertilizer ranged from 1 to more than 6 times in a year.

Before introduction of NAAIAP, over 80% of the beneficiaries used to miss the desired fertilizer from the agrodealer shops, meaning that only 20% of them had never missed the desired fertilizer (Figure 15). However, the trend was reversed with introduction of NAAIAP where the number of beneficiaries that had never missed the desired fertilizer increased from 20 to 95%. Even those who had benefited from the NAAIAP's credit facility (Kilimo Biashara), exhibited a similar trend where the proportion of those who missed the desired fertilizer reduced from 80% before NAAIAP to 4% after NAAIAP.

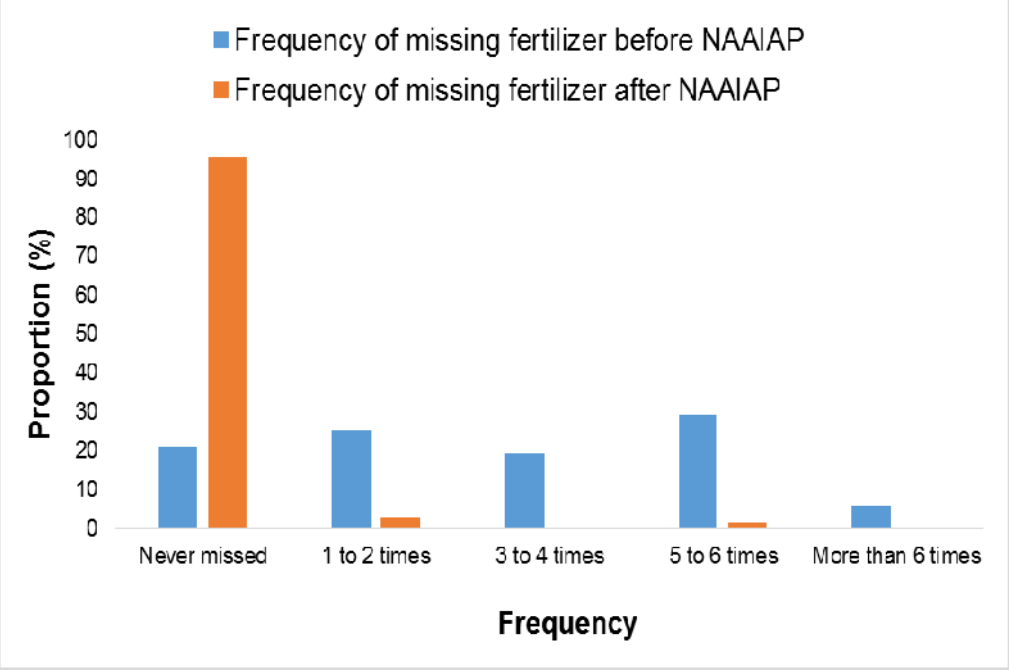

Figure 15: Frequency at which NAAIAP beneficiaries missed fertilizer before and after subsidy.

The trend was similar for the non-beneficiaries where 83% of them used to miss the desired fertilizer before NAAIAP and only 17% had never missed (Figure 16). However, this trend was reversed with introduction of NAAIAP where the number of non-beneficiaries who have never missed the desired fertilizer has increased from 17 to 78% (Figure 16).

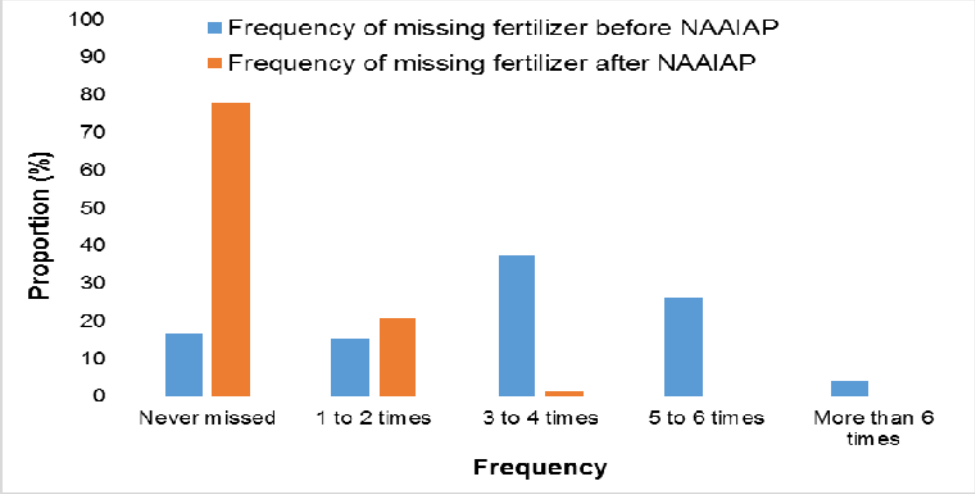

Figure 16: Frequency at which NAAIAP nonbeneficiaries missed fertilizer before and after subsidy.

Relationship Between Farmers' Rates of Fertilizer Usage and Maize Grain Yield

There was a strong positive correlation ($R^2 = 0.915$) between the amount of DAP fertilizer applied and the quantity of maize yield harvested by the farmers (Figure 17).

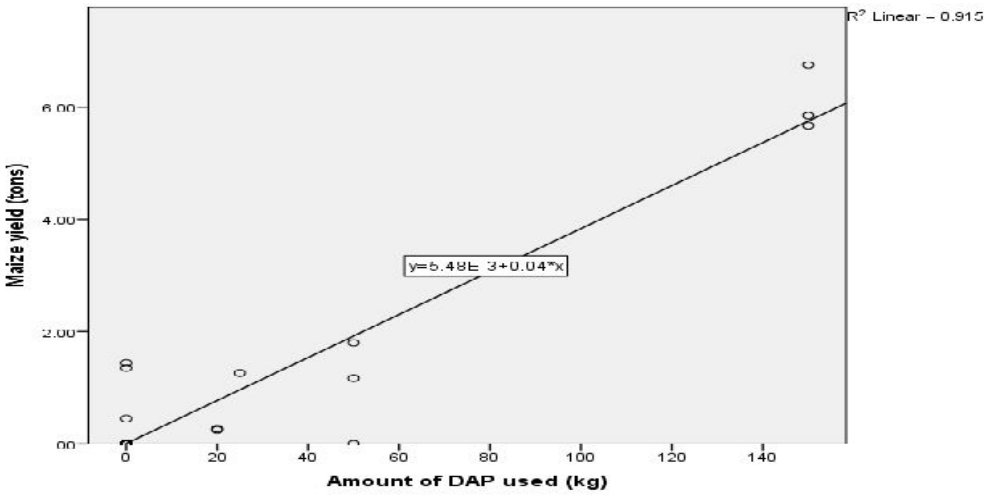

Figure 17: Relationship between amount of DAP fertilizer used and maize yield.

Similarly, there was a strong positive correlation ($R^2 = 0.852$) between the amount of CAN fertilizer applied and the quantity of maize yield harvested by the farmers (Figure 18).

