FACTORS INFLUENCING AGRIPRENEURS' PARTICIPATION AND INVESTMENTS IN CLEAN SEED POTATO ENTERPRISES IN MOLO, NAKURU COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

I sincerely declare that this thesis is my original work and it has not been submitted wholly or in part for conferment of any degree in this or any other institution.

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Recommendation

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DEDICATION

This thesis is dedicated to my lovely parents Stephen Mutinda and Veronica Mwongeli, brothers and sister Yvonne Mumbua, nephews Ian and Abed as well as aunt Josephine Ndila for their support and prayers.

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ABSTRACT

The Kenyan Seed potato production sector has failed to meet the high and growing demand for high quality seed. Enhanced participation and investments of more private seed potato multipliers could help increase availability and accessibility of quality seed and bridge the supply gap that meets less than 5% of the demand. However, factors that influence agripreneurs' participation and level of investment in the multiplication of clean potato seed are not well known. The overall objective of this study was to contribute to food and nutrition security by increasing capacity of seed potato systems through enhanced clean seed potato enterprises in Nakuru County. The specific objectives were to: (1) characterize potato seed systems in Nakuru County, Kenya; (2) characterize the nature of investments in seed potato enterprises; (3) assess determinants of agripreneurs' participation in the multiplication of clean seed potato; and (4) evaluate the factors influencing agripreneurs' level of investment in the multiplication of clean seed potato. A cross-sectional survey was conducted in June, 2019 to 380 agripreneurs selected using both purposive and random sampling techniques. Data management and analysis was done using STATA and Statistical Package for Social Sciences (SPSS). Descriptive and inferential statistics were used for objectives one and two. Double hurdle model was used for objectives three and four. The results show that the dominant seed system used by the agripreneurs was own farm saved seed (60%). There was also a decrease in amount invested in seed potato enterprise from KES 167,248 in 2017 to KES 82,961 in 2019. The analysis revealed that some agripreneurs had previously been involved in selling seed potato at different levels. Majority (89%) were selling uncertified seed with a few (11%) involved in selling of certified seed. The double hurdle model analyses revealed that age, sex (male), having access to seed store, better selling price, having acquired trainings, longer family history in seed potato business, more years spent in school and years in potato farming significantly ($P \leq .1$) increased probability of agripreneurs' decision to participate in clean seed potato enterprises. Number of seasons produced, total land under seed potato, annual income, frequency of getting extension service and initial acres under production significantly ($P \leq .01$) influenced level of investment in clean seed potato enterprises. There is need to strengthen the seed potato value chain through increased agripreneurs capacity building on potato production technologies. Inclusivity by encouraging youth and women to participate in seed enterprises to combine efforts with relatively older male producers will lead to increased seed supply. Government and other development agencies' should support in key investments such as seed storage facilities would encourage more agripreneurs to invest in seed enterprises.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

ADC	-	Agriculture Development Corporation
CARP	-	Community Action Research Project
CIP	-	International Potato Centre
DLS	-	Diffused Light Store
FAO	-	Food and Agriculture Organization of the United Nations
GTIL	-	Genetic Technological Innovations Laboratory
IFAD	-	International Fund for Agricultural Development
IRR	-	Internal rate of Return
KALRO	-	Kenya Agricultural and Livestock Research Organization
KEPHIS	-	Kenya Plant Health Inspectorate Service
KIPPRA	-	Kenya Institute for Public Policy Research and Analysis
MoALF&I	-	Ministry of Agriculture, Livestock, Fisheries and Irrigation
NACOSTI	-	National Commission for Science, Technology and Innovation
NPCK	-	National Potato Council of Kenya
NPV	-	Net Present Value
RMTs	-	Rapid Multiplication Technologies
RUFORUM	-	Regional Universities Forum for Capacity Building in Agriculture
SADC	-	Southern African Development Community
SCAO	-	Sub-County Agricultural Officer
SPSS	-	Statistical Package for Social Sciences
TAGDev	-	Transforming African Agricultural Universities to Meaningfully Contribute to Africa's Growth and Development
UNICEF	-	United Nations International Children’s Emergency Fund
USAID	-	United States Agency for International Development
WAO	-	Ward Agricultural Officer
WFP	-	World Food program of the United Nations
WHO	-	World Health Organization of the United Nations

CHAPTER ONE
INTRODUCTION

1.1 Background Information

Potato (*Solanum tuberosum* L.) is the fourth most important food crop in the world after maize, rice and wheat on basis of production (Taiy *et al*., 2016). The world potato production was 374,070,106 Tonnes during the year 2013 with China as the highest producer (FAO, 2015). World potato production is reported to have increased from 256,993,281 Tonnes in 1991 to 388,190,674 Tonnes in 2017. Despite the world production increase, average yields of potato across Africa were 12.2 Tonnes/ha with total production of 24,932,066 Tonnes, lowest globally in 2010 (FAO, 2012). In 2017, the average potato yields in Africa had increased to 13.2 Tonnes/ ha. However, in Eastern Africa it was still as low as 9.6 Tonnes/ha (FAO, 2017). In Kenya, the average potato production wa 10 Tonnes/ha (KEPHIS, 2016). Many factors affect potato yields in developing countries, which include but is not limited to seed quality and affordability, which limits participation and investments in the seed potato production business. The Western Australian Agriculture Authority, (2014) reported that only 11% of worlds' potato crop is raised from certified seed which is much better than that of Kenya at 2.6 % only (NPCK, 2017).

In Kenya, potato is the second after maize as the highest consumed staple crop with an average of 29.9% consumption per capita against 69.5% consumption per capita for maize (Kenya National Bureau of Statistics, 2019). Potato industry provides direct and indirect employment to over three million people, acting as growers as well as market agents (KIPPRA, 2018). It is grown by approximately 800,000 small-scale farmers on 161,000 hectares with average production of 10 Tonnes/ha (KEPHIS, 2016). Potato is mainly grown in the high altitude areas where maize does not thrive well. Thirteen major counties where potato is produced include Nakuru, Nyandarua, Elgeyo Marakwet, Bomet, Narok, Meru, Kiambu, Nyeri, Trans Nzoia, Bungoma, Uasin Gishu, West Pokot and Taita Taveta. There are other counties producing in small quantities such as; Kisii, Nyamira, Nandi, Laikipia, Murang'a, Kirinyaga, Baringo as well as Kericho. The high altitude regions of Makueni, Machakos, Embu, Kwale, Samburu, Tharaka Nithi, Nairobi and Kajiado have the potential to grow potato and increase production too (NPCK,2016).

There are more than 30 seed potato varieties grown in Kenya that are both local and imported. However, the varieties mostly grown and popular in the Kenya markets are: Shangi, Tigoni, Asante, Kenya Mpya, Desiree, Kenya Karibu and Sherehekea (NPCK, 2017). The other varieties are produced by seed growers mostly on request because they are less demanded in

the markets. This can be because of overdependence on Shangi which is the dominating variety in Kenya. Nyandarua County is the leading potato producer at 29.8% followed by Nakuru and Elgeyo Marakwet counties with 18.9% and 16.2%, respectively (Ruto, 2018). According to the Kenya's fourth president big four agenda report of 2017, total potato productivity in Kenya by 2017 was greater than 7.6 Tonnes/ha (Development Initiatives, 2019). This is far below the potential of producing 40 Tonnes/ha according to NPCK, 2017.

On May 2019, the Cabinet Secretary for Agriculture, Livestock, Fisheries and Irrigation in consultation with Food authority, National potato council of Kenya and county governments launched crops (potato) regulations, 2019 (Kenya Gazette, 2019). The purpose of the regulations was to ensure registration of potato growers, dealers and collection centers. They were also made to establish and enforce standards in potato packaging as well as grading. The standard unit of measure is supposed to be a Kilogram and maximum weight per package should be 50 kilograms. The county governments in potato producing counties have been enforcing the new regulations at different levels. Nakuru, Narok, Nyandarua and Meru Counties have been in the forefront ensuring the regulations are adhered (National Potato Council of Kenya, 2019) .

Nakuru County is one of the major potato producing Counties in Kenya with a total production of 541,054 Tonnes in 40,689 hectares in 2017. On average the potato productivity in Nakuru by 2017 was 5.2 Tonnes/ha (County Government of Nakuru, 2018b). Out of the total potato production in the County, more than 30% is produced in Kuresoi South Sub County. The potato industry in Nakuru has high potential of addressing unemployment as well as food security. The value chain in the county is characterised by majorly small-scale farmers distributed across ten Sub-Counties. A few medium to large scale farmers are scattered in Mau-Narok as well as Sirikwa Sub-Counties. Potato marketing in the County comprise of several value chain actors including growers, brokers/middlemen, transporters, wholesalers, retailers, processors as well as the end consumers.

The potato supply in Nakuru County is purely dictated by rainfall patterns, that is, during dry seasons potatoes are out of supply since many farmers practice rainfed agriculture. This directly affects the prices which are mainly controlled by brokers in major urban centres within Nakuru County. The glut season of potatoes is usually in February, July as well as August, although it changes due to weather pattern unpredictability (County Government of Nakuru, 2018a). The low potato supply in the County occurs during planting and towards planting that is in the months of April, May and October. Potato prices range from Kenya

Shilling 800 to 1000 per extendent bags approximately weighing 130 to 200 Kilograms during the glut season. The prices increases during scarcity period to a range of Kenya Shillings 2000-3000 (County Government of Nakuru, 2018b). In 2019, Nakuru county hired 23 inspectors to monitor compliance of potato regulations, 2019 (Matara, 2019). This is aimed at improving sharing of benefits across the potato value chain actors.

