POTATO SUPPLY RESPONSE IN KENYA

A CASE STUDY OF KINANGOP DISTRICT

BY

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DECLARATION

This paper is my original work and has not been presented for a degree in any other university

MUIGAI WAINAINA **DATE**

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

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DR ODHIAMBO SULE **DATE**

…….. …….

DR MARY MBITHI **DATE**

DEDICATION

I wish to dedicate this paper to my departed parents Mr. and Mrs. Elijah Mwororo who invested heavily in my education but never lived to see much of my success

ACKNOWLEDGEMENT

First and foremost is to thank our dear heavenly father who granted me the gift of life, knowledge and ability to undertake my studies. I thank Him for the divine intervention throughout the course.

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ACRONYMS

ADC	Agricultural Development Corporation
AHM	Agriculture Household Model
ARIMA	Autoregressive integrated moving-average
CS	Certified Seed
ESP	Economic Stimulus Program
EU	European Union
FAO	Food for Agricultural Organization
FSS	Farmer Saved Seed
KARI	Kenya Agricultural Research Institute
MOA	Ministry of Agriculture
MVP	Marginal Value Product
OLS	Ordinary Least Square
USAID	United Sates Agency for International Development
VIF	Variance Inflation Factor

ABSTRACT

Potato is an important food crop in Kenya and the government policy objective is to increase its production in order to attain country's food self sufficiency and security. Potato production has been on a declining trend with consumption demand being way above domestic supply. The purpose of this study is to assess how responsive potato output is to variable input factors. The study used cross sectional farm level data for the 2011 and 2012 crop years obtained from ninety (90) potato farmers in Kinangop district in Kenya. The study employed Cobb Douglas production function and a profit function to estimate potato output response to variable inputs. Results show that crop farming (potato) was the major source of livelihood; potato production was negatively affected by high input cost, shortage in supply of input, disease, poor selling price, and decrease in market demand. Fertilizer, seeds quality and herbicides cost were factors that affected potato production. The fertilizer costs was the most significant factor, followed by credit access, seed quality and cost, herbicides costs and labour costs respectively. Based on the findings, the study recommends that the government improve the road network in the region to facilitate the marketing of potatoes, decentralise government subsidized fertiliser to enable farmers access the product easily, subsidize certified seed cost to farmers, and the government and other financial institutions should offer credit facilities to the potato farmers.

CHAPTER ONE

1.0 INTRODUCTION AND BACKGROUND OF THE STUDY

1.1.1 Background

Potato is an important food crop which is grown in over 100 countries worldwide**.** The United Nations FAO reported that the world production of potatoes in 2010 was about 324 million tones. Over two thirds of the global production is eaten directly by humans with the rest being fed to animals or used to produce starch. It remains an essential crop in Europe (especially eastern and central Europe), where per capita production is still the highest in the world, but the most rapid expansion over the past few decades has occurred in southern and eastern Asia. China is now the world's largest potato-producing country, and nearly a third of the world's potatoes are harvested in China and India. The geographic shift of potato production has been away from wealthier countries toward lower-income areas of the world, although the degree of this trend is ambiguous.

In 2008, several international organizations highlighted the potato's role in world food production, in the face of developing economic problems. They cited its potential derived from its status as a cheap and plentiful crop that grows in a wide variety of climates and locales. Due to perishability, only about 5% of the world's potato crop is traded internationally. Potatoes minimal presence in world financial markets contributed to its stable pricing during the 2007–2008 world food price crisis. Thus, the United Nations officially declared 2008 as the International Year of the Potato, to raise its profile in developing nations, calling the crop a "hidden treasure". The table below shows world potato production from various countries.

Figure 1.1 Potato Production by Countries

The world dedicated 18.6 million hectares in 2010 for potato cultivation. The average world farm yield for potato was 17.4 tonnes per hectare, in 2010. Potato farms in the United States were the most productive in 2010, with a nationwide average of 44.3 tonnes per hectare. United Kingdom was a close second. New Zealand farmers have demonstrated some of the best commercial yields in the world, ranging between 60 to 80 tonnes per hectare, some reporting yields of 88 tonnes potatoes per hectare.

There is a big gap among various countries between high and low yields, even with the same variety of potato. Average potato yields in developed economies ranges between 38–44 tonnes per hectare. The two largest producers of potato, China and India which accounted for over a third of world's production in 2010, had yields of 14.7 and 19.9 tonnes per hectare respectively. The yield gap between farms in developing economies and developed economies represents an opportunity loss of over 400 million tonnes of potato, or an amount greater than 2010 world potato production. Potato crop yields are determined by factors such as the crop breed, seed age and quality, crop management practices and the plant environment. Improvements

in one or more of these yield determinants, and a closure of the yield gap, can be a major boost to food supply and farmer incomes in the developing world.

According to FAO (2008), potato is consumed by more than one billion people in the world. Potato is ranked fourth in terms of the largest food crop, the first three being wheat, rice and maize. In Kenya, it is ranked second in importance after maize (Ministry of Agriculture, 2007). The crop is one of the most important sources of income and employment in the rural areas (Olanya et al., 2006). The potato's high energy content and ease of production have also made it an important component of urban agriculture which provides jobs and food security to some 800 million people globally (Hoffler and Ochieng, 2008). Due to the ever escalating prices of staple foods in developing countries Kenya included, people in their hundreds of millions are facing food crisis. Rice prices have almost doubled during the year 2008, as wheat prices are climbing rapidly while maize prices are skyrocketing. Most often at harvesting, there is glut of supply and farmer's income is reduced ostensibly due to low prices offered in the market. Poor potato prices are a result of farmer's inability to put up storage facilities forcing them to dispose them off at throw away prices. Market cartels on the other hand are a big blow to farmers since they dictate the commodity prices (Wang'ombe, 2008). In agricultural producing areas, there exist dilapidated road infrastructures which increase the transportation costs while inadequate market information to the farmers contributes to exploitation by potato traders. These factors combined have curtailed production which has lagged behind while demand has been on the upward trend.

Low fertilizer use has contributed significantly to the low productivity. In the year 2007 to 2009, the increase in global fertilizer prices has also been attributed to the high global energy prices and adoption of biofuels production in the United States, where large corn plantations for ethanol and Jatropha plantations for biodiesel have been established leading to high fertilizer demands. In the United States of America and other first world countries, farmers apply high levels of fertilizer to maximize corn harvests. Lack of clean certified seed owing to their high costs forces farmers to use local seeds or retained hybrid crop thus reducing yields since they are not cleaned

from seed contaminants. Potato seeds used for production face many challenges. They do not withstand adverse weathers such as frost and heavy rains which leave the plants submerged for a period. To eliminate the effects of frost, farmers invest in expensive sprays which do not totally shield the plants against the effects of frost. Various government supported research and development activities have been undertaken in an effort to improve smallholder resource productivity. For example, efforts towards development of the potato industry in Kenya have focused on the development and dissemination of high yielding varieties (Ministry of Agriculture, 2007). Over the years and despite the efforts directed at improving potato production, low resource productivity still remains a major challenge in the subsector – the average national farm level yields of 7.3 tons per hectare is very low compared to a potential of 14.5 - 20 tons per hectare under farm level conditions and those from research stations of 25 - 35 tons per hectare (Kenya Agricultural Research Institute, 2005). This is a clear indication that technological advances emanating from various research have not yet resulted into increased efficiency and resource productivity. The main farm inputs required in potato production include the seeds, fertilizer, pesticides, herbicides and labor. Potato seeds are produced in two forms-Certified (CS) and Farmer Saved Seeds (FSS).the farmers saved seeds or uncertified seeds are obtained from neighboring farms and in local markets which are then used for planting. Farmers normally select Small potatoes since they are more difficult to market and it is also easier to transport and store them on the farm.

Micronutrients

A raw potato tuber is rich in micronutrients the vitamins and minerals that are essential to health. A medium-size potato contains high levels of potassium and nearly half the daily adult requirement of vitamin C. It is also a good source of B vitamins, and minerals such as phosphorus and magnesium. These micronutrients are as described in the table below.

Table 1.1 Content of a raw potato weighing 213 grams including its skin.

Minerals	Vitamins
Potassium 897 mg	Vitamin C 42 mg
Phosphorus 121 mg	Niacin 2.2 mg
Magnesium 49 mg	Vitamin B6 0.62 mg
Iron 1.66 mg	Thiamine 0.17 mg

Source: United States National Nutrient Database

Uses of potato

Once harvested, potatoes are used for a variety of purposes, and not only as a vegetable for cooking at home. In fact, it is likely that less than 50 percent of potatoes grown worldwide are consumed fresh. The rest are processed into potato food products and food ingredients, fed to cattle, pigs and chickens, processed into starch for industry, and re-used as seed tubers for growing the next season's potato crop. FAO estimates that just over two-thirds of the 320 million tonnes of potatoes produced in 2005 were consumed by people as food, in one form or another. Home-grown or purchased in markets, fresh potatoes are baked, boiled or fried and used in an astonishing range of recipes: mashed potatoes, potato pancakes, potato dumplings, twice-baked potatoes, potato soup and potato salad. Potato starch is also widely used by the pharmaceutical, textile, wood and paper industries as an adhesive, binder, texture agent and filler, and by oil drilling firms to wash boreholes. Potato starch is a 100% biodegradable substitute for polystyrene and other plastics and used, for example, in disposable plates, dishes and knives. Potato peel and other "zero value" wastes from potato processing are rich in starch that can be liquefied and fermented to produce fuel-grade ethanol. One of the first widespread uses of the potato in Europe was as farm animal feed. Cattle can be fed up to 20 kg of raw potatoes a day, while pigs fatten quickly on a daily diet of 6 kg of boiled potatoes. Chopped up and added to silage, the tubers cook in the heat of fermentation. Potatoes are the world's most popular vegetable, and have been welcomed into the cuisines of countries around the globe. While the choice of tubers is more limited elsewhere, modern varieties offer a wide range of cooking characteristics suitable for hundreds of different dishes. Some give soups a creamy density, providing a delicate taste that highlights other

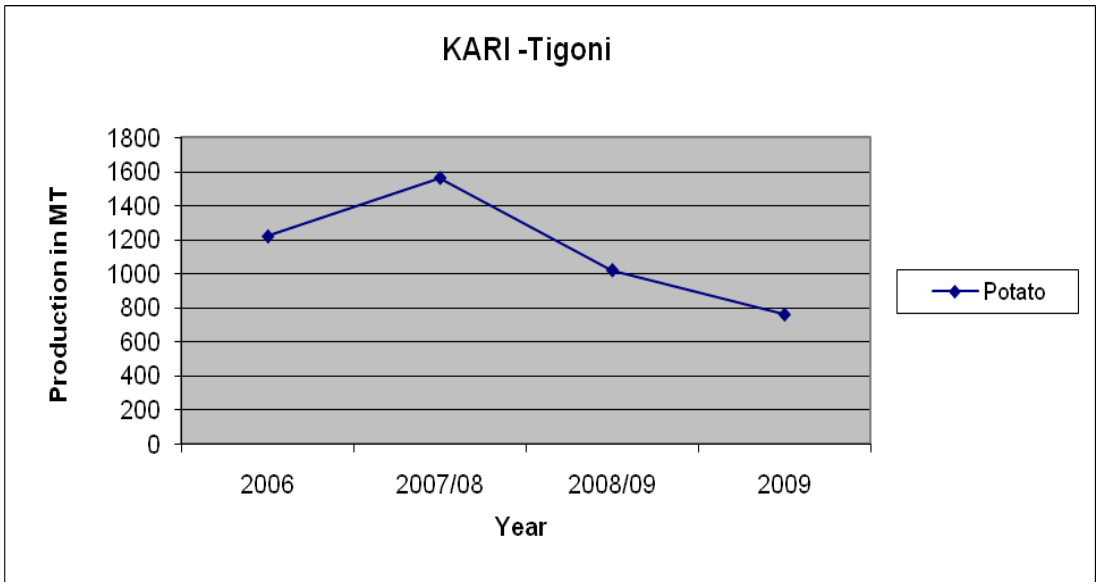
ingredients. Other potatoes are great when baked, served as a simple snack or with a filling as a complete meal. Most potato recipes are easy to prepare. But choosing the right potato variety is essential for a successful potato dish – in the kitchen; potatoes are classified according to their starch content, which determines how they react to cooking. Basically, the more starch they contain, the more easily the tuber's starch cells burst when heated.