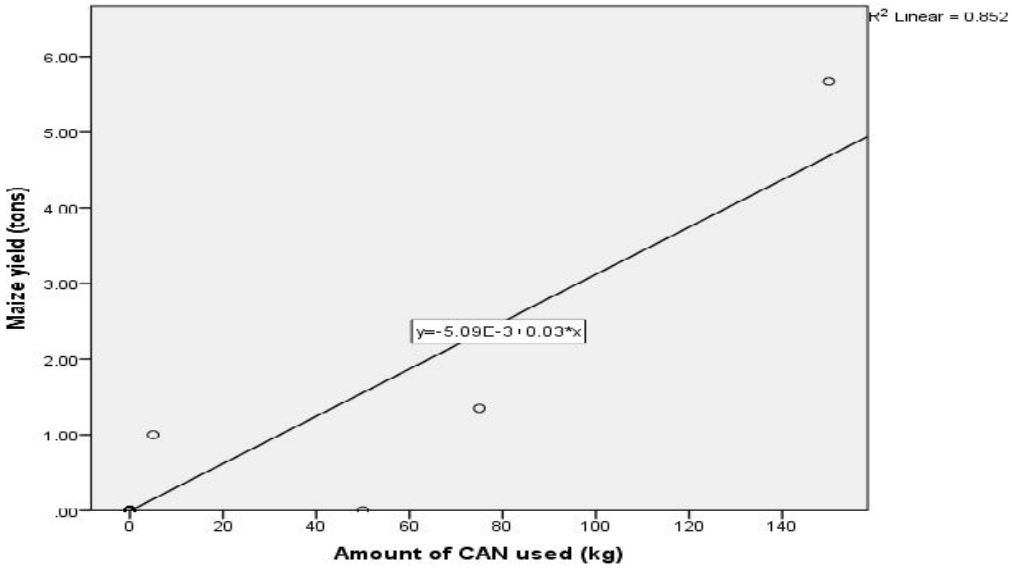

Figure 18: Relationship between amount of CAN fertilizer used and maize yield.

In addition, there was a significant positive correlation (R (144) = 0.167, $p <$ 0.05, one-tailed) between the quantity of DAP fertilizer used by farmers and their estimated annual income. Similarly there was a significant positive correlation (R (144) = 0.195, $p < 0.05$, one-tailed) between the quantity of CAN fertilizer used by farmers and their estimated annual income.

There was also a significant positive correlation (R (144) = 0.957, $p < 0.001$, one-tailed) between the quantity of DAP fertilizer used by farmers and their maize yield. Also there was a significant positive correlation (R (144) = 0.923, $p < 0.001$, one-tailed) between the quantity of CAN fertilizer used by farmers and their maize yield.

Effects of Promotion of Maize on Food Crop Diversification

There were no significant differences in the views given by NAAIAP beneficiaries and non-beneficiaries on whether the choice to specifically promote maize affected crop diversification (χ^2, 1 = 0.466, *NS*, two-tailed). There seemed to be consensus between the beneficiaries and non-beneficiaries of NAAIAP that the choice to promote maize under the subsidy program had affected crop diversification, especially other cereals such as sorghum and millet (Figure 19). The growing of beans, the commonly used grain legume in the region was not affected by the promotion of maize under NAAIAP program. Almost every farmer grows beans (Figure 19). Other legumes such as groundnuts and cowpeas are grown by almost half of the farmers irrespective of whether they benefited from NAAIAP or not (Figure 19). Other crops grown by about 15% of the farmers (Figure 19) included cabbages, spinach, kales and indigenous vegetables.

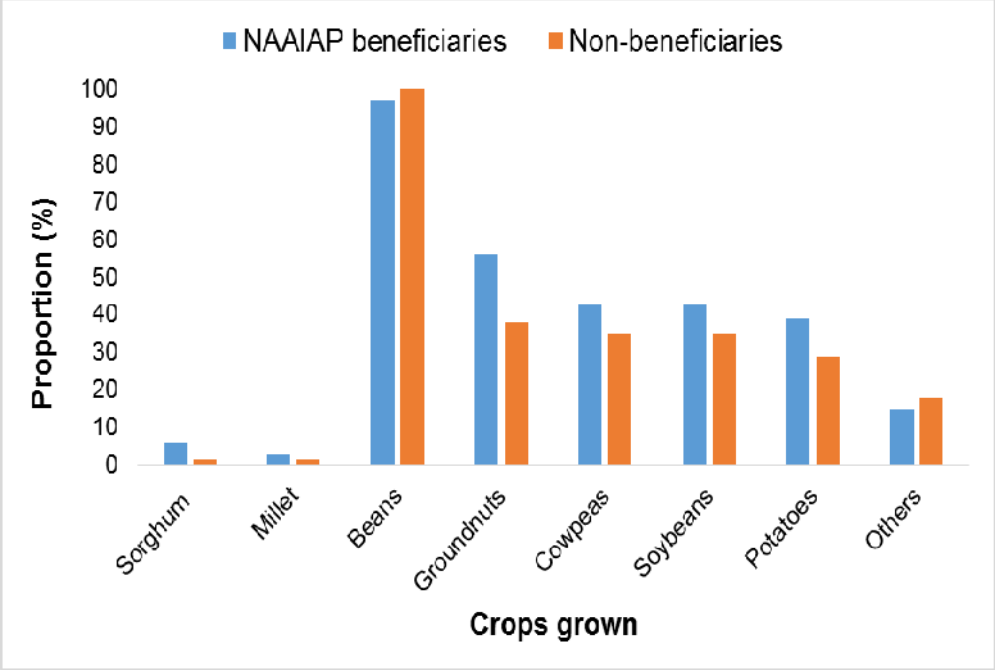

Figure 19: Other crops grown by farmers besides maize in Kakamega County.

Effects of NAAIAP on Food Security

This study revealed that NAAIAP subsidy program was able to improve food security in Kakamega County by reducing the number of hunger months experienced by the farmers per year. Before start of NAAIAP only 38% of the farmers in the County were food secure in the sense that they never experienced any hunger month throughout the year. After implementation of NAAIAP, 55% of the farmers became food secure and experienced no hunger month throughout the year (Figure 20). Before NAAIAP, over 55% of the farmers experienced hunger in more than 3 months in a year but after NAAIAP, this proportion was reduced to 6% (Figure 20). In addition, while 6% of the farmers used to suffer hunger in more than half of the period in a year

before NAAIAP but the situation was reversed after implementation of NAAIAP where none of them suffered hunger for such a long period (Figure 20).

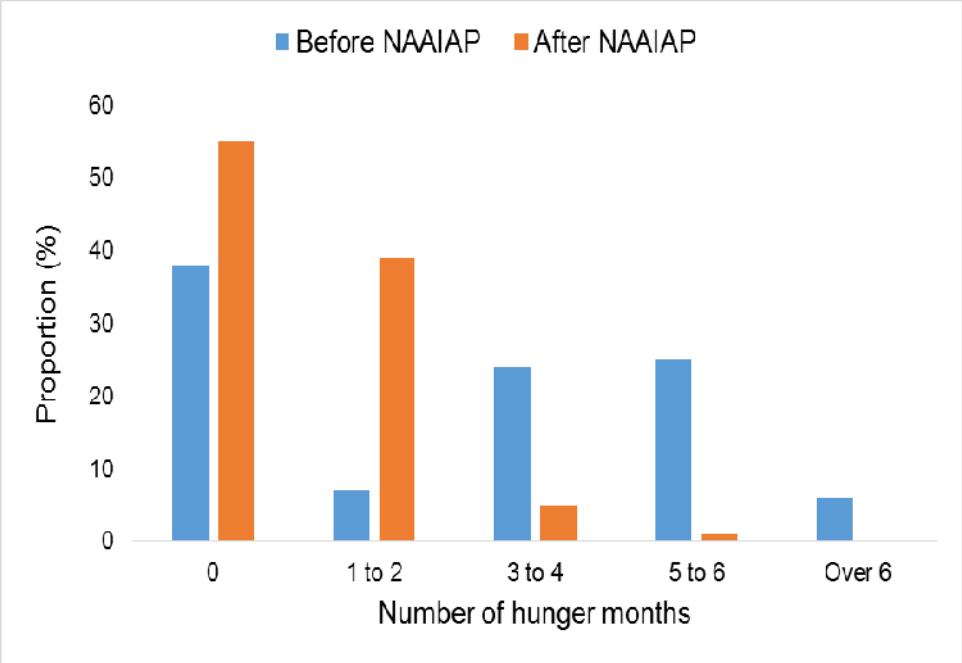

Figure 20: Effect of NAAIAP on food security in Kakamega County.