The low potato production is attributed to factors such as diseases, adverse weather conditions, use of low quality seed, use of low yielding potato varieties as well as low soil fertility (Kaguongo *et al*, 2008). Improved access to good quality seed potato is increasingly important to reverse the declining trend of potato production in Kenya (Karanja *et al*., 2014). Formal and informal seed systems exist in Kenya based on research, certification, production, multiplication as well as distribution. Among the existing seed systems, the dominant one is informal that produces clean, positively selected and farm-saved seed potato. Use of farm-saved seed over many seasons has been associated with declining quality of seed (Kaguongo *et al*., 2013). As of the year 2013, only one percent (1%) certified seed potato and three percent (3%) of other seed were considered to be of good quality is grown in Kenya. In 2017, only 10,600 Tonnes of certified seed potato were available against demand of 250 000 Tonnes (TechnoServe, 2018).

Majority of potato farmers source seed potato from own and neighbours farm-saved as well as other informal sources. The informal system is dominating the seed systems with 95% of seed potato being either farm-saved or sourced from neighbours (Janssens *et al*., 2013). Farm-saved seed have been found to be of low quality hence when planted low yield are achieved. The informal seed potato system proves to have potential of being efficient in supply and accessibility of seed potato. The system ensures improved seed quality status by agripreneurs multiplying certfied seed to produce clean seed that can significantly improve potato production and consequently agripreneurs' income. Farmer based seed multiplication has been reported to increase seed supply as well is improve seed markets (Walelign, 2008).

Empirical evidence indicates that potato farmers in Kenya are aware of the benefits of using quality seed. Kaguongo *et al*. (2013) reported that farmers were willing to pay 190% and 170% more for certified and clean seed, respectively, compared to the price for farm-saved seed that ranges from Kenya shillings 1000 to 1500. To produce one million Tonnes of ware potato, 165,000 Tonnes of seed potato are required. This translates to a multiplicative factor of 1:6 or 1 kg of seed produces 6 kg of ware potato (TechnoServe, 2018). Total potato production in the same year was 1,519,870 Tonnes of ware potato, which required over 250,000 Tonnes

of quality seed potato (FAO, 2017). This reflects a supply of only 4.2% certified seed. This shows that there is a huge supply gap in the existing seed systems. Increasing the number of agripreneurs producing seed potato can unlock this supply gap. Efforts to meet this demand are evident by the use of the three-generation ('3G') technology in a few seed potato projects in Kenya where rapid multiplication technologies (RMTs) using 3G are being adopted by seed agripreneurs (CIP, 2011). Potato minitubers produced in Kenya increased from 30,000 to 1,000,000 mainly due to efforts of private seed multipliers (Labarta and Mulwa, 2011).

Different seed systems for potato multiplication have been put in place in developing countries that grow potato. In Sub- Saharan Africa, the seed potato systems have resulted into different scales of success. Despite the many efforts of improving potato productivity, seed potato quality has been identified as the major area of focus in Kenya, Ethiopia as well as Uganda (Gildemacher *et al.,* 2006). To increase high quality seed potato supply in Kenya, KEPHIS managing director in 2019 recommended cluster farmer seed production. In this model, farmer groups from particular locality can grow seed and inspected at the same time. The model helps towards reducing the inspection costs that are usually high when done to individual farmers in different localities. Cluster farmer seed production has worked well in pulse seed production and it can be replicated in seed potato production to increase the supply (National Potato Council of Kenya, 2018).

1.2 Statement of the Problem

Ware potato productivity in Nakuru County is still low (5.2 Tonnes/ha) compared to the potential average yield of up to 40 Tonnes/ha. This continues to limit total production and the achievement of food and nutrition security by 2030. Among other factors of production, the cultivation of high quality seed potato greatly influences the total potato production. There are only four seed potato producers in Nakuru County that supply certified seed potato to ware potato farmers in the region and neighbouring counties. The number of seed potato agripreneurs and levels of investment in certified and "clean seed" potato are estimated at only 5 % of the total demand of 160,000 Tonnes for the more than 160,000 ha. It is, however, not clear, what makes agripreneurs relent to participate in seed potato enterprises despite the high demand. This study sought to fill this gap by identifying factors influencing agripreneurs' participation and level of investments in clean seed potato production.

1.3 General Objective

The general objective of this study was to contribute to sustainable seed system by increasing the capacity of seed potato production systems through enhanced clean seed potato enterprises in Nakuru County.

1.3.1 Specific Objectives

i. To characterize potato seed systems in Molo, Nakuru County.
ii. To characterize nature of investments in seed potato enterprises in Molo, Nakuru County.
iii. To assess determinants of agripreneurs' participation in the multiplication of clean seed potato in Molo, Nakuru County.
iv. To evaluate the factors influencing agripreneurs' level of investment in the multiplication of clean seed potato in Molo, Nakuru County.

1.3.2 Research Questions

i. What are the characteristics of the existing seed potato systems in Molo, Nakuru County?
ii. What are the characteristics the nature of investments in seed potato enterprises in Molo, Nakuru County?
iii. What are the determinants of agripreneurs' participation in multiplication of clean seed potato in Molo, Nakuru County?
iv. What are the factors that influence agripreneurs' the level of investment multiplication of clean seed potato in Molo, Nakuru County?

1.4 Justification of the Study

The study contributes towards attaining Sustainable Development Goal, zero hunger; since potato is a food security. The fourth president of the Republic of Kenya during his speech on *Jamhuri* day celebrations of December 2017 elaborated specific agenda the government will focus on in five years' time (2017-2021). The agenda is termed as "the big four" and it includes i) food security and nutrition, ii) universal health care, iii) affordable housing and iv) enhancing manufacturing. Potato, being one of the focus crops, is expected to play a vital role in realizing Kenya's food and nutrition security (KIPPRA, 2019). In line with Nakuru county potato strategy, this study contributes to identifying the current situation of seed potato systems used in Nakuru county as well as factors that influence multiplication of seed potato towards achieving a sufficient and vibrant seed potato sub-sector in the county. Until recently, most of

the studies conducted on potato in Kenya were concerned with ware potato production and marketing aspects, investment opportunities in the seed potato production as well as willingness to pay for high quality seed potato (CIP, 2011; Kaguongo *et al*.,2013; Mutunga, 2014 and Karanja *et al*., 2014). This study provides evidence on viability of clean seed potato enterprise to agriculture and potato industry stakeholders in making strategies as well as policies for seed potato sub-sector development. The policies might lead to recognition of clean seed potato by KEPHIS and support of its production and marketing for increased seed supply. The findings of this research would be a reference for researchers and other personnel interested in the seed potato value chain.

1.5 Scope and Limitation of the Study

This study was specific to farmers who grew and marketed potatoes in Molo sub-County, of Nakuru County. Nakuru County has the highest acearage under potato production and is second to Nyandarua County in total production. Nakuru County was the focus of the Seed Potato Community Action Research Project (Seed Potato CARP+) that supported this work through the MasterCard-RUFORUM and TAGDEv project funding. The overall objective of the project was to enhance access to high quality seed potato for improved productivity and income of smallholder farmers in Nakuru County. This study answers the one of the project objectives by identifying the factors influencing seed potato production investments and giving recommendations on investments opportunities in seed potato enterprises. Reliability and quality of the results entirely depended on the respondent's willingness to respond and ability to remember. Language barrier was also a challenge during data collection. These challenges were overcome by using local extension staff and enumerators from the study area in order to enhance the trust of respondents hence their willingness to respond. Ward agricultural officers from the Molo, Elburgon, Turi as well as Marioshoni wards were involved to guide in relevant data collection and enhance trust among respondends.

1.6 Definition of Terms

Agripreneurs	-	Farmers who grow and market both ware and seed potato.
Clean seed	-	Potato tubers produced from certified seed using the right agronomic requirement but without KEPHIS monitoring and registration.
Certified seed	-	Potato tubers that are grown following right agronomic practices and undergoes certification by KEPHIS.
Informal seed production	-	This involves ways of producing seed that are outside the formal KEPHIS certification process and are not legally recognized. Clean seed is part of informal system.
Investment	-	Outlay of cash in inputs, agronomic advice and seed store needed in clean seed potato enterprises.
Farm-saved seed		Seed produced without any input from other seed industry players and is considered of unknown quality
Seed potato	-	*Solanum tuberosum* L. tubers (Irish potato) produced for cultivation / propagation only
Seed potato system	-	Formal or informal seed production that result to certified seed, clean seed and farm-saved seed.
Seed potato multiplication enterprise	-	This refers to a business where agripreneurs purchase certified seed potato from certified seed merchants, produce the seed for selling to other farmers as clean seed.
Ware potato	-	Potatoes produced and marketed for direct consumption or processing.

CHAPTER TWO
LITERATURE REVIEW

This chapter presents the empirical evidences on factors influencing participation decisions on agricultural related enterprises and seed businesses, theoretical framework, conceptual framework and relevant literature on participation decisions in seed potato enterprises.

2.1 Importance of Potato

Potato is consumed worldwide by more than one billion people hence an important crop to face increasing food insecurity. The crop is grown in nearly all the continents of the world (FAO, 2012). Potato has a high potential of contributing to food security, it produces high energy levels (87 Kcal) almost double that of rice and wheat (FAO, 2008). It also has opportunities for rural economic development since it is majorly grown in the rural areas (Scott *et al*., 2000). This makes potato crop an important food crop, considering the increasing population that requires intensfied food production. Potato crop takes at least three months to mature, making it suitable crop for farmers who undertake rainfed agriculture. Fast maturing makes it be harvested before cereal crops like maize (six months) and wheat (four months), hence acts as food crop before maturity of other crops (Muthoni and Nyamongo, 2009). Potato is traded locally and nationaly, therefore, its price is determined locally hence less prone to international food prices like the cereals (Cromme *et al*., 2010). Prokop and Albert (2008) gave a report on potato nutrition and diet. It was reported that in terms of nutrition, potato contains 80% water and 20% dry matter content. The crop has a high protein content (1.87 grams) which is very high compared to other tuber and root crops. It is moderately rich in iron as well as high vitamin C that promotes iron absorption (FAO, 2008). Potato is playing a role in developing countries as they have changing food requirements. Since the tuber have diverse ways of preparing makes it qualify as a fast food. The growing urbanization and increased income levels creates a demand for fast foods (International Food Policy Research Institute (IFPRI), 2000)

Potato production is projected to grow by 2.7% every year globally until 2020. This growth exceeds the projected production growth rate for all other food crops (Scott *et al*., 2000). The same authors projected annual demand growth of 3.1% for potatoes in Sub-Saharan Africa. Potato consumption per capita in Kenya ranged from 30 to 40 kilograms per year in 2015 with increasing consumption in urban areas upto 100 kilograms (MoALF&I, 2016a). Food insecurity continues to be a global challenge with 821 million undernourished people in the world comprising 30% of Eastern African population (FAO *et al*., 2018).The demand for food

crops is, therefore, increasing to match the growing undernourished population. Despite the importance of potato crop, its productivity in tropical highlands of Africa is low, mainly atrributed to inadequate supply as well as farmer access to quality seed. Sustainable production requires constant as well as reliable supply of quality seed (Birch *et al*., 2012).