1.1.2 Potato Seeds

Production of potato seed in Kenya is undertaken at the National Potato Research Station situated at KARI- Tigoni and its substations. This basic seed is afterwards bulked through three generations at farms that are operated or subcontracted by the Agricultural Development Corporation (ADC) while others are bulked by the farmers. Many farmers do not purchase these certified seeds due to their high costs but ends up using the uncertified ones.

The figure below shows the seed production trends over four year period

Figure 2.2 Trend of potato seed production



The chart above that shows a declining trend in potato seed production over the past years'. Data from KARI indicates that the seed yield potential varies from one variety

to another with an average of about 15 tubers per seed or 1500 tubers per 50 kg bag of about 1000 tubers. According to KARI-Tigoni, 1217 tons of seed were propagated in 2006 rising to 1559 tons in 2008. This is equivalent to about to 4% of the national potato seed demand. Currently, therefore, the supply of certified potato seeds is not commensurate with farmers demand. In response to this gap, KARI in collaboration with USAID-EU is implementing a mini seed production program using hydroponics technology as measure to increase potato seed production. Certified Potato seed is sold to farmers at ksh 2,200 per 50Kg bag which they consider to be high.

1.1.3 Study Area: Kinangop District

Potato farming in Kenya is practiced in many areas like Meru, Embu, and Kirinyaga on the slopes of mount Kenya, Nakuru, Molo and Kericho on the Mau range, several highland areas in Nyanza and western regions including Nandi, Uasin Gishu, Kakamega, Kisii and Trans Nzoia, Nyeri, Muran'ga, Kiambu and Nyandarua on both sides of the aberdare range. Kinangop district falls in this latter category of Nyandarua as it is one of the seven districts forming Nyandarua County. All these districts could have been taken as study areas but Kinangop was chosen as a representative because of the researcher's experience of the prevailing potato farming practices in the district.

1.1.4 Size and Location

The geographical coordinates of Kinangop district are 0° 43' south and 36° 39' 0° East. The district borders Nyandarua South district to the North, Nyeri and Murang`a to the East, Kiambu to the South and Nakuru District to the West. The District has a total area of 349.2 square kilometers and a population of 104,982 persons (Kenya national housing and population census 2009). This translates to an average population density of 301 persons per square kilometer. The settlement patterns in the district have historical origin from colonial times. The pattern is dichotomous in nature i.e. urban and rural with differences in both economic and spatial characteristics.

There are a total of fifteen trading centers in the district with a sizable number of residents. These urban settlements mainly engage in agro economic activities as well

as commerce, industry and services. The district receives rainfall throughout the year with long rains setting in from March to June and short rains from September to December. This high level of precipitation leads to wet conditions conducive for potato production.

1.1.5 Major Agricultural Activities

Farming is the main agricultural activity in the area with the farmers growing, Irish potatoes, cabbages, carrots, garden peas, spinach, kales, sweet potatoes oat, grain amaranth, beans, garden peas, lima beans, among others. A good number of farmers practice livestock farming rearing dairy cattle, beef cattle, dairy goats, sheep for meet (mutton) plus wool, fish farming, bee keeping and poultry. Fish farming has been introduced recently through the economic stimulus programme (ESP) where farmers established fish ponds and introduced fingerlings. Fish survival has been handicapped by the low temperatures in the area though the ministry of fisheries is putting in every effort to avail the correct species that would survive in the extreme temperatures. Value addition is being practiced through farmer's cooperative societies, marketing of milk and artificial insemination. Brookside and Tuzo are some of the milk processors buying milk from the area.

1.2 Problem Statement

The population of Kenya stood at 39 million people according to the Kenya national bureau of statistics population census of 2009 with the rate of population growth being 1 million people per year. This means the population will double in the next 39 years and the same will total 60 million by 2030, the time the country will be achieving its long term blue print of vision 2030.At this time, the urban dwellers will have doubled partly due to the rural urban migration in search of employment. Kenya's potato production meets only 50% of national potato requirement as shown in the table below. The demand for processed potato is likely to increase due to increased urbanization, preference for fast foods, rising per capita income and increased demand for convenience food.

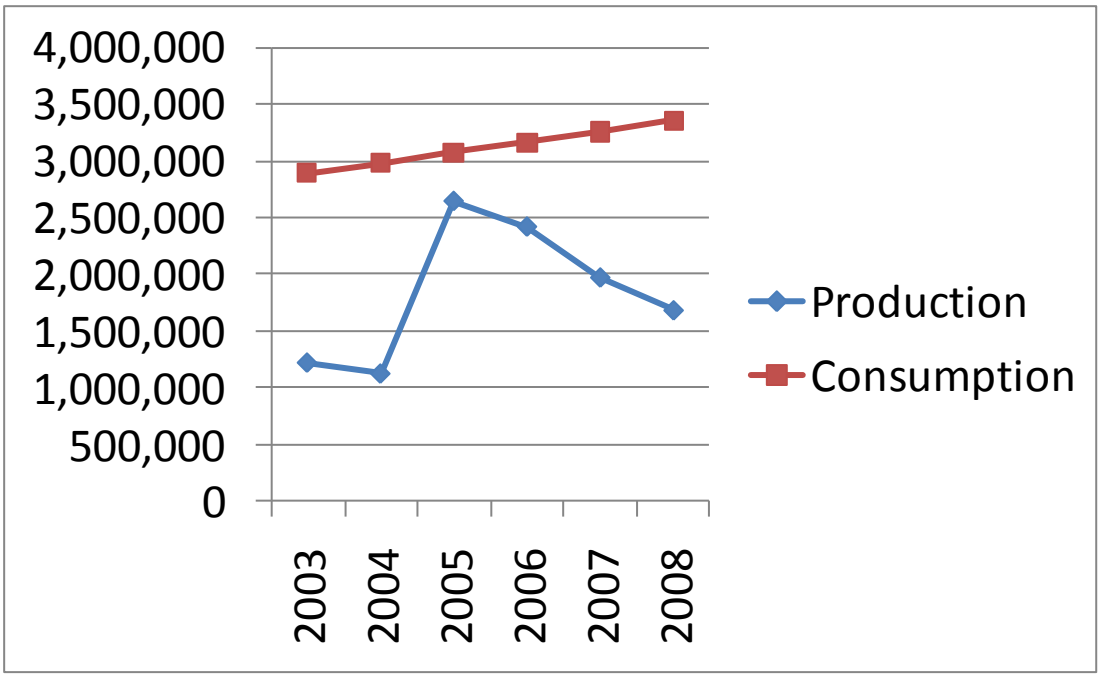
The table below indicates the production and consumption trends of potatoes from the year 2003 up to 2008.

Table 2.2 Production and consumption trends of potatoes from 2003 up to 2008

Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Area(Ha)	126,490	128,484	132,030	120,754	98,401	139,974
Prod(Tons)	1,220,629	1,124,235	2,640,600	2,415,080	1,968,020	1,679,688
Consumption estimates (Tons)	2,892,300	2,981,780	3,074,000	3,166,220	3,261,200	3,359,000

Source: MOA; Economic Review of Agriculture 2008 & KIPPRA; Kenya Agric. Sector Data Compendium.

From the table above, the average production for the six years is 1.8 million tons whereas latest consumption estimate is 3.4 million tons leading to a deficit of almost 50%. Projection of these figures will result in consumption estimates of 6.4 million tons by the year 2030. This means the country will increasingly rely on potato imports to meet domestic demand. If the country is to be self sufficient by 2030, domestic production has to grow at a sustainable rate of 7% annually. Thus, increased productivity is the only viable option to enhance production (Ogola et al., 2002).



In Kenya potato plays a major role in national food and nutritional security (Maina and Chui, 1999). Furthermore, the crop is an important food and cash crop in the medium and high rainfall areas (Kiiya et al., 2006). Its domestic production in Kenya is very low despite its nutritional importance and cash income importance. The existing demand outweighs the local supply and hence imports are used to fill the gaps (MOA 2007). Kenya like other developing countries faces a persistent fiscal deficit and a weak balance of payment.

Foreign exchange therefore is highly valued and so should be used only in importation of capital goods that the country lacks, rather than agricultural commodities which can cheaply and competitively be produced within the country.

While average potato yields in North America and Western Europe often reach 40 tons per hectare, yields in developing countries are usually below 20 tons per hectare. The national average potato yields for Kenya has been reported at 7.7 tons per hectare, but this figure has fluctuated considerably over recent years, from over 9.5 tons per hectare to around 7.5 tons per hectare (FAO, 2008). The low yields have been attributed to poor agronomic practices, low use of inputs especially fertilizers, poor and deteriorating prices, and lack of markets.

All the above factors have made farmer's investments to realize net losses from potatoes, an activity that should be productive and profit making at the same time guaranteeing food security for the country. It is in this context that this study has been designed to look at how the factors above affect the overall potato production and offer policy recommendation on how the government should assist farmers in the production activity to increase production in the country.

1.3 Objective of the Study

The overall objective of this study is to assess factors affecting potato productivity in Kenya. Specific objectives include:

i. To examine the economic factors influencing levels of potato production in Kenya.

ii. To examine significance of input prices on profitability of potato production in Kenya.

iii. Drawing conclusions and making policy recommendations which will encourage increased potato production in Kenya.

This study aims to answer the following questions:

i. What are the major factors influencing the levels of potato production and yield?

ii. What is the importance of input prices in potato production?

iii. What are the major problems faced by farmers in the course of potato production?

1.4 Significance of the study

Kenya is a potentially conducive country for potato production due to its favorable weather conditions and the good strategic location. The country on the other hand is endowed with arable land that can be optimally utilized in potato cultivation for

positive returns though the current area cropped with potato is small and the yield very low. The government has continually put up efforts geared towards improving productivity but the results have not been satisfying. Various factors that have in the past led to this dismal performance include poor managerial and entrepreneurial skills, inadequate technical skills, weak institutional framework, weak communication channels such as dilapidated and undeveloped infrastructures and imperfect markets.

Expected positive outcomes could only be achieved if proper channels are put in place and analysis undertaken from the grass root which comprises the individual farmer and his individual farm. It is this individual farmer who determines the agricultural outcomes of the entire country.

The farmer's choice in land allocation, selection of farm inputs, the farming methods, technology and crop mixes determines to a great extent the aggregated country's potato output. The individual results achieved by the individual farmer could be used to replicate the outcome to location levels, regional levels and sectoral performance and even to the national level (Gabre-Madhin and Haggblade, 2003). The study will be useful in assessing the area, production and productivity of potato and analyze potato production from the smallest production unit of an individual farm with the objective of identifying major constraints contributing to low level of potato yield and come up with possible recommendations that could be used to improve potato production. The results of the study will be useful for policy makers, researchers, farmers and input agencies involved in promotion of potato cultivation in formulation policies and strategies to boost the production of potato.