In addition, NAAIAP subsidy program helped to increase the income levels of farmers in Kakamega County. Before NAAIAP was started, 8% of the farmers could not get any income from their farms in an entire year (Figure 21). After start of NAAIAP, at least every farmer recorded some annual income from the farm. Before the start of NAAIAP about 60% of the farmers used to get below Ksh. 30,000 (300 USD) but with start of NAAIAP, over 90% of them could earn above 300 USD from their farms per year (Figure 21). The farmers' income levels were improved drastically by NAAIAP. For instance, it was only 24% of the farmers in the county who could earn an annual income of above Ksh. 50,000 (500 USD) but this

proportion increased to 67% after implementation of NAAIAP (Figure 21). What is more, over one third of the farmers (32%) realized annual incomes of over 100,000 (1000 USD) after NAAIAP compared to a meagre 1% before NAAIAP (Figure 21).

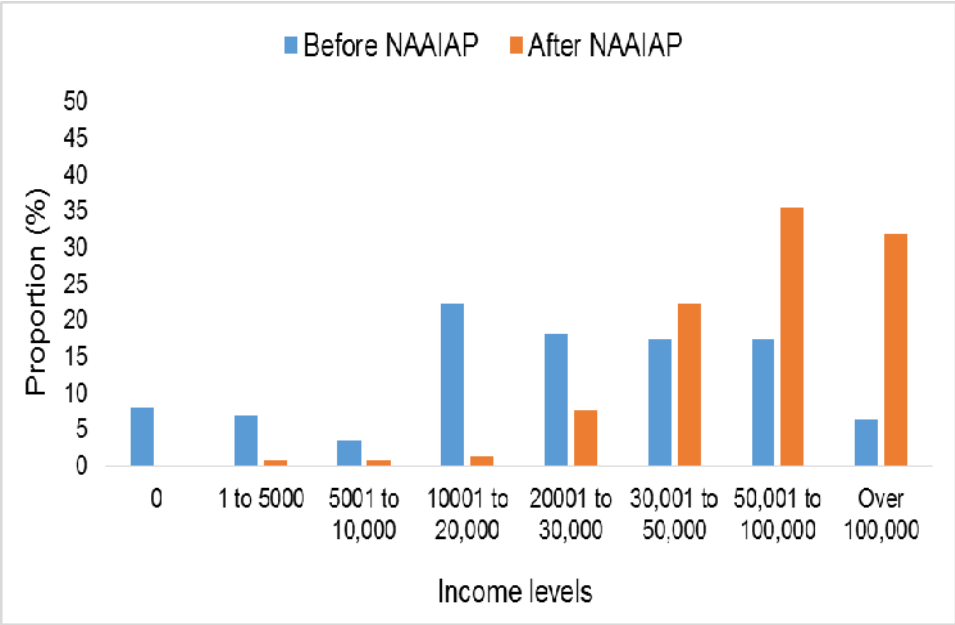

Figure 21: Effect of NAAIAP on income levels in Kakamega County.

Summary

Data emerging from this study have revealed that farming activities in Kakamega County, Western Kenya, are carried out mostly by women. (60% of the participants were females). Majority of these farmers were elderly where over 80% of the participants were above 35 years old. In addition, 44% of the participants were above 46 years old indicating that the youth are not attracted to farming activities. The good news, though, is that over 60% of them have secondary education and above meaning that they can write and read well. Over 82% of them are married and over half of them have between 4 to 6 children who have been raised with income coming largely from crop farming, livestock and poultry. The participants reported that NAAIAP subsidy program was able to improve their annual incomes from an average of 390 USD to 950 USD.

The fertilizers commonly used by farmers in Kakamega County, are consistent with those used in many parts of Kenya and they were Di-ammonium Phosphate (DAP) for planting and Calcium Ammonium Nitrate (CAN) for top-dressing that occurs 3 to 4 weeks after crop germination. The current average annual usage of DAP and CAN in the county is 37 kg and 34 kg, respectively. This indicates an increment of more than threefold from the baseline of about 10 kg before start of NAAIAP. The reported rates of DAP and CAN fertilizer usage are, however, below the Government's target that was to be achieved by 2015, in response to the Abuja Declaration of 2006.

The rates of fertilizer usage in Kakamega County, Western Kenya, were significantly predicted by the amounts of income earned from sale of surplus maize yield. Although the beneficiaries of NAAIAP subsidy purchased fertilizer 5 days on

average, earlier than the non-beneficiaries, this difference was not significant. This suggests that NAAIAP subsidy program did not significantly influence farmers in their preparedness to use fertilizers given that the days prior to rain season when the fertilizers were bought in readiness for use did not differ significantly between the beneficiaries and non-beneficiaries of NAAIAP. However, the beneficiaries of NAAIAP's credit program known as Kilimo Biashara purchased fertilizers 8 days on average, earlier than the non-beneficiaries of the credit program and this difference was significant. This suggests that NAAIAP credit program significantly influenced farmers in their preparedness to use fertilizers.

In terms of fertilizer accessibility, the distance travelled by the farmers to buy fertilizers did not influence their preparedness to use fertilizers irrespective of whether they benefited from NAAIAP subsidy program. In addition, the average annual income after NAAIAP was not a significant covariate for the days prior to rain season when fertilizers were bought (F (1,141) = 1.895, $p > 0.05$, partial $\eta^2 = 0.013$, power = 0.277. This suggests that the farmers' annual income after NAAIAP had no significant effect on the number of days prior to rain season when DAP and CAN fertilizers were purchased by the farmers.

The distance travelled by both groups to access fertilizer before NAAIAP reduced significantly from 4.62 km (SE = 0.220) to 2.0 km (SE = 0.087) after implementation of NAAIAP. Over 85% of the farmers, whether NAAIAP beneficiaries or not, shared a common view that NAAIAP made fertilizers fairly affordable. Over 55% of the NAAIAP credit beneficiaries were not satisfied with the high interest rates charged on the credit facility while about 90% of the non-beneficiaries shared the same opinion. This implies that they are likely to prefer

informal sources of credit to the formal bank credit as explained through the credit channel theory. Reduced demand of bank's credit may lead to a banking crisis even when the central bank relaxes monetary policies to increase banks liquidity (Their opinions on the interest rates charged on the NAAIAP's credit facility differed significantly (χ^2, 1 = 33.43, $p \leq 0.001$) where non-beneficiaries felt that the facility was out of their reach due to the high interest rates.

Over 80% of both the beneficiaries and non-beneficiaries opined that NAAIAP subsidy made fertilizers more available. Before introduction of NAAIAP, over 80% of the beneficiaries used to miss the desired fertilizer from the agrodealer shops. However, the trend was reversed with introduction of NAAIAP where the number of beneficiaries that had never missed the desired fertilizer increased from 20 to 95%.

There was a strong positive correlation ($R^2 = 0.915$) between the amount of DAP fertilizer applied and the quantity of maize yield harvested by the farmers. Similarly, there was a strong positive correlation ($R^2 = 0.852$) between the amount of CAN fertilizer applied and the quantity of maize yield harvested by the farmers.

In addition, there was a significant positive correlation (R (144) = 0.167, $p <$ 0.05, one-tailed) between the quantity of DAP fertilizer used by farmers and their estimated annual income. Similarly there was a significant positive correlation (R (144) = 0.195, $p < 0.05$, one-tailed) between the quantity of CAN fertilizer used by farmers and their estimated annual income.

There seemed to be consensus between the beneficiaries and non-beneficiaries of NAAIAP that the choice to promote maize under the subsidy program affected the diversification of other cereals such as sorghum and millet but not the grain legumes.

