ASSOCIATION BETWEEN SELECTED SOCIAL, ECONOMIC AND TECHNOLOGY RELATED FACTORS AND ADOPTION OF CLEAN SEED POTATO BY SMALL SCALE FARMERS IN NJORO SUB-COUNTY NAKURU, KENYA

LAMECH AMWINE

EGERTON UNIVERSITY LIBRARY
17 JAN 2021
P.O. BOX 536, EGERTON
ACQUISITION SECTION

A Thesis Submitted to the Graduate School in Partial Fulfillment of the Requirements for the Master of Science Degree in Community Studies and Extension of Egerton University

EGERTON UNIVERSITY LIBRARY

EULIB
072920

EGERTON UNIVERSITY LIBRARY
26 MAR 2021
P.O. BOX 536, EGERTON
AFRICANA SECTION

EGERTON UNIVERSITY

JULY 2020

DECLARATION AND RECOMMENDATION

Declaration

I hereby declare that this thesis is my original work and has never been presented previously for conferment of any degree in any University.

Signature ---------- Date July 13, 2020 ----------

Lamech Amwine

Reg. No.EM21/12025/17

Recommendation

This thesis has been submitted for examination with our approval as University supervisors.

Signature ---------- Date 14/07/2020 ----------

Dr. Milcah Mulu - Mutuku

Department of Applied Community Development Studies

Egerton University

Signature ---------- Date 14th July 2020 ----------

Dr. Agnes Nkurumwa

Department of Agricultural Education and Extension

Egerton University

COPYRIGHT

©2020, Amwine Lamech

All rights reserved. No part of this thesis may be reproduced, stored in any retrieval system, or transmitted in any form or by any means without prior written permission of the author and/or Egerton University

DEDICATION

To my beloved wife Kemigisha Marycent and sons Jason and Malik

ACKNOWLEDGEMENT

I am greatly humbled and thankful to God for keeping me alive, energetic and sane to have accomplished this work successfully. Much appreciation goes to my supervisors Dr. Milcah. Mulu-Mutuku and Dr. Agnes Nkurumwa for working patiently with me from the time when I knew little to time I completed this work. I acknowledge the support extended to me by my fellow students and the faculty staff at the Department of Applied Community Development Studies and the Faculty of Education and Community Studies of Egerton University. May God reward you abundantly.

I would like to extend my sincere appreciation to the MasterCard Foundation through TAGDev Project at Egerton University and RUFORUM for financing this research and my entire Masters studies at Egerton University. I am appreciative and greatly thankful for your support that was extended to me in many different ways during the course of my studies at Egerton University.

I would also like to acknowledge the Seed Potato Value Chain Action Research Project (SPVC CARP+) at Egerton University. You contributed much towards my full exposure to communities that I later conducted my research. The SPVC CARP+ helped me in identifying the problem and shaped my research towards practical gap identification inclusive of affected communities.

Finally, I would wish to express my gratitude to the potato farmers of Njoro Sub County from whom the data was collected for analysis and compilation of this research thesis. I am also grateful to those people who helped in data collection like the lead farmers, village chiefs, and translators.

ABSTRACT

The potato (*Solanum tuberosum*) is the world's fourth largest food crop after rice, wheat and maize, and only second to maize in Kenya. Potato productivity is largely dependent on the type of seed potato used by farmers. There is low adoption of clean seed potato in Njoro Sub-County despite its potential to increase the yields. This has kept potato productivity in Njoro Sub-County below the optimum. This study sought to determine the association between selected social, economic and technology related factors and adoption of clean seed potato by small scale farmers in Njoro Sub- County, Kenya. The study was guided by Diffusion of Innovations Theory. The study used correlational research design. The accessible population of this study was 8603 potato farmers in Njoro Sub-County. Mau Narok, Mauche and Nessuit wards were selected for this study. Simple random sampling procedure was used to select 130 respondents for the study. A researcher-administered questionnaire was used to collect data. Reliability of the questionnaire was determined through pilot testing using 33 potato farmers in Lare Ward of Njoro Sub-County. Cronbach's alpha Coefficient was computed yielding 0.7038, which was accepted. Data analysis relied on percentages, frequencies, measures of central tendency and dispersion to describe variables of the sample. Chi-square test was used to examine the association between selected social, economic and technology related factors, and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County at a significance level of 0.05 using Statistical Package for Social Sciences (SPSS) version 20. There was a statistically significant association between education level completed by respondents, belonging to farmer groups and distance from the source of clean seed potato to farms, and adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya [(education χ^2 (3, n= 130) = 8.596), (belonging to potato farmer group χ^2 (1, n = 130) = 4.665), (distance χ^2 (4, n= 130) = 39.502), $p < .05$. The study concludes that belonging to potato farmer groups, level of education completed, and the distance between the farms and the source of seed potato is associated with adoption of clean seed potato by small scale farmers in Njoro Sub-County. The study recommends that the Ministry of Agriculture Livestock and Fisheries, and extension agents help farmers in formulating groups and increasing clean seed potato production for increased adoption.

TABLE OF CONTENTS

DECLARATION AND RECOMMENDATION ..... **ii**

COPYRIGHT ..... **iii**

DEDICATION ..... **iv**

ACKNOWLEDGEMENT ..... **v**

ABSTRACT ..... **vi**

LIST OF TABLES ..... **xi**

LIST OF FIGURES ..... **xii**

LIST OF ABBREVIATIONS AND ACRONYMS ..... **xiii**

CHAPTER ONE **1**

INTRODUCTION **1**

1.1 Background Information 1

1.2 Statement of the Problem 6

1.3 Purpose of the Study 6

1.4 Objectives of the Study 6

1.5 Hypotheses of the study 7

1.6 Significance of the Study 7

1.7 Scope of the Study 7

1.8 Assumptions of the Study 8

1.9 Limitations of the Study 8

1.10 Definition of Key Terms 9

CHAPTER TWO **12**

LITERATURE REVIEW **12**

2.1 Introduction 12

2.2 An Overview on Global Potato Production 12
2.3 Importance of Potato Production in Kenya 13
2.4 The Extent of Potato Production in Kenya 14
2.5 Food and Nutritional Value of Potatoes for Human Beings 14
2.6 Challenges to Potato Production in Kenya 15
2.7 Adoption of Agricultural Innovations by Farmers 16
2.8 Social Factors Associated with Adoption of Agricultural Innovations by Farmers 17
2.9 Economic Factors Associated with Adoption of Agricultural Innovations by Farmers 18
2.10 Technology Related Factors Associated with Adoption of Agricultural Innovations by Farmers 19
2.11 Identified Gaps in the Existing Knowledge on Adoption of Clean Seed Potato in Njoro Sub-County 21
2.12 Theoretical Framework of the Study 22
2.13 Conceptual Framework 25
CHAPTER THREE 27
RESEARCH METHODOLOGY 27
3.1 Introduction 27
3.2 Research Design 27
3.3 Study Location 28
3.4 Target Population 29
3.5 Sampling Procedure and Sample Size 29
3.6 Instrumentation 31
3.6.1 Validity 32
3.6.2 Reliability 33
3.7 Data Collection Procedure 33

3.8 Data Analysis 33
3.9 Ethical Considerations 34
CHAPTER FOUR 35
RESULTS AND DISCUSSIONS 35
4.1 Introduction 35
4.2 Profile of Respondents 35
4.2.1 Gender of Respondents 36
4.2.2 Age of the Respondents 36
4.2.3 Number of People Living in the Household of Respondents 38
4.2.4 Number of Years Respondents Have Been Producing Potatoes 39
4.2.5 Highest Level of Formal Education Attained by Respondents 40
4.3 Adoption of Clean Seed Potato in Njoro Sub-County 40
4.3.1 Types of Seed Potato Used by the Respondents 41
4.3.2 Frequency of Using Clean Seed Potato by Respondents 42
4.3.3 Adopters and Non Adopters of Clean Seed Potato 42
4.3.4 Reasons for Preferring Clean Seed Potato 43
4.3.5 Reasons Why Some Respondents do not Use Clean Seed Potato 44
4.4 Association between Selected Social Factors and Adoption of Clean Seed Potato by Small scale Farmers in Njoro Sub-County Kenya 44
4.4.1 Group Membership of Respondents 45
4.5 Association between Selected Economic Factors and Adoption of Clean Seed Potato in Njoro Sub County Kenya 50
4.5.1 Major Sources of Income of Respondents 50
4.5.2 Estimated Total Annual Income and Expenditure of the Respondents 51
4.5.3 Sources of Money for Financing Potato Production 51

4.5.4 Size of Farmland Owned by Respondents 52
4.5.5 Distance from the Source of the Seeds to the Respondents' Farms 54
4.6 Association between Selected Technology Related Factors and Adoption of Clean Seed Potato in Njoro Sub-County, Kenya 56
4.6.1 Perception of Respondents towards Clean Seed Potato 56
CHAPTER FIVE 60
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 60
5.1 Introduction 60
5.2 Summary of Study Findings 61
5.3 Conclusions of the Study 62
5.4 Recommendations of the Study 63
5.5 Suggestions for Further Research 63
REFERENCES 64
APPENDICES 74
Appendix A: Questionnaire for Small Scale Potato Farmers in Njoro Sub County 74
Appendix B: Map Showing Location of the Study Area 79
Appendix C: Letter of Research Authorisation 80
Appendix D: Research Permit 81
Appendix E: Abstract of the Publication 82
Appendix F: Chi-Square Test Results for Selected Social, Economic and Technology Related Factors 83

LIST OF TABLES

Table 1: Potato Yields in Nakuru County for the Year 2017 4

Table 2: The Selected Wards for the Study and Target Population 29

Table 3: Age Ranges of Respondents (n=130) 37

Table 4: Number of People Living in the Household (n=130) 38

Table 5: Number of Years a Respondent has been a Potato Farmer (n=130) 39

Table 6: Highest level of Education Completed by Respondents (n=130) 40

Table 7: Reasons Why Some Respondents do not Use Clean Seed Potato (n=111) 44

Table 8: Activities Done in the Farmer Groups (n=99) 46

Table 9: Chi Square Test Results for Association between Selected Social Factors and Adoption of Clean Seed Potato 47

Table 10: Major Sources of Income for Respondents (n=130) 50

Table 11: Where the Respondent Gets Money for Potato Farming (n=130) 52

Table 12: Distance Travelled to Look for Seed Potato (n=130) 54

Table 13:Chi-Square Test Results for Association between Selected Economic Factors and Adoption of Clean Seed Potato 55

Table 14: Perception of Respondents towards Clean Seed Potato 57

Table 15: Chi-Square Test Results Showing the Association between Selected Technology Related Factors on Adoption of Clean Seed Potato 58

LIST OF FIGURES

Figure1: Conceptual Framework of the Study 25

Figure 2: Sampling Framework for the Study 30

Figure 3: Gender of Respondents 36

Figure 4: Types of Seed Potato Used by Respondents in Njoro Sub-County 41

Figure 5: Frequency of Using Clean Seed Potato by Respondents 42

Figure 6: Adopters and Non-Adopters of Clean Seed Potato 43

Figure 7: Reasons Why Farmers Prefer to Use Clean Seed Potato 43

Figure 8: Group Membership of Respondents 45

Figure 9: Estimated Annual Income and Expenditure of Respondents 51

Figure 10: Size of Farmland Owned by Respondents 53

LIST OF ABBREVIATIONS AND ACRONYMS

ADC	Agricultural Development Cooperation
CSP	Clean Seed Potato
FAO	Food and Agricultural Organization of the United Nations
KALRO	Kenya Agricultural and Livestock Research Organization
KEPHIS	Kenya Plant Health Inspectorate Services
KNBS	Kenya National Bureau of Statistics
MMT	Million Metric Tons
MT	Metric Tons
NIDP	Nakuru Integrated Development Plan
NPCK	National Potato Council of Kenya
RUFORUM	Regional Universities Forum for Capacity Building in Agriculture
SPSS	Statistical Package for Social Sciences
TAGDev	Transforming African Agricultural Universities to Meaningfully, Contribute to Africa's Growth and Development

CHAPTER ONE
INTRODUCTION

1.1 Background Information

The potato (*Solanum tuberosum*) is a starchy tuberous crop and the world's fourth largest food crop after rice, wheat and maize (Muthoni, Shimelis & Melis, 2013). Potato is the world's most important root and tuber crop grown in more than 125 countries and consumed almost daily by more than a billion people globally (FAO, 2009). Global annual potato production was about 300 million tons in 2011 produced from close to 20 million hectares of land (Jasim, Husseins & Nayef, 2013). China is the world's leading potato producing country in terms of volume and area contributing about 100 million tons towards global production (Hong, Fen, Yu, Hong-hai, & Xiao-feng, 2017; Li & He, 2018). Potato is the second staple food crop in United states of America (Hong *et al.*, 2017).

Similarly, potato is a staple food for many families in East Africa, both in rural and urban. In 1992, the East African countries including, Kenya, Uganda, Tanzania, Burundi, Rwanda, Zaire and Ethiopia established Regional Potato Improvement Program for Eastern and Central Africa (PRAPACE) to achieve improved quantity and quality production in these countries (Kaguongo *et al.*, 2008). Potato production is favoured by the double cropping seasons common with the rain-fed systems in most African countries. Because potato is a short cycle crop (3 to 4 months), potato can be produced for up to three seasons a year hence improving food accessibility (Sanginga & Mbabu, 2015)

In Kenya, potato is the second most important food crop after maize (Muthoni *et al.*, 2013). It is grown on about 161,000 hectares with a production of close to 2-3 Million metric tons worth Kenyan Shillings 40-50 billion annually at farm gate prices (Mumia, Muthomi, Narla, Nyongesa, & Olubayo, 2018). An estimated 800,000 farmers grow potatoes in Kenya, while over 3.3 million people are employed along its value chain as growers, traders and processors (Okello, Zhou, Kwikiriza, Ogutu, Barker, Schulte-Geldermasnn, Atieno & Ahmed, 2016). About 97% of the potato farmers in Kenya are small scale farmers owing to less than five acres of land devoted to potato production (Ministry of Agriculture, 2016). Consequently, potato contributes to poverty

alleviation through income generation in both urban and rural households (Laibuni & Omiti, 2014).

Despite the potatoes' increasing importance in terms of consumption and income, a number of problems continue to threaten its productivity in Kenya (Ebrahim, Mohammed & Ayalew, 2018). For instance, most of Kenya's potato production is dependent on landrace seed varieties, which farmers get from the previous harvests, neighbours, or from the open markets (Taiy, Onyango, Nkurumwa & Ngetich, 2017). These varieties are degenerated with low yielding capacity, and infested with pests and diseases such as bacterial wilt and late bright. This leads to low yields and poor quality produce (Byarugaba, Namugga & Kashaija, 2013). Other factors that threaten potato productivity in Kenya include pests and diseases, poor marketing systems, poor farming methods and poor post-harvest handling mechanisms among others (Schulte-Geldermann, 2012). According to Muthoni *et al.* (2013) diseases especially blight and bacterial wilt which are a major threat to potato production in Kenya, spread rapidly through use of farmer saved seed potato and inadequate rotation. This problem can be solved through use of clean seed potato (Schulte-Geldermann, 2012).

According to National Potato Council of Kenya (NPCK) (2017), apart from climatic and agro ecological factors, the quality of seed potato used by farmers is the major yield determinant. Certified seed potato is considered to be of the best quality in Kenya (Ministry of Agriculture, 2016). Certified seed potato is produced under the formal seed system and is obtained from multiplication of basic seed under guidelines and supervision of Kenya Plant Health Inspectorate Services (Kenya Plant Health Inspectorate services (KEPHIS), 2017). Certified seed potato has a higher yielding capacity compared to other seed potato types like the farmer saved seed and clean seed potato, is resilient to diseases, pests and drought. Kenya requires 8000MT of certified seed potato annually yet only 208MT (NPCK, 2017). The production and use of certified seed potato in Kenya is insufficient in that only about 1% of potato farmers use it (Kaguongo, Ng'ang'a, Muthoka, Muthami, & Maingi, 2009). The of production of certified seed potato is inefficient and highly centralized to a few organizations for example, Kisima Farm in Nyeri County, Agricultural Development Cooperation (ADC), Kenya Agricultural Livestock Research Organisation (KALRO) Tigoni, Agrico East Africa in Nakuru County among others (Janssens,

Wiersema, Goos, & Wiersma, 2013). In addition, certified seed potato is expensive costing an average of 3000 Kenya shillings per 50kg bag making it economically inaccessible to many farmers (Laibuni & Omiti, 2014).

The second best type of seed potato that can increase productivity is the clean seed potato also known as quality declared seed potato (FAO, 2017). This type of seed is produced under the semi-formal seed system or the quality declared seed system (Kaguongo, Maingi, Barker, Nganga, & Guenthner, 2014). Clean seed potato is produced from certified seed and has the same qualities as certified seed for example; high yielding capacity, resilience to pests and diseases and fast maturity but lacks inspection, sample testing and certification by KEPHIS thus making it less expensive than certified seed potato (Kaguongo *et al.*, 2013). Clean seed potato is produced by trained farmers at farm level and is intended to bridge the gap for insufficient supply of certified quality seed to the farmers (Kaguongo *et al.*, 2013). The output from clean seed potato is quite good as compared to farmer saved seed (Kaguongo *et al.,* 2009). According to Kaguongo *et al.* (2014), clean seed potato is disease free and drought resilient. Clean seed potato matures faster and can increase potato yields by 30% through reducing disease incidents hence increasing farm productivity and incomes (Kamuyu, Muiru, Kimenju, & Nyongesa, 2017). According to FAO (2017) clean seed potato has been so instrumental in increasing the potato yields in Ethiopia where 99% of the farmers used to rely on informal seed sources like the farmer saved seed and seed from the open markets.

Kaguongo *et al.* (2014), conducted a study on the value of seed potato from the different seed systems in ten major potato producing counties in Kenya, that is; Nyandarua, Nakuru, Bomet, Kiambu, Nyeri, Meru,Narok, Mount Elgon, Taita Taveta, and Keiyo-Marakwet. They found out that only 1.4% of the respondents used clean seed potato while 1.1% of the respondents used certified seed potato, and 96.4% used farmer saved seed. Gichuru and Dijk (2015), also conducted a study on low potato yields in Kenya in the counties of Nyandarua, Meru and Nakuru and found out that only 4.48% of the respondents used clean seed potato. This is despite the fact that clean seed potato increases yields, and can be easily accessed by the farmers.

Consequently, farmers continue to use farmer saved seed and seed bought from nearby markets and neighbours (Taiy *et al.*, 2017). Farmer saved seed potato is obtained from the previous

harvests and kept as planting materials for the next season (Kaguongo *et al.*, 2008). Most times this seed is highly degenerated with low yielding capacity (Mumia, Muthomi, Narla, Nyongesa, & Olubayo, 2018; Gildemacher, Schulte-geldermann & Borus, 2011).

The consistent use of farmer saved seed potato maintains productivity below the optimum. Average potato productivity in Kenya is 7-10 tons per hectare compared to achievable 20 and 40 tons per hectare in Egypt and Netherlands respectively (Janssens *et al.*, 2013). In Nakuru County, potato productivity is generally low at about 14 tons per hectare though above the national average. Kuresoi South and Njoro Sub-Counties record the lowest productivity at 8.14 and 9.10 tons per hectare respectively as illustrated in Table 1 compared to Kuresoi North at 33 tons per hectare (Nakuru County, 2018).

Table 1: Potato Yields in Nakuru County for the Year 2017

Sub County	Area (Ha)	Quantity(Ton)	Tons Per Hectare
Kuresoi North	5,330	175,890	33.00
Molo	9,574	148,261.5	15.49
Njoro	8,049	73,231	9.10
Kuresoi South	12,839	104,454	8.14
Total	**35,792**	**501,837**	**14.02**

Source: Adapted from Draft Nakuru County Potato Strategy 2018-2022

The low yields lead to low incomes for farmers and reduces access to food, increasing food and nutritional insecurity. To increase income and improve food security of potato farmers, there is a need to increase the yields. Yields can be enhanced through increased adoption and use of high quality seed potato like the clean seed potato.