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter presents a review of some of the studies that have in the past been undertaken on agricultural output by examining the research area, reasons for the study, the methods used and results of the studies.

2.1 Theoretical Literature Review

The work of Robert Solow (1957) paved way for studies on agricultural output growth in response to price and non price factors. The model relates growth in a model economy to productivity through a production function and a process for technology growth. Robert Solow model opened the way for studies on agricultural output response to price and non price factors with majority of these studies focusing on technology and efficiency.

Robert Solow attributed growth of output to growth of inputs and technical change by distinguishing movements along a production function frontier from shifts in the frontier. The studies are paramount to agricultural responses analysis since price and non price factors are avenues through which policies affect agricultural variables such as output supply and input demand, all geared towards increasing efficiency in agricultural production. Harbans and Sharma (2006) studied the economics of potato production based upon primary survey of 50 growers selected randomly from lahaul valley during 2001-2002. This crop was found to be the most capital and labour intensive due to substantial cost incurred on seed, fertilizer and human labour.

Out of the total cost of 74,461 rupees the human labour alone accounted for around 30 per cent followed by seeds at 18 percent. The analysis showed that there is a lot of scope for increasing the profit from potato crop by rationalizing the use of human labour, manures and fertilizers. Singh and Mathur (1994) assessed instability in potato production in India by using coefficient of variation. They found out that the area and production were unstable because of the response of potato production to prices of competing crops and the adoption of modern technology, respectively.

Arun Pandit *et al.* (2003) studied on potato marketing in India by way of surveying potato producers in India. The study revealed that the Indian marketing system suffers from high marketing cost, high middleman's margin, low producers share and inadequate marketing infrastructure. Their solutions were, grading should be followed rigorously; marketing cost could be reduced by establishing cold stores in producing areas. Regulation of potato market could be done by establishment of more processing units.

Owuor (1999) used the partial factor productivity measure defined simply as the ratio of physical output to factor inputs to analyze productivity among some 1540 households derived from a rural household survey by Tegemeo institute in 1997. Data was clustered into different agro-ecological zones spread in eight provinces and 24 districts in Kenya. The study used two indices of partial productivity i.e. land and family labour. The two indices were hypothesized to depend on the degree of commercialization and crop mix and the intensity of use of fertilizer among other variables. The study demonstrated that a positive and significant statistical relationship exists between fertilizer use and productivity.

In the study ''A review of constraints to Irish wares production in Kenya'' by Muthoni and Nyamongo (2009), they found out that low soil fertility, lack of quality seeds and attacks by pests and diseases were the main factors that limit Irish potato production in Kenya. The study also revealed that access to certified seed is limited by lack of appropriate supply channels and high per unit cost. This led to self supply and neighbor supply being the main sources of potato seed in the country. In addition, high costs of inputs such as fertilizers and fungicides led to their suboptimal application resulting in low yields. Production of potatoes being largely rain-fed resulted to seasonal fluctuations in supply of potatoes. This, coupled with limited on-farm storage facilities, results in low prices during the peak production periods and hence low returns to farmers. Furthermore, marketing channels of the produce were controlled by cartels and brokers leaving farmers with minimal opportunity to negotiate for prices. Poor road infrastructure and disregard to standards such as weight per bag and produce quality tend to worsen the situation. The two

recommended the urgent need for the government to enforce the existing regulatory measures such as weight standards to save the farmers from exploitation by the market cartels, improvement of the road network, the government should assist farmers to organize themselves into cooperatives that will assist in selling their produce protecting farmers from exploitation by brokers and building the capacity of farmers to produce certified potato seed.

Olujenyo (2005) studied the determinants of agricultural production and profitability with special reference to maize production in Akoko north east and south west local government areas of Ondo-state. Using structured questionnaires administered on 100 respondents selected through random sampling technique and using production function analysis and ordinary least square criterion to estimate the parameters of the production function. Results showed that age, education, labour and cost of non labour inputs were positively related to output while farm size and years of experience were negatively related to output, only labour input had significant influence on outputs. Walingo et al (1997) did an analysis on the requirements of potato processing in terms of their preferred varieties, the availability and price of raw materials, pre-processing storage practices and constraint facing the industry. They used a two-stage sampling procedure for potato chips preparation survey. They found out that potato processing will always be an alternative to fresh consumption since the perishability and bulkiness of potato increases marketing costs and consumer prices. In developing country like Kenya, this could be true only if the production increase stays ahead of the population growth. They also found a declining trend in potato exports from the country since most of the potatoes was consumed locally. They advocated for intensification of potato production through irrigation and appropriate rustic storage at the factory level which would reduce the manufacturer's necessity to pay high costs during periods of short potato supply.

2.2 Empirical Literature Review

A review of the empirical research work done earlier pertaining to the present study on production has been presented below. These are text written by researchers considering critical points of current knowledge including substantive findings and

methodological contributions to the production areas. It indicates what these researchers did, the methodologies applied and their findings. Narayana and Shah (1984) estimated the expected prices and yields using ARIMA to estimate Nerlovian response functions for large and small farms in Kenya. They found out that expected yield levels rather than expected output prices affected the supply response of small farms, whereas large farms reacted more to output prices.

Durr and Lorenzl (1980) undertook a study on deficiency in potato industry in six areas namely Molo, Ol Kalou, Kiambu, Nyeri, Murang'a and Meru. They found out that production costs of potatoes in Kenya could be reduced by selection of larger tubers from healthy plants as planting material, proper seed treatment, effective weed control, improved soil fertility and control of pests and diseases (e g, nematodes and bacterial wilt). The study also found out that effects of pests and diseases could be reduced through adequate crop rotation. They argued out that if such measures were not effective, farmers would end up using lots of finances in potato production and since capital would still be scarce they would produce potatoes mainly for food. Capital intensive production methods could be introduced but only if the new inputs were subsidized and provided at low, or no cost. The survey further revealed that in most areas in Kenya, potatoes are produced in a bimodal seasonal pattern, with six months between harvests.

The producer survey further indicated that on many farms potato consumption was determined by the condition, or rather the deterioration, of the crop in store. The aim was to adjust consumption to minimize storage losses. Therefore, most farmers consume their own potatoes within a period of about three months, and after that they purchase potatoes for home consumption. Improved storage of ware potatoes could help ensure a continuous supply of potatoes throughout the year. Abrar, Morrisey and Rayner (2004) did a study on the responsiveness of peasant farmers to price and non-price factors in Ethiopia using quadratic production function and data at the farm level. They found out that own price output elasticity was very low and output supply was not responsive to fertilizer price or wage rate. Non price factors were far more important in affecting production and resource use than price incentives. They

compared the use of primal and dual approaches to estimating elasticities and concluded that both approaches gave the same results.

Evensen and Mwambu (1998) analyzed the effects of agricultural extensions on farmers' productivity. They estimated a Cobb Douglas production function in which productivity was defined as farm yield as a function of the area cropped, labour resources, fertilizer and sprays per acre, extension and other social economic and ecological attributes. The function was established using quartile regression technique controlling for the effects covariates of extensions. Morrissey and Rayner (2004) by using a quadratic function studied on the responsiveness of peasant farmers to price and non price factors in Ethiopia using farm level data and found out that own price output supply elasticity was very low and output supply was not responsive to fertilizer prices or wage rate. Non-price factors were far more important in affecting production and resource use than price incentives. The study compared the use of primal and dual approaches to estimating elasticities and concluded that both approaches give the same results.

Daniel et al (2010) conducted a survey in Nyandarua North District, one of the major Irish potato growing districts in Kenya On the technical efficiency in resource use with data being obtained from 127 Irish potato producers using a two - stage sampling technique. Data was collected on output levels including input use, and socio-economic and institutional variables and potato output comprising of quantities sold and those retained for consumption and as seeds. A parametric stochastic efficiency decomposition approach to measure the technical efficiency in Irish potato production was used. The stochastic frontier production function model was specified as follows:

Yi f (Xi;β) εi (1) Where Yi measures the quantity of output; Xi is a vector of the input quantities; β is a vector of parameters to be estimated; f (Xi;β) is a frontier production function; and εi, is a composite error term. Following Aigner et al. (1977), the composite TEi XitPi/ XiPi .To determine the relationship between socio-economic and institutional factors and the computed indices of technical efficiency, a second step analysis (Binam et al., 2003; Bravo-Ureta and Pinheiro, 1997) was performed where a two-limit Tobit equation was estimated. The results show that farmers with

more years of formal schooling were more efficient than their counterparts. Access to extension variable had a positive significant coefficient in relation to technical efficiency, implying that technical efficiency increases with the number of visits made to the farm household by extension workers. Further results show that there was a positive and statistically significant effect of credit use on technical efficiency at 1% level, implying that increasing credit use would enhance technical efficiency of sample farms.

Sidhu and Baanate (1981) used translog Cobb Douglas function to farm level data from Punjab, India to analyze supply response of wheat. They compared the translog and Cobb Douglas production function and concluded that the flexibility afforded by translog formulation permitted measurement of different impacts that exogenous variables have within and across input demand and output supply functions. The study found that expansion in farm capital in the form of implements and machinery decreased significantly the demand for animal power, contributed positively to wheat supply, but did not significantly influence labour and fertilizer demand.

De Groote et al (2005) analyzed factors influencing maize production in Kenya using a linear model with yields (kg/ha) as the dependent variable. The use of improved maize variety (binary) and intensity of fertilizer use were included as explanatory variables. The study found out that of the two technologies, only fertilizer had a significant impact on yields, while using improved varieties did not improve yield. The study however failed to consider other factors such as costs of inputs and the impact of such on maize production.

Ogola et al (2002) estimated the farmers' demand for fertilizer in the production of potatoes, by analyzing the structure, conduct and performance of the fertilizer market in Nakuru district, Kenya. They selected and interviewed 250 farmers and 36 fertilizer traders between February and April 2001using systematic and simple random sampling procedures, respectively. Two models (the Structure-Conduct- Performance Model, and the potato Input Demand Analysis model) were used to assess fertilizer use in potato production in Nakuru district, Kenya. The results indicated that it was mainly the producer price that affected the fertilizer demands. The fertilizer prices

were generally high and were mainly influenced by the relatively low usage of fertilizer in potato production. The study also revealed that there was formal marketing and distribution channel for fertilizer and that fertilizer trade depicted oligopolistic tendencies. In analyzing the impact of market access on agricultural productivity, Odhiambo(1998) specified and estimated a system of equation in which productivity , defined simply as the value of output per unit of land was a function of resources used(land , labour input material(fertilizer, pesticides, herbicides, high yielding variety seeds) , credit and market access (defined in terms of time taken to the market). The input use variables were in turn specified as endogenous variables in recognition of their simultaneity with productivity. A three stage least square estimation technique using farm level data collected from 226 households in Meru and Machakos districts was then applied.