Despite its economic and potential to improve food security, potato production in Kenya has been declining at a rate of 11% annually (FAO, 2014). Efforts to address the declining potato yields has been a major goal of policy makers and key stakeholders in agriculture and potato sectors. This includes National potato council of Kenya whose mandate is to plan coordinate and organize potato value chains in Kenya. In Kenya, potato-producing Counties have formulated multi-partner potato strategies to tackle challenges in the sector. In 2010, International Potato Center started developing a road map for developing sustainable commercial quality seed potato production in Eastern Africa. The countries involved were Kenya, Tanzania, Rwanda, Ethiopia as well as Uganda. The strategy had several objectives including enhancing food security, increasing smallholder farmers' incomes, improving potato productivity as well as growing urban and rural economies of the five countries. In Kenya, a seed potato multiplication technology, widely known as three "G" technique was implemented from 2008 to 2011 (CIP, 2011). Various seed multipliers such as Kisima farm in Meru adopted the technique proving private seed investors can increase access and supply of quality seed (Obado, 2010). Although there is potential of private seed multipliers to bridge the gap between seed demand and supply, seed potato multiplication levels are still low to meet the demand.

2.2 Seed Potato Systems

A study to describe seed potato systems in Kenya, Ethiopia and Uganda was done in 2009 (Gildemacher *et al*., 2009). The study reported there were two main seed potato production and marketing syatems. This included local seed system aand specialized seed potato system. In the specialized seed system, seed growers produced seed potato as a business, including multiplication of seed that is not certified. In the local seed system, the seed was a by-product of ware potato, small sized potatoes sorted and traded locally as seed. Framers in Ethiopia (56%) of the surveyed respondents, indicated that they never renewed their seed potato. Farmers in uganda and Kenya, 74% and 59% respectively indicated that they also never renewed their seed potato. The farmers who renewed their seed potato did so after 6 seasons in kenya, 7 seasons in uganda and 3 seasons in Ethiopia. The study also reported that only 7 % of Kenyan seed potato stock was renewed each season from sources outside the farm. The dominant source of seed potato in the three countries was farmers' own fiels seed and

neighbours' seed potato. Purchasing seed from certified seed potato growers was generally low in Kenya, Uganda and Ethiopia.

In Kenya, the seed regulating and certifying body is KEPHIS, with mandate of regulating see potato from breeding stage up to marketing. There are two main seed systems; formal sector that is legally recognised by KEPHIS and informal sector, that is not recognised as tradable seed (KEPHIS, 2016). The formal sector produce certified seed potato while informal sector produce seed potato that are not legally recognised including farm-saved seeds, clean seed as well as positively selected seeds. Clean seed potato starts with planting basic or certified seed potato, producing seed potato of better quality than farm-saved seed , although, lower quality than certified seed potato. Farm saved seed potato is produced by farmers who do not use input from certified seed potato industry players. The farm saved seed is of poor as well as untraceable quality. Farm saved seed is also sold in open air markets by individual farmers or traders. Positive selected seed is produced when farmers stick pegs next to healthy looking potatoes in the field during their active growth. The pegged tubers are harvested separately and they retain them as seed for next planting season.

Kenya plant health inspectorate service futher classfies the formal seed potato system into; public formal seed system, public-private seed system and closed value chains which are fully private seed syatems. In public seed system, government owned organisations undertakes all the seed production, distribution as well as marketing. For instance, Kenya Agricultural and Livestock Research Organization is involved in breeding of seed potato varieties, seed production as well as multiplication under supervision of KEPHIS. In the public-private formal seed system, public and private sector partner in variety development, seed potato production, multiplication and marketing. For instance, KALRO, public organization does the beeding of the kenyan potato varieties like Shangi then Stokman Rozen, private seed potato company, does the multiplication and marketing under KEPHIS supervision. Closed value chains are entirely under the private investors. The private sector controls all the processes involved in seed potato from breeding to marketing. The only government intervention in closed value chain is through KEPHIS for regulation as well as certification. An example of closed seed potato value chain is Agrico East Africa Limited, who work in close cooperation with their mother company based in Nertherlands.

In 2010, the major system in seed potato sub-sector was farm-saved seed contributing to 96.3% of total seed used in Kenya. This was followed by positive selection and clean seed systems with 2.6% (Kaguongo *et al*., 2010). In 2016, KEPHIS reported that still less than 2%

farmers use certified seed potato with the rest coming from informal sector; clean seed and farm-saved amounting to 4 % and 95% respectively. The seed potato sub-sector is characterised by a few cold stores which are found in Kenya Agricultre and Livestock Research Organization, KALRO Tigoni and in Agricuture Development Corporation , ADC Molo. The Tigoni and Molo cold strores has a capacity of 40 Tonnes and 2000 Tonnes respectively. In efforts to increase seed supply in Kenya, the government of Kenya funded Agriculture Development Coporation to start satelite centers in six major potato growing Counties. The official source of Kenyan potato varieties is Tigoni and ADC Molo. The source of seed of other varieties is the owners that is the private seed companies in Kenya (KEPHIS,2016).

The informal sector is distributed all over the potato growing regions and can unlock the gap of seed supply if improved. Clean seed potato can increase potato productivity as long as other good agricultural practices are adhered to, its productivity has been found to be better compared to farm-saved seed potato (Kaguongo *et al*., 2013). Similar findings were also reported by Gildemacher *et al*., (2009), that 95% of seed potato in Ethiopia, kenya and Uganda was produced by local seed system considered as unofficial. They recommended a different outlook on seed potato production by considering each ware potato producer in production of high quality seed potato. A decentralized network of seed producers was recommended by CIP (2011), to improve quality seed potato availability locally. International potato center also recommended consideration of different seed potato difusion strategies to spread clean seed to ware potato growers as well as private multipliers. This was overseen to increase linkage between formal and informal seed potato sources, improving the seed system by the certfied seed producers training the informal seed producers. Despite this opportunity, clean seed potato has been unrecorgnized, unappreciated as well as undocumented. Therefore, there is a need to enhance collaboration between the government, parastatals, seed producers, research organizations as well as Non Governmental Organizations involved in seed information distribution and network establishment (Neuendorf, 2004). Clean seed potato adoption in Nakuru county is still low. A study done on adoption of clean seed potato in Njoro Sub-County, Nakuru, reported that only 12% had adopted use of clean seed with 88% using other types of seed potato (Amwine *et al.,* 2019). All chain actors in seed potato sub-sector, should appreciate the existence of both formal and informal seed potato sources. The informal seed potato sources, especialy clean seed potato, needs to be promoted as a way of ensuring sufficient high quality seed potato supply in the country. The formal seed potato sources also requires more

innovations to ensure the certified seed potato is affordable, accessile and consistently suplied when needed.

2.3 Seed Potato Enterprises

Seed potato entrepreneurship, as an effective module for seed potato sector, was recommended by CIP in 2011. This applies where farmers are trained to become decentralized seed potato multipliers and key actors in seed value chain. The training is supposed to ensure consistency as well as adherence to the right agronomic practices for producing seed potato (CIP, 2011). In the Kenyan history, certified seed production and distribution have been a responsibility of government. Seed potato has been produced by ADC Molo and KALRO Tigoni under KEPHIS regulations for many years (KEPHIS, 2016). However, private seed multipliers have been penetrating in seed markets recently with new seed potato multiplication technologies and varieties. These investors include Kisima farm, Charvi limited, Suera limited, Gene Biotech, Singus Enterprises, East Africa Seed Co, Agrico (East fricaA) limited, Singus limited, Syngenta (East Africa) limited, Kevian, Seeds 2B, GTIL (Minitubers and Apical Cuttings), Stokman Rozen (Apical Cuttings) and Sigen Hortipruce. All seed potato registered by these companies are inspected and certified by KEPHIS. In the year 2005, KEPHIS facilitated special arrangement where small scale farmers can use KALRO, ADC Molo and other registered companies licences as outgrowers. Importation of seed potato tubers from Netherlands started in 2012 whereby the Kenyan Government signed a bilateral agreement with Netherlands on importation. Upto 1,500 Tonnes of seed potato tubers of different varieties have been imported. By 2018, a total of 61 potato varieties were in Kenya developed by Kenyan breeders, Nertherlands and Scottland out of which 53 varieties are in use (Kimani, 2019).

There are only four certified seed potato producers distributed in different parts of Nakuru County in Kenya. Table1 shows the certified seed growers and varieties they grow. Certified seed potato production enterprise is expensive to establish compared to ware potato enterprise. This is because seed production requires zero tolerance of bacterial wilt disease for certification. Studies recommend use of semi-formal sytems (clean seed) that have relatively low cost of production (Kaguongo *et al.*, 2013).