While studies have been conducted to document the factors that influence small scale farmers' choice of seed potato, most of them focus on certified seed potato. These factors could be classified into three; social, economic and technology related factors. Social factors relate to culture, organizations and interactions that regulate access to and utilization of resources and services by people. They include membership in farmer organizations, farmer education level, age, gender, farming experience, government policies, and level of participation in programmes or projects (Dsouza *et al.*, 1993). The selected social factors for this study were; age, gender,

farmer education level, potato production experience, and belonging to farmer groups. These factors were selected for this study because they have been found to be associated with adoption of agricultural technologies and innovations. Farmers are motivated to appreciate benefits of certain technologies practiced by some members of their organizations and try out the innovations in their own fields (Rodgers *et al.,* 2003).

Economic factors are associated with improvement of welfare of the people through enhancement and advancement of production, investment, profitability and marketing capacity (Tey, 2013). These include distance between the farmers and the source of the seeds, farmers' income level, size of farmland owned by famers, and access to credit services (Okello *et al.*, 2016). Other economic factors such as use of credit in potato farming, farmer's off-farm income, income of the farmer may influence his choice to adopt seed potato. The selected economic factors for this study were; major sources of income of farmers, estimated annual incomes, size of farmlands, and the distance from the source of seed to farms. These were selected because they have been found to be associated with adoption of agricultural innovations especially the choice of seed potato.

Technology related factors refer to the perceived attributes or characteristics of an innovation which influence acceptance and use of a new practice, object or idea by the people (Rogers, Singhal & Quinlan, 2003). In relation to clean seed potato, these attributes are, high yielding, early maturity, resilience to pests and diseases and ability to survive in different weather conditions (Okello *et al.*, 2016). Adopters are likely to adopt an innovation with positive attributes that are desirable in terms of their relative advantage, compatibility, complexity, trialability and observability as compared with conventional and existing practices (Rodgers *et al.,* 2003). When people perceive an innovation positively, it compels them to find information about it, which increases its likelihood for adoption. This study sought to determine whether these factors are associated with adoption of clean seed potato. The selected technology related factors for this study were; first maturity, high yielding capacity, resilience to pests and diseases and cost of the seed. The study was conducted in Njoro Sub-County, one of the sub counties with low potato productivity in Nakuru County.

EGERTON UNIVERSITY
LIBRARY

1.2 Statement of the Problem

Potato is the second most important food crop after maize in Kenya as well as Njoro Sub-County. Despite increasing importance of potato for both consumption and income, potato productivity is still low in Njoro Sub-County. This is partly due to use of poor quality seed potato. There is low adoption of clean seed potato in Njoro Sub-County. Farmers, continue to use farm saved seeds and seeds bought from neighbours and nearby open markets, which is mostly degenerated and infected with pests and diseases, with low yielding capacity. This has kept potato productivity in Njoro Sub-County below the optimum leading to food and nutrition insecurity and low incomes to farmers. Use of clean seed potato can result in higher yields as compared to farm saved seed. Despite its benefits, like having the capacity to increase production yields, being suitable to the social, economic conditions of most small scale potato farmers, its adoption is still low in Njoro Sub-County. There are many factors associated with adoption of agricultural innovations, which include social, economic and technology related. Few studies have been carried out to examine the association of these factors with adoption of clean seed potato among small scale farmers in Njoro Sub-County. This study, therefore, sought to determine the association between selected economic, social, and technology related factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County.

1.3 Purpose of the Study

The purpose of this study was to determine the association between selected social, economic and technology related factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County Nakuru, Kenya.

1.4 Objectives of the Study

The following were the objectives of the study.

i. To determine the association between selected social factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

ii. To determine the association between selected economic factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

iii. To determine the association between selected technology related factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

1.5 Hypotheses of the study

The hypotheses of the study were:

$H0_1$: There is no statistically significant association between selected social factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

$H0_2$: There is no statistically significant association between selected economic factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

$H0_3$: There is no statistically significant association between selected technology related factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

1.6 Significance of the Study

The findings of this study may guide the ministry of Agriculture Livestock and Fisheries of Kenya in formulating appropriate policies, decisions, interventions, and strategies aimed at increasing adoption of high quality seed potato for increased productivity and food security. The documentation of association between selected factors and adoption of clean seed potato by small scale potato farmers may be very informative for extension services in increasing clean seed potato adoption. This can be achieved through guiding farmers especially in formulating potato farmer groups and increasing clean seed potato production. This may help increase yields, income and improve food and nutrition security of potato farmers.

1.7 Scope of the Study

This study focused on small scale potato farmers in Njoro Sub-County, Nakuru County, Kenya. The study was restricted to analysis and documentation of the association between social, economic and technology related factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County. The selected social factors were, age, gender, household size, farmer education level completed and experience of the farmer in potato production. The selected economic factors were farmers income, sources of income, size of farmland owned, and the distance of farms from the source of seed potato. The selected technology related factors were, high yielding capacity, fast maturity, resilience to drought, resilience to pests and diseases and the cost of clean seed potato.

1.8 Assumptions of the Study

The study was guided by the following assumptions:

i. The respondents would be able to recall their experiences like yields they obtain, source of the seed potato they plant, challenges they face, and provide realistic responses.

ii. Extension information disseminated by service providers in Njoro Sub-County contains information about adoption of clean seed potato.

iii. Respondents would be available for data collection and would be able to provide realistic and sincere responses based on their real life experiences.

1.9 Limitations of the Study

This study was limited by the following:

i. There was a challenge of language barrier between the researcher and the respondents. The researcher is only fluent in English. Most small scale farmers were not fluent in English. This hindered effective communication. However, the researcher elicited the assistance of a translator to aid communication.

ii. Adverse weather conditions and other commitments of the target respondents affected their availability for data collection. To this, the researcher allocated adequate time for the exercise.

1.10 Definition of Key Terms

Accessibility: This is a pre-condition for inclusiveness of every individual in the society with flexibility to accommodate every member's needs and preferences (Pe´rez *et al.*, 2018). In this study, accessibility meant the ability, and favourable conditions for the farmers in purchasing clean seed potato in terms of variety preferences, social, economic and technological conditions.

Adoption: This is the acceptance and use of an idea, practice or object by an individual or members of a social system as a part of course of action for addressing a particular need (Rogers *et al.*, 2003). In this study, adoption meant accepting and using clean seed potato by potato farmers. Those potato farmers who had used clean seed potato consistently for at least two consecutive seasons were termed as adopters, while those who had used clean seed potato less than two times were termed as non-adopters.

Association of variables: Association of variables helps to tell if/whether two or more variables tend to occur together (Patel, 2009). Association also tells if two or more variables are statistically significant or not. As such, the main goal in studying association is to find causal explanations that help us to understand our environment (Jones, 1998). By establishing the associations, between independent and dependent variables, the researcher was able to adequately interpret results and reliably relate them to the problem of the study. This helped to draw valid and reliable conclusions and recommendations.

Availability: This is "the percentage measure of the degree to which an item is in an operable or committable state at the point in time when it is needed" (Paschall, Ringwalt, Grube, & Miller, 2018). Operable and committable state means that the item is at the disposure of the customer to use whenever the customer is ready to commit resources on a particular item. For this study, availability meant clean seed being at the disposure of the farmer whenever the farmer is ready to commit resources on it. This means that clean seed is available for the farmer to purchase whenever the farmer decides to plant using it.

Certified seed potato: This is the seed potato obtained from multiplication of basic seed under strict supervision and guidelines of KEPHIS. It is the only legally recognised seed potato that can

be traded in formal markets in Kenya. It is mainly produced by the public sector and a few certified seed potato producers (Okello *et al.*, 2016).

Clean seed potato: This is seed potato that originates from certified seed or basic seed and is produced by trained farmers who follow specific guidelines. Most production guidelines are similar to those of certified seed except that clean seed is not inspected, tested and certified by KEPHIS (Kaguongo *et al.*, 2009).

Economic factors: These are factors associated with improvement of welfare of the people through enhancement and advancement of production, investment, profitability and marketing capacity of people (Tey, 2013). This study looked at farmers' major sources of income, farmers' income levels, and income, size of land, and distance from the seed source as economic factors that might favourably influence to adopt clean seed potato.

Farmer saved seed potato: This is the type of seed potato, which farmers get from previous harvests and keep them for use as seed for the next planting season and accounts for more than 90% of the total seed potato used in Kenya (Kaguongo, *et al.*, 2013). According to Mumia *et al.* (2018), this seed is usually of low quality with low yielding capacity due to pest and disease infestation.

Seed potato: Seed potato is the planting material for the ware production of potatoes (Janssens *et al.,* 2013). There are three types of seed potato used by farmers in Kenya in the production ware potato why include, certified seed potato, clean seed potato and farmer saved seed potato (Kaguongo, *et al.*, 2013). According to Ogola *et al.* (2012), Kenya requires about 240, 000 tons of seed potato annually. This study concentrated on clean seed potato.

Social factors: These relate to culture, organizations and interactions that regulate access to and utilization of resources and services by people (D'souza, Cyphers, & Phipps, 1993). They are characteristics inherent in the farmer, societal perception and attributes among others. For this study, they included; age of the farmer, membership in farmer organizations, farmer experience, and education level, size of the household, gender and experience of the farmer in potato production.

Small scale potato farmer: The concept of small scale farmers have been relatively defined depending on the context and location. FAO (2016), described small scale potato farmers as those famer devoting less than 10 hectares of land to potato production. While many researchers have targeted small scale farmers in Kenya, most of them describe them in terms of acreages as those farmers devoting less than 5 acres of land to potato production in Kenya These constitute more than 78% of the potato producers (Kaguongo *et al.*, 2014; Okello *et al.,* 2016). For this, study a small scale potato farmer was a farmer devoting less than 5 acres of land to potato production.

Technology related factors: These refer to the perceived attributes of an innovation which influence acceptance and use of a new practice, object or idea by the people (Rogers, 2003). For this study, technology related factors were the attributes of the clean seed as a technology. They are; high yielding capacity, fast maturity, resilience to major pests and diseases and ability to survive in different weather conditions and cost of the seed. If an innovation is perceived as a strong relative advantage, fulfills present needs and values, easy to try and simple to understand, then it is more likely to be adopted.

Ware potato: Ware potato is the fresh produced potatoes for consumption as fresh and traded for processing into consumable products like crisps, chips, powder etcetera (Janssens *et al.,* 2013). According to MoALF (2016), Kenya produces about three million tons of ware potato annually.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter discusses information relevant to the study. It gives an overview on global potato production, food and nutritional value of potatoes, importance of potato production and challenges to potato production in Kenya. The chapter also provides information on the association between selected social, economic and technology related factors and adoption of agricultural innovations by farmers. Furthermore, this chapter provides the information about identified gaps on the existing knowledge on adoption of clean seed potato in Njoro Sub-County, which the study set to fill. The theoretical framework and the conceptual framework of the study are also presented in this chapter.

2.2 An Overview on Global Potato Production

The potato (*Solanum tuberosum*) is the world's fourth largest food crop after rice, wheat and maize (Muthoni, Shimelis & Melis, 2013). Potato is the world's most important root and tuber crop grown in more than 125 countries and consumed almost daily by more than a billion people globally (FAO, 2009). Global annual potato production was about 300 million tons in 2011 produced from close to 20 million hectares of land (Jasim, Hussein & Nayef, 2013). China, India, and Russia are the principal potato producers (Wang, Liu, Ren, Yang, & Feng, 2019). China is the world's leading potato producing country in terms of volume and area contributing about 100 million tons towards global production from around 5.6 million hectares (Hong, Fen, Yu, Hong-hai, & Xiao-feng, 2017; Li & He, 2018). Yield per unit area in China increased from 15 tons/ha to 17 tons/ ha from 2007 to 2016. However, yield per unit area is less than the world average (20 tons/ha), and much lower than in developed countries (40 tons/ha) such as Holland, France, the United States and New Zealand (Hong *et al.*, 2017).

Potatoes play an important role in developing countries' food security; 50% of the world's food energy needs are supplied by potatoes, rice, wheat and maize (Su & Wang, 2019). Global potato consumption was on average 35 kg/capita/year in 2013 (Jansky, Navarre, & Bamberg, 2019). Trends in potato consumption show that while in Europe potato consumption has been steadily decreasing, Africa and Asia have seen a 70% increase between 1961 and 2013 (Su & Wang,

2019). Potato is an important food and cash crop in Eastern and Central Africa, playing a major role in national food security and nutrition, poverty alleviation and income generation, and; provides employment in the production, processing and marketing sub-sectors (Su & Wang, 2019).

Global potato production and productivity faces relatively similar challenges like prolonged droughts, pests and diseases among others. However, developed countries are more resilient to these shocks and have a relative advantage in mitigating these challenges over developing countries (Wijesinha-bettoni & Mouillé, 2019). Just like in Kenya, one of the major challenges of global potato production is insufficient high quality seeds almost in all potato producing countries. This leads to use of poor quality seeds by farmers contributing to low productivity and food insecurity. There is need to document the factors associated with adoption and use of high quality seed potato by farmers in order to improve productivity.

2.3 Importance of Potato Production in Kenya

Potato plays a major role in poverty alleviation, food and nutritional security, and as an important food and cash crop in Central and Eastern Africa (Okello *et al.*, 2016). Potato provides employment opportunities in the production, processing and marketing subsectors (Menza & Gebrerufael, 2018). There is growing concern in Kenya that potato production can greatly contribute to achieving the national objectives of vision 2030 by boosting food security, raising incomes, creating employment and improving nutritional security (Schulte-Geldermann, Wachira, Ochieng, & Barker, 2013). Vision 2030 is a long-term national blue print that aims at transforming Kenya into an industrial, middle-income Country by 2030 (Government of Kenya, 2007).

Potatoes can contribute to industrial growth and economic development of Kenya. For example, potato contributes about 50 billion Kenyan shillings annually towards the Growth Domestic Product of Kenya [GDP], and it is identified as one of the pillars that will greatly contribute to achievement of Kenya vision 2030 because it substantially contribute to food availability in the country (Ministry of Agriculture, 2016). According to Lutaladio *et al.* (2009), these attributes have made it a valuable food and cash crop for millions of people. To maintain potatoes importance in Kenya, there is need to remove the bottlenecks on its productivity like lack of

access to high quality seed by famers. Increased productivity may improve farmers' incomes, food and nutritional security.

2.4 The Extent of Potato Production in Kenya

Despite its nutritional advantages and ability to produce more yields per unit area, potato has been sidelined for subsistence production and its high production potential is still underutilized in Kenya (Kirub & Asfaw, 2013). Potato yields remain low in Kenya between 7- 10MT/ha against a potential of 20 MT/ha obtained in Egypt and 40 MT/ha obtained in the Netherlands (Janssens *et al.*, 2013).

The low potato productivity compared to its importance has attracted the attention of policy makers and researchers to find out and mitigate the causes of this low production. Some studies have found out that the existing low potato productivity is majorly due to inadequate certified seed (Kiplagat, Rehema, Xianli, Mchomvu & Baloch, 2016). This forces the farmers to use farm saved seed potato which is usually associated with poor quality, low yielding capacity, and contamination with pests and diseases such as bacterial wilt and late bright which leads to low yields and poor quality produce (Muthoni, Mbiyu, & Nyamongo, 2010). Despite these disadvantages, farmers continue to use farmer saved seed potato majorly because that is what they access and can afford. It is thus inevitable that to improve potato productivity in Kenya, potato farmers must be included and accessed with a more accessible and affordable seed potato like the clean seed potato. Policy makers and extension staff need to be guided on helping farmers to access clean seed potato for increased productivity.

2.5 Food and Nutritional Value of Potatoes for Human Beings

Potatoes (*Solanum tuberosum*) are important food crops for human consumption and contribute about 240MMT of global food annually (Sanginga & Mbabu, 2015). The developing world has witnessed a rapid expansion of potato production due to its ease of cultivation and high nutritive value. Potato for consumption comes in two forms, which are fresh and processed. The processed potato include; French fries, canned, dehydrated and frozen among others (Abong & Kabira, 2015).

Nutritionally, potatoes are rich in carbohydrates (Bilate & Mulualem, 2016). They also provide potassium, vitamin C and proteins with no fat or cholesterol (Kaplan, Ulger, & Kokten, 2018). Potatoes also have a high level of antioxidants that help heart and eye health (Hielke, De Jong, Joseph & Sieczka, 2011). Furthermore, peels of potatoes contain potassium and fibre, as well as vitamins like folic acid and B6 (Silver, 2013). They therefore improve human food and nutrition. Potatoes are also used for making alcohol, animal feed, pharmaceuticals, food, and textiles; they are also used as a starch for making adhesives, texture, and filler in paper (National Potato Council of Kenya, 2017). In order to increase potato consumption in Kenya, improving potato productivity must be prioritized. More so, to maintain quality and nutritive value of potato products, it must begin with quality production. Quality production itself includes using quality seed like the clean seed. Productivity of potatoes is highly dependent on the type and quality of seed used by farmers (Thomas-Sharma *et al.*, 2016).

2.6 Challenges to Potato Production in Kenya

Despite potato's increasing importance in terms of consumption in Kenya, potato production faces numerous challenges such as limited supply of quality seeds, pests and diseases especially bacterial wilt and blight, poor marketing systems, poor farming methods and lack of proper storage and packaging facilities (Obare, Nyagaka, Nguyo, & Mwakubo, 2010). These production and postharvest constraints have led to low production and reduced potato harvest quality and quantity, which in turn reduce the market potential, yields and profit margins to the farmers. Muthoni *et al.* (2013), identify inadequate certified seed potato, low productivity, weak research-extension-farmer linkages, low level of value addition and poor market infrastructure as other challenges facing the potato sub-sector. Poor seed potato quality is a major yield-reducing factor in potato production in Kenya.

Other challenges include; inadequate financing and credit services, poor enforcement of produce and product standards, lack of proper on-farm storage facilities at farm level and at the marketing centers. This leads to huge losses during marketing, instability of supply and prices, lack of technical know-how by farmers to store potatoes, poverty which forces people to harvest pre-mature potatoes, pests and diseases which leads to poor and reduced produce (Kenya Plant Health Inspectorate services, 2017).

There is also a challenge of insufficient supply and adoption of high quality seed potato among farmers. The supply and adoption of clean seed potato and certified seed potato is very inadequate in Kenya. This is because there is scarcity in production and supply of certified seed potato. With only 2.6% of the certified seed potato requirement being produced, accessibility of certified seed potato is a challenge to many farmers especially those on small scale. Use of farmer saved seed potato is a root cause of many challenges, like pests and diseases, low yields, low income, food insecurity, and reduced quality of farmers' livelihoods.

According to Ogutu *et al.* (2013), low yields prevents commercialization of potato production and keeps small scale farmers in subsistence production. This explains slow small scale sector development and continued poverty and food insecurity. Farmers need access to clean seed potato in order to increase their yields, income and improve their livelihoods. According to Lanteri and Quagliotti (1997), seeds are important sources of innovation, especially in resource deficient small scale and rain fed farming environments. Improved seeds can make a substantial contribution to agricultural productivity. There is a need to understand the dynamics surrounding the adoption of clean seed potato especially by small scale farmers in order to improve its accessibility and usage for ultimate increment in yields and incomes.

2.7 Adoption of Agricultural Innovations by Farmers

Innovations are technological advances that create new or improved products. Hence, agricultural innovations are those advances in agriculture that creates new or improved quality and quantity produce (Alirah, Mulubrhan, Hildegard, & Hermann, 2018). They include improved seed varieties, improved fertilizers, chemicals, harvesting technologies and storage technologies (Pisante, Stagnari & Grant, (2012). Diffusion and adoption of these agricultural innovations is associated with a number of factors including social, economic and technology related. For example, gender has been found to be associated with agricultural production and adoption of agricultural innovations because of its potential to influence access to and use of production resources (GoK, 2004). According to Anon and Calvelo (1980), women especially in the developing countries are rural dwellers and produce most of the domestic food. Sulo *et al.* (2012), found household size significant in influencing women to adopt agricultural

technologies. They noted that farmers with larger household size would have the needed labour required for these activities in addition to having more mouths to feed and more income needs.

According to Rodgers *et al.* (2013), time or experience is a very important factor especially in adoption of technologies and innovations. According to Khai *et al.* (2008), age predisposes a farmer to better farming techniques and management skills through learning by doing. Taiy *et al.* (2016), observed that age increases adoption of agricultural innovations but with diminishing effect as age increases.