Ng'ong'ola and Mangisoni(1994) in central Malawi used a Cobb Douglas production function to explain variations in barley tobacco yield among tenants. Their results demonstrated that area under barley tobacco and quality of fertilizer applied were the main factors determining tobacco yield. The study however failed to look into costs of inputs which are important factors influencing production. Kipkoech et al (2007) determined the technical efficiency levels among potato smallholder in Kenya given their production technologies. A study to determine the technical efficiency among small holder farmers in Kiambu, Nakuru and Nyandarua districts of Kenya was carried out. A total of 211 randomly sampled potato growing households were surveyed. The Cobb-Douglas stochastic production function was used to measure the technical efficiency. The potato production efficiency varied widely among farmers, with Nakuru varying from 11- 83%, Nyandarua 16-89% and Kiambu 17-88% and averages of 72% for Nakuru and 44% for Nyandarua and Kiambu. This implied that given the level of technology and inputs, the output could be increased by 28% to 56% through better use of available resources thus farmers should be trained to enhance their capacity to efficiently use the available resources.

2.3 Literature review overview

The studies on potato production in Kenya have not been comprehensive. From the literature review, there is a general consensus that the level of farm input application, use of certified seeds and farmer's training influence agricultural productivity and profitability. High fertilizer application leads to high productivity of potato production. The study by Durr and Lorenz (1980) showed that production costs of potatoes in Kenya could be reduced by selection of larger tubers from healthy plants as planting material, proper seed treatment, effective weed control, improved soil fertility and control of pests and diseases. Muthoni and Nyamongo (2009) found out that production was hampered by low soil fertility, lack of quality seeds and attacks by pests and diseases. Daniel et al (2010) concluded that farmer's education and access to extension services had an upper hand in potato production. Kipkoech et al (2007) found out farmers training was needed to enhance their capacity to efficiently use the available resources.

The studies above were not comprehensive enough since they omitted important factors like input prices, amounts of rainfall and frost effects that greatly affect the level of productivity. This study will attempt to incorporate these important factors and looking at both prices and non price factors that influence the level of potato production in Kenya.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Theoretical framework

The theoretical concept used in this study is described as follows:

Production Function

Farmers and any other producer is faced with the challenge of choosing what to produce, the quantity to be produced and the method to be applied in production. The farmer therefore needs to make a decision on the type of product combination he want to obtain plus identifying the optimal combinations of the factors of production as well as the input mix for the final output. A production function describes the technical relationship that exists between inputs and outputs and the maximum outcome emanating from a given set of inputs. The relation that exists between the inputs and outputs is described as:

Y=f(Xi) which relates the output Y to various inputs x,i= 1,2,3…..n

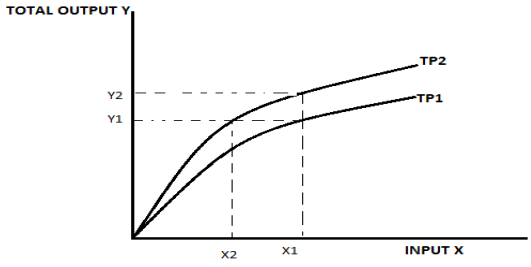
The best established production function taking this form is the Cobb Douglass production function which is written as:

Q=$AK^{\alpha}L^{\beta}$ where Q denotes the output, A is a constant while K and L are combinations of inputs used to produce Q.

The production function refers to a given level of technology such that if the level of technology changes, the production functions will also change.

The technical relationship between inputs and outputs is described by a production function while the technical relationship between one input (all other inputs held constant) and the output is represented by a total product curve as shown in the figure below.

Figure 2.1 Technological change and total product curve



The total product curve TP shown above is for a given level of fixed inputs and a given state of technology such that the relation of one single variable input factor X and output Y can be derived. When technology is not introduced, the variable input factor at the level X1 gives a corresponding output Y1. When technology is introduced, the production function changes as shown in the shift from TP1 to TP2.

Using the same level of input X1, as without the new technology increases the output level from Y1 to Y2 or producing the same level of output Y1 decreases the required level of the variable input factor from X1 to X2, hence the production process gains a higher productivity because the new technology allows for substitution of the input factor X.

The production function in this study intends to reveal the relationship between the inputs and outputs. In this study, Output (Q) is a function of input factors namely land, labour and capital. The production function in the potato study is expressed as:

$Q=f(x_1,x_2,x_3,x_4\ldots\ldots x_n)$

Where Q is the potato output and x_1, x_2, x_3,….x_n are inputs used to produce the output. In this study, the inputs are fertilizers, herbicides, labour, rainfall and seeds.

The study used farm level data for the years 2011-2012 for medium scale farmers in Kinangop district in Kenya. The study employed a linear production function estimated using a linear estimation technique, the ordinary least square method, to

measure how output (potato output) is influenced by factors of production such as input costs.

This study will among other things do the following:

i. Examine the methods of production used by the potato farmers in Kinangop district.

ii. Discover the various types of variables and fixed inputs used by the farmers.

3.2 Empirical Model

The main objective of this paper is to identify the most important factors influencing potato production and yield. For this objective to be addressed, an econometric model based on OLS regression will be developed to analyze the data gathered in the field.

The study will employ a linear production function. This will be estimated using a linear estimation technique, the ordinary least square (OLS) to measure how output is influenced by factors of production such as costs of fertilizers, seeds, labour, machinery, access to market, and rainfall availability among others. Statistical tests will be used for tests for the statistical significance of the variables.

A Cobb Douglas production function is specified as:

Q=$AK^{\alpha}L^{\beta}$, where Q is output and K and L are measures of capital and labour respectively, A is the autonomous variable.

The production function in this paper would be specified as follows:

$$Qt = f\ (F^{b1}, S^{b2}, L^{b3}, H^{b4}, C^{b5}, Sq^{b6}, R^{b7})$$

Q is the quantity of output; F is the fertilizer cost; S is the seed cost; L is the labour cost; H is herbicides costs; C is access to credit (dummy); Sq is seed quality (dummy); R is the amount of Rainfall.

However, estimation of the above function may result in residuals that violate the assumption of normality of the error terms. This is a simplifying assumption of the classical normal linear regression model and must be satisfied for the method of ordinary least square to be the best linear unbiased estimator. To ensure normality of the residuals, the estimation equation used in this study is expressed in logarithmic form to ensure that the errors are both homoscedastic and normally distributed.

The production function is therefore specified in log linear form as follows:

LnQ= b0+b1lnF+b2lnS+b3lnL+b4lnH+b5lnC+b6lnSq+b7lnR+μt

Where, b0 is an autonomous variable

F is fertilizer (measured in terms kilograms of fertilizer applied per acre of potatoes)

S is seeds (also measured in kilograms of seeds planted per acre)

L is labour (measured in amounts of money paid for labour per acre)

H is herbicides costs (measured in terms of monetary costs incurred per acre)

C is access to credit facilities (dummy) (those with access to credit will be given a score of 1 while those with no access will have a score of 0)

Sq is the seed quality (dummy) (those with access to quality seeds will be given a score of 1 while those with no access will have a score of 0

R is the amount of Rainfall (measured in millimeters of rainfall received per planting season)

μt is the error term

The profitability function on the other hand will be specified in log linear form as follows:

LnP= b0+b1lnF+b2lnS+b3lnL+b4lnH+b5lnM+μt

Where, b0 is an autonomous variable

P is the profitability per acre of potatoes or the amount of profits the farmer receives per acre; **F** is fertilizer- fertilizer cost of potatoes produced per acre; **S** is seeds- seed costs per acre; **L** is labour- cost of labour used per acre of potatoes; **H** is herbicides costs- costs of herbicides applied per acre; **μt** is the error term

Model justification

The production function model employed is an appropriate function when many input variables are included in the model.

It has several advantages including the following:

i. Its linearity in logarithmic form makes its computation easier

ii. The estimated parameter represents the elasticity of outputs with respect to the inputs.

iii. It has in the past been proved to be a highly appropriate statistical function to measure agricultural productivity.

Description of Hypothesized Variables

The study makes the following hypothesis.

i. Fertilizer costs- a negative relationship exists between fertilizer costs and potato output.

ii. Seed costs- a negative relationship exists between seed costs and the quantity of potatoes produced.

iii. Labour costs- a negative relationship exists between labour costs and the quantity of potatoes produced.

iv. Credit access -a positive relationship exists between access to credit and potato output.

v. Seed Quality- a positive relationship exists between seed quality and potato output.

vi. Rainfall- A positive relationship exists between rainfall amounts and potato output

vii. Profitability- a negative relationship exists between input costs and profits from potatoes.

3.3 Data types

Both qualitative and quantitative data was collected from both primary and secondary sources. Primary sources of data were mainly potato growers from Kinangop district and to some extent experts in district offices. Supplementary information from other secondary sources was gathered from various published and unpublished documents. The main sources of secondary data included reports from different organizations like Ministry of Agriculture, Ministry of state for planning, national development and vision 2030, Kenya agricultural research institute, FAO website among others.

Sampling- No of Households

Primary information pertaining to potato production in the year 2012 was collected from 90 randomly sampled households in the district using standardized questionnaire (presented in Anex 1). From each of the three divisions, information from 30 households was collected. Informal interviews from agricultural experts were also conducted.

3.4 Limitation of the study

This research was confined to Kinangop district only which is one of the 286 districts in the Kenya. Though the research was expected to be a representative of the entire country, various factors such as climatical conditions, rainfall and other ecological conditions in other district might render this research inaccurate. The research was carried out using primary as well as secondary data.

The primary data was collected from farmers and agricultural experts involved in potato production through personal Interview. Farmers in the study area were predominantly small, medium land holders. Hence, it would be difficult to draw precise generalizations regarding the implications of the study. The findings in this study, interpretations and conclusions drawn could be best seen with in these limitations.

CHAPTER FOUR:

DATA ANALYSIS, RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents analysis and findings of the study as set out in the research methodology. The results were presented on the social economic factors influencing potato production in Kenya: a case study of Kinangop District. The overall objective of this study was to assess factors affecting potato productivity in Kenya. The study sought answers to the following research questions: What are the major social economic factors influencing the levels of potato production and yield? What is the importance of input prices in potato production? What are the major problems faced by farmers in the course of potato production? The study targeted 90 household heads out of which 64 household heads responded and returned their questionnaires contributing to a response rate of 73.3%. This response rate was sufficient and representative and conforms to Mugenda and Mugenda (2003) stipulation that a response rate of 50% is adequate for analysis and reporting; a rate of 60% is good while a response rate of 70% and over is excellent.

4.2 Factors affecting potato production

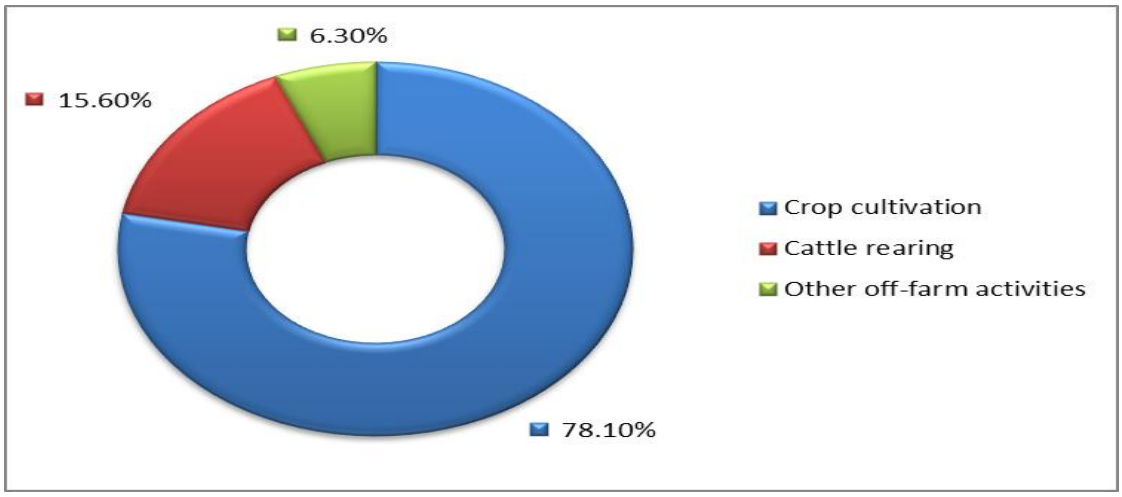
The study initially sought to ascertain the factors affecting potato production with regards to the gender, age and level of education. On age of the respondents, majority of the respondents (71.4%) were between 25-35 years old while 28.6% were 36-45 years old. The findings indicate that majority of the farmers in Kinangop District are aged 25-35 years. Therefore they were young and energetic to carry out potato farming which is labour intensive. The majority (71.4%) of the household heads were male while 28.6% were female. This implied that majority of the household in Kinangop District were male headed and consequently, most of the responses emanated from the males. On family size, most of the families (46.9%) had 4-5 family members, 21.9% had over 5 members while 15.6% had 1-3 members. This implies that majority of the families were big families as the large number of family members was instrumental in offering labour in potato farming which was labour intensive. On

the level of education, most (40.6%) of the respondents had secondary level of education, 25% were degree holders, 21.8% were diploma holders while 12.5% had primary level of education as their highest level of education. This shows that most of the farmers have attained basic education and thus were trainable in potato production as they could easily grasps concepts that they could be trained in.