Table 1: Certified Seed Growers and Varieties Grown

Name	Location	Varieties	Business Model
ADC	Molo	Shangi, Sherekea, Kenya Karibu, Dutch Robjin, Kenya Mpya, Asante, Desire, Kenya Mavuno, Kenya Sifa and Tigoni	Breeder seed to produce certified seed
Agri.Co	Rongai	Markies, Arnova, Rudolph, Destiny, Ambition, Arizona, Manitou, Toluca, Saviola, Faluka, Carolus, Kuroda and Zafira	From Breeder seed to produce certified seed
Charvi Limited	Mau-Narok	Jelly, Rumba, Milva and Laura	From Breeder seed to produce certified seed
Singus Limited	Molo	Shangi and Sherekea	From Breeder seed to produce certified seed

Source: Adapted from (NPCK, 2017)

Clean seed multiplication involves planting certified seed potato for not more than two times according to KEPHIS guidelines. Clean seed potato is a lucrative business compared to ware potato as the price of seed is higher because of high demand. A baseline survey report by seed potato CARP+ in Nakuru indicated that only 18.8 % of 175 respondents were engaged in clean seed multiplication. The survey was done on Molo and Njoro Sub-Counties targeting potato farmers who grew and marketed their potatoes. (Seed Potato Community Action Research Project, 2018). This shows that in Nakuru clean seed multiplication is still at low levels. It has been reported that a certified seed potato grower can get a net return of two hundred kenyan Shillings for every one hundred invested in seed potato. This can only be achieved if a premium price for seed potato is set, slightly higher than of ware potato. The return in seed potato is not achieved in one season, but within three seasons (Gildemacher *et al*., 2009).

Poor potato marketing channels has been reported as a major challenge in potato enterprises. This is due to the reason that most farmers do not store potatoes, they sell direct from the field hence getting low returns (Kaguongo *et al*., 2008). The value chain is dominated

by middlemen who buy potatoes direct from farmers and take to markets in bulk. The potatoes are packaged in extended bags that weigh upto 200 kilograms. There are new potato regulations that were launched in May 2019, maximum package should weigh 50 kilograms. In seed potato value chain, the case is different, seed growers sell direct to farmers minimizing the transaction costs. The packaging in seed potato marketing has been 50 kilograms for certfied and clean seed potato. The farm saved seed potato that is traded locally in open air markets is sold in 100 kilograms bags, not extended. This, makes seed potato enterprise more profitable compared to ware potato production.

2.4 Investments Needed in Seed Potato Production

Seed potato production in kenya should have zero bacterial wilt according to KEPHIS regulations (KEPHIS, 2016). To achieve that, strict agronomic measures have to be followed compared to ware potato production, which is not regulated by KEPHIS. To produce clean seed potato, the right agronomic measures should be followed as well, although KEPHIS inspection do not take place. Therefore, to be able to produce high quality seed potato, the cost of production is slightly higher compared to ware potato production (TechnoServe, 2018). Some of the investments made in ware potato production are similar to seed potato production but some are different. For instance seed store is needed in seed production but not in ware potato production. Although ware potato production needs investments in cold stores, the specifications are different as well as the building costs. There are various investments needed in seed enterprises ranging from seed acquistion, planting, pest and disease managemment, harvesting as well as post-harvest handling (Westra *et al*., 2020). Agripreneurs in seed production should invest in acquiring information related to potato and seed production, farm land, labour, pestcides, fungicides, fertilizers, seed, seed store as well as packaging bags (CIP, 2011).

The investment levels differs depending on scale of production and type of seed potato grown. For Instance, growing certified seed potato requires relatively more investment compared to clean seed potato. For certified seed potato production, KEPHIS inspection cost must be incurred to facilitate the certification process. There are key success factors that need to be considered for seed enterprises including scale of farm, best agronomic practices, choice of right varieties and storage (CIP, 2018). Profitability of certified seed is driven by large scale because mechanization, certification cost and cold storage is relatively cheap with higher scale. Late stage multiplication to get clean seeds are feasible with small scale farmers. Seed agripreneurs need to invest in the right agronomic advice to improve yields. Seed production

requires more investment in quality inputs as well as soil analysis for seed potato is a high value crop relative to ware potato production. Considering that different potato varieties are suitable for different user needs, agripreneurs need to produce according to market needs. To ensure that this is achieved, it is necessary to invest in market surveys to different levels of potato consumers that is the processors and direct potato consumers.

Seed storage investment is critical to avoid wastage and at the same time relieve pressure on quick sales in order to fetch better prices. Therefore, investment in cold stores and diffused light stores are necessary when in potato production (TechnoServe, 2018). During glut season, agripreneurs fetch minimum prices for ware potato. In seed potato production, storage plays a crucial role because there is a need to store seed potato waiting for next planting season as well as enabling sprouting of the tubers, for them to be suitable for planting. In addition to the public sector seed storage available in Tigoni and Molo, there are other private sector seed stores, owned by private investors in seed potato. The stores are found in Suera flowers, Kisima farm, Agrico East Africa with capacity of 200 Tonnes, 1000 Tonnes and 2000 Tonnes respectively (KEPHIS, 2016). A study done on characterization of seed potato storage, pre-planting treament and marketing systems in Ethiopia, case of West-Arsi Zone indicated that from farmers who stored seed potato, none of them used improved storage facilities. They entirely depended on traditonal storage options because they lacked improved stores such as diffused light stores, which have been reported to have good storage ability compared to traditional stores (Ayalew *et al*., 2014).

From 2019, organizations such as Agricultural Development Corporation (ADC) Molo, Stokman Rozen in Nakuru, Genetic Technologies Innovations Laboratories (GTIL) in Nairobi, National Youth Services (NYS) in Nyandarua and Kisima farm in Meru are using tissue cultured potato (TCP) to produce mini-tubers (MT) through the rapid multiplication technology (RPT) in seed potato value chain (SPVC). Egerton University is also promoting this technology amongst Nakuru farmers in collaboration with private partner organizations, namely CIP and Stokman Rozen. So far, they have reached over 4,000 Nakuru farmers. Only a few farmers reached have been able to adopt the technology in small scale. The challenge in its adoption by Small and Micro Enterprises is the fragile nature of the apical rooted cuttings (ARC), which require higher investments and commitment to care and protect the delicate seedling from insect pests, diseases and drought. It is therefore required that the income threshold and preparedness of the investor-farmers be determined and encouraged to participate, through training and extension support.

2.5 Deteminants of Agripreneurs' Participation Decision in Farm Related Enterprises

Decision is a function of various farm and agripreneur characteristics, institutional factors, capital as well as asset endowment factors (Okello *et al*., 2011). A study done on impacts of tenancy arrangements on investments used multivariet tobit model. It was found out that land tenure agreements had influence on investment decisions on productivity as well as soil-improving measures. It was reported that decision to participate in any enterprise is affected by its benefits as well as costs incurred (Ali *et al*., 2012). More production cost minimises the returns hence more efforts should be made at minimising the production costs and consequently increase the net returns. A study on determinants of investment decisions among agribusiness investors in South-East Nigeria found out that; age of entrepreneurs, annual income, nature of enterprise, source of start-up capital, household entreprenurship history, individual experience, favourable government policies, profitability of the participation, solvency and access to investment infrastucture significantly influenced decision to participate. Their study used a combination of purposive as well as multi-stage sampling techniques to collect data from 360 agribusiness investors using structured questionnaires. The data was analysed using probit regression as well as factor analysis. The results revealed that agribusiness investors in Nigeria between age of 40-59 years were active in supply of farm inputs while relatively older investors. Agribusiness investors who were more than 60 years were majorly active in farm production. Male investors were found to be more active in farm production and input supply while women investors participated more in agro-processing. Individual income levels were found to positively influence the type of enterprise to participate in. Favourable government policies were also found to influence decisions to invest in agribusiness (Nwibo and Alimba, 2013).

Entrepreneurs' participation decision in any crop production and marketing is influenced by different factors. Findings from previous studies proved different social-economic, institutional as well as farm factors influence decision to participate in different crop systems. A study about determinants of smallholders' participation decision in local based onion seed production system used two-stage Heckman model to analyse determinate as well as intensity of participation decision in producing onion seeds. It was found out that access to credit,experience in production of improved varieties, land holding as well as livestock holding positively and significantly influenced their decision making. Farmers who had access to credit had a higher probability of participating in onion seed production. Farmers who had more experience in producing improved onion varieties were more likely to invest in onion seed

production. Having large land holdings increased the probability of participating in onion seed production. This also applied to farmers who had large livestock holdings (Demisse, 2010). Household head's age was found to be negatively and significantly influencing probability of participating in onion seed production. An increase in age of household age, reduced the probability of participating in onion seed production.

Yami *et al.*, (2013) study used double hurdle model to analyse factors influencing farmers' decision in bread wheat seed and seed potato multiplication. The authors found out that access to input, distance to main road and participation in field days had a positive and significant influence on the decision as well as the level. Farmers who had access to complemantary inputs were found to have a relatively high probability of participating in seed multiplication. Attending field days and learning about improved seed technologies positively influenced farmers' decision to participate in wheat seed multiplication. According to the results, access to training increased probability of participating in seed potato multiplication. Farmers who had attended trainings more times participated in seed multiplication.

A study on factors influencing farmers' participation in crop intensification program in Rwanda applied binary logistic regression. It was found out that in regard with gender, male headed households were more likely to participate in crop intensification program. Non-farm income significantly influenced farmers' decision to participate in crop intensification program since it helped in soil conservation investments. Farm land size influenced the decision positively, as joining crop intensification program helped farmers grow one crop in a large area. Land consolidation would also help in accessing extension services and purchasing farm inputs such as fertilizers. It was also found out that land acquisition means influenced farmers' decision to participate in the crop intensification program. Farmers who had bought land as well as inherited participated more in the crop intensification program since they felt they had more land tenure security. Farming experince negatively influenced decision to participate in crop intensification program. Increase in number of years in farming, reduced the probability of participating in crop intensification program (Nahayo *et al*., 2017).

Market systems influences value chain actors' participation in marketing their agricultural produce. The same applies to potato markets where farmers, brokers as well as traders at different levels of potato value chain face various different challenges. Brokers usually have difficult time negotiating prices of the extended bag sizes with the farmers. Poor rural road network make it difficult to transport the potatoes from farm to markets. Wholesellers and retail traders face a challenge of lacking storage facility hence forced to sell

within short period. Large infomal market systems have been found to reduce willingness to participate in potato production and marketing in Kenya (Kaguongo *et al*., 2014). The informal markets discourage farmers from investin in potato production since they get negative returns most of the time. Some actors along the potato value chain such as brokers benefit more leaving other actors like famers to suffer low returns.