Balakrishnan (2001), suggests that there is an important link between education level, possession of appropriate information and making of informed choices. Therefore, educated famers may favourably make decisions to adopt clean seed potato than their uneducated counterparts. According to Haque (2009), education helps in information dissemination, provides necessary skills and expertise and helps in changing attitudes towards farming.

Technologically, if an innovation is perceived as a strong relative advantage, fulfills present needs and values, easy to try and simple to understand, then such a technology is more likely to be adopted. According to Sulo *et al.* (2012), farmers might not adopt an innovation which is not compatible with their norms, traditions and socio economic status. Clean seed potato is produced at farm level and in the localities where it is used. Clean seed potato is therefore compatible with the norms, traditions and socio economic status of farmers like being cheap and affordable.

2.8 Social Factors Associated with Adoption of Agricultural Innovations by Farmers

Social factors relate to culture, organizations and interactions that regulate access to and utilization of resources and services by people. They include access to extension services, membership in farmer organizations, farmer education level, farming experience, age, and gender (Dsouza *et al.,* 1993). Culturally, most of societies in developing countries do not allow women farmers to have complete access to and control over production resources like land and credit. This prevents them from taking full participation in decision making which includes adopting agricultural innovations like clean seed potato.

The collective decisions made within farmers' organizations such as cooperatives, associations and clubs tend to influence its members to make certain adoption decisions about a wide range of

agricultural practices. Therefore, potato farmers who belong to farmer groups are more likely to adopt certain seed potato as group influence. According to Rodgers *et al.* (2003), famers are motivated to appreciate benefits of certain technologies practiced by some members of their organizations and try out the innovations in their own fields. The organizations also serve as entities within which extension services are efficiently delivered to the members. Collective activities like marketing and production, purchasing of inputs by farmer organizations help them maximize returns on their initiatives and increase their financial capacity to invest in sustainable farming (Tey, 2013)

Kiplagat *et al.* (2016), found out that farmer education level, membership to farmer associations, years of experience in potato farming, the age of the farmer, gender of the farmer and household size are significant factors that influence the probability of adoption and use of agricultural innovations like the certified seed potato. Okello *et al.* (2016) concluded that food insecurity of a household determines the farmers' choice of adopting certified seed potato. This is because a household focuses on finding means to feed its members instead of purchasing the expensive certified seed potato. Okello *et al.* (2016), recommended that this could be overcome socially through collective action and collective purchase. This can be achieved when farmers form groups. They suggest that farmers can come together in groups and work collectively hence reducing the operational costs. Socially, with farmer group approach, clean seed potato adoption can be increased by rapid multiplication through combined effort. This can be achieved through training different farmers groups in clean seed potato multiplication which will translate into increased adoption. Kaguongo *et al.* (2013), also recommend for training of more farmers in clean seed potato production in order to increase its production and adoption. The association of such factors like belonging to groups, household size, age, gender, and farmer education level with adoption of agricultural technologies is important, more so with adoption of clean seed potato.

2.9 Economic Factors Associated with Adoption of Agricultural Innovations by Farmers

Economic factors are variables which are directly associated with improvement of welfare of the people through enhancement of production, investment, management and marketing capacity of

people and their organizations (Tey, 2013). These include the cost of the innovation, incomes of the farmers, major sources of incomes to farmers, transaction costs among others. Okello *et al.* (2016), found out that the long distance to the seed potato source, and hence the high transaction cost, has an effect on the decision to adopt certain seed potato varieties by farmers because it increases the transactional costs. This is because; small scale farmers have limited economic capacity to support their agricultural activities. Besides, the farmers need to support their families and their livelihoods financially. Therefore, for the case of small scale farmers, who are in most cases financially constrained, their rate of adoption of certified seed potato is still low. Poor households are less likely to benefit from the use of certified seed potato. They suggest that farmers need financial support in form of subsidies and financial empowerment. However, these subsidies may not be sustainable in the end.

Household food insecurity can affect the use of certified seed potato. For example, farmers who are food insecure would divert funds that would be invested in potato purchasing and adopting to an agricultural innovation to buying food for their households. Other economic factors such as use of credit in potato farming, farmer's off-farm income, by the farmer, income of the farmer may influence his choice to adopt seed potato. Kiplagat *et al.* (2016), found out that economic factors like, distance to the market, household food insecurity and asset endowment affect the decision by the farmers to adopt certain agricultural innovations like the clean certified seed potato. Farm sizes are also known to determine production levels and adoption of innovations (Ojango & Pollot, 2002). Less is known about the association of economic factors with adoption of clean see potato especially by small scale farmers in Njoro Sub County.

2.10 Technology Related Factors Associated with Adoption of Agricultural Innovations by Farmers

Technology related factors are the perceived characteristics or attributes of an innovation, which influence acceptance and adoption of a technology or idea by people. Adopters are likely to adopt an innovation with positive attributes that are desirable in terms of their relative advantage, compatibility, complexity, trialability and observability as compared with conventional and existing practices (Rodgers *et al.,* 2003). Relative advantage is the degree to which an innovation is seen as a better idea or innovation it replaces. Clean seed potato offers a relative advantage

over farmer saved seed potato because it is free from pests and diseases, is resilient to drought and therefore can yield higher than the farmer saved seed (Kaguongo, Maingi, Barker, Nganga, & Guenthner, 2013). Clean seed potato also, is cheaper when compared to certified seed potato hence reduces costs of production when compared to certified seed potato. On the other hand, compatibility is the degree to which an innovation is consistent with the values, experiences and needs of potential adopters. Clean seed potato can be produced in local varieties, yields higher and therefore can increase productivity. Increased productivity boosts farmers' incomes, food and nutritional security of farmers.

Complexity of an innovation is how difficult it is to understand and use. It is not difficult to understand and use clean seed potato, as the agricultural practices are the same as for other seed potato types like farmer saved seed. In addition, trialability is the extent to which an innovation can be tested or experimented with before a commitment to adopt it is made. Potato farmers can plant using clean seed potato as experimentation and if they do not observe their expectations, some of them stop using it. On the other hand, observability is the extent to which the innovation produces tangible results. In a social system, potato farmers are able to observe from their own fields and in the neighbourhood the vegetative potatoes, and the high yields obtained by those using clean seed potato for ware potato production. This can influence them to adopt the clean seed potato.

When people perceive an innovation positively, it compels them to find information about it, which increases its likelihood for adoption. This study hypothesized that technology related factors like fast maturity, resilience to pests and diseases and high yielding capacity, which can be easily observed by farmers in the neighborhoods, can increase small scale farmers' likelihood to adopt and use clean seed potato. With increased communication and awareness creation, potato farmers may increase their uptake and use of clean seed potato, which will increase their yields, food and nutritional security. The low potato yields in the tropical highlands of Africa are largely attributed to pests and diseases, particularly late blight, bacterial wilt, and to the inadequate supply and access to quality seed by ware potato farmers (Laibuni & Omiti, 2014).

This means that farmers will always consider varieties and forms of seed potatoes, which are resilient to major pests and diseases.

Clean seed potato has resilient qualities and is resilient to major pests and diseases. Past studies draw a direct link between poor access to clean seed potatoes and the low yields obtained by potato farmers in sub-Saharan Africa. These studies argue that the low yield result from the accumulation of seed-borne diseases, especially bacterial, fungal, and viral diseases, which have been associated with severe degeneration in seed quality (Thomas-Sharma *et al.*, 2016). Clean seed potato being a new technology in Njoro Sub-county, little is known about its inherent positive attributes that may be desirable to farmers like fast maturity, high yielding resilience to pests and diseases a factor that may have contributed to its low adoption.

2.11 Identified Gaps in the Existing Knowledge on Adoption of Clean Seed Potato in Njoro Sub-County

Studies on adoption of seed potato have focused on certified seed potato (Kiplagat *et al.*, 2016; Okello *et al.,* 2016). Certified seed potato has the capacity to improve production and reduce food insecurity and poverty among potato farmers. However, it may not be the most feasible option to improve potato productivity by small scale farmers, ultimate poverty alleviation and improving food and nutritional security. In Kenya where certified seed potato production is only 2.6% and 98% of potato producers operate on small scale with less than five acres of land devoted to potato production, certified seed potato may not provide an immediate solution to production constraints due to scarcity and limited accessibility of these seeds.

Moreover, the 2.6% national certified seed potato requirement produced makes it extremely difficult to be accessible by an estimated 800,000 potato farmers (Okello *et al.,* 2016; Muthoni *et al.*, 2013). This forces the demand to surpass the supply forcing the prices to rise. This leads to an increment in transactional costs, which reduces the profit margins to farmers hence reducing the likelihood of its adoption especially among small scale farmers with limited financial capabilities. According to Muthoni *et al.* (2010), the concept of certified seed potato is not quite clear to many farmers and its adoption remains low.

EGERTON UNIVERSITY
LIBRARY

According to Janssens *et al.* (2013), due to limited capacity in production of certified seeds, farmers have limited choice in terms of varieties and resort to available farm saved seed for varietal satisfaction especially those for consumption purposes. Kaguongo *et al.* (2009), conducted a study to compare the profitability in using farmer saved seed and certified seed. They concluded that farmers would incur losses if they used certified seed as opposed to farmer saved seed. This may be another reason for its low adoption.

A more accessible and affordable seed with resilience to pests and diseases, a high yielding capacity and fast maturity rate is necessary to improve potato productivity in Kenya. Clean seed potato presents such opportunities. Therefore, understanding the dynamics surrounding the adoption of clean seed potato planting materials is important. More so, gaining the understanding of the socio-economics of its adoption among farmers is very important if full utilization is to be achieved. This study sought to find out the factors associated with its adoption in order to make policy recommendations that will increase its production and adoption among farmers in Njoro Sub-County.

Past studies on adoption and usage of clean seed potato found out that there is low adoption of clean seed potato in Njoro Sub County, which partly accounts for the low yields obtained by farmers (Kaguongo *et al.*, 2013). Gichuru and Dijk (2015) found out that only 4.48% of the farmers use clean seed potato, which is very low. This is despite the fact that clean seed potato has the capacity to increase yields by over 30% (Kaguongo *et al.*, 2014). The study focused on selected social, economic and technology related factors associated with adoption of clean seed potato in Njoro Sub County. The findings may be useful and might contribute to increased adoption of clean seed potato in Njoro Sub County. Increased adoption of clean seed potato may lead to increased yields, incomes, food and nutritional security to potato farmers. Njoro Sub County is located in Nakuru county which is the third is the major potato-producing County in Kenya (Nakuru County, 2013)

2.12 Theoretical Framework of the Study

The study was based on Diffusion of Innovations Theory by Everett Rogers. The theory seeks to explain how, why, and at what rate new ideas and technologies spread. According to Rogers (2003), diffusion is the process by which an innovation is communicated over time among the

participants in a social system. Rogers explains that an innovation is "an idea, practice, or project that is perceived as new by an individual or other units of adoption" (Rogers, 2003). Regardless of the characteristics of the people, the properties of an innovation can affect its adoption in the society (Almobarraz, 2007).

The idea may have been invented a while ago but as long as the society perceives it as new, it can be referred to as an innovation (Sahin, 2006). Rogers *et al.* (2003), explains that, adoption is a decision of "full use of an innovation; as the best course of action available" and rejection is a decision "not to adopt an innovation". Rogers further explains diffusion as "the process in which an innovation is communicated thorough certain channels over time among the members of a social system".

The diffusion of innovations is still one of the strong theories in explaining adoption of innovations in social systems (Wani & Ali, 2015). According to Karimov *et al.* (2015), an innovation is useless and not important until it is effectively diffused to the final user. Before adopting an innovation, users check its pros and cons. In the same way, farmers consider economic, social and technology related factors before deciding on which type of planting material to use. These factors also inform the choice of varieties to be grown.

In addition, farmers may choose certain varieties after observing successful production by their neighbours in their localities. Rogers (2003), explains that observability and trialability can influence adoption of new technologies. In addition, information from extension agents can positively influence the farmers to adopt clean seed potato through trainings. Once the choice is made, the farmers will consider the variety, source and the distance from where to get the seed potato they have chosen to grow before purchasing. According to the diffusion of innovations theory, the perceived benefits of a technology can favorably influence people to adopt it. More so, the perceived benefits of using clean seed potato like increasing yields and farmers income, which improves the livelihoods of farmers may influence them into adopting it.

According to Rogers *et al.* (2003) diffusion research focuses on numerous areas. (1) The characteristics of an innovation, which may influence its adoption. According to this study these are the technology related factors which in relation to clean seed potato include, high yielding

capacity, fast maturity, resilience to pests and diseases, and low cost of the seed that are likely to influence a farmer to adopt and use clean seed potato as a technology. (2) The characteristics of individuals that make them likely to adopt an innovation (these according to this study, were the social factors which include, house hold size, farmer education level, farmer experience, age, gender, experience, belonging to farmer groups and observing others using it, that are likely to influence the famer's choice of adopting clean seed potato). (3) The consequences for individuals and society of adopting an innovation. These according to this study are the economic factors including, farmers income and income levels, major sources of income, distance from the source of seed to the farm, size of farmland owned, likely to influence a farmer to adopt and use clean seed potato.

Time in the diffusion of innovations helps establish relative lengths of periods within which different individuals use information to make decisions of whether to adopt or reject an innovation. For this reason, the study considered farming experience as one of potential factors that can influence a famer to adopt clean seed potato since different categories of potential adopters may require varying number of years to make informed decisions to adopt it. Experience also gives the confidence to the farmers to try new agricultural innovations. This study recognised that experienced farmers my might have confidence to try planting using clean seed potato.

Diffusion of Innovations Theory also assumes a social system in influencing adoption decisions of its units. Each system has a structure, which provides certainty, predictability, and stability in the way individuals behave and communicate (Rogers *et al.*, 2003). The study recognized the potential influence of social factors such as membership in farmer groups on adoption of clean seed potato. The decisions made within a farmer group can influence its members to adopt clean seed potato. In addition, within a social system, the farmers have a chance to observe the use of clean seed potato by their neighbours hence observing the benefits that might compel them to adopt the clean seed potato. The social system breaks the complexity of trying and using an innovation due to observing and learning by doing from members of the society. The study recognised that this might influence potato farmers to adopt clean seed potato.

2.13 Conceptual Framework

The Conceptual framework shows the association between independent and dependent variables in the adoption of clean seed potato by small scale potato farmers in Njoro Sub-County. It is summarized in Figure 1.

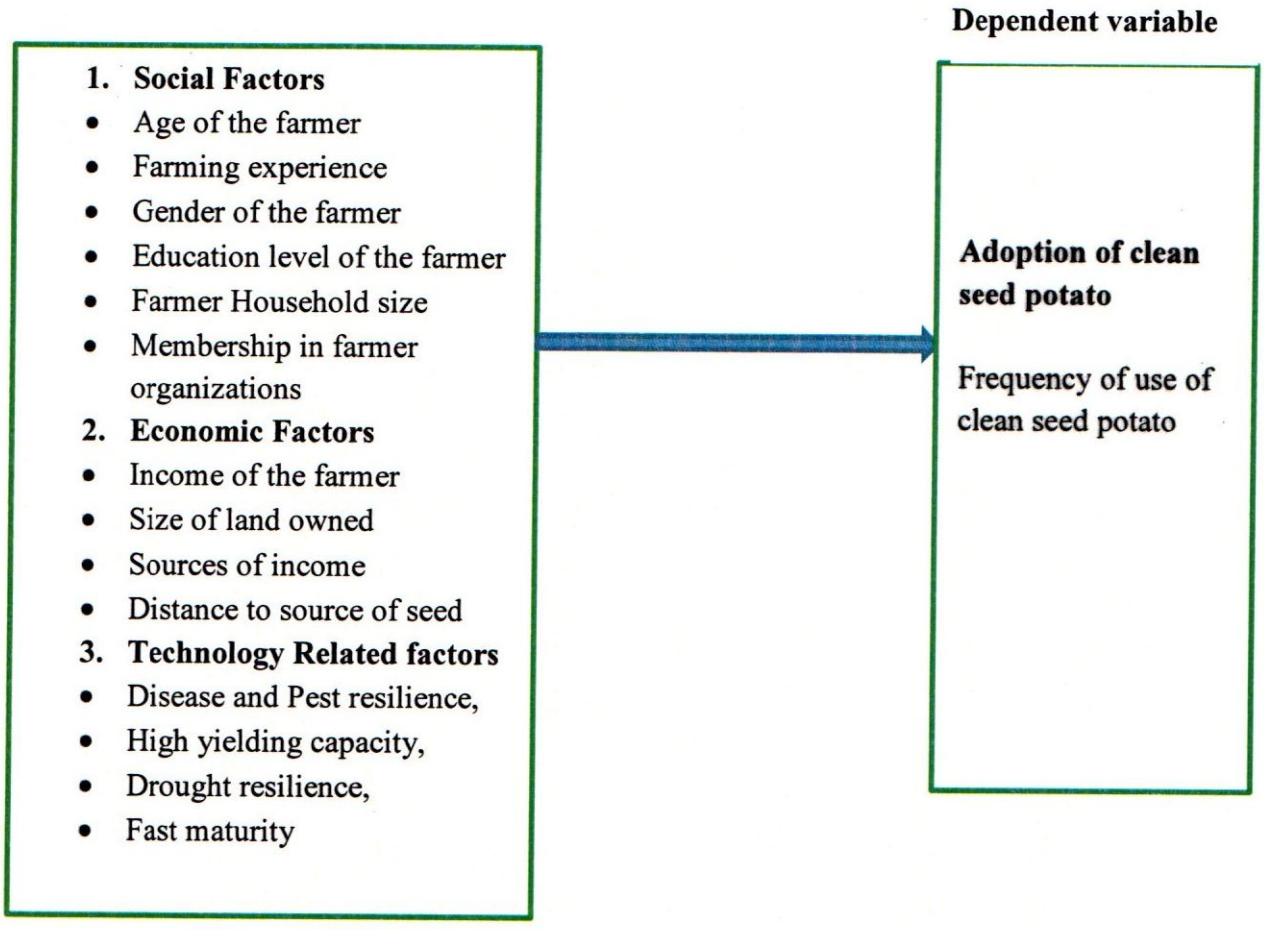


Figure1: Conceptual Framework of the Study

As shown in Figure1, independent variables of this study were the Economic, Social and Technology related factors that are associated with adoption of clean seed potato by small scale farmers. Particularly, economic factors included; income of the farmer, size of land owned by the farmer and sources of income and distance between the farms and the source of seed. Social factors included; age, gender, experience, education level of the farmer, household size and membership in farmers' organization. Technology related factors included; disease and pest

resilience, yielding capacity, drought resilience and fast maturity. The dependent variable of this study was adoption of clean seed potato. This was measured by looking at frequency and consistency of planting using clean seed potato.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methods that were used in sampling, data collection and analysis. The chapter begins with the research design and study area, and later explains the population of study, sampling techniques and the sample size from which the data was collected. This chapter also describes the data collection methods, data collection procedures and data analysis. Validity and reliability of the data questionnaire as well as ethical considerations are also presented in this chapter.

3.2 Research Design

A research design includes ways in which data is collected, instruments used and how, and means of data analysis (Wani & Ali, 2015). This study used correlational research design. This design attempts to explore associations between variables and helps to make predictions. According to Creswell (2012), correlational research describes and measures the degree of association or relationship between two variables of sets of scores. Therefore, correlational research is designed to study the relationships between two or more variables or to predict the outcomes. Furthermore, this study used explanatory type of correlational research design which explains or clarifies the degree of association among two or more variables at one point in time. This type of correlation tends to explain whether two points co-vary or whether a change in one variable reflects a change in another variable. In so doing, the researcher was able to effectively study the associations between the independent and dependent variables of the study.

Data for this study was collected in a cross sectional survey using a researcher administered questionnaire. The data was coded and analysed using statistical package for social sciences (SPSS version 20) computer software to find out the associations between variables, magnitude and direction of relationships in order to draw conclusions of likelihood of association. This study used Chi-square test in establishing associations between selected social, economic and technology related factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya. The study also used Spearman's rank correlation coefficient to establish the relationships between variables as well as the strength and direction of relationships.