4.2.1 Primary activity

The respondents were asked to indicate the primary activity they were involved in. Figure 4.3 illustrates the study findings.

Figure 4.3 Primary activity



Source: Field work (September- November, 2013)

From the findings, majority of the respondent (78.1%) had their primary activity as crop cultivation, 15.6% as cattle rearing while 6.3% had their primary activity as other off-farm activities. This implies that crop farming was the major source of livelihood for the majority of the families in Kinangop District.

4.2.2 Reason for doing the primary activity

The respondents were asked to indicate their reason for doing the primary activity. The study findings are indicated in Table 4.3.

Table 4.3 Reason for doing the primary activity

	Frequency	Percent
It generates good income	46	71.9
I prefer doing it because I like it	6	9.4
I do it because it is easier to do this activity as compared to other activities	8	12.5
I do it because my father, grandfather have been doing it	4	6.2
Total	**64**	**100.0**

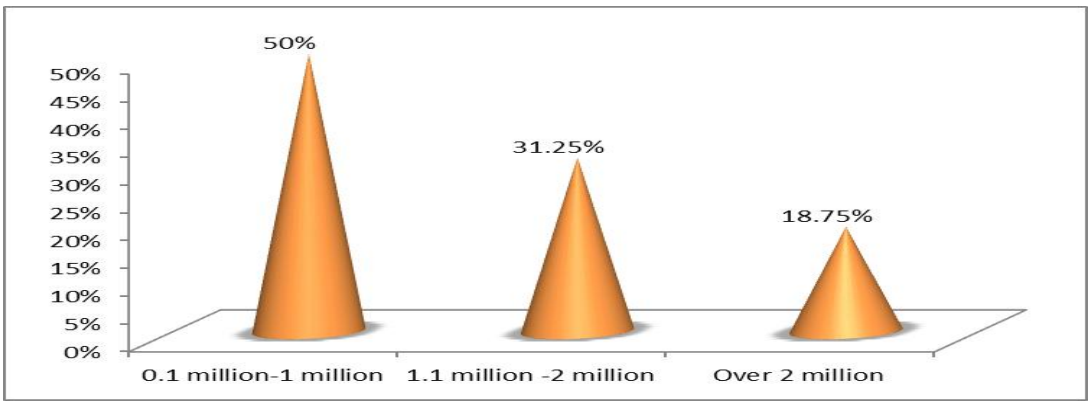
Source: Field work (September- November, 2013)

According to the findings 71.9% conducted their primary activity since it generates good income, 12.5% did it because it is easier to do this activity as compared to other activities, 9.4% preferred doing it because they liked it while 6.2% did it because my father, grandfather have been doing it. This depicts that crop farming was mainly carried out as an income generation venture for majority of the families as the area was good for farming.

4.2.3 Household wealth

The study also sought to establish the household wealth and the findings are as shown in Figure 4.4 below.

Figure 4.4 Household wealth



Source: Field work (September- November, 2013)

The study findings in Figure 4.4 shows that majority of the households (50%) had their wealth as at 0.1 million to 1 million, 31.25% as at 1.1 million -2 million while 18.75% had their family wealth as 2 million. This illustrates that majority of the families had a wealth ranging between 0.1 million to 2 million and therefore could not carry out farming on large scale basis as they lacked adequate capital to finance their farming activities owing to the small value of family wealth.

4.2.4 Potato farming in relation to other crops

The study also compared potato farming in relation to other crops that the farmers cultivated.

Table 4.4 Potato farming in relation to other crops

	Mean	Std Dev
Market demand	2.8751	0.604
Price	2.5938	0.609
Profitability per acre	2.6562	0.781
Resistance to diseases	2. 4062	0.830
Resistance to drought	2.5161	0.718
Duration of maturity	3.875	0.604

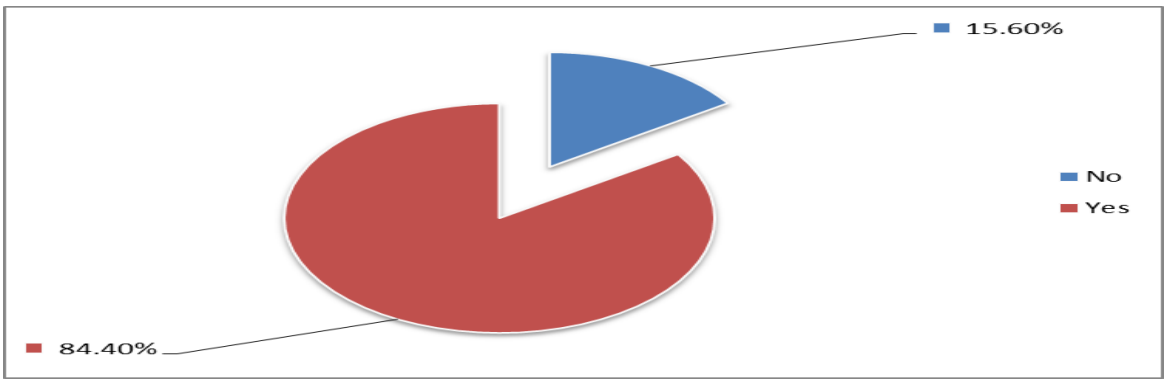
Source: Field work (September- November, 2013)

According to the findings, duration of maturity (Mean=3.875), profitability per acre (Mean=2.6562), market demand (Mean=2.875), Price (Mean=2.5938), Resistance to drought (Mean=2.5161), Resistance to diseases (Mean=2. 4062) respectively.

4.2.5 Experiencing frost in the season

The study sought to establish whether the farmers had experienced frost during potato farming and the findings are as shown in Figure 4.5 below.

Figure 4.5 Experiencing frost in the season



Source: Field work (September- November, 2013)

From the findings, majority (84.4%) of the respondents attested to having experienced frost during the last season of potato farming while 15.6% had not experienced frost during the last season of potato farming. This depicts that crop diseases negatively affected potato farming to a great extent as frost was experienced regularly in the area.

4.2.6 Mitigation cost against frost per acre

The study further sought to ascertain the amount of money per acre that the farmers used to cope with and mitigate against frost.

Table 4.5 Mitigation cost against frost per acre

	Frequency	Percent
Kshs.00	16	25.0
Kshs 1-1,000	8	12.5
Kshs 1,001-5,000	40	62.5
Total	**64**	**100.0**

Source: Field work (September- November, 2013)

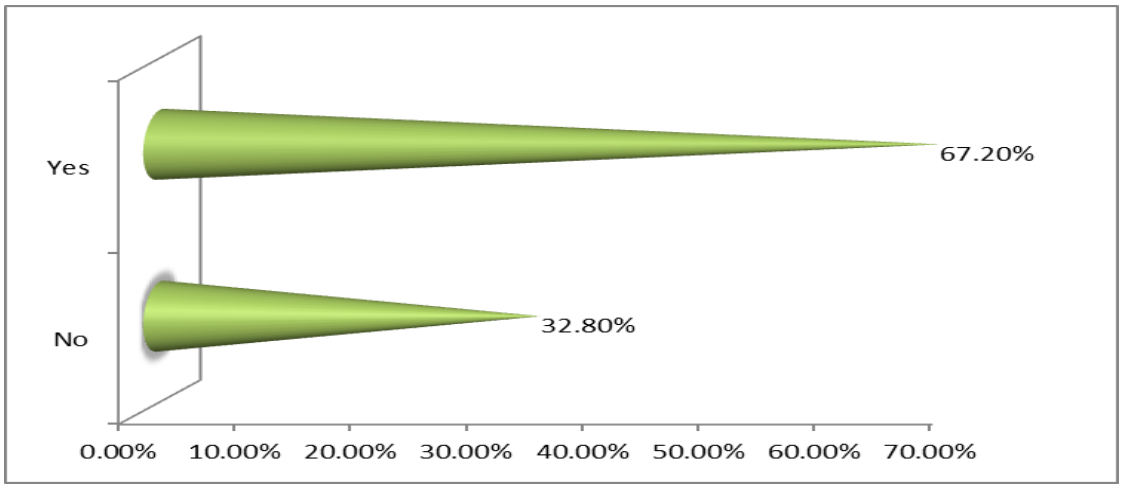
From the findings, majority of the respondents (62.5%) indicated that the cost of cope with and mitigate against frost was kshs1,001-5,000 while 12.5% used Kshs 1-1,000.

The farmers therefore used high amount of money to cope and mitigate against frost which made potato farming less profitable due to the high production costs.

4.2.7 Effectiveness of mitigation measures

The study sought to establish whether the mitigation measures they employed against frost were effective. The results are as tabulated in the Figure 4.6 below.

Figure 4.6 Effectiveness of mitigation measures



Source: Field work (September- November, 2013)

From the findings the majority (67.2%) of the respondents posited that the measures that they adopted against frost were effective while 32.8% posited that the measures that they adopted against frost were not effective. This depicts that the measures that majority of the farmers adopted were useful in reducing the negative effects of frost.

4.2.8 The amount of money the farmer lost due to frost

The respondents were asked to indicate the amount of money the farmer lost due to frost. Figure 4.6 illustrates the study findings.

Table 4.6 The amount of money the farmer lost due to frost

Cost In kshs	Frequency	Percent
Kshs 0.00	10	15.6
Kshs 1,000-10,000	28	43.75
Kshs 10,001-20,000	20	31.25
Over Kshs 20,000	6	9.4
Total	**64**	**100.0**

Source: Field work (September- November, 2013)

From the findings, most of the respondent (43.75%) indicated that they lost Kshs 1,000-10,000, 31.25% lost Kshs 10,000-20,000 while 15.6% of the farmers never lost any money due to frost. The findings depicts illustrates that majority of the farmers incurred high losses owing to frost due to the high cost of frost management.

4.2.9 Reasons for the decrease in potato production

The respondents were asked to indicate the reasons for the decrease in potato production. The study findings are indicated in Table 4.7 below.