Two-stage Heckman model was used on a study about smallholder farmers' decision and level of participation in potato market, Uganda. Literacy levels of the household head determined decisions concerning potato production and marketing positively and signficantly (Sebatta *et al*., 2014). House heads who had high education level participated more in potato marketing. Distance to market centers, market informatin sources, off-farm income sources, labour availability and farming experience were found to have positive and significant influence on decision to participate in potato marketing. Farmers were near market centers participated more in potato marketing. This is expected as proximity to market centers encourages one to take part. Increase in number of years the farmers had been doing potato farming, increased the probability to participate in potato marketing.

Large family households had a positive influence on decision to participate in potato marketing. This is because the larger the household size, the more labour available for potato production. Being a male increased probability of participating in potato marketing. Therefore, male farmers were found to participate more in potato marketing compared to women. This is mostly the case because women are more involved in on-farm activities as male participate in marketing activities. Potato prices also influenced decision to participate as farmers tend to study price trends over seasons. High selling price motivates farmers to participate in potato marketing. Age of the farmers influenced decision to participate in potato marketing. Relatively older farmers were more likely to participate compared to younger farmers. Seed certification process and costs have been found to be a limiting factor to private seed multipliers in Kenya. Limited capacity of Kenya Plant Health Inspectorate Service makes the process expensive (CIP, 2011). Access of certified seed by private seed multipliers postively influence the decision to participate in farmer-led seed enterprises as it was found by (Rajendran *et al*., 2016).

Not all potato agripreneurs decides to participate in seed potato multiplication enterprises, some chooses not to participate. The decision to participate in seed potato production is assumed to be influenced by farm as well as agripreneurs' characteristics, institutional arrangements and market conditions. Age of the agripreneurs and experience in seed multiplication can influence participation decision positively or negatively depending on

the levels of participation. A study done on farmers' perceptions and factors influencing the adoption of no-till conservation, agriculture by small-scale farmers in Zashuke, South Africa employed binary logistic regression model. The results revealed that relatively old farmers were receptive to adopting the technology. In general, it is mostly older people who participated in the study and it was confirmed that despite the results, it was challenging to introduce new technologies to elderly people who had limited education levels. Considering sex of the respondents, it was found out that being a male increased probability of adopting no-till technology. Years in school positively and significantly influenced decision to adopt no-till agriculture (Ntshangase *et al*., 2018).

Logit model was used to ascertain factors influencing adoption of modern agricultural production technologies among farm households in Ghana. The results indicated that relatively young agripreneurs are not likely to adopt modern technologies in agricultural production because they might not have adequate resources. Farm size had a positive significant influence on adoption of modern agricultural technologies. Cost of the modern technologies was found to be negativley related to probability of adopting modern agricultural technologies. Expected benefit derived from modern technology was found to have a positive significant influence on its adoption. Access to agricultural extension services positively influenced decision to adopt modern agricultural technologies (Akudugu *et al*., 2012). It is expected that old agripreneurs might adopt new seed potato multiplication techniques such as apical rooted cuttings easily than than young agripreneurs due to the factors found out in earlier studies. However, these new technologies are technical, requiring higher education level where young people are expected to adopt them easily. Alcon *et al*., (2019) confirmed that young, more educated and least experienced farmers expressed more intrest in adopting a new irrigation technology. Relatively old (more than 50 years) agripreneurs have the potential to assess viability of an enterprise since they have experience in farming. This could increase their probability of participating in seed potato compared to young agripreneurs. An agripreneur with higher education level is more likely to make decision because they have access to information concerning seed potato. Seed potato requires good rotation program hence agripreneurs with relatively large farm land, more than five (5) acres, are likely to make decision to participate. Farm size also influences the levels of invesment positively. Large family size, more than five members, can positively influence decision to participate in seed potato enterprise. This is assumed because labour contributes to cost of production, family labour can reduce. Demand of potato varieties grown can postively or negatively influence

decision to participate in seed enterprises, since highly preferred varieties increase the probability of participation.

Emana and Nigussie (2011) reported that farmers are the major buyers of seed potato and farmer to farmer distribution system have been found to be dorminant and mostly used in Ethiopia. The same case applies in Kenya where the informal and semi-formal seed distribution channels are dominant. However, informal markets receive minimal attention from researchers and governments despite their role in seed security. Seed certification process and cost are a limiting factor to private seed multipliers. Limited capacity of Kenya Plant Health Inspectorate Service (KEPHIS), in terms of skilled labour and recources, makes the process expensive (CIP, 2011). Levels of potato production can be influenced by various factors such as belonging to a farmer group and price of potatoes (Sebatta *et al*., 2014).

A study done on analysis of entrepreneur's motivation to start business used a five-point Lickert scale to measure motivation as well as success factors to start a business. It was found out that; making own decision, increasing income and maintaining personal freedom were the main motivational factors (Biruta *et al*., 2014). Entrepreneurs are assumed to be less risk averse compared to the general population. Motivation to start ventures is associated to risk attitude of entrepreneurs. A study on risk attitude differences in entreprenures revealed that entrepreneurs who are motivated by high level of creativity are more risk tolerant. It was also found out that entrepreneurs who had been successful in prior risky situations were willing to take risks (Block *et al*.,2015). A study done to determine socio-economic factors that influence adoption of clean seed potato in Njoro Sub-County, Nakuru, Kenya found out that level of formal education, belonging to a potato group as well as distance to source of seed had a significant relationship with adoption of clean seed potato (Amwine *et al*., 2019).

2.6 Theoretical Framework

This section presents a review of selected theories that were used in this study to establish theoretical as well as methodological framework needed to show how agripreneurs make participation decisions. This study used utility theory to explain participation decisions and capital budgeting theory to explain investment levels.

2.6.1 Utility Theory

Utility theory focuses on people's decisions as well as choices based on fact that people can rank their choices depending on preferences. It is assumed that the potato agripreneurs decision to participate in seed potato multiplication enterprises or not depends on the net

benefits they attain from participating. Their decision is a result of social-economic characteristics of the agripreneurs as well as the challenges they face. This study assumes that agripreneurs participated in seed potato enterprises or not in line with objective of improving their income and other benefits from such enterprises. Suppose that Ui and Ul represent an agripreneurs' utility for two options, then the model is specified as Equation 2.1:

$U_i = \beta_i X_n + \varepsilon_i$ and $U_l = \beta_l X_n + \varepsilon_l$ …… (2.1)

where U_I and U_l = perceived utilities of participating in seed potato multiplication *i* and non participants in seed potato multiplication *l.* X_n = Vector of explanatory variables is represented by and it influences perceived attractiveness of each option. β_i and β_l = parameters to be estimated are. ε_I and ε_l = error terms and are assumed to identicaly and independently distributed. It is expected that a agripreneurs who chose to participate in seed potato multiplication (U_i) is greater than those who chose not to participate (U_l) as illustrated by Equation 2.2:

$U_{ni}(\beta_i X_n + \varepsilon_i) > \ (U_{nl}(\beta_l X_n + \varepsilon_l)$ ……(2.2)

Probability that an agripreneur to participate in seed potato multiplication and chooses option i instead of l is defined in Equation 2.3 as follows:

$$\left.\begin{aligned} &P(Y=1|X) = P(U_{ni} > U_{nl}) \\ &P(\beta'_i X_n + \varepsilon_i - \beta_l X_n + \varepsilon_l > 0|X) \\ &P(\beta'_i X_n - \beta'_l X_n + \varepsilon_i - \varepsilon_l > 0|X) \\ &P(X * Xn + \varepsilon^* > 0| \ X = F(\beta * Xn)) \end{aligned}\right\} \quad \text{……(2.3)}$$

where *P* is a probability function, U_{ni} and U_{nl} = agripreneurs' utility for the two choices and X_n = vector of explanatory variables that influence the perceived attractiveness either participating in seed potato or not. The random disturbance is represented by $\varepsilon^* = \varepsilon_i - \varepsilon_l$, $\beta^* = (\beta i' - \beta l')$ = net influence of right hand side variables vector influencing participation in seed potato enterprises. $F(\beta^* Xn)$= cumulative distribution function of ε^* that is evaluated at $\beta^* X_n$, , ε^*= random disturbance term and it determines distribution of F (Greene, 2012).

2.6.2 Capital Budgeting Theory

The theory of capital budgeting explains variables related to the agripreneur's or manager's choice on liquidity, profitability and risk of a farm. The theory was developed in 1989 by Woods and Randal. Present value models such as net present value (NPV) and internal rate of return (IRR) provide farm decision-makers with information needed by converting future cash flows to present cash equivalent. In the theory of capital budgeting, NPV criterion is used to measure the main financial manegement objective, shareholders' wealth. Project cash flows risk equals to other assets cash flows including firs's weighted average capita cost is used to get net present value. Part of future investment opportunities noticed by market because of their risk perceptions and uncertainty (Woods and Randall, 1989). Capital budgeting theory has been defined as the process by which organizations appraise projects for allocation of scarce resources in order to arrive at optimal outputs (Burns and Walker, 2015). Profitability of investment, liquidity, solvency as well as net profit of the farm are farm specific factors that can motivate an agripreneurs to invest. The NPV rule requires that managers should invest in projects with a positive net present value (Barry *et al.,* 2000). Solvency and liquidity affects investment decision because farms with high solvency are less dependent on banks and other lending institutions (Lusine *et al*., 2007). Higher farm's net profit also motivates agripreneurs to invest in various enterprises.