3.3 Study Location

The study was conducted in Njoro Sub-County, Nakuru County in Kenya. Nakuru is one of the 47 counties of the Republic of Kenya and the third largest potato producing county in Kenya (Nakuru County, 2013). The county lies within the Great Rift Valley and is located between longitude 35 ° 28` and 35° 36` East and Latitude 0 ° 13 and 1° 10` South. The county is divided into nine administrative Sub Counties namely; Njoro, Naivasha, Gilgil, Nakuru Town, Rongai, Nakuru North, Subukia, Molo, and Kuresoi.

The study was conducted in Njoro, which is one of the sub counties that make up Nakuru County. The map showing the study area is annexed as Appendix B. Njoro was purposively selected for the study because it is one of the leading potato producing sub counties in this county (Nakuru County, 2013).

The settlement patterns in this sub county are influenced by availability of natural resources, soil fertility and rainfall, pasture, infrastructure, economic opportunities, proximity to urban set-ups and security. Njoro Sub County receives rainfall of 1600-2200 mm, which is suitable for potato production (Taiy *et al.*, 2016). The sub county experiences long rains in March, April, May and June, while short rains occur between October and November. The main food crops produced in the sub county include maize, potatoes, beans and wheat. Farmers in this sub county rank potato as their major important commercial crop (Taiy *et al.*, 2016). Factors that have favoured potato production in this area include the rich volcanic soils, reliable rainfall, readily available labour force and the availability of ready market for crop produce in both the urban centers such as Nakuru, Nairobi, Naivasha, Gilgil and Narok. These offer incentives for the potato sector to flourish.

3.4 Target Population

The target population of this study was 8,603 potato farmers in the wards of Mauche, Mau Narok, and Nessuit in Njoro Sub – County as shown in Table 2.

Table 2: The Selected Wards for the Study and Target Population

Ward	Number of farmers	2/3 of farmers
Mauche	5590	3727
Mau Narok	4791	3194
Nessuit	2523	1682
Total	**12904**	**8603**

Source. Adapted from Draft Nakuru County Potato Strategy 2018-2022

According to Njoro Sub-County agricultural reports (2017), two thirds of the farmers are potato farmers. These were the target population for this study. Three wards of Mauche, Mau Narok and Nessuit were purposively selected for the study because they are the leading potato producing wards in Njoro Sub - County with a total of 12,904 farmers as shown in the Table 2

3.5 Sampling Procedure and Sample Size

Purposive sampling was used to select Njoro Sub-County for the study. This was because potato is an important food crop despite the fact that its productivity is low in this area compared to other sub counties in Nakuru County. The wards of Mauche, Mau Narok and Nessuit were purposively selected for the study due to their importance in potato production in this Sub County. Proportionately, the sample was distributed among the three selected wards. Simple random sampling procedure was used to select respondents with relatively similar characteristics to be involved in the study from each of the three wards.

According to Ebrahim (2018), sample size is the number of units, or items in the sample and it determines the precision for the accuracy of the inferences made from the sample to be generalized to the population. The sample size for the small scale potato farmers was determined using the formula recommended by Nassiuma (2000), for determining sample size. This formula is used to determine a study sample for the known population in a survey study.

The formula is given by;

$$\mathbf{n} = \frac{NC^2}{C^2+(N-1)e^2}$$

Where n is the required sample size, N is the population, C is the coefficient of variation, and e is the standard error value. The lowest acceptable values for the coefficient of variation is 0.21 and the standard error is 0.02 (Nassiuma, 2000). This study used C = 0.21 to ensure minimum variation between the characteristics in the sample and those in the target population and e = 0.02 which helped reduce the variability of the sample with respect to the population of the study.

$$\mathbf{n} = \frac{8603\times(0.21)^2}{(0.21)^2+(8603-1)(0.02)^2} = \mathbf{108.87 \approx 109}$$

The calculated sample size from 8603 potato farmers based on the formula was 109 farmers.

A 20 percent (22 respondents) adjustment was made on the sample size obtained from Nassiuma's formula in order to cover for uncertainties like possible non-responses in some situations and outliers. Israel (1992), suggests that a 10-30% of the calculated sample size may be added to cater for persons that the researcher is unable to contact and for non-responses. Finally, the adjusted sample was 131 potato farmers from which data was collected for the study. Proportionately 131 respondents were distributed to the three wards based on estimated total number of potato farmers from each ward using the formula

$$\left(\mathbf{n} = \frac{\textbf{farmers from a ward}}{\textbf{total number of farmers}} * 131\right)$$

There were 57 respondents from Mauche, 26 respondents from Nessuit and 49 respondents from Mau Narok ward. At the ward level, simple random sampling procedure was used to select respondents for data collection as shown in Figure 2.

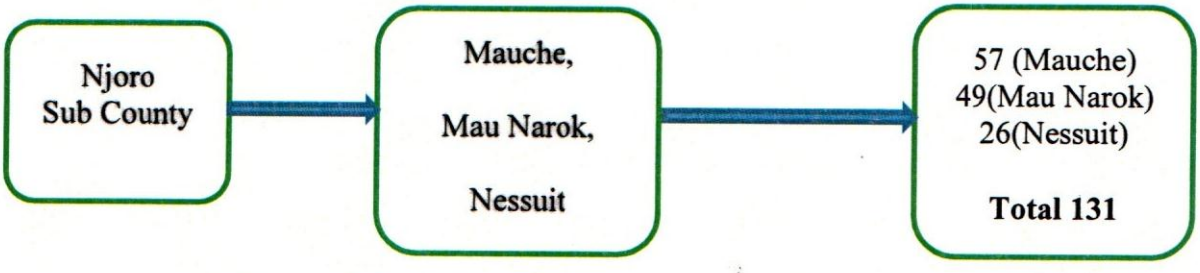


Figure 2: Sampling Framework for the Study

3.6 Instrumentation

The study used a researcher-constructed questionnaire, to collect required data in line with the objectives. A structured questionnaire containing a combination of dichotomous, polytomous, continuous closed-ended, open-ended and Likert scale items was used to collect the data in Line with the study objectives. Further, the questionnaire was divided into sections A,B,C,D and E. (it is annexed as Appendix A).

Section A of the questionnaire collected data about background and demographic information of the respondents. Age, gender, household size, education level, farmers experience in potato farming, amount of land owned, major crops grown and location of respondents. Respondents' age, experience, land size and household size were treated as continuous variables, while respondents' education level, location and major crops grown are scored as polytomous and gender of the farmer was dichotomous (male=1 and female=0)

Section B collected information on respondents' economic activities like respondents' major sources of income, estimated income from these sources, total income, expenditure and respondents' source of financing for potato planting. Estimated incomes from different sources, total incomes, and estimated expenditure were treated as continuous variables, while major sources of income and respondents' source of financing for potato growing were scored as polytomous.

Section C collected information on potato farming. Variables of interest in this section were whether the respondent grows seed potato or ware potato and whether the respondent knows about clean seed potato. These were scored as dichotomous (yes=1 and no=0). In addition, this section collected information on the purpose of growing either seed or ware potato. These were also scored as dichotomous (income=1 and own use=0). The type of seed potato used, potato variety planted, reasons for preferring these varieties, reasons for planting using clean seed potato, reasons for not planting using clean seed potato, source of seed potato, number of seasons planted in a year, means of communication between seed potato producers and farmers were all treated as polytomous. Variables like distance between the farms and seed potato producers, incomes from potato, yield harvests from potato, size of land used for potato production were treated as continuous.

Section D collected information of farmers' participation in groups. Variables like whether the farmer belongs to the group, grow potatoes as a group, the group plants using clean seed were scored as dichotomous (Yes=1 and No=0. Reasons for planting using clean seed potato and not planting using clean seed potato as a group, source of information about potato farming, major decision maker and what influences such a decision were all scored as polytomous variables.

Section E collected data on the technology related factors of clean seed potato that can favorably influence them to adopt it. This section is composed of closed ended Likert scale items and ranked on the scale of 1 to 5. On the scale 1=strongly disagree, 2= disagree, 3=neutral, 4=agree, 5 =strongly agree)

3.6.1 Validity

To guarantee content validity of the research instrument, the tool was developed in line with the study objectives. The research instrument was also given to the experts in Department of Applied Community Development Studies (ACDS) and Department of Agricultural Education and Extension under the Faculty of Education and Community Studies (FEDCOS) for review and advice and the researcher made corrections as was advised. The experts checked whether the instrument would generate valid data that would truly represent the studied phenomenon. Construct validity was evaluated to ascertain whether the data collection tools would yield data that meaningfully reflected the theoretical concepts, principles or paradigms related to the study. Face validity assessment checked to ascertain whether the instruments would logically measure what it was designed to measure.

The study instrument was also examined for internal and external validity. According to Mugenda and Mugenda (2003), internal validity helps determine the extent to which extraneous variables are controlled in a study. This helped ascertain whether the effects on a criterion variable is due to predictor variables or extraneous variables. External validity tests assisted in determining the degree to which the results obtained after the administration of instruments could be generalized to populations and wider environments. The instruments was also subjected to content validity scrutiny to determine whether the data collected would realistically and fully reflect the indicators or content of concepts relevant to the study (Mugenda & Mugenda, 2003).

3.6.2 Reliability

Reliability of the questionnaire was determined through pilot testing and analysis of the results. The questionnaire was pilot tested with 33 small scale potato farmers from Lare ward to ensure that those who participate in the pilot study were not involved in the main study. According to Monette *et al.* (2002), in survey studies, especially with homogeneous populations, a small sample of about 20-30 people can be contacted for pilot study. This study used 33 respondents during the pilot study. The questionnaire was considered reliable up on attaining a Cronbach's alpha correlation coefficient of 0.7038 ($\geq$.7).

3.7 Data Collection Procedure

The researcher sought a research permit from the National Commission for Science, Technology and Innovation through the Graduate School, Egerton University. After obtaining the permit, the researcher presented it to Nakuru County commissioner's office and county education officer seeking permission to conduct the study. The Agricultural Extension Officer and the Crops Officer of Njoro Sub-County were also informed before the commencement of the study. Lead farmers were identified who helped in identifying potato farmers who were respondents. Appointments for visits were made with the respondents in advance. Questionnaires were then taken to the participants in their homes. The researcher would introduce himself and the purpose of the visit and sought participants' consent to participate in the research before data collection would commence. The respondents were assured of the confidentiality of their information and identity. They were also informed that the information given was purely for academic purposes and participation in the study was voluntary. The researcher administered the questionnaire and collected it on the same occasion.

3.8 Data Analysis

Data was cleaned, organized and coded according to study objectives. Summarized data was keyed into the computer for analysis using Statistical Package for Social Sciences software (SPSS) version 20. Data analysis for this study relied on both descriptive statistics, that is; percentages, frequencies, measures of central tendency and standard deviation, and inferential statistics Chi-square test and Spearman's rank correlation coefficient.

All the three objectives were analyzed using Chi-square test to examine the associations between economic, social and technology related factors, and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County at 0.05 level of confidence. Chi-square test was preferred to find associations between the selected social, economic and technology related factors and adoption of clean seed potato due to its ability to test the association of individual factors with adoption of clean seed potato. Spearman's correlation coefficient was also used to determine the relationships between dependent and independent variables as well as the strength and direction of relationships.

3.9 Ethical Considerations

This study was guided by the following ethical considerations.

i. Participation of respondents was voluntary and there was neither payment nor coercion of respondents as it would have resulted into misguided information.

ii. Respondents' identities were kept secret and their responses were recorded and used for the purposes of this study and were not disclosed to anybody or authority.

Respondents were assured of these considerations before the researcher got information from them.

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and discussions based on the objectives and hypotheses of the study. The study examined the association between selected social, economic and technology related factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya. The chapter presents the profile of respondents, adoption of clean seed potato, association between selected social, economic and technology related factors and adoption of clean seed potato in Njoro Sub-County and testing of hypothesis. Testing of hypotheses was presented concurrently with the study objectives. A total of 130 respondents participated in this study. This study used correlational research design. Chi-square test was used to establish associations between selected social, economic and technology related factors with adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya. The study also used Spearman's rank correlation coefficient to establish the relationships between variables as well as the strength and direction of relationships. This helped to draw valid and reliable conclusions and recommendations.

4.2 Profile of Respondents

The characteristics of the respondents that were assessed in this study include; gender, age, education level completed, potato farming experience, and house hold size. These characteristics gives an image of the respondents in terms of gender, age, education level, household size as well as their potato farming experience.

4.2.1 Gender of Respondents

Data was collected on the age of respondents. Figure 3 presents the results on the gender of the respondents.

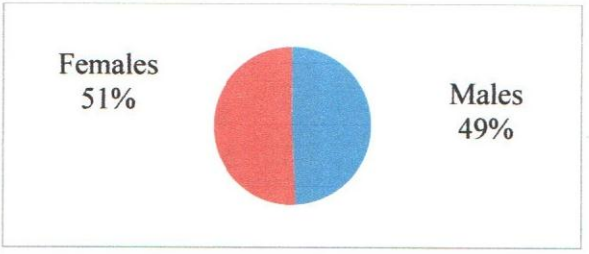


Figure 3: Gender of Respondents

Fifty one percent of the respondents were females while 49 percent were males as shown in Figure 3. An assessment of gender of respondents revealed that there were more female respondents than males. These results are inconsistent with statistics of Nakuru County where males are more than females. These results are also inconsistent with those of Taiy *et al.* (2016), who conducted a study in the same area documenting the social economic characteristics of potato farmers and observed that there were more male respondents than females. However, their study targeted household heads who in most cases are males in this area. Gender has been found to be associated with adoption of agricultural technologies because of its potential to influence access to and use of production resources (GoK, 2004). According to Anon (1980), women especially in the developing countries are rural dwellers and produce most of the domestic food. This may explain why there are more female potato farmers than males involved in potato production.

4.2.2 Age of the Respondents

The study collected data on the age of respondents. The distribution of age for the respondents is presented in Table 3.

Table 3: Age Ranges of Respondents (n=130)

Scale	Frequency	Percent
18-35	38	29.2
36-45	40	30.8
46-55	29	22.3
56-65	9	6.9
Above-66	14	10.8
Total	**130**	**100.0**

The ages of respondents ranged from 21 to 89 years with a standard deviation of 13.560 and the mean age was 44.89 years. As indicated in Table 4, only less than a third of the respondents were youths (18-35 years) while over three quarters of respondents were below 55 years. Only about 16 percent of respondents were above 55 years.

According to Ongusumi (2007), there is a positive relationship between age and adoption of agricultural innovations. The research results indicate that there is low participation of the youths in potato production in Njoro Sub-County. The youths in the Kenyan context are both males and females aged between 18 and 35 years. These findings agree with those of Guthire (2001), who observed the low participation of youths in agricultural activities and concluded that most Kenyan youths prefer formal employment to farming activities. They have limited access to production resources especially land and capital, which are major factors in potato production (African Union, 2011). There is unexploited labour potential among this age group especially those out of school because they are energetic and can provide labour required for potato production.

The age groups between 36-45 years are the most engaged in potato production in Njoro Sub-County. These findings agree with those of Taiy *et al.* (2016), who conducted a study on the analysis of potato value chain in the same study area and found out that age group 30-45 years were more engaged in potato production. These age groups own families and production assets. They are capable of making rational decisions an opportunity that can be exploited by community change agents and agricultural extension officers in efforts to improve potato production in this sub county. According to Khai *et al.* (2008), age predisposes a farmer to better farming techniques and management skills through learning by doing. There is also low

participation of the age groups above 56 years. According to Taiy *et al.* (2016), age increases adoption of innovations but with diminishing effect as age increases.

4.2.3 Number of People Living in the Household of Respondents

The study collected data on Number of people living in the household with the respondents. The results are presented in Table 4.

Table 4: Number of People Living in the Household (n=130)

Household members	Frequency	Percent
1-5	52	40.0
6-10	72	55.4
11-15	6	4.6
Total	130	100.0

The mean household size was 6.15 people with a standard deviation of 2.547 while the minimum and maximum were 1 and 12 household members respectively. Further analysis revealed that more than half of the respondents (55.4 %) had between 6-10 members in their households while 40 percent had between 1-5 members, and only 4.6 percent of the respondents had between 11-15 members living in their households as shown in Table 4.

Sulo *et al.* (2012), found household size significant in influencing women to adopt agricultural innovations. They noted that farmers with larger household size would have the needed labour required for these activities in addition to having more mouths to feed and more income needs.

4.2.4 Number of Years Respondents Have Been Producing Potatoes

The study aimed at establishing the number of years respondents have been producing potatoes. The results are presented in Table 5.

Table 5: Number of Years a Respondent has been a Potato Farmer (n=130)

Experience (years)	Frequency	Percent
0-5	78	60.0
6-10	26	20.0
11-15	7	5.4
16-20	7	5.4
21-30	4	3.1
31-40	5	3.8
41-50	2	1.5
51-60	1	.8
Total	**130**	**100.0**

The respondents were asked to provide information about the years they have grown potatoes. This was to help to establish the experience farmers have in potato production. According to Rodgers *et al.* (2013), time or experience is a very important factor especially in adoption of technologies and innovations. Data analysis revealed that the average years respondents have grown potatoes is 8.93 while the minimum and maximum years are 1 and 51 years respectively with a standard deviation of 10.56. Further analysis revealed that more than half of the respondents (60%) had spent less than five years growing potatoes while twenty percent had spent between 6-10 years growing potatoes as shown in Table 5. This translates to 60 percent of the respondents having up to five years of experience in potato production.

This indicates that more households are taking up potato production in this area as one of their sources of livelihoods. This information is informative to development partners and extension staff in that they need to put more efforts in helping farmers to improve potato production considering its contribution towards food security and income.

4.2.5 Highest Level of Formal Education Attained by Respondents

The study collected data on highest level if formal education completed by the respondents. The results are as shown in Table 6.

Table 6: Highest level of Education Completed by Respondents (n=130)

Level	Frequency	Percent
None	4	3.1
Primary	70	53.8
Secondary	46	35.4
College/University	10	7.7
Total	**130**	**100.0**

Results of this study shows that majority of the respondents (53.8%) completed primary level of education while 35.4 percent completed secondary, 7.7 percent completed College/University education and only 3.1 percent never attended any formal education as indicated in Table 6. These results indicate that about 97 percent of the respondents can read and write, revealing a higher literacy rate in Njoro Sub-County.

Education and ability to read and write improves people's understanding, mobilization and decision making capabilities. As Balakrishnan (2001), suggests, there is an important link between education level, possession of appropriate information and making of informed choices. Therefore, educated famers may favourably make decisions to adopt clean seed potato than their uneducated counterparts. According to Haque (2009), education helps in information dissemination, provides necessary skills and expertise and helps in changing attitudes towards farming. This niche can be utilized by extension services in Njoro Sub-County to improve potato production.

4.3 Adoption of Clean Seed Potato in Njoro Sub-County

This section provides information on adoption of clean seed potato in Njoro Sub-County by farmers. It provides information on the different types of seed potato used by farmers and means of access to information from seed potato producers by respondents. The section also provides

information on the frequency of using clean seed potato by respondents, reasons why some respondents prefer to use clean seed potato, reasons why some respondents do not use clean seed potato, adopters and non adopters of clean seed potato.

4.3.1 Types of Seed Potato Used by the Respondents

The study collected data on the different types of seed potato used respondents. The results are presented in Figure 4.