For instance, beans were grown by every farmers before and after NAAIAP irrespective of whether they benefited from NAAIAP programs not. Other legumes such as groundnuts and cowpeas are grown by almost half of the farmers irrespective of whether they benefited from NAAIAP or not.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this quantitative study was to explain the impact of a subsidy program in Kakamega County, Western Kenya. It was dubbed NAAIAP. This program aimed at revamping the agriculture sector in Kenya for sustainable food production that ensured food security and income, especially for the resource-poor rural farmers. It was in response to the 2006 AfDB. This was important because of the role that the agriculture sector plays in the support of African economies where over 65% of the African population relies on agriculture for livelihood (AGRA, 2016, 2016; McIntire, 2014). This study was conducted to determine the effects of NAAIAP on the rate of fertilizers used by farmers in Kakamega County, Western Kenya. The study also sought to determine how the NAAIAP's credit program known as Kilimo Biashara affected farmers' preparedness to use fertilizer for food production and how the credit program affected fertilizer accessibility, availability, and affordability in Kakamega County. In addition, the study established the relationship between fertilizer usage rates and maize grain yield in addition to determining whether the deliberate choice to promote maize under NAAIAP affected crop diversification in the county.

The study revealed that NAAIAP was instrumental in increasing fertilizer usage rates by more than threefold from about 10 kg/ha/year in 2007 to 37 kg/ha/year in 2016 among the sample population. It was revealed that the rates of fertilizer usage were predicted by the income earned from the sale of surplus maize yield. Thus, getting higher incomes from the sale of surplus maize catalyzed the usage of higher rates of fertilizers. In addition, NAAIAP's credit program had a significant effect on

fertilizer accessibility and availability. The credit program also made fertilizer fairly affordable with farmers requesting further policy interventions to make fertilizers easily affordable. The 10% interest rate charged under the NAAIAP's Kilimo Biashara program was expensive for the resource-poor farmers. As explained by Archarya et al. (2014) and De Fiore and Tristani (2013) through the credit channel theory, the unaffordable interest rates forced many farmers to seek credit facilities from the informal sector. This has the potential for inducing a banking crisis (Archarya et al., 2014; De Fiore and Tristani, 2013).

NAAIAP helped to reduce the distance travelled by farmers to access fertilizer. In addition, there was a positive significant correlation between rates of fertilizer usage and maize grain yield where increasing the rates of fertilizer usage resulted in increased maize yield. The choice to promote maize crop under NAAIAP affected the cultivation and diversification of cereal crops only but not the legume crops. This chapter discusses these findings in greater details.

Interpretation of the Findings

Demographic Characteristics of the Sample

The farmers who participated in this study consisted of 60% females and 40% males, indicating that smallholder farming in the region is done largely by women. This is consistent with various studies that have revealed that close to 70% of smallholder farmers in Africa are women and this region of Western Kenya is no exception (AGRA, 2016). The results also indicate that the study sample was a good representation of the gender composition in the county whose population consists of 48% males and 52% women (Government of Kakamega County, 2013; NAAIAP, 2014).

Only 19% of the participants were youthful farmers below 35 years and this has policy implications in socioeconomic development given that close to 30% of the population in Kakamega County consists of youthful people aged between 18 to 35 years (Government of Kakamega County, 2013; NAAIAP, 2014). This observation is consistent with several studies that have found that most farming activities in Kenya, and Africa in general, are done by farmers aged over 55 years; hence, the urgent call by stakeholders to make agriculture attractive to the youth (AGRA, 2016).

Over half of the participants (53%) had secondary education while 40% had primary education indicating that they could at least read and write. Only 7% of them had middle level and university education. This result is consistent with the studies done by NAAIAP (2014) and the Government of Kakamega County (2013), which recorded high literacy levels in the county where only 1% finished primary school. About 82% of the participants were married, about 5% were single, 3% divorced and 10% were widowed. More than half of the participants (56%) had 4 to 6 children while a small proportion of 2% did not have any children. This is consistent with the studies by Ndirangu et al. (2014) and Government of Kakamega County (2013), who reported the population growth rate of Kakamega County to be 2.5%, which was higher than Kenya's national average of 2.3%. In addition, the average family size reported by the Government of Kakamega County (2013) was 5.6 children, which is consistent to the findings of this study.

The annual incomes of participants ranged from Ksh. 5,000 (50 USD) to Ksh. 420,000 (4,200 USD), depicting the high poverty levels in the county at 51% compared to Kenya's national rate of 46% (Government of Kakamega County, 2013). Their annual average before NAAIAP was about Ksh. 39,000 (390 USD), but after

NAAIAP, it increased by more than twofold to Ksh. 950,000 (950 USD). This indicates that NAAIAP was able to improve the income and general livelihoods of the farmers in Kakamega County. All participants quoted crop farming as the main source of income while 89% of them mentioned livestock and poultry keeping as the second most important source of income. The other important sources of income mentioned by the participants were off-farm enterprises and job salary, at the proportions of 64% and 34%, respectively. These results are consistent with the findings of the Government of Kakamega County, which reported farming as the main economic activity in the county. Maize crops dominate the fields and are supplemented by livestock and poultry keeping. Fifty-three percent and 92% of the farmers keep cattle and poultry, respectively. This study found that the main food crops in Kakamega County to be maize, beans, and groundnuts consistent with the study by Thuweba et al. (2013).

Effect of NAAIAP on Fertilizer Usage

The farmers in Western Kenya mostly use DAP fertilizer as basal fertilizer for planting compared to other types of basal fertilizers such as NPK. At the time of this study in October, 2016, the average rate of DAP usage was 37 kg per annum. These farmers mostly use CAN fertilizer for top-dressing compared to Urea. As at October 2016, the average rate of CAN usage was 34 kg per annum. This indicates that NAAIAP had a positive effect in increasing the rate of fertilizer used in the county from about 10 kg/ha/year (Government of Kakamega County, 2013) to these current rates that are more than three times higher.

About 48% of the participants do not use DAP while another 51% do not use CAN fertilizers that are commonly used by farmers in Kakamega County. It was only

about 25% of the participants that were, at the time of the study, using 50 kg of the fertilizer per annum. This was the 2015 target set by African governments in the Abuja Declaration of 2006.

These results indicate that there is an improvement in the number of farmers using fertilizers from 30% (Government of Kakamega County, 2013) to about 50% that is reported in this study. This is perhaps due to reduction in the cost of the fertilizer and mass creation of awareness through the NAAIAP subsidy program. A study by NAAIAP (2014) reported that 70% of the farmers had been made aware of the benefits of using fertilizers and 46% of the farmers who participated in this study reported that they were able to use fertilizer since its price was reduced through NAAIAP subsidy, thereby making it fairly affordable.

The combination of the first three predictors, that is, shortest distance travelled to access fertilizer after NAAIAP, number of times that desired fertilizer was missed after NAAIAP, and preferred affordable price for a 50 kg bag of DAP fertilizer, accounted for 3.1% of the variance in DAP fertilizer usage. This variation was not significant ($p > 0.05$). When the other three predictors, namely, maize surplus yield for sale, annual income earned from sale of surplus maize, and average annual income after the start of NAAIAP were added into the regression model, they brought an additional variance of 12.5% in the usage of DAP fertilizer. The combined set of predictors in the second model accounted for 15.5% of the variance in the current usage of DAP fertilizer and it was a significant fit to the data (F (4,139) = 6.374, $p < 0.001$). This means that among the six main variables that were hypothesized to predict the rate of DAP usage, it was only the income earned from the sale of surplus

maize yield that predicted the DAP usage rate significantly, $N = 144$, $R = 0.394$, Adj $R^2 = 0.131$, $B = 0.001$; $\beta = 0.001$, $Sr^2 = 0.0.124$, $t\ (139) = 4.513$, $p < 0.001$.

In addition, there was a significant positive correlation between the income earned from the sale of surplus maize yield and the annual quantity of DAP & CAN fertilizers used by the farmers. This means that farmers in Kakamega County bought and used higher amounts of fertilizers with increased income from the sale of surplus maize yield.