2.7 Conceptual Framework

In this research, conceptual framework helps to identify key concepts, draw relationships as well as highlighting meaningful interactions between the concepts that have emerged from the literature. It forms basis for the research problem as well as enabling the reader to understand what the research seeks to accomplish and how to achieve it with ease. In this study,the decision to participate in seed potato multiplication and levels of investment was assumed to be influenced by socio-economic factors, institutional factors, seed potato business models and agripreneur related factors. Socio-economic factors included sex of agripreneurs, their age, annual income, their source of income, education level in terms of years spent in school, experience of potato farming in terms of years. Agripreneur related factors include their risk taking and innovativeness, history of seed business in agripreneurs' family as well as their motivation and projected benefits to be gained from participating in clean seed multiplication. In conclusion, it was assumed that right investment decisions and levels would lead to increased clean seed potato production. This would contribute to sustainable seed systems, hence,

increased ware potato productivity. The interrelationship between key variables that were used in this study is outlined by conceptual framework in Figure 1

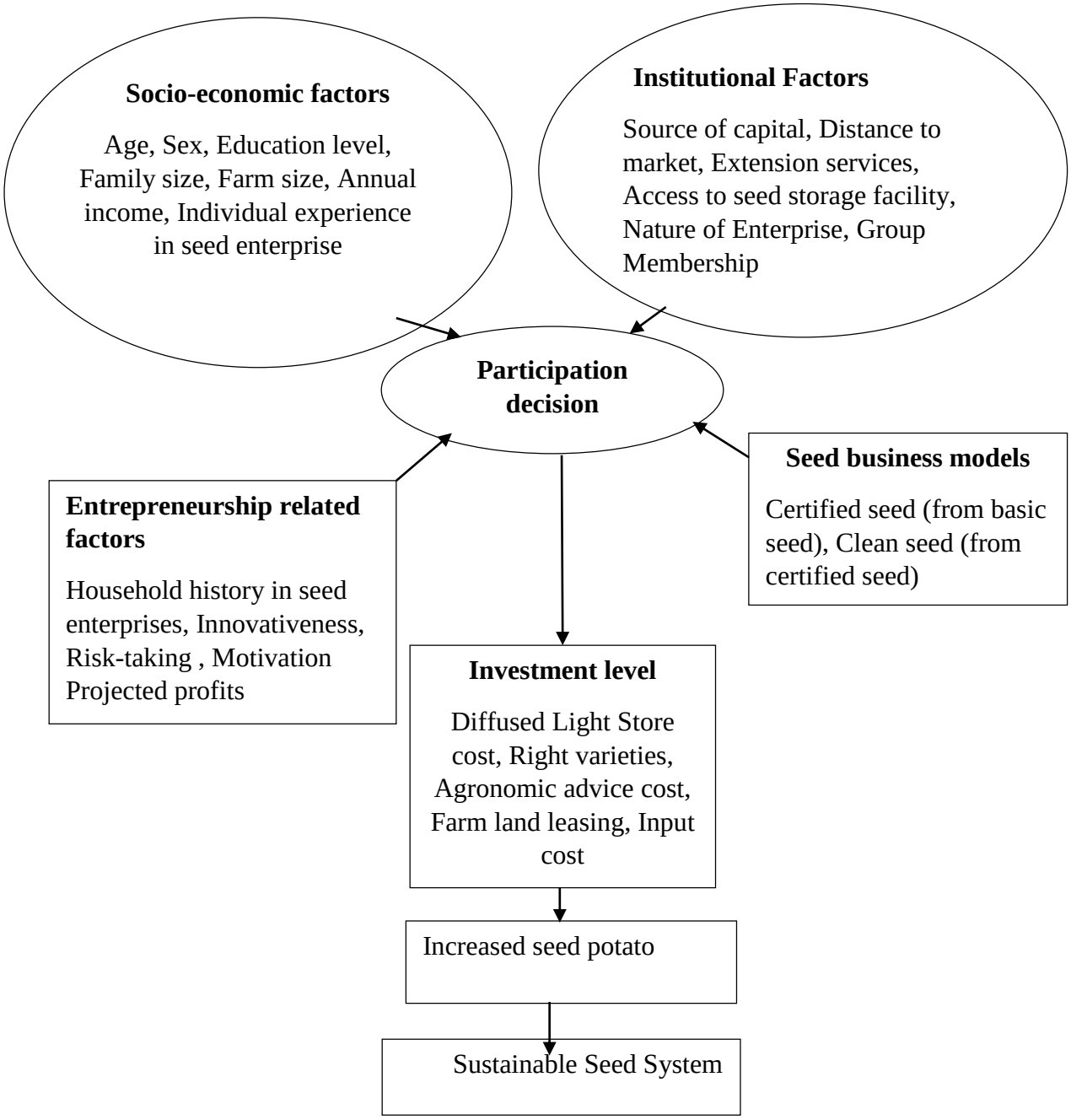

Figure 1: Conceptual Framework

CHAPTER THREE
METHODOLOGY

3.1 Study Area

The study was done in Nakuru County that is among the 47 Counties in Kenya with regard to 2010 Kenyan constitution. Nakuru borders eight Counties namely, Laikipia and Baringo to the North, Kericho and Bomet to the West, Nyandarua to the East, Narok to South West and Kiambu and Kajiado to the South. Nakuru County covers an area of 7,495.1 square kilometers out of which 5,274 Km^2 is arable with a population of 2,162,202 people. Administratively, the county is divided into 11 Sub-Counties. These are Njoro, Molo, Kuresoi South, Kuresoi North, Rongai, Nakuru East, Nakuru West, Naivasha, Gilgil, Bahati and Subukia. Out of these, nine Sub-Counties are potato growing, that is, Njoro, Molo, Kuresoi South, Kuresoi North, Rongai, Naivasha, Gilgil, Bahati as well as Subukia. The county has diversified climatic conditions, ranging from semi-arid to upper highland in Njoro, Molo, Kuresoi, Bahati, as well as some parts of Naivasha and Gilgil. The agro ecological zones range from tropical alpine, upper and lower highlands. There is wide variation in altitude (1400-2970 m ASL). Rainfall is bimodal with an annual average range of 500-1900 mm. Temperature range is between 9 ^oC to 27 ^oC. Climatic condition influences soil patterns with three main classifications, latosolic soils, planosolic as well as alluvial deposits Soils are volcanic and well drained with low to moderate fertility (County Government of Nakuru, 2017). Nakuru has the largest acreage under potato production in Kenya, but is ranked as the second highest producer after Nyandarua (County Government of Nakuru, 2018b). Molo Sub-County was chosen for the study due to its significance in seed potato production. It is the leading seed potato producer in Nakuru. Molo has four administrative wards that is, Elburgon, Marioshoni, Turi and Molo. It is relatively cold while some places during dry seasons experience hot weather. Molo lies between 35° 40', 35° 53' East and 00° 32', 00° 10' South (MoALF&I, 2016 b). The study area is shown in Figure 2.

Figure 2: Map of Molo Sub-County

Source: Department of Geography, Egerton University, 2019

3.2 Sampling Procedure

This study employed both purposive and random sampling techniques. Nakuru County was purposively selected because it is the targeted area of seed potato community action research project (CARP+) that supports this study. Molo was purposively selected because it is the second highest ware potato producing Sub County and leading in seed potato production in Nakuru. Molo, Elburgon, Marioshoni and Turi wards were all selected. Agripreneurs from the four wards were proportionately selected to obtain appropriate sample size of 380 potato agripreneurs. Systematic sampling was then done using a list of agripreneurs provided by ward agricultural officers to get the appropriate respondents.

3.3 Sample Size Determination

The target population was agripreneurs who grow and market both seed and ware potato in Molo Sub County. The study focused on all the four wards in Molo Sub-county that is Molo, Turi, Marioshoni as well as Elburgon. According to a report from Sub-County Agricultural Officer (SCAO), there are 7,731 agripreneurs in the four wards (Molo SCAO, 2019). The sample size was calculated using probability proportionate to size methodology specified by Israel (1992), specified in Equation 3.1:

$$n = \frac{N}{1 + N e^2} \quad \text{.....(3.1)}$$

$$n = \frac{7{,}731}{1 + 7{,}731(0.05)^2} = 380$$

Where n is the sample size, N is the total population and e is the precision error. Proportionate to size calculations were done to obtain the specific sample from each ward. Systematic sampling was then done using a list provided by the Ward Agricultural Officers (WAO) to enable access to specific respondents. The distribution of target population and specific numbers are shown in the Table 2.

Table 2: Target Population and proportional distribution of agripreneurs in each Ward

Sub County	Ward	Target Population	Percentage*	Sample**
Molo	Elburgon	2,565	34	126
	Molo	2,586	33	129
	Turi	1,527	19	72
	Marioshoni	1,053	14	53
	Total	7,731	100	380

Source: (SCAO, Molo, 2019)

Note:* and ** represents author's computations

3.4 Data Collection

Semi-structured questionnaire composed of closed and open-ended questions were used as a survey instrument to collect primary data from the sample using cross-sectional survey. The primary data collected include social economic characteristics of potato agripreneurs, production activities and requirements as well as marketing channels of seed potato. Farm characteristics and institutional factors were also collected. The socio-economic characteristics collected were age of agripreneurs that was a continuous variable in years. Sex of agripreneurs where male, was coded one (1) and female as zero (0). Education level was collected in terms of years spent in school as a continuous variable. Family size was collected in terms of number of people living and depending on the agripreneurs as a continuous variable. Farm information was collected in different forms including size in acres and acquisition in terms of family, own and leased land. Annual income was collected by getting information on both on-farm and off-farm sources per month or seasons then summing up to get the annual income. Individual experience in potato farming was collected as a continuous variable in terms of years the respondents had been growing potatoes. The institutional factors collected include source of capital as a categorical variable, where various categories of income source were give. They could tick more than one source of income. Extension services access data was collected as a binary variable that is, if agripreneurs accessed extension services, it was coded as one (1) and if not accessed not accessed the services coded as zero (0). Frequency of getting extension services was collected as a continuous variable in terms of number of times the agripreneurs got the extension services. Access to seed storage facility was collected as a binary variable where, if the agripreneurs had access to seed store, it was coded as one (1) while if they had no access

to seed store it was coded as zero (0). The nature of enterprise was collected as categorical variable, where sole proprietorship, family as well as group owned were the categories provided. Group membership status was collected as a binary variable where if the agripreneurs' were in a group was coded one (1), if not a member of any group it was coded zero (0). Other entrepreneurial related factors collected included projected profits, innovativeness and entrepreneurs' risk taking behaviour. The innovativeness, risk-taking and motivation perceptions were collected using a five point lickert scale (1=strongly agree 2=agree, 3=neutral 4=disagree and 5= strongly disagree). Validity of the questionnaire was established by careful consideration of the items in the questionnaire to ensure that they collected relevant information and address the entire objectives. Reliability and validity of the questionnaire was determined through a pilot test that was carried out in Mau-Narok ward with 30 agripreneurs. The reliability and validity was determined qualitatively and qualitatively. The questionnaire items were later changed to improve its validity.