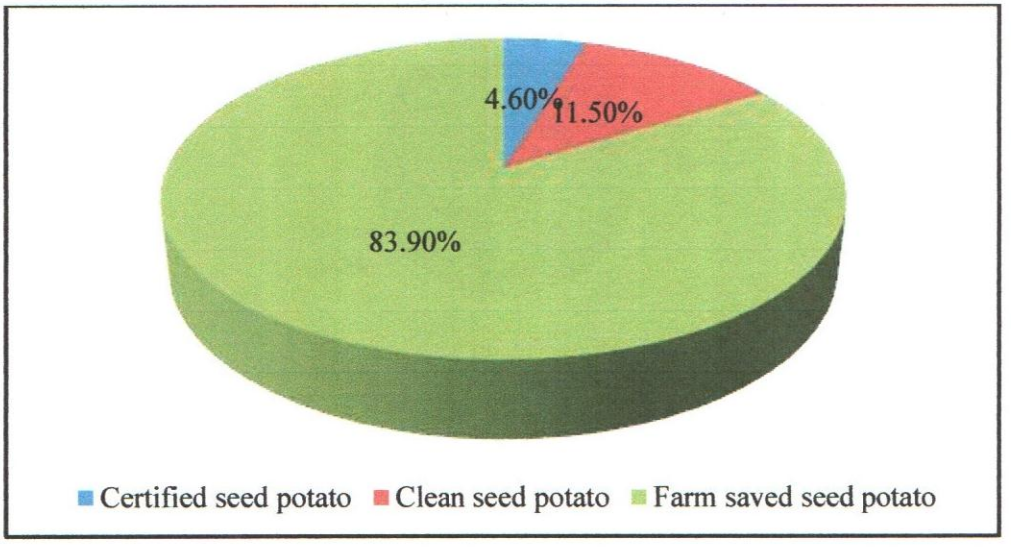


Figure 4: Types of Seed Potato Used by Respondents in Njoro Sub-County

Results revealed that over three quarters (83.9%) of the respondents use farmer saved seed potato, 11.5 percent use clean seed potato, while 4.6 percent use certified seed potato as shown in Figure 4. These results confirm the problem of the study that there is low adoption of clean seed potato in Njoro Sub County Kenya.

The results agree with the findings of Kaguongo *et al.* (2014), who found out that farmer saved seed potatoes are the most used by farmers in Nakuru County followed by clean seed potato, positively selected seed potato and certified seed potato being the least used. According to Kaguongo *et al.* (2014),clean seed potato is not recognised for formal trade, a factor that might hinder its adoption despite its potential to reduce pest and disease incedences hence increasing

yields. The farmer saved seed potato is degenerated, infected with pests and diseases hence with a low yielding capacity. This may explain why farmers continue getting low yields.

4.3.2 Frequency of Using Clean Seed Potato by Respondents

Those respondents who indicated that they have ever planted using clean seed potato were asked to indicate the number of times they have planted using clean seed potato in the previous three seasons they planted potatoes. The results are presented in Figure 5.

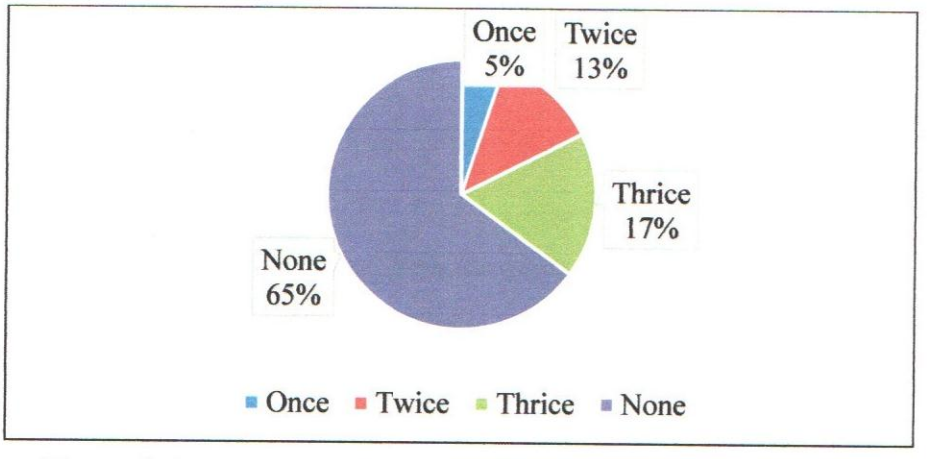


Figure 5: Frequency of Using Clean Seed Potato by Respondents

Sixty five percent of these respondents reported to have not used clean seed potato in the previous three seasons, 17 percent used it three times while 5 percent and 12 percent used it twice and one time respectively.

4.3.3 Adopters and Non Adopters of Clean Seed Potato

The respondents who normally plant clean seed potato were chategorised as adoptors and non adoptors. Respondents were considered adoptors of clean seed potato only when they indicated that they used clean seed potato at least for two consuctive times in the last three planting seasons as shown in Figure 6.

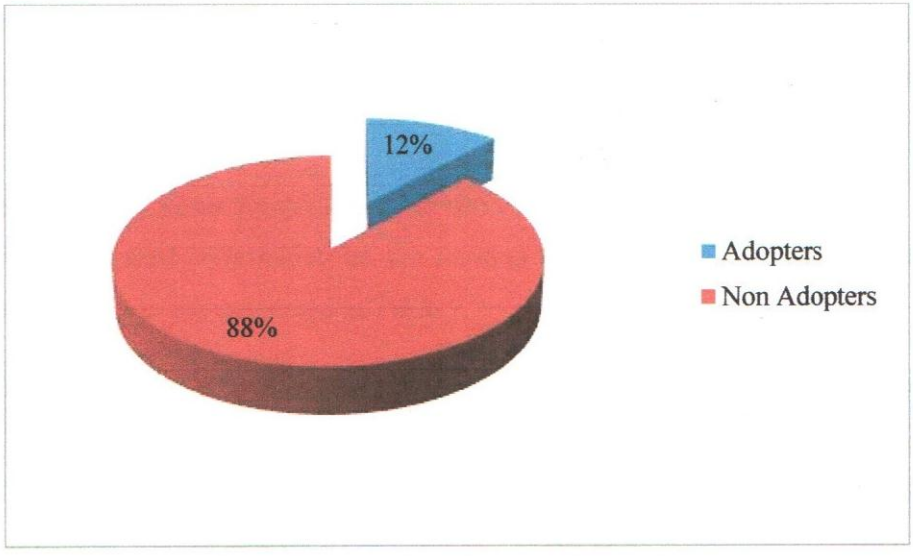


Figure 6: Adopters and Non-Adopters of Clean Seed Potato

Results revealed that famers who normally plant using clean seed potato, only 12 percent of them were considered adoptors while over three quarters (88%) were characterised as non adoptors.

4.3.4 Reasons for Preferring Clean Seed Potato

The study collected data on reasons for preferring to use clean seed potato from respondents who use it results are presented in Figure 7.

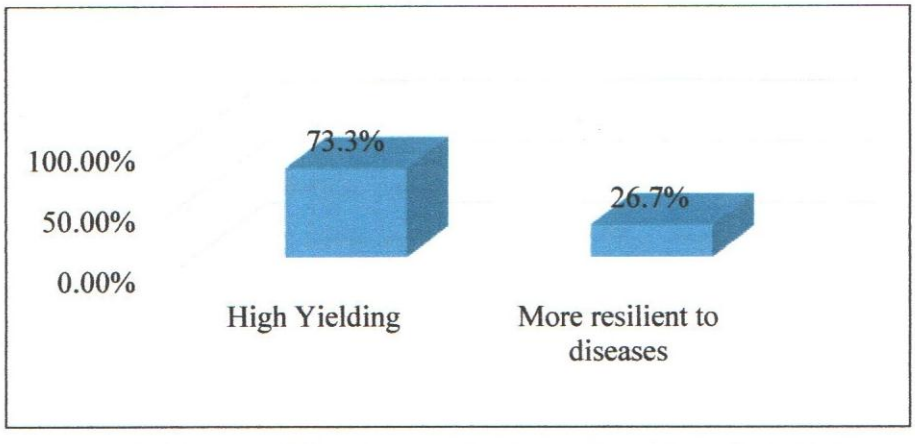


Figure 7: Reasons Why Farmers Prefer to Use Clean Seed Potato

Only two reasons were given by respondents as to why they preferred to plant using clean seed potato. About three quarters (73.3%) of them used clean seed potato because it is high yielding while about a quarter (26.7%) used it because they perceived it to be more resilient to diseases.

4.3.5 Reasons Why Some Respondents do not Use Clean Seed Potato

The researcher collected information on the reasons for not using clean seed potato by some respondents. The results are presented in Table 7.

Table 7: Reasons Why Some Respondents do not Use Clean Seed Potato (n=111)

Reason	Frequency	Percent
Lack of clean seed potato	10	9.0
Clean seed potato is expensive	26	23.4
I don't Know where to get clean seed potato	29	26.1
Clean seed potato lacks in preferred varieties	3	2.7
Long distance from the source of Clean seed potato	5	4.5
Lack of information on clean seed potato	38	34.2
Total	**111**	**100.0**

Over three quarters (84.6 %) of the respondents, who do not use clean seed potato, identified lack of information on clean seed potato, clean seed potato being expensive as the most important reasons why they don't use clean seed potato in order of their importance. When farmers have no or limited information about clean seed potato, they are less likely to adopt it since they may not know about its advantages like high yielding capacity and resilience to pests and diseases. Other reasons for not adopting clean seed potato were lack of clean seed potato in preferred varieties, and some respondents do not know where to get the clean seed potato as indicated in Table 7.

4.4 Association between Selected Social Factors and Adoption of Clean Seed Potato by Small scale Farmers in Njoro Sub-County Kenya

The first objective sought to determine the association between selected social factors and adoption of clean seed potato by small scale farmers in Njoro Sub - County, Kenya. The selected

social factors were membership of the respondents in farmer groups, previous experience of respondents in potato production, age, gender, education level completed by respondents and household size. These factors were selected because they have been found out to be associated with adoption of agricultural technologies. All these factors were discussed under the section of profile of respondents except group membership which is presented here.

4.4.1 Group Membership of Respondents

The researcher collected data about the group membership of respondents. The respondents were asked whether they belong to any farmer groups and the reasons or activities that they do within those groups. Results are given in Figure 8.

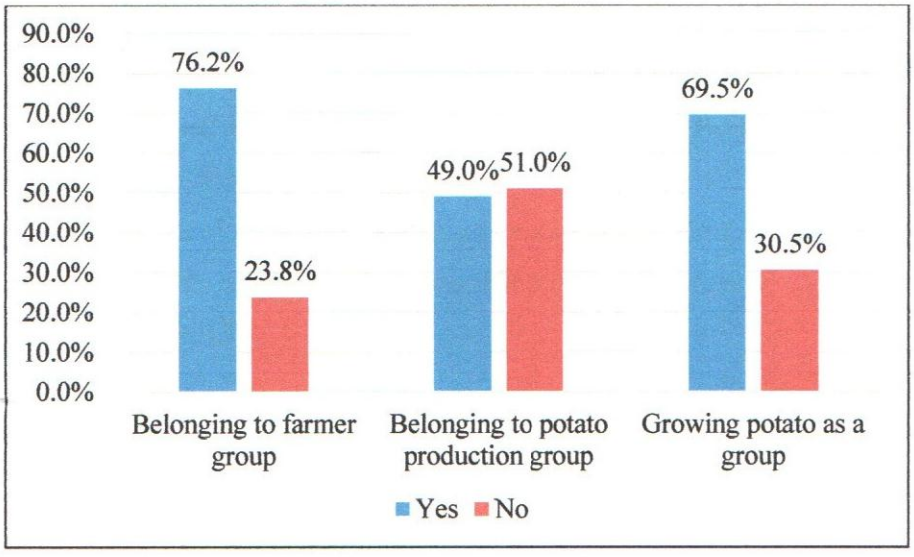


Figure 8: Group Membership of Respondents

Study results revealed that about three quarters (76.2 %) of the respondents belonged to farmer groups while almost a quarter (23.8 %) of the respondents did not belong to any farmer groups. Those respondents who belonged to farmer groups were further asked whether they belonged to specifically potato production groups and analysis revealed that 49 percent of them belonged to potato production groups while 51 percent did not. Of the respondents who belonged to potato farming, groups 69.5 percent of them grew potatoes in groups while 30 percent did not grow potatoes in groups

Belonging to farmer groups presents more opportunities to farmers like reduced cost of inputs due to collective group action. According to Sulo *et al.* (2012), belonging to farmers groups favourably influences farmers to adopt agricultural innovations including improved high yielding varieties like the clean seed potato. Mmbando and Baiysegunhi (2017), found out that farmers who are members of farmer groups are two times more likely to adopt improved maize varieties compared to their counterparts who do not belong to farmer groups in Hai District of Tanzania.

The collective decisions made within farmers' organizations such as cooperatives, associations and clubs tend to influence its members to make certain adoption decisions about a wide range of agricultural practices. Therefore, potato farmers who belong to farmer groups are more likely to adopt certain seed potato as group influence. According to Rodgers *et al.* (2003), farmers are motivated to appreciate benefits of certain technologies practiced by some members of their organizations and try out the innovations in their own fields. The organisations also serve as entities within which extension services are efficiently delivered to the members. Collective activities like marketing and production, purchasing of inputs by farmer organizations help them maximize returns on their initiatives and increase their financial capacity to invest in sustainable farming (Tey, 2013)

Apart from potato production, farmers carried out other activities within their groups as indicated in Table 8.

Table 8: Activities Done in the Farmer Groups (n=99)

Activity	Frequency	Percent
Merry go round	31	31.3
Crop production	47	47.5
Social welfare	13	13.1
Table banking	8	8.1
Total	**99**	**100.0**

About 31 percent of the respondents indicated that they belong to groups for merry go round, almost a half (47.5%) indicated crop production as the reason they belong to farmer groups.

About thirteen percent of the respondents identified social welfare as the reason they belong to farmer groups, while only 8.1 percent indicated table banking.

In order to determine the association between social factors and adoption of clean seed potato, the following hypothesis was tested.

$H0_1$. There is no statistically significant association between selected social factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

Chi-square test was used to test the association between selected social factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya and results are given in Table 9.

Table 9: Chi Square Test Results for Association between Selected Social Factors and Adoption of Clean Seed Potato

Scale	χ^2Value	df	P.value
Household size	2.170	2	.338
Experience	10.508	7	.162
Age	5.222	6	.516
Gender	.129	1	.720
Highest level of formal education completed	8.596	3	.035*
Respondent belonging to a potato farmer group	4.665	1	.031*

n=130

Among the selected social factors, only level of formal education completed and belonging to potato farmer groups had a significant association with adoption of clean seed potato at 0.05% level of significance [(education χ^2 (3, n= 130) = 8.596), (belonging to farmer group χ^2 (1, N = 130) = 4.665)] $p < .05$.

The association between household size, experience, gender, age, and adoption of clean seed potato was not statistically significant at 0.05 level of significance, [age χ^2 (6, n= 130) = 5.222), (household size χ^2 (2, n= 130) = 2.170), (experience χ^2 (7, n = 130) = 10.508), (gender χ^2 (1, n= 130) = .129), $p > .05$. Therefore, the null hypothesis which stated that selected social factors have

no statistically significant influence on adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya was rejected.

There was a statistically significant association between belonging to farmer groups and adoption of clean seed potato in Njoro Sub-County at 0.05 level of significance. Indeed, of the respondents who were adopters of clean seed potato, 75 percent of them belonged to farmer groups while only 25 percent did not.

These results are consistent with the findings of Mmbando and Baiysegunhi (2017), who concluded that farmers who are members of farmer groups are two times more likely to adopt improved maize varieties compared to their counterparts who do not belong to farmer groups. These findings also agree with those of Sulo *et al.* (2012), who found out that belonging to farmers groups favourably influences farmers to adopt agricultural innovations including improved high yielding varieties like the clean seed potato. This they argued is due to reduced cost of inputs due to collective group action. Ugwumba and Okechukwu, (2014), also found the same results in Nigeria. However, these results disagrees with the findings of Kiplagat *et al.* (2016), who found out that belonging to a farmer group or association was not significantly associated with adoption of clean certified seed potato in Baringo County, Kenya.

Equally, formal education level completed by the respondents was significantly associated with adoption of clean seed potato by small scale farmers in Njoro Sub-county [(education χ^2 (3, n= 130) = 8.596), $p < .05$. Further results revealed that all the respondents who have adopted clean seed potato had attained and completed some level of formal education hence, 33.3 percent of the respondents who are adopters of clean seed potato had attained primary level of education, 50.0 percent secondary level while only 16.7 percent only had a University/college education. This study further revealed a strong, positive and significant correlation between formal education level completed by the farmers and adoption of clean seed potato [r (129) =.183, P=.037] at 0.05 level of significance. These results suggest that increasing level of education of respondents increases the likelihood of adopting clean seed potato however with diminishing effect as education level increases.

These results agree with other studies that found education of farmers statistically and significantly associated with adoption of agricultural innovations. For example Mmbando and Baiyegunhi (2017), found out that increasing number of years of education by the farmer statistically and significantly influenced maize farmers in Hai district of Tanzania to adopt improved maize varieties. Deepa *et al.* (2015); Ahmed (2015), also found education to have a positive association with adoption of agricultural innovations by farmers especially in developing countries.

The association between the age of respondents and adoption of clean seed potato at 0.05 level of significance (p= .516), was not statistically significant. Increasing age of farmers does not explain increasing adoption and use of clean seed potato. Indeed spearman's rank correlation coefficient test results between age of respondents, and adoption of clean seed potato revealed a weak, positive and none significant relationship [r (129) =.049, P=.581].

Gender of the respondents did not have statistically significant association with adopt adoption of clean seed potato by small scale farmers. The association between gender and adoption of clean seed was positive but not statistically significant. This result is in agreement with the findings of Kiplagat *et al.* (2016), who found out that gender was not statistically significantly in influencing adoption of certified seed potato in Baringo County Kenya. There was a positive but non statistically significant relationship between household size and adoption of clean seed potato. This result agree with Kiplagat *et al.* (2016), who also found household size non-significant in explaining adoption of certified seed potato in Baringo County Kenya.

In addition, the association between experience of farmers in potato production and adoption of clean seed potato was not statistically significant at 0.05 significance level. Indeed spearman's correlation test results between potato production experience of respondents, and adoption of clean seed potato revealed a weak, positive but non statistically significant relationship [r (129) =.079, P=.369]. This result however, is inconsistent with the findings of Kiplagat *et al.* (2016), who found experience to influence farmers in adopting clean/certified seed potato in Baringo Kenya. They explained that increasing years of experience in potato production influences farmers into adopting improved varieties of potatoes.

4.5 Association between Selected Economic Factors and Adoption of Clean Seed Potato in Njoro Sub County Kenya

The second objective sought to establish the association between selected economic factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya. The selected economic factors were; major sources of income, estimated annual income and expenditures, sources of money for financing potato production, size of farmland ownership and distance from farms to the source of clean seed potato. These were selected because they are known to be associated with adoption of agricultural technologies.

4.5.1 Major Sources of Income of Respondents

The study collected data on the sources of income of the respondents. The income sources that were identified include farming, employment, business and remittances as indicated in Table 10.

Table 10: Major Sources of Income for Respondents (n=130)

Sources of Income	Frequency	Percent
Farming	125	96.2
Employment	1	.8
Business	3	2.3
Remittances	1	.8
Total	**130**	**100.0**

Data analysis revealed that 96.2% of the respondents get their income from farming, 2.3% of the respondents indicated business as their major source of income while only 0.8% indicated that their major sources of income were employment and remittances as indicated in Table 10. This indicates that most of the respondents get their income from farming. This finding is important especially to the development agencies targeting to improve incomes, food and nutritional security of the people of Njoro Sub-County. Targeting improving potato production would be ideal for improvement of peoples' lives in this area. Increasing adoption of clean seed potato can improve potato production.

4.5.2 Estimated Total Annual Income and Expenditure of the Respondents

The study also sought to establish the levels of income and expenditure of the respondents .The respondents were asked to give their estimated annual income and expenditure. The results are presented in Figure 9.