Effect of NAAIAP's Credit Program on Farmers' Preparedness to Use Fertilizers

The days prior to rain season when farmers purchased fertilizer, especially DAP and CAN that are commonly used by most farmers in Kenya, did not differ significantly between the beneficiaries and nonbeneficiaries of NAAIAP subsidy program $F\ (1,142) = 3.547$, $p = 0.062$. However, the days prior to rain season when farmers purchased the fertilizers differed significantly between the beneficiaries and nonbeneficiaries of NAAIAP's credit program known as Kilimo Biashara $F\ (1,142) = 7.135$, $p = 0.008$. The beneficiaries of NAAIAP purchased fertilizers much earlier ($M = 25.61$, $SE = 2.051$) than the nonbeneficiaries ($M = 20.\ 07$, $SE = 2.051$) in preparation for planting. Similarly, the beneficiaries of NAAIAP's Kilimo Biashara credit program purchased fertilizers much earlier ($M = 28.36$, $SE = 2.519$) than the nonbeneficiaries ($M = 20.17$, $SE = 1.753$).

The distance travelled by the two groups of NAAIAP program was not a significant covariate for this analysis $F\ (1,141) = 2.181$, $p > 0.05$, partial $\eta^2 = 0.015$, power = 0.311, meaning that the distance travelled by the groups of the NAAIAP subsidy program to access fertilizer after NAAIAP had no significant effect on the

number of days prior to rain season when they bought DAP and CAN fertilizers. The average annual income after NAAIAP was not a significant covariate for the days prior to rain season when DAP and CAN fertilizers are purchased (F (1,141) = 1.895, $p > 0.05$, partial $\eta^2 = 0.013$, power = 0.277, meaning that the farmers' annual income after NAAIAP had no significant effect on the number of days prior to rain season when DAP and CAN fertilizers were purchased by the farmers.

As conceptualized through the credit channel theory (Bougheas, Mizen & Yalcin, 2006) farmers were able to buy fertilizers early enough before the onset of rain season when they were financially capacitated. In addition, as theorized by Madestam (2014) through the bank lending channel theory, the provision of NAAIAP credit seemed to have advanced the economic welfare of the beneficiaries compared to the nonbeneficiaries. The nonbeneficiaries of NAAIAP's credit reported that the market interest rate of over 20% on financial credit was way beyond their reach, and hence, unlike the beneficiaries who borrowed at 10% interest rate, they could not have the luxury of buying fertilizers early enough in preparation for use at the onset of the rain season.

The current quantity of DAP fertilizers used significantly predicted whether a farmer benefited from NAAIAP's credit program, Ward = 14.34, $p < 0.001$ (Table 21). However, the current quantity of CAN fertilizer used did not significantly predict whether a farmer benefited from NAAIAP's credit program or not, Ward = 0.502, $p > 0.05$ (Table 21). A farmer who uses higher quantities of DAP fertilizer is less likely to benefit from the NAAIAP's credit program B = - 0.07, (Exp (B) = 93, $CI_{0.95}$ = [0.899, 0.967]). This is perhaps caused by the possibility of the farmer getting surplus maize yield for income generation, with higher usage of DAP fertilizer. He therefore uses

the generated income to buy DAP fertilizer instead of borrowing a Kilimo Biashara loan to buy the fertilizer.

Effect of NAAIAP's Credit Program on Fertilizer Accessibility, Availability, and Affordability

NAAIAP's effect on fertilizer accessibility. Before the start of the subsidy program, there was no significant difference F (1,142) = 0.071, p = 0.79 in the distance the farmers travelled to access fertilizer between the beneficiaries and non-beneficiaries of NAAIAP. Similarly, there was no significant difference F (1,142) = 0.014, p = 0.906 between the shortest distance travelled by the beneficiaries and non-beneficiaries of NAAIAP after the subsidy program. However, the distance travelled by both groups to access fertilizer before NAAIAP reduced significantly from 4.6 km (SE = 0.220) to 2.0 km (SE = 0.087) after implementation of NAAIAP. The distance travelled before NAAIAP was a significant covariate for this analysis (F (1,141) = 44.421, $p < 0.001$, partial $\eta^2 = 0.24$, power = 1.00 (Table 17). This means that the distance travelled to access fertilizer before NAAIAP had a significant effect on the distance travelled to access fertilizer after NAAIAP. The number of times that desired fertilizer was missed after NAAIAP significantly predicted whether a farmer benefited from NAAIAP subsidy program. This indicates that NAAIAP program created mass awareness on the type of fertilizer to use for increased crop productivity, consistent with the conceptual framework for this study. However, the shortest distance travelled to access fertilizer and the preferred affordable cost of DAP fertilizer did not significantly predict whether a farmer benefited from NAAIAP subsidy program.

After the implementation of NAAIAP, the distance travelled by the program beneficiaries was almost the same ($M = 1.98$, $SE = 0.109$) as that travelled by the non-beneficiaries ($M = 2.03$, $SE = 0.109$). This means that NAAIAP's positive effects of making fertilizers more accessible to farmers were enjoyed by everyone. It also means that the agrodealer networks that were expanded through NAAIAP served everyone who wanted to buy fertilizers. A study by (Jayne et al., 2013; Sheahan et al., 2013) showed that most agrodealers who sell fertilizers are located in cities and other big towns that are far away from the farmers, making fertilizers inaccessible. Related studies showed that expanding agrodealer networks from the urban centres where they are mostly concentrated to the rural areas where most farming activities take place, improves fertilizer accessibility to farmers (AGRA, 2011; Mutoko et al., 2014).

NAAIAP's effect on fertilizer availability. As opposed to studies by Hanjra and Culas (2011) and Kerr (2012) in Malawi where an input subsidy program resulted in unavailability of fertilizers, NAAIAP increased fertilizer availability. The opinions on fertilizer availability expressed by both the beneficiaries and non-beneficiaries of NAAIAP did not differ significantly (χ^2, 2 = 1.0, *NS*, two-tailed). Over 80% of them opined that NAAIAP subsidy made fertilizers more available. Before introduction of NAAIAP in 2007, there was no significant difference in the frequencies at which the desired fertilizer was missed by the beneficiaries and non-beneficiaries of NAAIAP (χ^2, 4 = 6.39, NS, two-tailed). However, after introduction of NAAIAP, there occurred significant differences in the frequencies at which the desired fertilizer was missed by the beneficiaries and non-beneficiaries of NAAIAP (χ^2, 3 = 13.29, $p \leq 0.05$).

Before introduction of NAAIAP, over 80% of the beneficiaries used to miss the desired fertilizer from the agrodealer shops, meaning that only 20% of them had

never missed the desired fertilizer. However, the trend was reversed with introduction of NAAIAP where the number of beneficiaries who had never missed the desired fertilizer increased from 20 to 95%. This means that it was only about 5% of the NAAIAP beneficiaries who had missed the desired fertilizer after introduction of the subsidy program. Even those who had benefited from the NAAIAP's credit facility (Kilimo Biashara), exhibited a similar trend where the proportion of those who missed the desired fertilizer reduced from 80% before NAAIAP to 4% after NAAIAP. The trend was similar for the non-beneficiaries where 83% of them used to miss the desired fertilizer before NAAIAP and only 17% had never missed. However, this trend was reversed with introduction of NAAIAP where the number of non-beneficiaries who have never missed the desired fertilizer has increased from 17 to 78%. Contrary to the report by the Republic of Kenya (2014) that agrodealers sometimes fail to stock the required types and quantities of fertilizers needed by farmers, especially at the start of planting season, this study revealed that with implementation of NAAIAP, farmers are now getting the desired type of fertilizer in a timely manner.