3.5 Analytical Framework

STATA and SPSS were used for descriptive, inferential and econometric data management and analysis in this study.

3.5.1 Objective One: To Characterize Potato Seed Systems in Molo, Nakuru County

In this objective, data that were collected included type of seed potato that both participants and non-participants in seed multiplication use when planting potatoes. Seed potato systems considered were certified seed, clean seed, own-farm saved as well as neighbours farm-saved seed. The social economic and institutional factors were also collected. This was used to describe the dominant seed system used by different agripreneurs in the study area. Descriptive statistics such as mean, median, mode, variance, standard deviation, percentages were used. Chi-square test was used to show relationship between seed system used by agripreneurs and the social economic factors. One-way Analysis of Variance was employed to compare mean differences of social economic factors with the seed systems used by seed potato agripreneurs in Molo, Nakuru County.

3.5.2 Objective Two: To Characterize the Nature of Investments in Seed Potato Enterprises in Molo, Nakuru County

In this objective, data on the type of business model used by the agripreneurs were collected. Business model includes the type of seed produced that is either clean seed or certified seed. Both participants and non-participants in seed multiplication were the targeted

respondents to capture data of those who started and stopped or changed the model. Some of agripreneurs could have started and stopped due to various reasons that were determined in this objective. The nature includes the phase's agripreneurs experiences in the business cycle. For instance, one might have started with certified seed business then over a period, they change to clean seed business. They could have started with clean seed business then later change to certified seed. Some could have started either of the business models and stopped producing seed with time. All that information was collected to be able to characterize the seed potato enterprise in terms the nature of investment. Data on total investment put in seed enterprise for 2017 and 2019 seasons were collected. For 2017 and 2018, two seasons were considered for each year then for 2019 one season was considered. That totaled to five seasons of seed potato production. Descriptive statistics such as mean, median, mode, variance, standard deviation and percentages were employed to characterize the phases of seed potato enterprises. This was used to compare and contrast the nature of seed business models used for the enterprise.

3.5.3 Objective Three: To Assess Determinants of Agripreneurs' Participation in the Multiplication of Clean Seed Potato in Molo, Nakuru County

In the third objective, the explained variable is a binary that is, whether the respondents are participating in seed multiplication or not. The explanatory variables collected include age, experience in potato farming, education level, land size, number of extension services, frequency of getting exxtension services, annual income, sex of agripreneurs, source of investment capital, access to seed store, nature of enterprise, innovativeness and risk-taking of the agripreneurs, price of selling seed potato, household experience in seed ptato enterprises as well as group membership.

3.5.4 Objective Four: To evaluate the factors influencing agripreneurs' level of investment in the multiplication of clean seed potato in Molo, Nakuru County

The fourth objective has a continous explained variable, the amount invested in seed potato enterprise. The explanatory variables to be measured include; amount invested in inputs, diffused light store, labour, annual income, nature of enterprise, seed potato business model, household size, years in potato farming, credit acqustion, soil testing cost, marketing costs incurred, group registration fee, training costs incured to acquire information regarding to potato farming, agripreneurs' innovativeness and risk taking abilities.

The third and fourth objectives were analysed using double hurdle model. The empirical model of participation decisions consists of two-stage decisions: whether or not to

participate and if the decision is to participate then how much to invest in the enterprise. The dependent variables contain zeros for the agripreneurs who do not participate in multiplication of clean seed potato and a certain amount of investment for those investing in the enterprise.

The positive observations on participation can be collapsed and treat it as binomial probit estimation, but that would loose all the information on amount invested in the seed enterprises. Likewise, zero observations can be discarded but it would lead to truncated distribution weaknesses. An important consideration in quantifying participation decisions is assumed to be the existence of a large number of zero observations in the data set. Excluding agripreneurs with zero seed participations from the sample would lead to a selection bias hence biased regression parameters.

Agripreneurs may not participate in clean seed potato due to limited finances or because they opt for other types of seed potato multiplication business models. Therefore, it was important to include zero observations as well as nonzero observations in the estimation model. Tobit model is frequently used for dealing with zero observations and discrete weaknesses (Tobin, 1958). This model employs maximum likelihood and combines probit as well as regression components of log-likelihood function (Baum, 2013).

The weakness with Tobit model is that it is very restrictive in that, any variable that increases the probability of a non-limit value must also increase the mean of the positive value, which is not always reasonable (Lin and Schmidt, 1984). Sometimes even if agripreneurs are eager to participate in seed potato enterprises, some factors such as insufficient finances and profitability uncertainty may limit them. Therefore, this study required a model that would treat probability of limit observations independent of regresion model for nonlimit observations. The decision to participate in seed potato or not should be different from the level of investments done.

Heckman two-stage model is an alternative for Tobit model and it allows one set of parameters to determine the probability of a limit observation (decision to participate or not), and a second set of parameters to determine the probability of the non-limit observation (level of seed potato investment). However, Heckman is appropriate when there is censoring process in estimating extent of participation (Heckman, 1976). In this study, the zeros in extent of investment is due to non participation in the seed multiplication, hence neither due to corner solution nor sample selection. Therefore, in this study, the appropriate model is double-hurdle model. It assumes that agripreneurs are faced with two hurdles in any agricultural decision making process (Cragg, 1971). The first stage involves running a probit regression for

identification of factors influencing the decision to participate in multiplication of certified seed potato to produce clean seed using all sample population. Truncated regression model was run on the second stage to analyse the extent of participation.

The two-step model allows different mechanisms to determine the discrete probability of participating in seed potato enterprises and the level of investment. It is assumed that some independent variables may affect differently the decision to participate in seed potato at all and the decision on the level of investment. Double hurdle model for observation k can be written as shown in Equation 3.2:

$$\left.\begin{aligned} i_k &= Y_{mi} = 0 \text{ if } S_{ni} \le 0 \\ i_k &= Y_{mi} = 1 \text{ if } S_{ni} > 0 \end{aligned}\right\} \quad \ldots\ldots 3.2$$

where;

y_{mi} = the binary response,

S_{ni} = the level of seed potato investment in terms of amount invested by by agripreneur i.

The likelihood function is derived as shown in Equation 3.3:

$$\log L = \sum_0 \log\left[1 - \phi\left\{\frac{\beta' X_j}{\sigma_e}\right\}\phi[\gamma' zj]\right] + \sum\left[-\log\sigma_e + \log\varphi\{i*_j - \beta' X_j|\sigma_e\} + \log\phi\{\gamma' Z_j\}\right]\cdots$$

$$\ldots\ldots(3.3)$$

The decicion of participation in multiplication of seed potato uses probit model in stage one is expressed as in Equation 3.4.

$$P(Y_i = 1) = \beta_0 + \beta_i X_i + \varepsilon \quad \ldots\ldots(3.4)$$

where

P = the probability of an individual farm household to participate,

β_i = the vector of parameters to be estimated,

X_i = the vector of exogenous explanatory variables expected to influence the participation decision probability and ε is the error term. The variables are included in the empirical model as shown in Equation 3.5:

$$(\Pr = 1) = \beta_0 + \beta_1(AGE)_i + \beta_2(EIPFAR)_i + \beta_3(EDUCL)_i + \beta_4(LNDSZ)_i + \beta_5(EXTSVS)_i + \beta_6(ANN.I)_{i_i} + \beta_7(GND)i + \beta_8(SOIC)i + \beta_9(ATSS)i + \beta_{10}(NOE)i + \beta_{11}(EI)i + \beta_{12}(ERT)_i + \beta_{13}(PSP)_i + \beta_{14}(HHESE)_i + \beta_{15}(GRPM)_i$$

.....(3.5)

In the second stage of double-hurdle model, factors affecting the level of investment in clean seed potato multiplied conditional on participation decision is done using the truncated regression analysis. Thus, it involves the truncated regression that can be specified as in Equation 3.6:

$Q = Q*$ if $Q* > 0$ and $Y = 1$

$Q = 0$ if otherwise

……...(3.6)

From Equation 3.6, reduced form of the truncation model is specified as in Equation 3.7:

$$Q = \beta_0 + \beta_i Z_i + u_i$$ ……(3.7)

where

Q = the observed amount invested for clean seed produced,

Q* = the latent variable which indicates the level of investment is greater than zero,

βi = the vector of parameters to be estimated,

Z_i = the vector of exogenous explanatory variables and

U_i = the error term.