Table 4.7 Reasons for the decrease in potato production

	Frequency	Percent
Disease	48	75
Decrease in market demand	16	25
Decrease in price	30	46.9
Shortage in supply of input	36	56.3
Increase in price of input	60	93.8
Natural hazards	10	15.6
Drought	8	12.5
Other crops are more of profitable	14	21.9

Source: Field work (September- November, 2013)

According to the findings, the main reasons that led to decrease in potato production included; increase in price of input (93.8%), shortage in supply of input (56.3%), disease (75%), decrease in price (46.9%), decrease in market demand (25%), s other

crops are more of profitable (21.9%), natural hazards (15.6%) and drought (12.5%) respectively. Therefore, potato production was negatively affected by high input cost, shortage in supply of input, disease, poor selling price, and decrease in market demand.

4.2.10 Labour areas

The respondents were asked to indicate the areas that they hired for labour. The study findings are indicated in Table 4.8 below.

Table 4.8 Labour areas

	Frequency	Percent
Ploughing	56	87.5
Planting	60	93.8
weeding	46	71.9

Source: Field work (September- November, 2013)

The study findings in Table 4.8 shows that majority of the respondents (93.8%) indicated that they hired for labour in planting, 87.5% in ploughing while 71.9% hired for labour in weeding. This depicts that potato farming was labour intensive and the farmers had to hire for labour in the different phases of potato farming. This therefore implies that the provision of labour was a significant factor affecting production of potato.

4.2.11 Input costs

The study investigated on the various inputs that the farmers used during potato farming.

Table 4.9 Input costs

	Frequency	Percent
Used uncertified seeds	32	96.9
Used fertilizers	100	100
Used humus	54	84.4
Used herbicides	56	87.5
Used pesticides	20	31.3

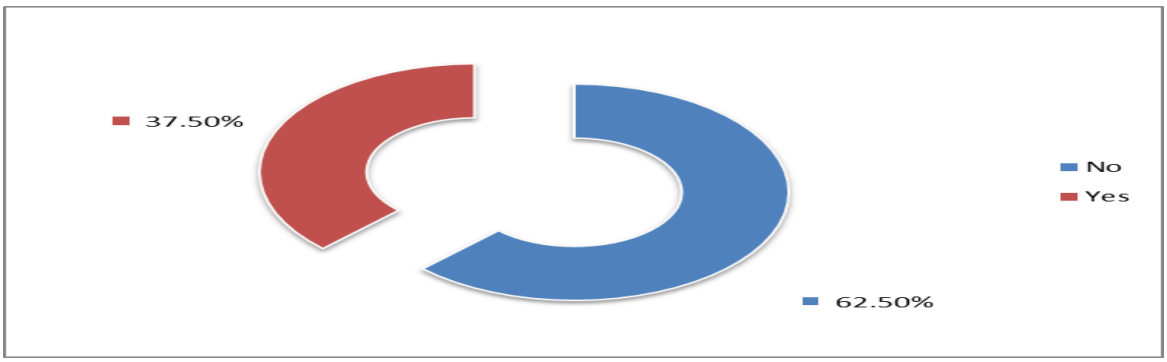
Source: Field work (September- November, 2013)

The study findings revealed that 100% of the farmers used fertilizers, 96.9% used uncertified seeds, 87.5% used herbicides, 84.4% used humus while 31.3% used pesticides. The finding implies that fertilizer, seeds quality and herbicides costs were factors that affected potato production.

4.2.12 Accessing credit from financial institutions

The respondents were also asked whether they accessed credit from financial institutions.

Figure 4.7 Accessing credit from financial institutions



Source: Field work (September- November, 2013)

According to the findings, 62.5% of the respondents attested that they had never accessed credit from financial institutions while 37.5% indicated that they had accessed credit from financial institutions. On whether in the last five years the prices

of inputs has increased, majority of the farmers (100%) indicated that the prices of inputs has increased over the last 5 years.

4.2.13 Rainfall distribution pattern in Kinagop District

The study assessed the pattern of rainfall in Kinagop District. Based on the rainfall patterns, the production of potato was based on two rainfall seasons every year on the months of April to June and October to December. The study established that there was higher yield during the seasons with higher rainfall amounts and vice versa as potato was rainfall dependent as it was not drought resistant.

4.3 Inferential Statistics

The study further applied multiple regressions to determine the response to output on potato production in Kenya.

4.3.1 Regression Analysis

The researcher conducted a multiple regression analysis so as to test relationship among variables (independent) on the potato production in Kenya. The researcher applied the statistical package for social sciences (SPSS V 17.0) to code, enter and compute the measurements of the multiple regressions for the study. Coefficient of determination explains the extent to which changes in the dependent variable can be explained by the change in the independent variables or the percentage of variation in the dependent variable (potato production in Kenya) that is explained by all the five independent variables (fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs).

Table 4.10 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.919	0.845	0.789	0.6273

Source: Field work (September- November, 2013)

The five independent variables that were studied, explain only 84.5% of the potato production in Kenya as represented by the R^2. This therefore means that other factors not studied in this research contribute 15.5% of the potato production in Kenya. Therefore, further research should be conducted to investigate the other factors (15.5%) that affect potato production in Kenya.

Table 4.11 ANOVA of the Regression

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.534	50	1.267	9.475	.000[a]
	Residual	9.307	200	2.327		
	Total	11.841	250			

Source: Field work (September- November, 2013)

The significance value is 0.000 which is less than 0.05 thus the model is statistically significance in predicting how fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs affect the potato production in Kenya. The F critical at 5% level of significance was 3.23. Since F calculated is greater than the F critical (value = 9.475), this shows that the overall model was significant.

4.3.2 Coefficient of determination on results of regression model

Table 4.12 Coefficient of determination

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.147	0.2235		5.132	0.000
	Fertilizer costs	0.752	0.1032	0.1032	7.287	.000
	Seed quality and cost	0.487	0.3425	0.1425	3.418	.000
	Credit access	0.545	0.2178	0.1178	4.626	.000
	Herbicides costs	0.439	0.1937	0.0937	4.685	.000
	Labour costs	0.3915	0.1341	0.00714	4.716	0.000

Source: Field work (September- November, 2013)

Multiple regression analysis was conducted as to determine the relationship between potato production in Kenya and the five variables. As per the SPSS generated table below, regression equation; ($\mathbf{Y} = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_4X_{4+}\varepsilon$) becomes: ($Y= 1.147+ 0.752X_1+ 0.487X_2+ 0.545X_3+ 0.439X_4 + 0.3915X_{4+}\varepsilon$). According to the regression equation established, taking all factors into account (fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs) constant at zero, potato production in Kenya will be 1.147 (coefficient). The data findings analyzed also shows that taking all other independent variables at zero, a unit increase in fertilizer costs will lead to a 0.752 increase in potato production in Kenya; a unit increase in seed quality and cost will lead to a 0.487 increase in potato production in Kenya, a unit increase in credit access will lead to a 0.545 increase in potato production in Kenya, a unit increase in herbicides costs will lead to a 0.439 increase

in potato production in Kenya while a unit increase in labour costs will lead to a 0.3915 increase in potato production in Kenya. This implies that fertilizer cost is the most significant factor affecting potato production in Kinagop District. This infers that fertilizer costs contribute the most to the potato production in Kinagop District followed by credit access, seed quality and cost, herbicides costs and labour costs respectively. At 5% level of significance and 95% level of confidence, fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs were all significant socio-economic factors in potato production in Kinangop District in Kenya.

4.3.4 Correlation analysis

To quantify the strength of the relationship between the variables, the study used Karl Pearson's coefficient of correlation.

Table 4.13 Correlation and the coefficient of determination

	Potato production in Kenya	Fertilizer costs	Seed quality and cost	Credit access	Herbicides costs	Labour costs
Potato production in Kenya (r) (p) Sig. (2 tailed)	1.000					
Fertilizer costs (r) (p) (2 tailed)	0.894 0.018	1.000				
Seed quality and cost (r) (p) Sig. (2 tailed)	0.493 0.031	0.316 0.047	1.000			
Credit access (r) (p) Sig. (2 tailed)	0.661 0.024	0.163 0.019	0.216 0.047	1.000		
Herbicides costs (r) (p) Sig. (2 tailed)	0.402 0.046	0.161 0.029	0.233 0.0464	0.462 0.014	1.000	
Labour costs	0.394 0.049	0.154 0.032	0.241 0.0464	0.468 0.022	0.318 0.034	1.000

Source: Field work (September- November, 2013)

According to the Table 4.13 there is a positive relationship between potato production in Kenya and fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs of magnitude 0.894, 0.661, 0.493, 0.402 and 0.394 respectively. The positive relationship indicates that there is a correlation between the social economic influencing potato productions in Kenya: a case study of Kinangop District with fertilizer costs having the highest value and labour costs having the lowest correlation value. This notwithstanding, all the factors had a significant p-value ($p<0.05$) at 95% confidence level. The significance values for relationship between potato production in Kenya and fertilizer costs, seed quality and cost, credit access, herbicides costs and labour costs were 0.018, 0.031, 0.024, 0.046 and 0.49 respectively. This implies that fertilizer costs was the most significant factor, followed by credit access, seed quality and cost, herbicides costs and labour costs respectively.

4.3.5 Hypothesis Testing

$Ho_{1.}$ Fertilizer costs- a negative relationship exists between fertilizer costs and potato output.

$Ho_{2.}$ Seed costs- a negative relationship exists between seed costs and the quantity of potatoes produced.

$Ho_{3.}$ Labour costs- a negative relationship exists between labour costs and the quantity of potatoes produced.

$Ho_{4.}$ Credit access -a positive relationship exists between access to credit and potato output.

$Ho_{5.}$ Seed Quality- a positive relationship exists between seed quality and potato output.

$Ho_{6.}$ Profitability- a negative relationship exists between input costs and profits from potatoes.

Table 4.14 Relationship between fertilizer costs and potato output (N=64)

Relationship between:	Chi-Square Value	P value
Fertilizer costs & potato output	38.322	.001
Seed costs & the quantity of potatoes produced	23.883	.002
labour costs & the quantity of potatoes produced	24.121	.004
Access to credit & potato output	13.782	.001
Seed quality & potato output	26.316	.002
Input costs & profits from potatoes	21.472	.001

Source: Field work (September- November, 2013)

On relationship between fertilizer costs and potato output, Table 4.16 shows that the chi-square value is 38.322 with an associated p of 0.001. Since p is less than $\alpha = 0.05$ confidence level ($p < 0.05\alpha$), fertilizer costs has significant relationship with potato output. On relationship between seed costs and the quantity of potatoes produced, the chi-square value is 23.883 with an associated p of 0.002. Since p is less than $\alpha = 0.05$ confidence level ($p < 0.05\alpha$), seed costs has significant relationship with quantity of potatoes produced. On relationship between labour costs and the quantity of potatoes produced, the chi-square value is 24.121 with an associated p of 0.004. Since p is less than $\alpha = 0.05$ confidence level ($p < 0.05\alpha$), labour costs has significant relationship with quantity of potatoes produced. On relationship between access to credit and potato output, the chi-square value is 13.782 with an associated p of 0.001. Since p is less than $\alpha = 0.05$ confidence level ($p < 0.05\alpha$), credit access has significant relationship with potato output. On relationship between seed quality and potato output, the chi-square value is 26.316 with an associated p of 0.002. Since p is less than $\alpha = 0.05$ confidence level ($p < 0.05\alpha$), seed quality has significant relationship with potato output. On relationship between input costs and profits from potatoes, the chi-square value is 21.472 with an associated p of 0.001. Since p is less than $\alpha = 0.05$ confidence level ($p < 0.05\alpha$), input costs has significant relationship with profits from potatoes.