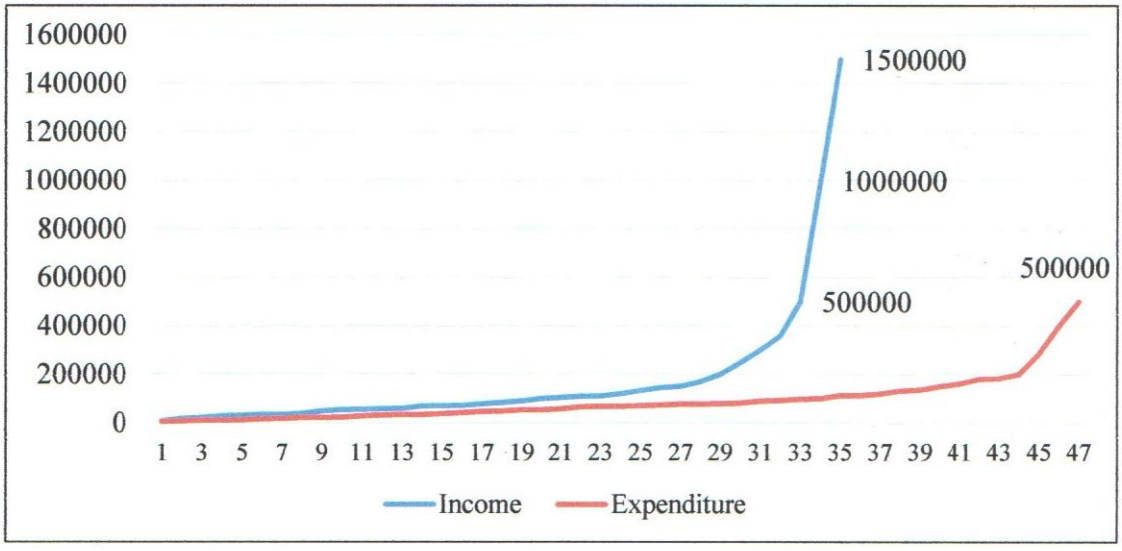


Figure 9: Estimated Annual Income and Expenditure of Respondents

Results from data analysis indicated that the minimum annual income of respondents is 10,000 Ksh while the maximum annual income is 1500, 000Ksh. The average annual income of the respondents is 134,428.99 Ksh with a standard deviation of 1,999,784.4 Ksh. Respondents were also asked to mention their estimated annual expenditure. Results from analysis revealed that the minimum annual expenditure is 7,500 Ksh and the maximum expenditure is 500,000 Ksh. The average annual expenditure is 88,009.54 Ksh with a standard deviation of 708, 66.93Ksh. A line graph was used to show the trends of respondents' income and expenditure as shown in Figure 9.

4.5.3 Sources of Money for Financing Potato Production

Respondents were asked to identify the sources of funds they use in financing potato production. This was important in establishing the farmers' access to finance. The sources of money for financing potato production identified by respondents were; own savings, family members, groups, Sacco and bank loans as shown in Table 11.

Table 11: Where the Respondent Gets Money for Potato Farming (n=130)

Source of Funds	Frequency	Percent
Own savings	110	84.6
Family members	4	3.1
Group	13	10.0
Sacco	2	1.5
Bank loan	1	.8
Total	**130**	**100.0**

More than three quarters (84.6%) of the respondents indicated that they get funds for financing potato production from their own savings, 10 percent get money from groups. Only 3.1 percent get financing from family members, 1.5 percent from the Saccos while only 0.8 percent of the respondents mentioned that they get money for financing potato production from banks as loans as indicated in Table 11. It was observed that most respondents (97.7%) finance potato production from their own savings and social networks of friends and family.

4.5.4 Size of Farmland Owned by Respondents

The researcher also sought to establish the size of farm land owned by respondents. Farm sizes are known to determine production levels and adoption of innovations (Ojango & Pollot, 2002). The respondents were asked to indicate the sizes of their land they have for agricultural production.

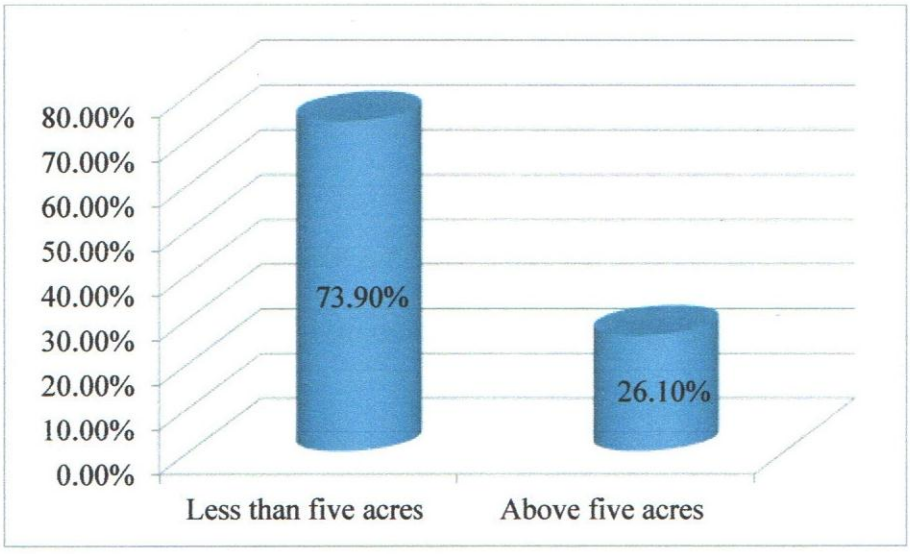


Figure 10: Size of Farmland Owned by Respondents

Study results revealed that most respondents owned and hired land for agricultural activities. Results from analysis further show that some respondents (1.5%) did not own land at all but leased land for agricultural production. The mean land size owned by respondents was 2.98 acres. The study results further revealed that 73.90 percent of respondents owned less than five acres of land for agriculture while about a quarter (26.1%) of the respondents owned more than five acres of farmland as shown in Figure 10.

The size of the farm is an important factor in crop production. It is important to note that the size of the land determines whether to use mechanization or plant certain crops such as perennial or cash crops as a tradeoff to food crops (Okello *et al.*, 2016). The lager the amount of land, the more the benefits to the farmer from the economies of scale as costs of fixed assets are spread to the economies of scale.

The study also sought to establish the acreage devoted for potato production. The mean acreage under potato production was 1.59 acres while the minimum acreage was 0.25 acres respectively. These results agree with the findings of Kiplagat *et al.* (2016); Kaguongo *et al.* (2013); Real *et al.* (2016) who found out that potato production is dominated by small scale farmers devoting to less than five acres of land devoted to potato production.

4.5.5 Distance from the Source of the Seeds to the Respondents' Farms

The study thought to establish the distance covered by the respondents to look for seed potato. In this regard, data was collected for the distance between the farms and the source of seed potato. Results are given in Table 12.

Table 12: Distance Travelled to Look for Seed Potato (n=130)

Scale	N	Minimum	Maximum	Mean	Std. Deviation
The distance between the Farm and the source of the seed in Km	130	.00	200.00	3.9269	20.47241
Valid n (listwise)	**130**				

Seed potato is bulky and delicate to transport. Therefore, the distance between the source of the seed and farms is important. Longer distances covered to access the seeds increases the cost of production and may lead to losses on the side of the farmers (Okello *et al.,* 2016). Some respondents have to travel a distance of up to 200 Kilometers to look for seeds while others do not travel any distance. It is worth noting that those farmers who traveled long distances to look for seeds used clean and certified seed potato while those who do not travel any distances use farm saved seeds. The mean distance traveled by respondents in search of seed potato was 3.927Km with a standard deviation of 20.472 as shown in Table 12.

In order to determine the association of selected economic factors and adoption of clean seed by small scale farmers in Njoro Sub-County, the following hypothesis was tested.

$H0_2$. There is no statistically significant association between selected economic factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

Chi-square test was used to test the association between economic factors and adoption of clean seed potato. The results are presented in Table 13.

Table 13:Chi-Square Test Results for Association between Selected Economic Factors and Adoption of Clean Seed Potato

Scale	χ^2 Value	Df	P.Value
Sources of income	2.311	3	.510
Size of land owned	9.007	6	.173
Income of the farmer	6.894	4	.142
Distance to the source of clean seed potato from farms	39.502	4	.000***

n=130

The association between distance from the farms to the source of clean seed potato, and adoption of clean seed potato is statistically significant at 0.05 level of significance, χ^2 (4, n= 130) = 39.502, $p < .05$.

The association between source of income, income, size of land ownership, and adoption of; clean seed potato is not statistically significant at 0.05 level of significance, [(sources of income χ^2 (3, n = 130) = 2.311), (income χ^2 (4, n= 130) = 6.894), (size of land owned χ^2 (6, n= 130) = 9.007)] $p> .05$. Therefore, the null hypothesis which stated that selected economic factors do not have a statistically significant association with adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya was rejected.

Spearman's rank correlation coefficient test results between distance to the source of clean seed potato from farms, and adoption of clean seed potato revealed a statistically significant positive relationship [r (129) =.433, P=.000] at 0.05 significance level. Of the adopters of clean seed potato, 58.3 percent of them are located within a distance less than 5 kilometers from the source of seed while 41.7 percent of them are located more than 5 kilometers. This indicates that the longer distance between the source of seed and the farms reduces the likelihood of the farmer from adopting clean seed potato. The longer distances may discourage respondents from using clean seed potato due to increased costs of transportation.

These findings agree with those of Kiplagat *et al.* (2016), who concluded that the distance between the farmers' farms and the source of the seeds influences the decision of the farmer to

adopt clean certified seed potato. Okello *et al.* (2016) argued that seed potato being bulky and expensive to transport, the longer the distance of the farm from the source of the seed the lesser the likelihood of a farmer to adopt it. This is true because Burke *et al.* (2015) found out that farmers located far away from the input markets are less likely to adopt such inputs due to increased transactional costs. This information is important especially to policy makers and extension agents in that they need to consider target increasing seed potato production to be near the farmers especially for the recommended seed potato types in order to increase their adoption and usage.

4.6 Association between Selected Technology Related Factors and Adoption of Clean Seed Potato in Njoro Sub-County, Kenya

The third objective sought to determine the influence of selected technology related factors on adoption of clean seed potato by small scale farmers in Njoro Sub-County Kenya. The selected technology related factors were, fast maturity, high yielding capacity, resilience to pests and diseases, cost of clean seed potato and resilience to drought. These factors relate to relative advantage and observability of the clean seed potato like high yielding capacity, resilience to pests and diseases, and drought, and longer shelf life. The compatibility of the clean seed potato like low cost as compared to certified seed potato.

4.6.1 Perception of Respondents towards Clean Seed Potato

Respondents were asked to rate their perceptions towards clean seed potato. Closed ended Likert scale questions were given to the respondents on which they were to rate their perception. Strongly disagree (SD) meant that the respondent strongly disagree with the statement, Dis agree (D) meant that the respondent somehow disagree with the statement, Neutral (N) meant that the respondent is not sure (neither agree nor disagree). Agree (A) meant that the respondent somehow agree to with the statement, while strongly agree (SA) meant that the respondent strongly agree with the statement. This question was only answered by respondents who normally plant using clean seed potato. The results are presented Table 14.

Table 14: Perception of Respondents towards Clean Seed Potato

No	Item	SD %	D %	N %	A %	SA %
1	Respondent believes that Farmers who Use Clean Seed Potato Harvest Earlier than Others	13.3	26.7	6.7	40.0	13.3
2	Respondent believes that those farmers Who Plant Using Clean Seed Potato do not Obtain Less yields	66.7	20.0	6.7	0	6.7
3	Respondent believes that Using Clean Seed Potato, a Farmer Can Still Harvest Amidst Minimal Rainfall	26.7	20.0	6.7	40.0	6.7
4	Respondent believes that Potatoes Planted Using Clean Seed Potato Have Minimal Pests and Diseases	0	6.7	6.7	46.7	40.0
5	Respondent believes that Potatoes Harvested From Clean Seed Potato Have a Longer Shelf Life	13.3	0	20.0	13.3	53.3
6	Respondent believes that Planting Using Clean Seed Potato is Costly as Compared to Farm Saved Seed	6.7	20.0	6.7	33.3	33.3

In order to ascertain the association of selected technology related factors with adoption of clean seed potato by small scale farmers in Njoro Sub-county, the following hypothesis was tested

$H0_3$. There is no statistically significant association between selected technology related factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County.

Chi-square test was used to establish the association between selected technology related factors and adoption of clean seed potato by small scale farmers in Njoro Sub-County Kenya. Results are presented in Table 15.

Table 15: Chi-Square Test Results Showing the Association between Selected Technology Related Factors on Adoption of Clean Seed Potato

Scale	χ^2value	Df	P-value
Fast maturity	1.283	4	.864
High yielding	.950	4	.917
Drought resilience	2.090	4	.719
Pest and disease resilience	2.253	4	.689
Longer shelf life	5.770	4	.217
Cost of the seed	2.042	4	.728

n=37

The Chi-Square test results revealed that the association between first maturity, high yielding, drought resilience, pest and disease resilience, longer shelf life, cost of the seed, and adoption of clean seed potato is not statistically significant at 0.05 level of significance.[(Fast maturity χ^2 (4, n = 37) = 1.283), (high yielding χ^2 (4, n = 37) = .950), (Drought resilience χ^2 (4, n= 37) =2.090), (pest and disease resilience χ^2 (4, n= 37) = 2.253), (longer shelf life χ^2 (4, n= 37) = 5.770), (cost of the seed χ^2 (4, n= 37) = 2.042] p >.05.

The results revealed that the association between the selected technology related factors and adoption of clean seed potato was not statistically significant at 0.05 level of significance. Therefore, the null hypothesis, which stated that selected technology related factors do not have a statistically significant association with adoption of clean seed potato by small scale farmers in Njoro Sub-County, is accepted.

This may be so because there are few cases for farmers who are use clean seed potato yet this section on the technology related factors targeted farmers who have been using clean seed potato. Clean seed potato is still a new idea in Njoro Sub-County and therefore is still in the process of diffusion. According to Sahin (2006), the idea may have been invented a while ago but as long as the society perceives it as new, it can be referred to as an innovation. Rodgers *et al.* (2003), explains that Adopters are likely to adopt an innovation with positive attributes that are desirable in terms of their relative advantage, compatibility, complexity, trialability and

observability as compared with conventional and existing practices. According to the diffusion of innovations theory the few farmers who have adopted clean seed potato are the early adopters from which the late majority will observe and adopt later.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of findings, conclusions and recommendations of the study. The summary of findings are presented according to the study objectives. The study had three objectives and these were:

i. To determine association between selected social factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.
ii. To determine association between selected economic factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.
iii. To determine association between selected technology related factors and adoption of clean seed potato by small scale potato farmers in Njoro Sub-County.

Data was collected in a cross sectional survey in June 2019. The target population of this study was 8,603 small scale farmers potato in Njoro Sub-County. The researcher selected a sample of 130 potato farmers using simple random sampling procedure from whom data was collected. A researcher-administered questionnaire was used to collect the required information from the respondents. The researcher used Statistical Package for Social Sciences (SPSS version 20) to analyse the data. Data was interpreted descriptively using frequencies, means, percentages and standard deviation and inferential statistics, Chi-Square test. Spearman's rank correlation coefficient was used to find out the relationships between the dependent and independent variables as well as the strength and direction of relationships. The summary results of this study are presented in this chapter according to the study objectives and hypotheses. The following is a summary of the study findings based on the objectives.

5.2 Summary of Study Findings

The researcher drew a summary from the findings of the study after data analysis based on the three objectives.

Association between Selected Social Factors and Adoption of Clean Seed Potato by Small Scale Farmers in Njoro Sub-County

The selected social factors were age, gender, potato production experience, belonging to farmer groups, household size and level of formal education completed by the respondents. Much as the study results indicated that more females participated in the study than males, more males had adopted clean seed potato compared to males. Majority of the respondents were aged between 36-45 years. Most respondents have less than five years of experience in potato production. More than ninety percent of the respondents had attained some level of education with exception. Over three quarters of respondents belong to farmer groups.

There association between belonging to famer groups and formal education level completed by the respondents, and adoption of clean seed potato was a statistically significant at 0.05 percent significance level. Other social factors like age, gender, experience, household size were found to have a non-significant association with adoption of clean seed potato.

Association between Economic Factors and Adoption of Clean Seed Potato by Small Scale Farmers in Njoro Sub-County

The selected economic factors were; major sources of income of respondents, incomes, farmland size, and distances from the source of seed potato to farms. Study findings indicated that majority of the respondents owned less than four acres of farmland with some respondents owning as low as a quarter acre of land. Most respondents devote less than 4 acres of land for potato production. Over 90 percent of the respondents do farming as their major source of income. Incomes of the respondents are generally low with some respondents earning as low as 10,000 Ksh annually. The majority of respondents get their funds for financing potato production from their own savings, while others get from family members, groups, SACCOs, and bank loans. Some respondents have to travel long distances to look for seeds.

Only distance from the source of clean seed potato to the farms had a statistically significant association with adoption of clean seed potato at 0.05 level of confidence. Other economic factors like income sources, farmland size, and incomes of respondents were found to have a non-significant association with adoption of clean seed potato by small scale farmers in Njoro Sub-County.

Association between Technology Related Factors and Adoption of Clean Seed Potato by Small Scale Farmers in Njoro Sub-County Kenya

The selected technology related factors were; high yielding capacity, resilience to pests and diseases, resilient to drought, fast maturity and low cost. Most respondents use clean seed potato because they perceived it to be high yielding while some respondents used clean seed potato because they perceived it to be more resilient to pests and diseases as compared to farmer saved seed potato. About a quarter of the respondents plant using clean seed potato because it is less costly as compared to farmer saved seed potato.

There was no statistically significant association between technology related factors and adoption of clean seed potato at 0.05 percent significance level.

5.3 Conclusions of the Study

The following are the conclusions of the study based on the study objectives.

i. The study concludes that the level of formal education completed by the respondents is associated with adoption of clean seed potato by small scale farmers in Njoro Sub–County.
ii. The study further concludes that belonging to farmer groups is associated with adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya.
iii. The study also concludes that distance between the farms and the source of clean seed is associated with adoption of clean seed potato by farmers in Njoro Sub-County, Kenya.
iv. The study also concludes that technology related factors are not associated with adoption of clean seed potato in Njoro Sub-County, Kenya.

5.4 Recommendations of the Study

The study makes recommendations for different stakeholders. Specifically, the study made policy recommendations to policy makers, recommendations for implementation to extension agents and development partners, and recommendations to researchers for further studies. They are presented in detail hereunder.

Policy Recommendations

i. The study recommends that extension agents encourage farmers to come together in groups in order increase adoption of clean seed potato.

ii. This study recommends that extension agents train more farmers in clean seed potato production. This will reduce the distances traveled by farmers in search of clean seed potato and hence will increase adoption of clean seed potato.

Recommendations for Implementation by Farmers

i. The study recommends that more farmers should come together and form farmer groups, which will help in collective group activity with benefits like economies of scale, reduced costs in purchase of inputs including clean seed potato and access to information.

ii. The study also recommends that more farmers should engage in clean seed potato production. This will increase clean seed potato production in terms of volumes, accessibility and adoption. Increased clean seed potato production will increase accessibility to high quality seed potato to small scale farmers in Njoro Sub-County.

5.5 Suggestions for Further Research

The study recommends that further studies should focus on the following;

i. Replicate this study in other potato growing areas in Kenya to enable the generalisation of the study findings.

ii. Focus on farmer group activity in potato and seed potato production.

REFERENCES

Abong, G. O., & Kabira, J. N. (2015). Potential Food Safety Concerns in Fried Potato Products in Kenya. *Open Access Library Journal,* 02(05), 1–11. https://doi.org/10.4236/oalib.1101522

African Union (2011). *Africa youth decade 2009-2018. Plan of Action.* Retrieved from http://www.africanmonitor.org/assets//files/african_youth_decade_2009-2018.pdf

Ahmed, MH. (2015). Adoption of multiple agricultural technologies in maize production of the cental rift valley of Ethiopia. *Studies in Agricultural Economics*, 117(2015): 1-19. http://dx.doi.org/10.7896/ j.1521.

Alirah E, W., Mulubrhan, A., Hildegard G., & Hermann W. (2018) Agricultural innovation systems and farm technology adoption: findings from a study of the Ghanaian plantain sector. *The Journal of Agricultural Education and Extension*, 24 (1)65-87, DOI: 10.1080/1389224X.2017.1386115

Almobarraz, A. (2007). *Perceived attributes of diffusion of innovation theory as predictors of Internet adoption among faculty members of Imam Mohammed Bin Saud University*. (Un published Doctoral dissertation). University of North Texas. Retrieved from %09Austin%0A, Texas%0A, United States

Añón, M. C., & Calvelo, A. (1980). Freezing rate effects on the drip loss of frozen beef. *Meat Science*, *4*(1), 1-14. https://doi.org/10.1016/0309-1740(80)90018-2

Balakrishnan R. (2001). *Gender Constraints to Rural Poverty Alleviation.* New Delhi: FAO, India. Retrieved from https://www.un.org/womenwatch/daw/csw/empower/documents/FAO-OP1.pdf

Bilate, B., & Mulualem, T. (2016). Performance evaluation of released and farmers' potato (Solanum tuberosum L.) varieties in eastern Ethiopia. *Sky Journal of Agricultural Research*, 5(2), 34–41. Retrieved from http://www.skyjournals.org/SJAR

Burke, W.J.; Myers, R.J.; Jayne, T.S. (2015) A triple-hurdle model of production and market participation in Kenya's dairy market. *American Journal of Agriculture and Economics* 3(14) 1-16

Byarugaba, A. A., Prossy, N., & Kashaija, I. N. (2013). Identification of potato clones of population B3C2 with durable field resistance to late blight (Phytophthora infestans) and

high yields in Uganda. *African Journal of Agricultural Research*, 8(23), 3055–3059. https://doi.org/10.5897/AJAR2013.6917

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* (6th) Boston: Pearson.