NAAIAP's effect on fertilizer affordability. The views shared by both NAAIAP beneficiaries and non-beneficiaries on fertilizer affordability did not differ significantly between the two groups (χ^2, 3 = 2.0, *NS*, two-tailed). Over 85% of the farmers from both groups shared a common view that NAAIAP subsidy program made fertilizers fairly affordable. A similar view was shared by the beneficiaries and non-beneficiaries of NAAIAP's credit program where 80% of the Kilimo Biashara beneficiaries felt that NAAIAP made fertilizers fairly affordable while over 90% of the Kilimo Biashara non-beneficiaries held a similar view. It was only about 10% of

the Kilimo Biashara beneficiaries and less than 5% of the non-beneficiaries who opined that NAAIAP's credit made fertilizers easily affordable meaning that there is need to explore other policy tools for making fertilizer easily affordable for farmers. The views of the Kilimo Biashara beneficiaries and non-beneficiaries on fertilizer affordability level were not significantly different (χ^2, 3 = 4.75, *NS*, two-tailed), meaning that there is consensus among the farmers in Kakamega County that the cost of fertilizers is still high for them to buy and use sustainably.

Over 55% of the credit beneficiaries were not satisfied with the interest rates charged on the credit facility while about 90% of the non-beneficiaries shared the same opinion. Their opinions on the interest rates charged on the NAAIAP's credit facility differed significantly (χ^2, 1 = 33.43, $p \leq 0.001$) where non-beneficiaries felt that the facility was out of their reach due to the high interest rates. In addition, since NAAIAP also supported subsidy on extension services, most farmers in the rural areas became aware of the agronomic and financial benefits of using fertilizers (Sheahan et al., 2013). Consistent with the study by Muyanga and Jayne (2014) farmers in Kakamega County reported that NAAIAP was only able to make the cost of fertilizers fairly affordable and hence they proposed a further reduction of their costs in order for them to be able to afford and use them for increased foods production.

Relationship Between Farmers' Rates of Fertilizer Usage and Maize Grain Yield

There was a strong positive correlation ($R^2 = 0.915$) between the amount of DAP and CAN ($R^2 = 0.852$) fertilizers applied and the quantity of maize yield harvested by the farmers, meaning that the fertilizer applied in the county are still below the optimal rate and therefore, any additional unit of fertilizer led to increased

units in the yield of maize. This finding is consistent with several other studies in the region and elsewhere, who reported a positive correlation between rates of fertilizers application and maize grain yield (FAOSTAT, 2013; Jama & Kiwia, 2009; Vanlauwe et al., 2011; World Bank, 2015). In addition, there was a significant positive correlation (R (144) = 0.167, $p < 0.05$, one-tailed) between the quantity of DAP and CAN (R (144) = 0.195, $p < 0.05$, one-tailed) fertilizers used by farmers and their estimated annual income.

Effects of Promotion of Maize on Food Crop Diversification

There were no significant differences in the views given by NAAIAP beneficiaries and non-beneficiaries on whether the choice to specifically promote maize affected crop diversification (χ^2, 1 = 0.466, *NS*, two-tailed). There seemed to be consensus between the beneficiaries and non-beneficiaries of NAAIAP that the choice to promote maize under the subsidy program had affected the production and diversification of cereals such as sorghum and millet and not the grain legumes. The growing of beans, the commonly used grain legume in the region was not affected by the promotion of maize under NAAIAP program. Almost every farmer in Kakamega County grows beans. Other legumes such as groundnuts and cowpeas are grown by almost half of the farmers irrespective of whether they benefited from NAAIAP or not. Other crops grown by about 15% of the farmers included cabbages, spinach, kales and indigenous vegetables. This finding is consistent with that of ASDSP (2014) who found that farmers in Western Kenya normally intercrop cereals and legumes as a way of minimizing risks of total crop failure in the event of drought or outbreak of pests and diseases of a given crop.

Findings in Relation to Theoretical Base and Conceptual Framework

In this study it was conceptualized that if a country develops an input subsidy program such as Kenya's NAAIAP with a component of linking framers to affordable finance such as Kilimo Biashara, then farmers would be in a better position to borrow agricultural loans to invest in producing diverse crops (Figure 4). The farmers would endeavor to increase their crop yields through the use of appropriate fertilizer rates that are higher than the meagre rates of 11 kg/ha/year used in many African countries. The farmers' usage of higher rates of fertilizers will, however, occur if it is accessible, available, and affordable (Figure 4). The usage of higher rates of fertilizers would enable farmers to produce surplus food for consumption and sale to generate income in a sustainable way leading to overall improvement of their livelihoods, food and nutritional security (Figure 4).

The findings of this study are consistent with the conceptual framework where it was envisaged that when farmers get higher incomes from the sale of surplus crop yields, they will be able invest in profitable and sustainable agricultural activities for improved livelihoods, income, food & nutritional security.

Limitations of the Study

The limitation of the study was that not all the farmers in Kakamega County were surveyed. Out of a population of about 400,000 farmers in Kakamega County, only 144 were sampled. Thus, in the sampling strategy, there was a potential ethical issue of bias, since it was only a few farmers who were sampled from each of the twelve sub-counties in Kakamega County. The study was thus faced with an internal validity of generalizability because recommendations on the effect of NAAIAP subsidy program in Kakamega County were generalized based on the responses from

144 farmers. However, in order to ensure justice in selecting the farmers that participated in the study, stratified random sampling was employed to pick a representative sample from each of the twelve focal sub-counties.

Recommendations

The County Government of Kakamega and others in Kenya should adopt input subsidy programs similar to NAAIAP for accelerating agricultural development and achievement of food security. In addition, in order to realize the 2014 Malabo Declaration goal on accelerated agricultural growth and transformation, it is necessary for Kenya and other African governments to increase their financial investments in support of subsidy programs similar to NAAIAP but ensure that lower interest rates are charged on agricultural loans.

Financial credit such as the NAAIAP's Kilimo Biashara is an important ingredient for financing farm inputs in a sustainable way. However, the interest rate charged on such credit facilities need to be reduced to below 10% per annum. Future studies could endeavor to find out the most appropriate interest to charge on such credit facilities to enable the farmers borrow loans sustainably while still keeping the financial institutional in business. This would enable more farmers to borrow money for buying the necessary farm inputs for increased agricultural production and transformation.

The issue of fertilizer affordability needs to be addressed by devising a policy tool that could sustainably facilitate farmers to afford fertilizers. From this study it is evident that NAAIAP made fertilizers fairly affordable with the farmers making a plea for further reduction in the cost of fertilizers.

Implications

Although NAAIAP supporters envisaged that the beneficiaries of NAAIAP's Kilimo Plus would all graduate to Kilimo Biashara and start borrowing loans from Equity bank, this study revealed that it was only 65% of the 72 beneficiaries of NAAIAP that borrowed Kilimo Biashara loans. The farmers reported that the 10% interest charged on the loans, although lower than the market rate, it was still high for them to borrow sustainably.

As explained by Archarya et al. (2014) and Black and Rosen (2016) in the credit channel theory, the opportunity for Kenyan farmers to access a NAAIAP's guaranteed loan from Equity Bank, through the credit initiative of Kilimo Biashara program, may have prompted them to take a higher risk of borrowing a loan to invest in the production of diverse, high-value legume crops. The legume crops commonly grown by the farmers in Kakamega County include common beans, groundnuts or soybeans. These high-value crops normally have a higher market potential than maize, in increasing farmer's income and nutritional security. Alternatively, as explained through the credit channel theory, the farmers might have opted to take the lower risk channel of investing in the cultivation of low income and less nutritional crops such as maize because the government provided free seeds, under the NAAIAP subsidy program (De Fiore & Tristani, 2012). This would be so even with the opportunity to access a guaranteed loan (De Fiore & Tristani, 2012; Jiménez et al., 2012). This is why the cultivation of other cereal crops such as sorghum and millet was affected negatively since farmers did not get free seeds like in the case of maize.

The implications on academic fraternity are that this study has filled many knowledge gaps presented in the reviewed literature. For instance, in the study by

Ahlers et al. (2013), there was no empirical data on the outcomes of implementing a government subsidy program like NAAIAP. This study has filled this knowledge gap by showing that NAAIAP was able to drastically reduce the number of hunger months experienced by farmers in a year.