CHAPTER FIVE:

SUMMARY, CONCLUSION AND RECOMENDATIONS

5.1 Introduction

This chapter presents summary of findings, conclusion and recommendations of the study in line with the objectives of the study. The research sought to establish the factors influencing potato production in Kenya: a case study of Kinangop District.

5.2 Summary

From the findings, it was established that majority of the farmers in Kinangop District are aged 25-35 years. Therefore they were young and energetic to carry out potato farming which is labour intensive. The majority (71.4%) of the respondents were male while 28.6% were female. This implied that majority of the household in Kinangop District were male headed. The males were endowed with physical energy which made them better placed in potato farming as compared to their female counterparts. The majority of the families were big families as the large number of family members was instrumental in offering labour in potato farming which was labour intensive. Most of the farmers have attained basic education and thus were trainable in potato production as they could easily grasps concepts that they could be trained in. The majority of the respondent (78.1%) had their primary activity as crop cultivation, 15.6% as cattle rearing while 6.3% had their primary activity as other off-farm activities. Thus, crop farming was the major source of livelihood for the majority of the families in Kinangop District. Crop farming was mainly carried out as an income generation venture for majority of the families as the area was good for farming.

The majority of the households (50%) had their wealth as at 0.1 - 1 million, 31.25% had 1.1-2 million while 18.75% had family wealth of 2 million. Therefore, majority of the families had a wealth ranging between 0.1 million to 2 million and therefore could not carry out farming on large scale basis as they lacked adequate capital to finance their farming activities owing to the small value of family wealth.

The study found out that majority (84.4%) of the farmers had experienced frost during the last season of potato farming. Therefore, crop diseases negatively affected potato farming to a great extent as frost was experienced regularly in the area. The majority of the farmers (62.5%) used Kshs1,000-5,000 to cope with and mitigate against frost. The farmers therefore used high amount of money to cope and mitigate against frost which made potato farming less profitable due to the high production costs. The measures that farmers adopted against frost were effective. Thus, the measures that majority of the farmers adopted were useful in reducing the negative effects of frost. Most of the farmers (43.75%) lost Kshs 1,000-10,000 due to frost. The findings depicts illustrates that majority of the farmers incurred high losses owing to frost due to the high cost of managing frost.

The study revealed that the main reasons that led to decrease in potato production included; increase in price of input (93.8%), shortage in supply of input (56.3%), disease (75%), decrease in price (46.9%), decrease in market demand (25%), s other crops are more of profitable (21.9%), natural hazards (15.6%) and drought (12.5%) respectively. Therefore, potato production was negatively affected by high input cost, shortage in supply of input, disease, poor selling price, and decrease in market demand.

The study established that the majority of the farmers (93.8%) hired for labour in planting, in ploughing (87.5%) and in weeding (71%). This depicts that potato farming was labour intensive and the farmers had to hire for labour in the different phases of potato farming. This therefore implies that the provision of labour was a significant factor affecting production of potato. The study findings revealed that 100% of the farmers used fertilizers, 96.9% used uncertified seeds, 87.5% used herbicides, 84.4% used humus while 31.3% used pesticides. The finding implies that fertilizer, seeds quality and herbicides costs were factors that affected potato production. Majority of the farmers (62.5%) had never accessed credit from financial institutions.

The study established that fertilizer costs contribute most to the potato production in Kenya followed by credit access, seed quality and cost, herbicides costs and labour

costs respectively. At 5% level of significance and 95% level of confidence, fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs were all significant socio-economic factors on potato production in Kenya.

The significance values for relationship between potato production in Kenya and fertilizer costs, seed quality and cost, credit access, herbicides costs and labour costs were 0.018, 0.031, 0.024, 0.046 and 0.49 respectively. This implies that fertilizer costs was the most significant factor, followed by credit access, seed quality and cost, herbicides costs and labour costs respectively.

5.3 Conclusion

From the findings, it is concluded that;

i. Majority of the farmers in Kinangop District were young and energetic to carry out potato farming which is labour intensive.

ii. The majority of the household in Kinagop District were male headed. The males were endowed with physical energy which made them better placed in potato farming compared to their female counterparts. The majority of the families were big families as the large number of family members was instrumental in offering labour in potato farming which was labour intensive. Most of the farmers have attained basic education and thus were trainable in potato production as they could easily grasps concepts that they could be trained in.

iii. Crop farming was the major source of livelihood for the majority of the families in Kinangop District. Crop farming was mainly carried out as an income generation venture for majority of the families as the area was good for farming. The majority of the families had a wealth ranging between 0.1 million to 2 million and therefore could not carry out farming on large scale basis as they lacked adequate capital to finance their farming activities owing to the small value of family wealth.

iv. Majority of the farmers had experienced frost during the last season of potato farming. Therefore, crop diseases negatively affected potato farming to a great extent as frost was experienced regularly in the area. The farmers used high amount of money to cope and mitigate against frost which made potato farming less profitable due to the high production costs. The measures that farmers adopted against frost were effective. Thus, the measures that majority of the farmers adopted were useful in reducing the negative effects of frost. Majority of the farmers incurred high losses owing to frost due to the high cost of managing frost.

v. The main reasons that led to decrease in potato production included; increase in price of input, shortage in supply of input, disease, decrease in price, decrease in market demand, and competition from other crops that are more of profitable natural hazards and drought respectively. Therefore, potato production was negatively affected by high input cost, shortage in supply of input, disease, poor selling price, and decrease in market demand.

vi. Majority of the farmers hired for labour in planting, in ploughing and in weeding. Thus potato farming was labour intensive and the farmers had to hire for labour in the different phases of potato farming. The provision of labour was a significant factor affecting production of potato. The study findings conclude that majority of the farmers used fertilizers, used uncertified seeds, herbicides, humus and pesticides. Thus fertilizer, seeds quality and herbicides cost were factors that affected potato production. Majority of the farmers had never accessed credit from financial institutions.

vii. Fertilizer costs contribute most to the potato production in Kenya followed by credit access, seed quality and cost, herbicides costs and labour costs respectively. At 5% level of significance and 95% level of confidence, fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs were all significant socio-economic factors on potato production in Kenya. The significance values for relationship between potato production in Kenya and fertilizer costs, seed quality and cost, credit access, herbicides costs

and labour costs were 0.018, 0.031, 0.024, 0.046 and 0.49 respectively. This implies that fertilizer costs was the most significant factor, followed by credit access, seed quality and cost, herbicides costs and labour costs respectively.

viii. Potato production in Kinangop District is responsive to fertilizer costs, credit access, seed quality and cost, herbicides costs and labour costs.

5.4 Recommendations

i. The majority of the farmers in Kinangop District faced lack of access to credit to scale up potato production. The government and other financial institutions should offer credit facilities to the potato farmers to enable the up-scale their farming initiatives. This should be coupled with farmer training on financial management and best farming practices to make the potato farming a profitable venture.

ii. The cost of farm input such as fertilizer was very high and therefore reduced the profit of the production. The government should offer farm input to the farmers at subsidized cost to lower the production cost of potato farming and encourage farmers to upscale the potato production.

iii. Majority of the farmers incurred high losses in controlling diseases that affected potato production. The government through the line ministry should offer up to date farmer training on best farming practices to reduce diseases that negatively affect potato production.

iv. The provision of labour was a significant factor affecting production of potato. The potato farmers should adopt new farming methods and technologies that would make farming efficient and more profitable.

5.5 Areas of further studies

The study recommends that; similar study should be done in other districts where potato production is done for comparison purposes and to allow for generalization of findings on social economic factors influencing potato production in Kenya.

REFERENCES

Abrar S., Morrissey, O., Rayner, T (2004). Aggregate agricultural supply response in Ethiopia: a farm level analysis. Journal of international Development, Vol. 16, Iss.4 pp 605-620.

Arun pandit, Rajesh, K., Rana, Pandu, .K. and Kumar, N.R., 2003, "Potato marketing in India". *Ind. Horticulture.*,

Cobb, C.W. and Douglas,P.H (1928). A theory of Production. American Economic Review 8:139-165)

Daniel O. Nyagaka, **Gideon A. Obare**, **Wilson Nguyo and Samuel M. Mwakubo (2010).** Are Kenyan smallholders allocatively efficient? Evidence from Irish potato producers in Nyandarua North district

De Groote, H.Owuor, G Doss,C. Ouma,J. Muhammad, L and Dandas, K.(2005) The maize green revolution in Kenya revisited. E journal of agricultural and development economics vol.2, No.1 pp32-49

Durr G. and G. Lorenzl (1980). Potato Production and Utilization in Kenya. International Potato Center (CIP).

Ellis, F. (1993). *Peasant Economics.* Cambridge, Cambridge University Press.

Evenson, R E and Mwambu, G.(1998). The effects of agricultural extensions of farm yields in Kenya. Centre discussion paper No. 708, Economic growth centre, Yale University.

FAO, 2008. Potato and Biodiversity. IYP Website, http://www.potato2008.org/en/potato/biodiversity.html

Harbans Lal And K.D. Sharma, 2006, The potato crop was found to be the most capital and labour intensive due to substantial cost incurred on seed, fertilizer and human labour, *potato journal*, 33(3-4): 139-143.

Hoffler H and Ochieng B.O (2008). High Commodity Prices – Who gets the Money? Preliminary findings for World Food Day 2008.Heirich Boll Foundation.

Kaguongo W.P., Gildemacher P, Demo P, Wagoire W, Kinyae P, Andrade J, Forbes G, Fuglie K, Thiele G (2008). Framer practices and adoption of improved potato varieties in Kenya and Uganda. International Potato Center (CIP) Lima, Peru. SOCIAL Sciences Working Paper 2008

Kiiya W.W., Mureithi J.G., Kiama J.M. (2006). Improving production of Irish potato (*Solanum tuberosum,* L.) in Kenya: The use of green manure legumes for soil fertility Improvement .In: Development and up scaling of Green manure legumes Technologies in Kenya. JG Mureithi, CKK Gachene, JW Wamuongo and Eilitta M. (eds). KARI, 2006

Kipkoech, D.N., J. Mburu, C.W. Ritho, N.W Ng'ang'a and C. Lung'aho (2007). Technical efficiency among the small-scale ware potato producers in Kenya. Kenya Agricultural Research institute

Maingi D.M., Nganga N, Kidanemariam H.M (1992). Collection and Evaluation of farmers' informally released potato varieties in Kenya.

Muthoni J and Nyamongo D.O. A review of constraints to ware Irish potatoes production in Kenya.(2009) Kenya Agricultural Research Institute (KARI)

Narayana,N.S and Shah, M.M.(1984). Farm supply response in Kenya: Acreage allocation model. European Review of Agricultural Economics, Vol 11, Issue 1, pp 85-105

Ng'ong'ola, D.H and Mangisoni, J.H(1994). Production efficiency of barley esattes: A case study of Kasungu Agricyltural DevelopmentDivision. *Agricultural Economics Analysis and Rural Development 4: 29-53*

Nganga N.M., Kinyae P, Walingo A, Wakahiu M, Kipkoech D, Muhonja L, Kabira JN (2002). Potato production and technology dissemination in Kenya. Unpublished Report.

Ogola J.B.O., Ayieko M.W., Orawo A.O, Kimani F.W (2002). Fertilizer use in Kenya: a case of potato in Nakuru district. A paper presented at a regional workshop (jointly organised by ECAPAPA and IFDC) on assessment of fertilizer sub-sector in Eastern Africa held in Nairobi. July, pp. 15-17.