D'souza, G., Cyphers, D., & Phipps, T. (1993). Factors Affecting the Adoption of Sustainable Agricultural Practices. *Agricultural and Resource Economics Review*, 22(02), 159–165. https://doi.org/10.1017/S1068280500004743

De Jong, H., De Jong, W., & Sieczka, J. B. (2011). *The complete book of potatoes: What every grower and gardener needs to know*. University of North Texas. Retrieved from %09Austin%0A, Texas%0A, United States. Deepa R, Bandyopadhyay AK, Mandal M. (2015). Factors related to adoption of maize production technology in Cooch Behar district of West Bengal. *Agriculture,* 5(2): 775-777

Deepa, R., Bandyopadhyay, A. K., & Mandal, M. (2015). Factors related to adoption of maize production technology in cooch behar district of West Bengal. *Agriculture,* 5(2), 775–777

Doss, C. 2001. Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience. *World Development* 29(12): 2075-2092

Ebrahim, S., Mohammed, H., & Ayalew, T. (2018). Effects of seed tuber size on growth and yield performance of potato (Solanum tuberosum L .) varieties under field conditions. *African Journal of Agricultural Research*, 13(39), 2077–2086. https://doi.org/10.5897/AJAR2018.13405

Ebrahim, Y.H (2017).*The effects of urban built form on micro temperature change: A case study of Komarock Infill 'B' Estate Nairobi.* (Unpublished doctoral thesis). University of Nairobi, Nairobi. Retrieved from https://www.researchgate.net/publication/325214979

Food and Agriculture Organization of the United Nations (2008). *International Year of the Potato*. Retrieved from www.potato2008.org

Food and Agriculture Organization. (2009). *Potato fact sheets.* International Year of the Potato. To Deepen Understanding of the Potato's Role in World Agriculture, the Economy and Global Food Security, FAO Specialists Compiled a Series of Factsheets on Key Issues in Potato Development, 1–17.

Food and Agriculture Organization. (2016). *Improving farmers' access to quality seed potato.* Strengthening linkages between small actors and buyers in the roots and tubers sector in Africa Kigali, Rwanda 25-27 November 2015.

Food and Agriculture Organization. (2017). African Roots and Tubers Project: Improving access to quality seeds potato. Retrieved from https://r.search.yahoo.com/_ylt=AwrC_DdAEJFcUXcAZfQPxQt.;_ylu=X3oDMTByOHZyb21tBGNvbG8DYmYxBHBvcwMxBHZ0aWQDBHNlYwNzcg--/RV=2/RE=1553039552/RO=10/RU=http%3a%2f%2fwww.fao.org%2f3%2fa-i7166e.pdf/RK=2/RS=3clAAEnayWiep1i7my8qB45Dvvc-

Gichuru, J., & Dijk, M. P. Van. (2013). Low potato yields in Kenya : do conventional input innovations account for the yields disparity ? *Agriculture & Food Security*, 2(1), 1–11. https://doi.org/10.1186/2048-7010-2-14

Gildemacher, P. R., Schulte-geldermann, E., & Borus, D. (2011). Seed Potato Quality Improvement through Positive Selection by Smallholder Farmers in Kenya, *Journal of Potato Research*, 3(54) 253–266. https://doi.org/10.1007/s11540-011-9190-5

Government Of Kenya (2004). *Strategy for Revitalizing Agriculture*. Kilimo House; Nairobi, Kenya

Government of Kenya (2007). *The Vision 2030 popular version*. Department of National Planning and Development. Retrieved from vision2030.go.ke/.../2018/05/Vision-2030-Popular-Version.pdf

Guthire, P., (2001). High – involvement work practices, turnover, and productivity: evidence from New Zealand. *Academy of management journal*, 44 (1) 180-190

Haque, S., (2009). "Challenges of People's Perception at Local Governance: A Case Study on the Standing Committees of Union Parishad in Bangladesh" *Nepalese Journal of Public and Governance* 24 (21) 43-61

Hong, Z., Fen, X. U., Yu, W. U., Hong-hai, H. U., & Xiao-feng, D. A. I. (2017). Progress of potato staple food research and industry development in China. *Journal of Integrative Agriculture,* 16(12), 2924–2932. https://doi.org/10.1016/S2095-3119 (17)61736-2

Hussein, M. J., & Nayef, M. N. (2013). Effect of foliar fertilizer (high in potash) on growth and yield of seven potato cultivars (Solanum tuberosom L.). *Euphrates Journal of Agriculture*

Science, 5(1), 1–7. Retrieved from https://www.researchgate.net/publication/320172775 Effect

Israel, G. D. (1992). *Determining Sample Size*. Frolida Cooperative Extension Service, University of Florida.

Jane Muthoni, J., Shimelis, H., & Melis, R. (2013). Potato Production in Kenya: Farming Systems and Production Constraints. *Journal of Agricultural Science*, 5(5), 182–197. https://doi.org/10.5539/jas.v5n5p182

Jansky, S., Navarre, R. & Bamberg, J. (2019). Introduction to the Special Issue on the Nutritional Value of Potato. *American Journal of Potato Research.* **96,** 95–97 https://doi.org/10.1007/s12230-018-09708-1

Janssens, S. R. M., Wiersema, S. G., Goos, H., & Wiersma, W. (2013). *The value chain for seed and ware potatoes in Kenya Opportunities for development*. Retrieved from www.wageningenUR.nl/en/lei

Jasim AH, Hussein MJ, Nayef MN (2013). Effect of foliar fertilizer (high in potash) on growth and yield of seven potato cultivars (*Solanum tuberosom* L.). *Euphrates Journal of Agriculture. Science* 5(1):1-7.

Jones, K.: 1998, 'The mediation of learning within a dynamic geometry environment', in Olivier, A., & Newstead K. *Proceedings of the 22nd Conference of the International Group for the Psychology of Mathematics Education*, Stellenbosch, South Africa: University of Stellenbosch, Volume 3, pp. 96–103.

Kaguongo, W., Alice, N., Mutunga, J., Nderitu, J., Lungaho, C., Nganga, N., Schulte-Geldermann. (2013). *A policymakers' guide to crop diversification : The case of the potato in Kenya.* https://doi.org/10.13140/2.1.3433.6963

Kaguongo, W., Gildemacher, P., Demo, P., Wagoire, W., Kinyae, P., Andrade, J., Fuglie, K. (2008). Farmer practices and adoption of improved potato varieties in kenya and uganda. *Social Sciences,* 2008(5), 67–68. https://doi.org/10.13140/2.1.2155.7449

Kaguongo, W., Maingi, G., Barker, I., Nganga, N., & Guenthner, J. (2014). The Value of Seed Potatoes from Four Systems in Kenya. *American Journal of Potato Research*, 91(1), 109–118. https://doi.org/10.1007/s12230-013-9342-z

Kaguongo, W., Ng'ang'a, N., Muthoka, N., Muthami, F., & Maingi, G. (2009). *Seed Potato Subsector Five Year Master Plan 2009-2014.* Seed potato study sponsored by GTZ-PSDA, USAID, CIP and Government of Kenya, Ministry of Agriculture.

Kamuyu, L. M., Muiru, W. M., Kimenju, J. W., & Nyongesa, M. W. (2017). Potato Seed Production Systems and Disease Prevalence in Major Potato Growing Regions in Kenya. *International Journal of Current Microbiology and Applied Sciences,* 6(10), 1012–1020. https://doi.org/10.20546/ijcmas.2017.610.122

Kaplan, M., Ulger, I., & Kokten, K. (2018). Nutritional composition of potato (Solanum tuberosum L .) Haulms. *Progress in Nutrition*, 20(1), 90–95. https://doi.org/10.23751/pn.v20i1-S.5541

Karimov, K., Ahmed, M. M., Noshin, F., Saleem, M., Mahroof-Tahir, M., Moiz, S. A., & Rashid, A. (2015). Nickel phthalocyanine based organic photo transistor: effect of semiconductor film thickness. *The European Physical Journal Applied Physics*, *72*(2), 20202.

Kassei M., Ndiritu S.W. and Stage J. (2014). *What determines Gender Inequality in Household Food Security in Kenya*? Application of Switching Treatment Regression. World Development Vol 56 pp. 153-171

Kenya Plant Health Inspectorate Services. (2017). *Guidelines for Authorization of Seed Certification Activities in Kenya.* Retrieved from https://mpala.org/wp-content/uploads/2019/11/KEPHIS.pdf

Khai, H.V., Yabe, M., Yokogawa, H., and Sato, G. (2008). Analysis of Productive Efficiency of Soybean Production in the Mekong River Delta of Viet Nam. *Journal of Agriculture*, Kyushu University. 53(1):271-279.

Khai, H.V., Yabe, M., Yokogawa, H., and Sato, G. (2008). Analysis of Productive Efficiency of Soybean Production in the Mekong River Delta of Viet Nam. *Journal of Agriculture, Kyushu University.* 53(1):271-279.

Kinkingninhoun-Mêdagbé, F. M., Diagne, A., Simtowe, F., Agboh-Noameshie, A. R., & Adégbola, P. Y. (2010). Gender discrimination and its impact on income, productivity, and technical efficiency: evidence from Benin. *Agriculture and human values*, 27(1), 57-69.

Kiplagat.W.K., Rehema, M., Xianli, X., Mchomvu, F & Baloch, Z. (2016). Factors influencing adoption and use of clean certified seed potato tubers among small-scale potato farmers: Evidence from Koibatek Sub County, Baringo, Kenya. *African Journal of Agriculture and Environment,* 1(1), 1–7. Retrived from http://onlinesciencejournals.com/index.php/ajae

Kirub, A., & Asfaw, F. (2013). *Seed potato tuber production and dissemination, experiences, challenges and prospects: Proceedings*. National Workshop on Seed Potato Tuber Production and Dissemination. Bahir Dar (Ethiopia). 12-14 Mar 2013. (Ethiopia). Ethiopian Institute of Agricultural Research (EIAR) Amhara Regional Agricultural Research Institute (ARARI) International Potato Center (CIP). ISBN 978-99944-53-87-x. 338 p.

Laibuni, N. M., & Omiti, J. M. (2014). Market Structure and Price: An empirical analysis of Irish potato markets in Kenya. *International Journal of Research in Marketing.* Retrieved from www.future-agricultures.org

Lanteri, S., & Quagliotti, L. (1997). Problems related to seed production in the African region. *Euphytica,* 96(1), 173–183. https://doi.org/10.1023/A:1002958325142

Li, S., & He, P. (2018). Identifying Yield and Nutrient Gaps for Potato Production in Northwest China. *Better Crops,* 102(2), 13–16. https://doi.org/10.24047/BC102214

Lutaladio NeBambi , Oscar Ortiz, Anton Haverkort, D. C. (2009). Sustainable potato production-Guidelines for developing Countries. *Agricultural and Forest Meteorology* (Vol. 127). https://doi.org/10.1016/j.agrformet.2004.08.003

Menza Mesfin, Gebrerufael Girmay, F. W. (2018). Enhancing Household Food Security through Irish Potato Production in Gamo Highlands of Southern Ethiopia. *Scholarly Journal of Agricultural Science,* 4(7), 410–419.

Ministry of Agriculture, Lands and Fisheries Department of Agriculture. (2016). *The National Potato Strategy 2016-2020.* Kilimo House; Nairobi, Kenya

Mmbando, F. E., & Baiyegunhi, L. J. (2016). Socio-economic and institutional factors influencing adoption of improved maize varieties in Hai District, Tanzania. *Journal of Human Ecology*, 53(1), 49–56. https://doi.org/10.1080/09709274.2 016.11906955

Monette, D. R., Sullivan, T. J., & DeJong, C. R. (2013). *Applied social research: A tool for the human services*. Nelson Education

Mugenda, O. M., & Mugenda, A. G. (2003). *Research Methods: Quantitative and Qualitative Approaches* (Second Edition). Nairobi: Acts Press.

Mumia, B. I., Muthomi, J. W., Narla, R. D., Nyongesa, M. W., & Olubayo, F. M. (2018). Seed Potato Production Practices and Quality of Farm Saved Seed Potato in Kiambu and Nyandarua Counties in Kenya. *World Journal of Agricultural Research,* 6(1), 20–30. https://doi.org/10.12691/wjar-6-1-5

Muthoni, J., Mbiyu, M. W., & Nyamongo, D. O. (2010). A Review of potato seed systems and germplasm conservation in Kenya. *Journal of Agricultural and Food Information,* 11(2), 157–167. https://doi.org/10.1080/10496501003680565

Muthoni, J., Shimelis, H., & Melis, R. (2013). Potato Production in Kenya : Farming Systems and Production Constraints. *Journal of Agricultural Science*, 5(5), 182–197. https://doi.org/10.5539/jas.v5n5p182

NakuruCounty. *Potato Strategic Plan 2018-2022* (County Potato Strategy) First Draft (2018).

Nassiuma, D. K. (2000). *Survey sampling: Theory and Methods.* Nairobi University Press.

National Potato Council of Kenya. (2017). *Seed potato availability for the month of January 2018.* E-Newsletter, 1–5. Retrieved from https://npck.org/Newsletters/December2017newsletter.pdf

Obare, G., Nyagaka, D., Nguyo, W., & Mwakubo, S. M. (2010). Are Kenyan smallholders allocatively efficient? Evidence from Irish potato producers in Nyandarua North district. *Journal of Development and Agricultural Economics,* 2(3), 78–85. Retrieved from http://www.academicjournals.org/JDAE

Ogola, J. B. O., Orawo, A. O., & Ayieko, M. W. (2012). Assessment of factors affecting the farmer demand for seed potato in Nakuru District, Kenya. *African Journal of Agricultural Research*, 7(23), 4151-4157.

Ogunsumi, O. L. (2007). Socio-economic conditions of peasant farmers: the case of agricultural technologies sustainability in southwest Nigeria. *African Journal of Agricultural Research*, 2(9), 441-446

Ogutu, S. O., Okello, J. J., & Otieno, D. J. (2013). *Impact of Information and Communication Technology- based Market Information Services on Smallholder Farm Input Use and Productivity: The Case of Kenya.* In International Conference of the African Association of Agricultural Economists (ICAAAE) (pp. 22–25). https://doi.org/10.1016/j.worlddev.2014.06.011

Ojango J.M.K. and Pollot, G.E. (2002). The relationship between Holstein bull breeding values for milk yield derived in both the U.K. and Kenya. *Livestock Production Science*, 74, 1-12.

Okello, J., Zhou, Y., Kwikiriza, N., Ogutu, S., Barker, I., Schulte-Geldermann, E., Ahmed, J. (2016). Determinants of the Use of Certified Seed Potato among Smallholder Farmers: The Case of Potato Growers in Central and Eastern Kenya. *Agriculture*, 6(55), 1–12. https://doi.org/10.3390/agriculture6040055

Paschall, M. J., Ringwalt, C. L., Grube, J. W., & Miller, T. (2018). Availability and consumption of different alcoholic beverages and use of drinking contexts among adolescents in three Mexican cities. *Cogent Medicine*, 5(1), 1–12. https://doi.org/10.1080/2331205X.2018.1537061

Patel, P. (2009, October). Introduction to quantitative methods. In *Empirical Law Seminar* (pp. 1-14). Retrieved from http://scholar.google.com/scholar_url?url=http%3A%2F%2Fhls.harvard.edu%2Fcontent%2Fuploads%2F2011%2F12%2Fquantitative_methods.pdf&hl=en&sa=T&oi=ggp&ct=res&cd=2&d=8188533209659882398&ei=91HfXsC6O4-Hy9YPv9KfsAU&scisig=AAGBfm2ouayUPkuG-6qyb3g-WbL-WVRITw&nossl=1&ws=1360x657&at=

Pérez-López, J. (2018). *Cuba's second economy: From behind the scenes to center stage.* 1st Edition. New York. Routledge https://doi.org/10.4324/9781351293600

Pisante, M., Stagnari, F., & Grant, C. A. (2012). Agricultural innovations for sustainable crop production intensification. *Italian Journal of Agronomy,* 7 (40) 300-311, Retrieved from https://www.researchgate.net/publication/285883137

Republic of Kenya: Nakuru County. (2013). *First Nakuru County Integrated Development Plan* (2013-2017).

Rogers, E. M., Singhal, A., & Quinlan, M. M. (2003). *Diffusion of Innovations. In An Integrated Approach to Communication Theory and Research.* In. Everett M. Rogers and Diffusion of Innovations (Fith, pp. 1–25). New York: Routledge. https://doi.org/10.1525/aa.1963.65.5.02a00230

Rogers, EM. (2003). *Diffusion of Innovations*. 5th Edition. New York: Free Press

Sahin, I., Rogers, F., Rogers, F., & Rogers, F. (2006). Detailed Review of Rogers' Diffusion of Innovations Theory and Educational Technology Related Studies Based on Rogers'. *The Turkish Online Journal of Educational Technology –, 5(2), 1–23.*

Sanginga N. and Mbabu A. (2015). *Root and Tuber Crops (Cassava, Yam, Potato and Sweet Potato)*. Background Paper - Feeding Africa Conference, October 2015. Retrived from https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Root_and_Tuber_Crops__Cassava__Yam__Potato_and_Sweet_Potato_.pdf

Schulte-Geldermann, E. (2012). *Tackling Low Potato Yields in Eastern Africa : an Overview of Constraints and Potential Strategies Major Constraints and Strategies for Increasing Potato* (pp. 72–80).

Schulte-Geldermann, E., Wachira, G., Ochieng, B., and Barker, I. (2013). *Effects of Field Multiplication Generation on Seed Potato*. Proceedings of the National Workshop on Seed Potato Tuber Production and Dissemination: Experiences, Challenges and Prospects, 12–14 March 2012. EIAR and ARARI, Bahir Dar, Ethiopia.

Silver, B. (2013). Commodity of the Quarter Potatoes. *Journal of Agricultural & Food Information,* 14(2), 91–97. https://doi.org/10.1080/10496505.2013.774649

Taiy, R. J., Onyango, C., Nkurumwa, A., & Ngetich, K. (2017). Socio-economic Characteristics of Smallholder Potato Farmers in Mauche Ward of Nakuru County, Kenya. *Universal Journal of Agricultural Research,* 5(5), 257–266. https://doi.org/10.13189/ujar.2017.050502

Taiy, R. J., Onyango, C., Nkurumwa, A., Ngetich, K., Birech, R., & Ooro, P. (2016). Potato Value Chain Analysis in Mauche Ward of Njoro Sub-County, Kenya. *International Journal of Humanities and Social Science*, 6(5), 129–138. Retrived from www.ijhssnet.com

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education,* 2, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Tey, Y. S. (2013). *The Adoption of Sustainable Agricultural Practices: An Integrative Approach for Malaysian Vegetable Farmers*. The University of Adelaide.

Thomas-Sharma, S., Abdurahman, A., Ali, S., Andrade-Piedra, J. L., Bao, S., Charkowski, A. O., Forbes, G. A. (2016). Seed degeneration in potato: The need for an integrated seed health strategy to mitigate the problem in developing countries. *Plant Pathology*, 65(1), 1–16. https://doi.org/10.1111/ppa.12439

Ugwumba COA, Okechukwu EO. (2014). Adoption of improved maize production technologies in Enugu State, Nigeria. *International Journal of Agriculture Innovations and Research*, 3(1): 259-261

Wang, Y., Liu, X., Ren, G., Yang, G., & Feng, Y. (2019). Analysis of the spatiotemporal variability of droughts and the effects of drought on potato production in northern China. *Agricultural and forest meteorology, 264*, 334-342

Wang, Y-S., Wang, Y-M., Lin, H-H. and Tang, T-I. (2003), "Determinants of user acceptance of internet banking: an empirical study", *International Journal of Service Industry Management*, 14 (5) 501-519.