In addition, the study by Kiratu et al. (2014) had showed farmers were likely to adopt NAAIAP policies if they had a positive perception about it. Their study did not show the socioeconomic benefits that accrued from adopting NAAIAP. This knowledge gap has been filled by this study where it revealed that NAAIAP led to increased food production through the use of higher rates of fertilizers, increased incomes from sale of surplus maize yield and overall achievement of food security. Attainment of food security occurred through reduction of the number of hunger months in a year.

In addition, the study by Ndirangu et al. (2013) had not highlighted the role of NAAIAP in increasing fertilizer usage. This study has revealed that NAAIAP led to increased rates of fertilizer usage by making fertilizers accessible and available to the farmers. Although NAAIAP did not fully address the constraint of high cost of fertilizers, many farmers reported that NAAIAP made fertilizers fairly affordable. Fertilizer accessibility was achieved through reduction of distances travelled by farmers to buy fertilizers while its availability was achieved by ensuring that agrodealers in the county were able to stock the appropriate fertilizers in a timely manner.

The implications for social change is that this study has revealed that subsidy programs such as NAAIAP play a crucial role in improving food production and incomes for resource-poor farmers by making farm inputs such as fertilizer accessible,

available and affordable. Kakamega County and the other counties in Kenya should adopt subsidy programs like NAAIAP in their agricultural development plans. However, they should ensure that the interest rates charged on financial credit is within farmers' financial ability in order to make the programs sustainable.

Conclusion

In conclusion, NAAIAP was a beneficial program to the farmers in Kakamega County and it led to multiple socioeconomic benefits in the county. It increased farmer's usage of fertilizer by more than threefold from 10 kg/ha/year to 37 kg/ha/year. NAAIAP subsidy program was able to reduce the distance that farmers travel to buy fertilizers. However, the rates of fertilizer usage are still below the target of 50 kg/ha/year agreed at the Abuja Fertilizer Summit of 2006 (NEPAD, 2016b). Increased usage of fertilizers in the county was achieved through various intervention points such as expansion of agrodealer network from urban centres to rural areas where most farming activities take place. The extension services provided through NAAIAP ensured that the agrodealers stocked the appropriate type of fertilizers needed by farmers and it sensitized farmers on the benefits of using fertilizers.

NAAIAP's credit program had significant effects on improving fertilizer accessibility and availability. This study revealed that NAAIAP was effective in reducing the distance travelled by farmers to access fertilizer. The study revealed that farmers were able to buy and use higher rate of fertilizers with increased income from sale of surplus maize yield. From the lenses of the credit channel theory, it means that farmers in Kakamega County are willing to borrow money and invest in agricultural production if at all it can be sustainably profitable.

NAAIAP's program did not have a big breakthrough on fertilizer affordability due to high interest rates charged on the credit. Although the interest rate was 10% and halfway below the market rates that are above 20%, farmers pleaded for policy interventions to reduce the interest rates to below 10%. They also proposed their preferred prices for the 50 kg bags of DAP and CAN fertilizers which are way below the subsidized costs adopted by NAAIAP implementers. Further reductions of interest rates on agricultural credit and the costs of fertilizers will facilitate farmers' easy affordability of fertilizers. NAAIAP was also successful in improving food security in Kakamega County by reducing the number of hunger months experienced by farmers in a year.

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Appendix A: Questionnaire

Effect of *NAAIAP* Subsidy Program on the Usage of Fertilizers in Kakamega County, Western Kenya

Thank you for taking time to respond to this questionnaire. The data collected will be handled with utmost confidentiality and will only be used for academic purposes. The filled questionnaire will not be revealed or shared with any third parties other than for the academic purposes. You have the right to terminate this interview, or decline from responding to a question should you feel it is necessary.

Instructions

Please tick (✔) the box that matches your answer or fill the space provided

A: General Participant's Information

Date ……

1. Participant's id code ----------
2. Gender i. Male ( ) ii. Female ( )
3. Age in years i. 18-25 ( ) ii. 26-35 ( ) iii. 36-45 ( ) iv. 46-55 ( ) v. 55+ ( )
4. Subcounty……. Ward…….
5. Level of highest education
   i. Primary ( ) ii. Secondary ( ) iii. Middle-level college ( ) iv. University ( ) v. Other (Specify)……
6. Marital status
   i. Married but spouse is away ( ) ii. Divorced/separated ( )
   iii. Widow/widower ( ) iv. Single ( ) v. Other (specify) ( )
7. Number of children
   i. Males ( ) ii. Female ( ) iii. None ( )

8. What is your annual income (Ksh) ----------

9. What is your main source of income (Tick only one)

   i. Farming of crops ( ) ii. Rearing of livestock & poultry ( )

   iii. Off-farm business enterprise ( ) iv. Salary from regular job ( ) v. Other (specify) ( )

10. Number of family members working on the farm as primary source of income ----------

11. Number of family members working off-farm as primary source of income ----

12. How long have been farming maize crop (years) ----------

13. Besides maize, what other food crops do you grow on your farm?

   i. Beans ( ) ii. Cowpeas ( ) iii. Groundnuts ( ) iv. Soybeans ( ) v. Green grams ( ) vi. Potatoes ( ) vii. Cassava ( ) viii. Others (specify) ----------

B. General Information on credit access by farmers

1. Which of the following sources do you mainly get agricultural credit from?

i. Kilimo Biashara ( ) ii. Savings and credit organizations (SACCOs) ( ) iii. Normal bank loans at market interest rates ( ) iv other (specify) ( )

2. What are your main uses of the credit you get from the sources above (tick 3 choices and rank them according to priority of use)

Table 1.1: Farmers' main uses of agricultural credit

Main uses of credit	Rank 1 = greatest priority and 3 least priority
Buy fertilizers basal fertilizer (e.g. DAP)	
Buy top-dressing fertilizer (e.g. Urea, CAN	

etc.)	
Buy improved seeds of maize	
Buy improved seeds of other cereals other than maize	
Buy improved seeds of grain legumes	
Buy pesticides	
Buy farm tools and machinery	
Hire extra labour for farm activities	
Transport farm produce to better markets	
Other use (specify)	

3. Have you ever benefited from the NAAIAP subsidy program?

   i. Yes ( ) ii. No ( )

4. What other government policy has helped you to increase food production (tick all that apply)

   i. Input subsidy programs of before 1990 ( )

   ii. Millennium Development Goals ( )

   iii. Agricultural Sector Development Strategy Programme (ASDSP)

   iv. Others (specify) ----------

5. Please fill in the table below from the best of your knowledge:

Table 2.1: Participant's benefits from NAAIAP sub-programs

Type of NAAIAP subprogram	Benefited from any of the NAAIAP's sub-program? 1= Yes 2 = No	Length in years that you have benefited from any of the NAAIAP's subprograms	What was your main benefit from NAAIAP subprograms (fill only one choice from the code below the table)
1. Kilimo Plus			
2. Kilimo Biashara			

i. Got 10 kg free maize seeds ( ) ii. Got 50 kg of free DAP fertilizer ( ) iii. Got 50 kg of free CAN fertilizer ( ) iv. Got both 50 kg of free DAP & CAN fertilizer ( ) v. Got free extension information of best farming practices ( ) vi. Got full package (10 kg of free maize seeds, 50 kg of both CAN and DAP fertilizers and free extension services) vii. Did not benefit from NAAIAP's Kilimo Plus program ( ) viii. Other (specify)

4. When did you first access any of the NAAIAP's subprograms?

    i. Kilimo Plus (year) ----------

    ii. Kilimo Biashara (year) ----------

5. After getting the first startup package of fertilizer and improved seeds under Kilimo Plus, did you continue to use fertilizer? i. Yes ( ) ii. No ( )

6. If you continued to use fertilizer or improved seeds after the first package of Kilimo Plus what quantity are you using over and above the startup package? (Please fill in the table below from the best of your knowledge).

Table 2. 2. Trend of farmers' use of fertilizer and improved seeds.