Olujenyo, F.O (2005). The determinants of Agricultural Production and Profitability in Akokoland, Ongo Esate, Nigeria. Adekunce Ajasin University, Akungba Akoko, Ondo State, Nigeria

Owuor, J.(1999). Determinants of Agricultural productivity in Kenya. Kenya agricultural marketing and policy analysis project. Tegemeo Institute/Michigan State University

Sindhu, S.S Baanante, C.A.(1981). Estimating farm level input demand and wheat supply in the indian Punjab using a translog profit function. *American journal of Agricultural Economics vol. 63, pp 237-246.*

Singh, C. And V.C. Mathur., 1994, Growth and instability in production and prices of Potato in India. *Agricultural Situation in India*, 44(6): 429 - 436.

Verma, Vibha, Singh, Lokendar And Singh, Rajpal. 2001, Consumption behavior of Potato products in rural and urban areas of Meerut district. *Journal of the Indian Potato Association*, 28(1):178-179.

Walingo, A.M., Ewell, P.T., Alexandre, C. and Kabira, J.N. 1998. Characterization of the potato processing industry I. Nairobi, Kenya. CIP. Lima Peru.

APPENDICES

APPENDIX: QUESTIONAIRE

Part 1: General Information

Date of interview: Day----------Month----------Year----------

Interviewed by----------

Household number----------

Division ----------

HOUSEHOLD Characteristics

1. **Name of the respondent……..**

2. Position of the respondent

1	Head of the household	
2	Spouse of head of the household	
3	Children	
4	Relative	
5	Other (Specify)	

3. Age of the respondent (year)…….

4. Gender of the respondent

1	Male	
2	Female	

5. Total size of the family……

6. Highest level of formal education attained by the respondent ……..

7. Highest level of formal education attained in the family as a whole…….

8. Primary activity of the respondent

1	Crop cultivation	
2	Cattle rearing	
3	Other off-farm activities	

9. Reason for doing the primary activity

1	It generates good income	
2	I prefer doing it because I like it	
3	I do it because it is easier to do this activity as compared to other activities	
4	I do it because my father, grandfather, etc have been doing it	
5	I do it because I don't have any other option	
6	Other ( )	

10. Secondary activity of the respondent

1	Crop cultivation	
2	Cattle rearing	
3	Other off-farm activities	

11. Reason for doing the secondary activity

	It generates better supplementary income compared to other types of activities	
	I prefer doing it because I like it	
	I do it because it is easier to do this activity as compared to other activities	
	Other	

Part 3: Has the respondent participated in any type of training and extension programs in 2012?

PART 5: HOUSEHOLD WEALTH INCLUDING LAND

s/n	House 1= permanent 2= Semi- permanent	Roof: 1=corrugated iron sheet, 2= grass	Wall: 1=bricks, 2=mud, 3=wood	Number of rooms in the house	Floor: 1=tiles, 2=cement, 3=mud
	Livestock	**Number**	**Average cost per head**	**Total value**	
a	Daily cows				
b	Zebu cows				
c	Sheep				
c	Goat				
d	Donkey				
e	Local poultry				

f	Layers				
g	Broilers				
h	Ducks				
i	Pigs				
j	Rabbits				
k	Others				
	Physical items	**Number**			
k	bicycle				
l	motor cycle				
m	car/truck				
n	mobile phone				
o	radio				
p	tv				
q	sprayer				
r	fridge				
s	grinding mill (for grain)				
t	wagon(cart)				
u	total arable land (owned) in hectares				
v	leased land in hectares				

PART 6: INCOME

Income sources in 2012 (*Exclude income from potato production*)

Income source	**Form of income** **1=cash** **2=kind**	**Quantity**	**Total value in Kshs** **2011**	**Total value in Kshs** **2012**
Remittance income from family members				
Assistance from relatives or friends				
Sale of animals and animal Products				
Income from livestock sale				
Income from business				
Salaries				
Others				

Income from other farm activities (*excluding* income from potatoes)

Crop type	Season	Amount produced in bags	Amount sold in bags	Unit price in Kshs	Total value sold in Kshs.

PART 7: Major crops grown in 2012

	Crops	Own land size allocated in hectare	Rented land size allocated in hectare	Total land size allocated both owned and rented in hectare i.e Grand total
a	Potatoes			
b	Cabbages			
c	Kales			
d	Spinach			
e	Garden peas			
f	Snow peas			
g	Carrots			
h	Lima beans			
i	Tomatoes			
j	Pyrethrum			
k	Others			

12. What is the total land size you have for farming (i.e both owned and rented)?

	In possession/ under command (in hectares)	Used for farming ?(in hectares
Owned		
Rented-in		
Total		

13. What is the total land size you rent out (in hectares).....

14. How much do you earn from this rent per year (in Kshs).....

Part 8. How do you compare potato farming in relation to other crops that are cultivated in the ***same season*** as potato, in terms of the following?

	1= very low	**2= low**	**3= medium**	**4=high**	**5= very high**
1. Market demand					
2. Price					
3. Profitability per acre					
4. Resistance to diseases					
6. Resistance to drought					
Maturity	**1= Very long**	**2=long**	**3= medium**	**4=Short**	**5= very short**

7. Duration of maturity					

15. From the seven factors stated above, which of them influenced you most to grow potatoes? Mention the first three in order of importance.

Importance	**Factor**
1	
2	
3	

Part 10. Household's experience in farming

	Household's experience in:	**Experience (year)**
a	Growing potatoes	
b	Agriculture in general	

16 (a) Potato production in the past two years

2011		**2012**	
Season	**No. of bags**	**Season**	**No. of bags**

Season 1		Season 1	
Season 2		Season 2	
Season 3		Season 3	
Season 4		Season 4	

(b) How did you distribute the potato harvested in the two years?

Year	**No. of Bags**		**Price per Bag**		**Amount**
	2011	**2012**	**2011**	**2012**	
Quantity sold					
Quantity consumed					
Qty converted into seeds					
Qty given away					
Qty spoilt					
Others					

c) Did you experience any frost in the seasons under review? Yes=1, No=2

d) If yes, how much acreage was affected? ……..

e) How much cost did you incur to mitigate against the frost effects per hectare? ……..

f) Were the mitigation measures effective? Yes=1, No=2

g) How much (approximately) did you lose due to effects of frost? ……

17. If potato production has decreased, what do you think is the main reason for this loss?

s/n	**Cause of Decrease**		e	Increase in price of inputs	
a	Disease		f	Natural hazards	
b	Decrease in market demand		g	Drought	
c	Decrease in price		h	other crops are more profitable	
d	Shortage in supply of inputs		i	Other (please specify)	

18. If potato prod has increased, what do you think has contributed to this gain?

s/n	**Cause of increase**		e	Increase in supply of inputs	
a	I use pesticides, herbicides and fungicides		f	I use high yielding varieties	
b	there was adequate rainfall		g	Increase in market demand	
c	I use natural (organic) fertilizer		h	Increase in price of potatoes	
d	Since it is more profitable than other crops		i	Other (please specify)	

19. How far is your potato farm from your house? (In kms)……

PART 11. Potato production methods

Technique of production					
1	Crop rotation		6	Inorganic fertilizer	
2	Incorporating crop residues		7	Herbicides	
3	Applying manure		8	Pesticides	
4	Composting		9	Irrigation	
5	Applying household refuse		10	Hired labour	

PART 12: LABOUR ACQUISITION/DISPOSITION

This refers to estimating the amount and value of labor services the household hires in or out in 2012 **per acre of land**

Activity	**No. of Laborer**	**Family labour used**	**Rate per person**	**Total Amount Spent**
Ploughing				
Planting				
Weeding 1				
Weeding 2				

Spraying 1				
Spraying 2				
Harvesting				
Sorting				

Part 13: Input Costs (2012) per acre

Input	**Variety**	**Amt applied (Kgs)**	**Price**	**Total Cost**
Seeds	Certified			
	Uncertified			
Fertilizers	DAP			
	Humus			
Herbicides				
Pesticides				
Others(specify)				

20. In the past two years, did you use certified potato seeds in your farm? .....

21. If no, why did you not use the certified seeds ……

a) High costs b) Not available locally c) I applied them last time but the yield did not improve d) others specify …….

PART 14: CREDIT ACCESS

From the list below, indicate where you access credit from which help you in financing farming activities.

S/N	**Source of Credit**	
1	**Bank**	
2	**Microfinance institutions**	
3	**Local money lenders**	
4	**Friends**	
5	**Cooperative societies**	
6	**Others (Specify)**	

PART 15: AGRICULTURAL MARKETS

22. From whom or from which organization do you primarily obtain price information?.....

a. Other farmers b. Wholesalers c. Neighbors d. Unions e. co-operatives f. processors g.

personal observation h. family and friends i. public sector j. middlemen k. Radio l. Newspaper

m. do not obtain price information n. others (Specify)_____

23 . From whom or from which organization do you primarily obtain other market information like input provision and market outlets?.....

a. Other farmers b. Wholesalers c. Neighbors d. Unions e. co-operatives f. processors g.

personal observation h. family and friends i. public sector j. middlemen k. Radio l. Newspaper

m. do not obtain price information n. others (Specify)……..

If the answer to both 22 and 23 is m, then proceed to 24 and 25

24. What additional information would you like to obtain? .....

A. Marketing opportunity B. Transportation cost C. Input sources D. others

(specify)…….

25. What would be the best or most effective method of providing information on prices and markets to you? …….

A. Radio B.. TV C. Posted bulletin D. Press E. Telephone F. Contacting informed people g.

Other …….

26. Did you transport potatoes to the market? …… Yes=1, No=2

27. If yes, how much did it cost? ……..

28. In general, in the last five years, what would you say about prices of inputs?(circle the answer) Increased=1, Decreased=2, Unchanged=3

29. Did the post election violence affect your production? Yes=1, No=2

30. If yes, (circle the correct answer) Prices of inputs went up=1, Markets expanded=2, Markets shrank=3, Potato production decreased=4, others =5 specify ……

APPENDIX II: RAINFALL DISTRIBUTION PATTERN IN KINAGOP DISTRICT

YEAR	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
2002	106.5	12.4	171.5	138.9	215.9	62.9	47.8	23.1	16.7	114.3	188.7	194.7	1293.4
2003	38.5	12.8	50.5	301.3	72.5	383.3	381	139.9	51.1	118.3	97.4	40.7	1687.3
2004	103.4	139.3	77	238.1	148	9.9	21.1	51.2	100.5	128.5	181.6	91.2	1289.8
2005	82.9	54.4	141.7	105.8	187.3	62	43	50.9	53.2	36.6	71.1	13.5	902.4
2006	22.7	63.3	75.3	163.9	167.8	51.8	45.6	53.6	20.6	110	194.4	231.6	1200.6
2007	109.6	86.05	68.25	188.2	158.55	156.1	63.8	100.78	66.8	182.2	41.66	30.5	1252.49
2008	43.6	95.78	183.5	184.2	231	46.28	5	56.6	84.2	130.7	95.8	13	1169.66
2009	23.7	26.1	81.6	113.3	91.3	59.9	0	0	57.9	187.7	118.1	106.7	866.3
2010	234.1	254	104.5	238.2	252.4	44	33	100	181	153	116	62.8	1773
201	33.	53.	349	145	104.	125	108	133.	152	357	476	195	2236.

1	3	2	.6	.7	5	.8	.4	6	.9	.7	.3	.3	3
2012	17.6	17.9	55.2	460.4	338.4	190.1	122.8	130.3	100	271.6	223.8	217	2145.1