Wani, T. A., & Ali, S. W. (2015). Review & Scope in the Study of Adoption of Smartphones in India. *Journal of General Management Research,* 3(2), 101–118. Retrieved from https://www.researchgate.net/publication/281060763

Wijesinha-Bettoni, R., & Mouillé, B. (2019). The Contribution of Potatoes to Global Food Security, Nutrition and Healthy Diets. *American Journal of Potato Research, 96*(2), 139-149

Wooldridge, J. M. (2001). Instrumental estimation of the average treatment effect in the correlated random coefficient model. East Lansing, MI: Department of Economics, Michigan State University

EGERTON UNIVERSITY
LIBRARY

APPENDICES

Appendix A: Questionnaire for Small Scale Potato Farmers in Njoro Sub County

Introduction

I am AmwineLamech, a student pursuing a Master of Science Degree Programme in Community Studies and Extension in the Faculty of Education and Community Studies Department of Applied ;Community Development Studies at Egerton University. I am carrying out a research project on ***Influence of selected social, economic and technology related factors on adoption of clean seed potato by small-scale farmers in Njoro Sub- County.*** The results from this study may be helpful in improving potato productivity in Njoro Sub- County and increasing household income and food security. You are among the selected farmers to participate in the study. I would like to assure you that your responses will be treated with at most confidentiality and used for academic research purposes. I therefore request you to voluntarily and sincerely provide relevant responses to the questions in an objective and honest manner. The exercise may last for approximately 30 minutes. Your participation will be greatly appreciated.

Section A. Background and Demographic Information (*please circle the appropriate*)

A.1 Respondents household ID	**A.5** Highest level of education completed 1 None 2 Primary 3 Secondary 4 College/University 5 Others specify	**A.7** Number of household members .....
A.2 Ward 1 Nessuit 2 Mauche 3 Mau Narok		**A.8.** Total amount of land owned (acres)..... **A.9** Total amount of land leased in the last one year (acres) .....
A.3 Gender **1** Male **0** Female	**A.6** Have you attended any training on potato farming **1** Yes **0** No	**A.10**How many acres do you use to grow potatoes? .....
A.4 How old are you		**A.11** How long have you been a potato farmer (years).....

Section B. Information on Farmers' Economic Activities and Income (*please circle the appropriate)*

B.1 What are your major sources of income (*you can choose multiple*) **1** Farming **2** Employment **3** Pension **4** Business **5** Remittances **6** Others (specify)	**B. 4** Where do you get money for financing potato production 1 Own savings 2 Family members 3 Group 5 SACCO 7 Others (specify).....\
B 2 Estimated total income per year (KESH).....	
B 3 Estimated total expenditure per year (Ksh).....	**B. 5** Do you know about clean seed potato? **1** Yes **0** No

Section C. Information on potato farming. (*Circle the appropriate*)

C.1 Do you grow ware potato?

1 Yes **0 No** (if no skip to C 19)

C.2 For what purpose do you grow ware potato?

0 For own use **1** For income **2** Both

C.3 Which potato varieties do you usually grow? (*Multiple response*)

1 Shangi **2** Asante

3 Tigoni **4** Sherekea

5 Others specify .....

C.4 Why do you grow these varieties (tick all appropriate)

	Variety	Ready market	Cooks faster	Tastes better	Matures faster	High yielding	Easy access to seed	Resilient to diseases	
1	Shangi								
2	Tigoni								
3	Sherekea								
4	Asante								
A									
B									

C.5 Which type of seed potato do you usually use in planting ware potatoes?
1 Certified seed
2 Clean seed
3 Farm saved seed
4 I buy from the market
5 Others (specify).....

C.6 Where do you get your seeds from?
1 Own farm saved
2 Trained seed producer
3 ADCMolo
4 Open markets
5 Group
7 Neighbours
6 Others (specify)
.....

C.7 How long is the distance from your farm and the source of the seed (km)?
.....

C.1;3 Who makes decisions on which type of seed potato to plant?
1 Spouse
2 Self
3 Both
4 Others (specify).....

C. 14 How many seasons do you plant potatoes in a year?
1 One
2 Two
3 Three

C.8 How do you access information from seed potato producers?
1. Extension officers
2. Neighbours
3. Radio
4. Telephone
5. Others (specify).....

C.9 Do you normally plant using clean seed potato?
1 Yes **0** No (if no skip to **C12)**

C.10 Give reasons for planting using clean seed.
1 High yielding
2 More resilient to diseases
3 Home consumption
4 Matures faster
5 Others (specify) .....

C. 15 How many bags of potatoes did you produce last season?
.....

C. 16 Estimated size of the bags e.g. 50kg,90kg, 120kg
.....

C.17 How many bags did you sell after harvest?.....

C. 18 How much did you sell per bag (Ksh).....

C 11 For the last 3 seasons, how many times did you plant using clean seed?
1 Once
2 Twice
3 Thrice
4 None

C.12 Give reasons for not planting using clean seed potato.
1 Lack of seed
2 Seed is expensive
3 I don't know where to get the seed
4 Seed lacks in preferred varieties
5 Long distance to the source of the seed
6 Others (Specify)
.....

C.19 Do you produce seed potato?
1 Yes **2** No

C.19.1 What type of seed potato do you produce?
1 Clean, **2** Certified, **3** Positively selected

C.19.2 For what reason do you produce seed potato?
1 Own use
2 Income

SECTION D. Information on group participation of farmers ***(Please circle the appropriate)***

D.1 Do you belong to any farmers group?

1 Yes **0** No (Skip this section)

D.2 What activities do you do as a group?

1 Merry go round

2 Crop production

3 Social welfare

4 Others specify

.....

.....

D.3 Do you belong to a potato-growing group?

1 Yes **0** No

D.4 Do you grow potatoes as a group?

1 Yes **0** No (if No skip this section)

D.5 Do you plant using clean seed potato as a group?

1 Yes **0** No (If no skip to D.7)

D.6 Give reasons for using clean seed potato as a group?

1 High yielding

2 Fast maturity

3 Resilient to diseases

4 The group decides

5 Others (specify)

.....

.....

D.7 Give reasons for not using clean seed potato as a group?

1. The group decides

2 It is expensive

3 Seed not available

4 Lack of information

5 Others (specify)

.....

.....

D. 8 Where do you get information on potato production from as a group?

1 Neighbours

2 Extension officers

3 Radio programs

4 Group members

5 Others (specify)

.....

D.9 Apart from potato growing, which other activities do you do as a croup?

1 Marketing of potatoes

2 Merry go round

1 Grow other crops as a group

2 Social welfare

3 Table banking

4 Grow other crops

5 Others (specify)

.....

D.10 Do you produce seed potato as a group?

1 Yes **2** No

D.11 Which type of seed potato do you produce?

1 Clean seed

2 Certified seed

3 Positively selected seed

D.12 For what purpose do you grow seed potato as a group?

0 Own use

1 Income

2 Both

D.13 How many bags of seed potato did you produce in the last season?

.....

D. 14 Size of the bags (kgs)

.....

SECTION E. Information on Technology perceptions of clean seed potato

Please rate your perception of clean seed potato based on the following on a score of 1-5. 1= Strongly disagree **(SD)**, 2 =Dis agree **(D)**, 3= Nuetral **(N)**, 4 =Agree **(A)**, 5= Strongly agree **(SA)**

NB 1 Means that you strongly disagree with the statement, **2** means that you somehow disagree with the statement, **3** means that you are not sure (neither do you agree or dis agree), **4** means that you somehow agree to with the statement, **5** means that you strongly agree with the statement.

No	Item	SD	D	N	A	SA
1	When you plant using clean seed potato, you harvest earlier than others.					
2	You do not obtain less yields when you plant using clean seed potato					
3	If you plant using clean seed potato, you can still harvest amidst minimal rainfall					
4	Potatoes planted using clean seed potato have minimal pest and disease incidences					
5	Harvested potatoes from clean seed have a longer shelf life					
6	Planting using clean is more costly than planting using farmer saved seed potato					

Suggest three ways through which farmers can be helped to increase the use of clean seed potato in Njoro Sub County?

.....

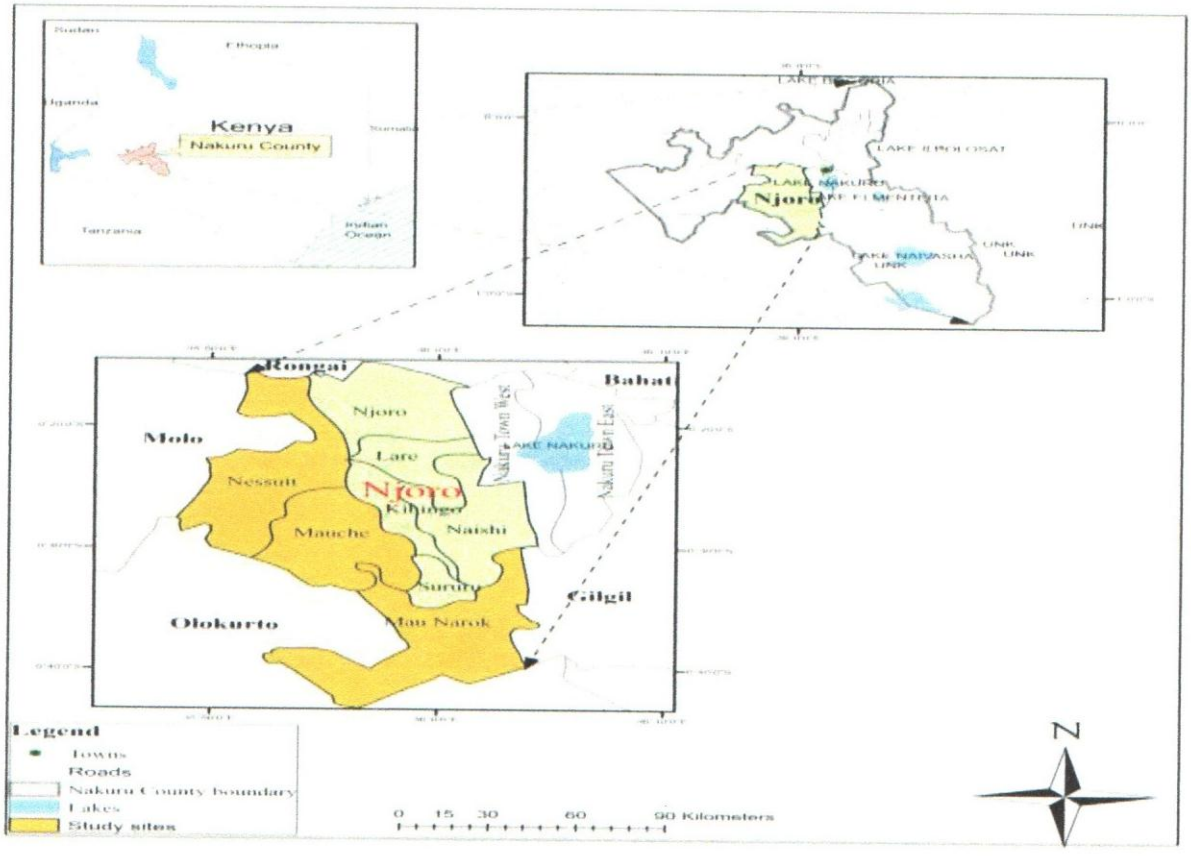
.....

.....

END

THANK YOU FOR YOUR COPERATION AND IN PUT

Appendix B: Map Showing Location of the Study Area



Appendix C: Letter of Research Authorisation

EGERTON
Tel. Pilot: 254-51-2217620
254-51-2217877
254-51-2217631
Dir.line/Fax: 254-51-2217847
Cell Phone

UNIVERSITY
P.O. Box 536 - 20115
Egerton, Njoro, Kenya
Email: bpgs@egerton.ac.ke
www.egerton.ac.ke

OFFICE OF THE DIRECTOR GRADUATE SCHOOL

EM21/12025/17 **11th, April, 2019**

Ref:..... **Date:**.....

The Director General
National Commission for Science Technology and Innovation,
P. O. Box 30623-00100
NAIROBI.

Dear Sir,

RE: REQUEST FOR RESEARCH PERMIT – MR. LAMECH AMWINE REG. NO. EM21/12025/17

This is to introduce and confirm to you that the above named student is in the Department of Applied Community & Development Studies, Faculty of Education & Community Studies, Egerton University.

He is a bona-fide registered M.Sc student in this University. His research topic is **"Influence of Selected Social, Economic and Technology Related Factors on Adoption of Clean Seed Potato by Small Scale Farmers in Njoro Sub-County, Kenya."**

He is at the stage of collecting field data. Please issue him with a research permit to enable him undertake the studies.

Your kind assistance to him will be highly appreciated.

Yours faithfully,

11 APR 2019

Prof. Nzula Kitaka
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

NK/vk

Appendix D: Research Permit

THIS IS TO CERTIFY THAT:
MR. AMWINE LAMECH LAMECH
of EGERTON UNIVERSITY, 0-536
Nakuru,has been permitted to conduct
research in *Nakuru County*

on the topic: *INFLUENCE OF SELECTED SOCIAL, ECONOMIC AND TECHNOLOGY RELATED FACTORS ON ADOPTION OF CLEAN SEED POTATO BY SMALL SCALE FARMERS IN NJORO SUB-COUNTY, KENYA*

for the period ending:
4th June,2020

.....
Applicant's Signature

Permit No : NACOSTI/P/19/28505/29766
Date Of Issue : 4th June,2019
Fee Recieved :Ksh 1000



.....
Director General
National Commission for Science, Technology & Innovation

Appendix E: Abstract of the Publication

The Authentic Knowledge: African Journal of Pure and Applied Science Research Volume 1 No 1, 2019 ISSN 2618-0626-p, 2618-0634-e



The Authentic Knowledge: African Journal of Pure and Applied Science Research
AJPASR - ISSN 2618-0626-p, 2618-0634-e
Volume 1, Issue No 1, 2019
P.O. Box 555 (00202) Nairobi, Kenya
editor@serek.or.ke

SOCIETY OF EDUCATIONAL RESEARCH AND EVALUATION IN KENYA

Socio - Economic Factors that Influence Adoption of Clean Seed Potato (*Solanum tuberosum*) by Small Scale Farmers in Njoro, Kenya

Anwine, L[1], Nkurumwa, A. O[2], Mulu-Mutuku, M.W[1]
[1]Egerton University, Department of Applied Community Development Studies
[2]Egerton University, Department of Agricultural Education and Extension
P.O.BOX 536-2115 Njoro, Kenya
Corresponding Author contact: E-mail: lamex1958@gmail.com

Abstract

This study sought to determine the influence of selected social-economic factors on adoption of clean seed potato by small scale farmers in Njoro Sub-County, Kenya. Clean seed potato is one of the best types of seed potato that farmers can use to increase potato productivity especially among resource-constrained farmers despite its low adoption. The objectives of this study were to determine the influence of selected social and economic factors on adoption of clean seed potato by small scale potato farmers in Njoro Sub-County. The findings of this study may guide extension service providers in formulating policies and interventions aimed at increasing adoption of high-quality seed potato for increased productivity. The study used a correlational research design. Data was collected in a cross-sectional survey. A researcher-administered questionnaire was used to collect data. The study used Chi-square test to examine the associations between selected socio-economic factors and adoption of clean seed potato at 5% level of significance. It was found out that the association between education level, belonging to farmer groups, and distance from the source of seed potato to the farms, and adoption of clean seed potato was significant ($p < 0.05$). The study concludes that the level of formal education attained by farmers, belonging to farmer groups, and distance between the farms and the source of seed influences adoption of clean seed potato by small scale farmers in Njoro Sub-County. This study recommends that the government encourage farmers to form groups and train more farmers in commercial clean seed potato production in order to increase clean seed potato adoption for improved productivity, incomes and food and nutritional security.

Key Words: *Adoption; Clean Seed potato; Kenya; Potato; Small Scale Farmers*

Appendix F: Chi-Square Test Results for Selected Social, Economic and Technology Related Factors

SELECTED SOCIAL FACTORS

Gender of Respondents

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.129[a]	1	.720		
Continuity Correction[b]	.375	1	.540		
Likelihood Ratio	.791	1	.374		
Fisher's Exact Test				.421	.271
Linear-by-Linear Association	.781	1	.377		
N of Valid Cases	130				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.38.

b. Computed only for a 2x2 table

Highest level of education completed

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.596[a]	3	.035
Likelihood Ratio	5.559	3	.135
Linear-by-Linear Association	5.498	1	.019
N of Valid Cases	130		

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is .46.

Household size

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.170[a]	2	.338
Likelihood Ratio	8.931	2	.628
Linear-by-Linear Association	1.006	1	.316
N of Valid Cases	130		

a. 16 cells (66.7%) have expected count less than 5. The minimum expected count is .12.

Experience

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.508[a]	7	.162
Likelihood Ratio	10.580	7	.158
Linear-by-Linear Association	1.128	1	.288
N of Valid Cases	130		

a. 11 cells (68.8%) have expected count less than 5. The minimum expected count is .12.

Belonging to potato farmer groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.4.665[a]	1	.031		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.073	1	.788		
Fisher's Exact Test				.754	.502
Linear-by-Linear Association	.074	1	.786		
N of Valid Cases	130				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 3.58.

b. Computed only for a 2x2 table

Age of the respondents

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.222[a]	6	.516
Likelihood Ratio	5.559	6	.135
Linear-by-Linear Association	5.498	1	.019
N of Valid Cases	130		

a. 3 cells (37.5%) have expected count less than 5. The minimum expected count is .46.

SELECTED ECONOMIC FACTORS

Distance to the source of clean seed potato from the farms

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	39.502[a]	4	.000
Likelihood Ratio	44.330	4	.000
Linear-by-Linear Association	4.666	1	.031
N of Valid Cases	130		

a. 29 cells (85.3%) have expected count less than 5. The minimum expected count is .12.

Sources of income

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.311[a]	3	.510
Likelihood Ratio	1.495	3	.683
Linear-by-Linear Association	.100	1	.752
N of Valid Cases	130		

a. 6 cells (75.0%) have expected count less than 5. The minimum expected count is .12.

Income of the respondents

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.894[a]	4	.142
Likelihood Ratio	29.628	4	.682
Linear-by-Linear Association	1.647	1	.199
N of Valid Cases	129		

a. 61 cells (87.1%) have expected count less than 5. The minimum expected count is .12.

Size of Land owned by the respondent

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.007[a]	6	.173
Likelihood Ratio	8.411	6	.210
Linear-by-Linear Association	.232	1	.630
N of Valid Cases	130		

a. 8 cells (57.1%) have expected count less than 5. The minimum expected count is .23.

SELECTED TECHNOLOGY RELATED FACTORS

Fast maturity

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.283[a]	4	.864
Likelihood Ratio	.507	4	.973
Linear-by-Linear Association	.158	1	.691
N of Valid Cases	37		

a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is .81.

High yielding

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.950[a]	4	.917
Likelihood Ratio	2.746	4	.601
Linear-by-Linear Association	.693	1	.405
N of Valid Cases	37		

a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is .41.

Drought resilience

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.090[a]	4	.719
Likelihood Ratio	2.944	4	.400
Linear-by-Linear Association	.475	1	.491
N of Valid Cases	37		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 1.62.

Pest and disease resilience

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.253[a]	4	.689
Likelihood Ratio	.591	4	.898
Linear-by-Linear Association	.392	1	.531
N of Valid Cases	37		

a. 4 cells (50.0%) have expected count less than 5. The minimum expected count is 1.22.

Cost of the seed

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.042[a]	4	.728
Likelihood Ratio	1.339	4	.855
Linear-by-Linear Association	.296	1	.586
N of Valid Cases	37		

a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is 1.22.

Longer shelf life

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.770[a]	4	.217
Likelihood Ratio	6.884	4	.142
Linear-by-Linear Association	.288	1	.591
N of Valid Cases	37		

a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is .41.