Input received under NAAIAP's Kilimo Plus sub-program	Received farm input under NAAIAP's Kilimo Plus? *1. Yes 2. No*	Quantity used in year 2 (Kgs)	Quantity used in year 3 (Kgs)	Quantity used in year 4 (Kgs)	Quantity used in year 5 (Kgs)	Quantity used currently (Kgs)
1. DAP fertilizers						
2. CAN fertilizer						
3. Improved maize seeds						

C. Effect of NAAIAP on Fertilizer Usage Rates

1. In your opinion did the NAAIAP subsidy program help farmers in Kakamega County to increase the rate of fertilizer use?

   i. Yes ( ) ii. No ( ) iii. Not sure ( ) iv. I do not know ( )

2. In your opinion how did the NAAIAP subsidy program increase the rate of fertilizers usage by farmers in Kakamega County?

   i. It reduced cost of fertilizers ( ).

   ii. Expanded agrodealer network to rural areas hence reduced distance to access fertilizer ( ).

   iii. Caused agrodealers to timely stock for sale, the right type of fertilizers before the onset of the planting season ( ).

   iv. Extension agents created mass awareness for fertilizer use

   v. I do not know ( ).

3. In your opinion did the extension agents supported under NAAIAP increase your awareness on the usefulness of fertilizer use?

   ii. Yes ( ) ii. No ( ) iii. Not sure ( ) iv. I do not know ( )

4. In your own judgement how did NAAIAP's credit program affect the accessibility of fertilizers (tick where appropriate)? With the introduction of NAAIAP's credit program:

   i. Fertilizers became more accessible ( )

   ii. Fertilizers became less accessible ( )

   iii. Fertilizer accessibility was not affected ( )

   iv. Not sure of the effect of the program on fertilizer accessibility ( )

5. Please fill in the table below from the best of your knowledge

   Table 3.1. Effect of NAAIAP on fertilizer accessibility

Benefited from NAAIAP	Shortest distance travelled to access fertilizer before start of NAAIAP (km)	Shortest distance travelled to access fertilizer after start of NAAIAP (km)
1. Yes		
2. No		

6. In your own judgement how did NAAIAP's credit program affect the availability of fertilizers (tick where appropriate)? With the introduction of NAAIAP's credit program:

   i. Fertilizers became more available ( )

   ii. Fertilizers became less available ( )

   iii. Fertilizer availability was not affected ( )

iv. Not sure of the effect of the program on fertilizer availability ( )

7. Before launch of NAAIAP in 2007 how often did you miss to get your desired type of fertilizer from agro-input shops (tick where appropriate)

   i. Never missed ( ) ii. 1 to 2 times ( ) iii. 3 to 4 times ( ) iv. 5 to 6 times ( ) v. more than 6 times ( )

8. After launch of NAAIAP how often did you miss to get your desired type of fertilizer from agro-input shops (tick where appropriate)

   ii. Never missed ( ) ii. 1 to 2 times ( ) iii. 3 to 4 times ( ) iv. 5 to 6 times ( ) v. more than 6 times ( )

9. In your own judgement how did NAAIAP's credit program affect the affordability of fertilizers (tick where appropriate)? With the introduction of NAAIAP's credit program:

   i. Fertilizers became more affordable ( )

   ii. Fertilizers became less affordable ( )

   iii. Fertilizer affordability was not affected ( )

   iv. Not sure of the effect of the program on fertilizer affordability ( )

10. How affordable is fertilizer to you?

    i. Easily affordable ( ) ii. Fairly affordable ( ) iii. Not affordable at all ( ) iv Not sure ( )

11. What would be your preferred price of a 50 kg bag of DAP fertilizer for you to afford? Ksh. ----------

12. What would be your preferred price of a 50 kg bag of CAN fertilizer for you to afford? Ksh. ----------

D. Effect of NAAIAP on Credit Access by Farmers

1. Did Kilimo Plus sub-program of NAAIAP help you to graduate to Kilimo Biashara sub-program?

   i. Yes ( ) ii. No ( )

2. How did Kilimo Plus sub-program help you to graduate to Kilimo Biashara sub-program of NAAIAP

   i. Kilimo Plus helped me to open a bank account after getting income from the sale of surplus maize yield ( )

   ii. It helped me to join a farmer's organization that I used to open a bank account ( )

   iii. The free extension information made aware of the Kilimo Biashara loans ( )

   iv. It helped me to graduate to Kilimo Biashara in the following other way (specify----------)

   v. None of the ways ( )

3. Are you satisfied with the interest rates charged on the Kilimo Biashara loans?

   i. Yes ( ) ii. No ( )

4. What else can be done to improve farmers' access to Kilimo Biashara loans?

   i. Reduce existing interest rate

   ii. Expand Equity Bank network to the rural areas

   iii. Increase mass awareness of Kilimo Biashara loans

   iv. Other (specify) ----------

Part D: Relationship between rate of fertilizer usage and crop yields

Please fill in the table below the to the best of your knowledge

Table 4.1: Rates of fertilizer use and maize yield

Type of fertilizer used to increase food production	Whether the fertilizer type is used (1 = yes 2. No)	Size of land where crops are grown with the fertilizer (ha)	Amount of fertilizer applied on the farms (kg)	Number of days prior to rain season when fertilizer is bought	Yield of maize grain from the farm (tons) 1 ton= 1000 kg
DAP only					
CAN only					
Urea only					
Both DAP & CAN					
Both DAP & urea					
NPK blends					
Farm yard manure					
Compost manure					
Other					
None					

Please fill in the table below to the best of your knowledge

Table 4.12 Rates of fertilizer use and other crop yields

Type of food crop grown	Whether any of the food crops is grown 1 = yes, 2. No	Do you use fertilizer to grow any of the crops 1 = yes 2. No	Size of land under the crop (ha)	Amount of fertilizer (Kg)	Yield in tons, (1 ton= 1000 kg)
Rice					
Wheat					
Beans					
Cowpeas					
Soybeans					
Sorghum					
Millet					
Groundnuts					
Simsim					
Potatoes					
Other					

Part E: Effect of NAAIAP on food security and farmers' income

1. Has any of the two subprograms of NAAIAP (Kilimo Plus or Kilimo Biashara) helped you to improve your food security status?

   i. Yes ( ) ii. No ( ) iii. Did not benefit from NAAIAP

2. Has any of the two subprograms of NAAIAP (Kilimo Plus or Kilimo Biashara) helped you to improve your income levels?

   i. Yes ( ) ii. No ( ) iii. Did not benefit from NAAIAP ( )

Please fill in the table below to the best of your knowledge

Table 5.1: Effect of surplus food on income generation

Crop grown	Surplus yield for sale (tons)	Total income earned from sale of food surplus (Ksh)	Uses of income from sale of surplus crop yields
Maize			
Rice			
Wheat			
Cowpeas			
Soybean			
Sorghum			
Millet			
Groundnuts			
Simsim			
Potatoes			
Beans			

3. How has NAAIAP helped you to improve your household food security and income? Please answer by filling in the table below

Table 5.2: Effect of NAAIAP on food security and income

Effect of NAAIAP on food security	Before launch of NAAIAP in 2007 (previously)	After launch of NAAIAP (currently)

i. Number of hungry months in a year		
ii. Average farm income per year in Ksh		

Part F: Effect of maize promotion under NAAIAP on food crop diversification

1. In the best of your knowledge, did the provision of improved maize seeds only affect the diversity of crops grown by farmers in Kakamega County?

   i. Yes ( ) ii. No ( )

2. In what ways did the provision of improved maize seeds only affect the diversity of crops grown by farmers in Kakamega County?

   i. Farmers' were reluctant to borrow loans under Kilimo Biashara to invest in buying improved seeds of other crops

   ii. The output market for other crops was limited

   iii. The Kilimo Biashara loans were restricted to maize farmers only

   iv. Other (specify) ----------

3. Other relevant note

   ……

   ……