The empirical model used in this study assumes that the total investment in clean seed produced is a linear function of continuous and dummy explanatory variables and is specified in Equation 3.8:

$$LSPI = \beta_0 + \beta_1(AAI)_i + \beta_2(AIDLS)_i + \beta_3(AIAA)_i + \beta_4(AIL)_i + \beta_5(AIMS)_i + \beta 6(ANN.I)_i + \beta_7(NOE)_i + \beta_8(EI)_i + \beta_9(ERT)_i + \beta_{10}(SPBM)_i + \beta_{11}(HHS)_i$$

……..……(3.8)

The choice of the explanatory variables is based on previous findings on decisions to participate in crop enterprises and investment levels in various agriculture related businesses. The variables used in the double hurdle model and priori expectations are shown in the following Table3:

Table 3: Description and Measurement of Variables to be used in the Empirical Model

Dependent Variable	Description	Unit of measurement	Expected sign
PRODPART	Whether respondent participated in seed potato enterprise or not	1= Participating, 0 = Not participating	
LSPI	Amount of money invested in seed enterprise	Kenya shillings	
Independent variables for Participation Decisions			
AGE	Age of the respondent	Years	+/-
EDUCL	Level of education	Years in School	+
GND	Sex of the agripreneurs'	Dummy(1=male 0= female)	+/-
LNDSZ	Amount of farm land for seed potato	Acres	+
EIPFAR	Number of years the agripreneur has been in clean seed potato production	Years	+
EXTSVS	Access to extension services	Number of times visited by extension officer	+
ANN.I	Annual Income	Kenya Shillings	+
SOIC	Source of investment capital	Dummy 1=Public lenders 0=Private lenders	+
ATSS	Access to seed store	Dummy (1=Yes, 0=No)	+
HHESE	Household history of seed multiplication enterprises	1=Yes 0=No	+
EI	Entrepreneurs' innovativeness		

ERT	Entrepreneurs' risk taking		
NOE	Nature of enterprise	Sole proprietorship, Partnership, Family	
PSP	Selling price of seed potato	Kenya shillings	+
GRPM	Member in a group	Dummy(1=Yes, 0=No)	+
Independent variables for Investment Levels			
AII	Amount of money used to purchase inputs	Kenya Shillings	+
AIDLS	Amount of money used to build a seed store	Kenya Shillings	+
AIL	Amount of money used to buy or lease land	Kenya Shillings	+
AIAA	Amount of money used in soil testing and information on good agricultural practices	Kenya Shillings	+
AIMS	Amount of money used in marketing	Kenya Shillings	+
ANN.I	Annual Income	Kenya Shillings	+

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter presents findings of the study and it is divided into four major sections according to the objectives. It starts by presenting descriptive statistics for socio-economic and institutional characteristics of agripreneurs based on the seed potato system they use. Then it also presents results of double hurdle model on factors influencing the agripreneurs participation decision and levels of investment.

4.1 Socio-demographic Characteristics of Respondents

The targeted respondents were 380 distributed in the Molo Sub-County four wards that is Molo, Elburgon, Turi and Marioshoni. Molo (34%), Elburgon (33%), Turi (19%) and Marioshoni (14%) wards. The average statistics of the socio-demographic characteristics of the surveyed agripreneurs in Molo Sub County are as provided in Table 4.

Table 4: Sampled Agripreneurs Socio-Economic and demographic Characteristics

Variable	Mean	Min	Max	SD	N
Age (years)	46.689	25	76	11.001	380
Education level (Years)	8.229	0	23	3.471	380
Household Members	4.808	1	15	2.088	380
Experience in potato farming (Years)	8.492	1	38	6.692	380
farm size (Acres)	2.851	0.25	25	2.737	380
Annual Income	298, 761	10,000	5,000,000	443,235.1	380

Note: SD=Stndrd

The results imply that the mean age of agripreneurs in Nakuru was 47 years ranging from 25 to 76 years. This finding is in line with Agiro (2011) and Manishimwe *et al*., (2019) who reported that those involved in potato production in Rwanda and Ethiopia were in their prime stage of life (below 50 years of age). This means that most of the respondents were in their productive stage of life. Age of farmers plays a key role in the provision of labor for performing farm operations. The mean education level attained by the sampled agripreneurs was 8 years of formal schooling (completion of primary school). Few farmers had completed post-secondary education, showing that the agripreneurs were literate and able to read and get agricultural information new potato production technologies and agricultural financial services. The study results are consistent with findings of Njuguna *et al*., (2015) who found that potato

farmers with at least primary school education recorded the highest percentage of education level (70%) in Baringo County, Kenya.

The study results indicate that the mean number of people living in a particular household 5 members. The members living in a household are a major source of family labour for the farm activities. Thus, a farmer's household size may influence seed potato production level through its supply of labour. Tolno *et al*., (2015) reported consistent results with potato farmers in Guinea had a mean of 7 household members (less than 10). The study revealed that the agripreneurs had a mean of 8 years of farming experience with a minimum of 1 year and a maximum of 38 years. This means that the agripreneurs were moderately experienced. Experienced agripreneurs are likely to manage inputs they use in potato production, hence, minimizing production losses. Similarly, Okello *et al*., (2016) stated that potato farmers in Kenya had a mean of 19 years (more than 5 years) of potato farming experience.

According to the results, the average farm size was 3 acres with some of the agripreneurs having a minimum of 0.25 acres and others a maximum 25 acres. This confirms that majority of the respondents were smallholder farmers. Land size determines whether an agripreneur follows the right agronomic practices when producing seed. One of them include proper crop rotation that can be achieved if one has reasonable land size. These results are consistent with the findings of Manishimwe (2019) who reported that potato farmers in Rwanda had average farm size of 2 acres (less than 5 acres). The results reveal that the mean annual income of the agripreneurs was KES 298, 761 with a range of KES 10,000 to KES 5,000,000.

The gender of respondents was comprised of female (52%) and male (48%). This means that more women were involved in potato production than men. This results are contrary to Kamau (2019) who found out that men were more involved in potato production (57%) than women (43%). This different result can be attributed to the fact that women have been identified to play an important role in agriculture and rural enterprises in developing countries (FAO, 2011). Despite their role, for many years, women have had limiting factors such as limited access to land. This has led to many donor projects in partnership with African Governments focus on empowering women. This could be the reason why this study report more women engaged in potato farming.

4.2 Characteristics of Seed Potato Systems

The most commonly grown potato variety by the respondents was Shangi (99%). The 1% grow other varieties including Jelly, Sherekea, Kenya Karibu, Voyager, Markies, Asante and Dutch Robjin. Majority of the farmers that were ware potato producers (99%) and seed

potato producers (88%), grow Shangi because of its high demand in the market and ease of access to its seed, respectively. The agripreneurs were reporting that Shangi was the only variety they could easily access its seed as well as sell its produce easily if grown as ware potato. Some agripreneurs were reporting that upon trying the red-skinned potato varieties such as Kenya Karibu, they regretted because buyers, who are mostly brokers, could reject them as they say the market does not need the red-skinned potato varieties. Those who grew other potato varieties grew them as ware for table consumption and processing purposes. Only two agripreneurs were growing other varieties for contracted market, which were Njoro canning factory and Sunripe limited, both located in Nakuru County. These results are consistent with the findings of Muthoni *et al*., (2013) who reported that 100% of farmers interviewed in Molo grew Shangi variety. Market factor was the most considered in deciding what variety to grow. Majority of the agripreneurs (83%) grow ware potato while 17% only, grow clean seed as an enterprise. Out of those who grow clean seed as an enterprise, majority were located at Molo ward (50%) with the least being located at Marioshoni ward (14 %) and Turi ward (14%).

Significant statistical relationship ($P \leq .1$) was evident between location (ward) of the agripreneurs with whether they grew clean seed as an enterprise or not as shown in Table 5. Agripreneurs from Molo ward in relation to seed system they use, 30% of them were using certified seed potato, 17% were using clean seed potato, 50% used own-farm saved seed potato and only 3% used neighbour's farm saved. Only 8% of Turi ward agripreneurs used certified seed potato as their planting material. Those who used clean seed potato in Turi ward were only 14% out of the total respondents interviewed in that ward. The highest number (74%) used own-farm saved seed potato in Turi ward. Agripreneurs from Marioshoni ward majorly (62%) use farm-saved seed potato with least (8%) using certified seed potato as their planting materials. Among the four wards, Marioshoni records the highest number of agripreneurs using neighbour's farm-saved seed potato. This could be because most of the Marioshoni ward agripreneurs hire farmland from Mau forest and majorly grow ware potato for commercial purposes. The agripreneurs do not pay attention to seed as they sell all ware potato grown without storing some as seed for the next seasons; hence, they end up buying from neighbours and from open-air markets during planting season. Elburgon agripreneurs majorly (59%) were using own-farm saved seed potato when planting. The least number of agripreneurs from Elburgon Ward (9%) use neighbour's farm saved seed potato as their planting material.

From the results, agripreneurs from Molo ward had the highest number of those using certified as well as clean seed potato. This could be to the fact that, agripreneurs from Molo

have easy access to markets as well as information since most of them are located near the Sub-County headquarter offices in Molo town. Being near a major seed producer in the country, ADC, Molo could have also contributed to the high usage of high quality seed potato. Molo is bordering Sirikwa North Sub-county, the highest potato producer in Nakuru County. Molo also borders Rongai Sub-County, where AgriCo East Africa Limited is situated. This could have contributed to agripreneurs from Molo ward have more access of high quality seed compared to other wards.

Table 5: Chi Square results showing relationship between location and seed systems used.

	Certified (n=64)	Clean (n=66)	Own farm saved seed (n=226)	Neighbour farm saved (n=24)	Chi= value	P-value
Location					30.253	0.000***
Molo	29.460	17.050	50.390	3.100		
Turi	8.330	13.890	73.610	4.170		
Marioshoni	7.550	18.870	62.260	11.320		
Elburgon	12.700	19.050	59.520	8.730		

*****Indicates significance at 1% probability level**

The seed systems used in Molo Sub-County are presented in Figure 3. Out of 380 respondents, only 60% used own-farm saved seed potato, 17% clean seed potato, 17% certified seed potato and 6% neighbour's farm saved seed potato. The dominant seed system was found to be own farm saved seed with the least used being neighbours farm-saved (6%). The use of own farm saved seed is attributed to the high cost of certified seed potato that is usually sold between Ksh. 2,500/- and Ksh 3,000 per 50 kg bag. The certified seed potato is also inaccessible, despite farmers being aware of the importance of high quality seed. The findings of this study that own-farm saved is the dominant seed system in Molo Sub-County confirms the study done by Kaguongo *et al*., (2010) who reported that the dominant seed potato system in Kenya was own-farm saved seed at 96 %. Another study done in Nakuru to determine smallholder farmer characteristics on Potato production found out that majority of farmers (71%) used uncertified seed potato (Kamau, 2019)

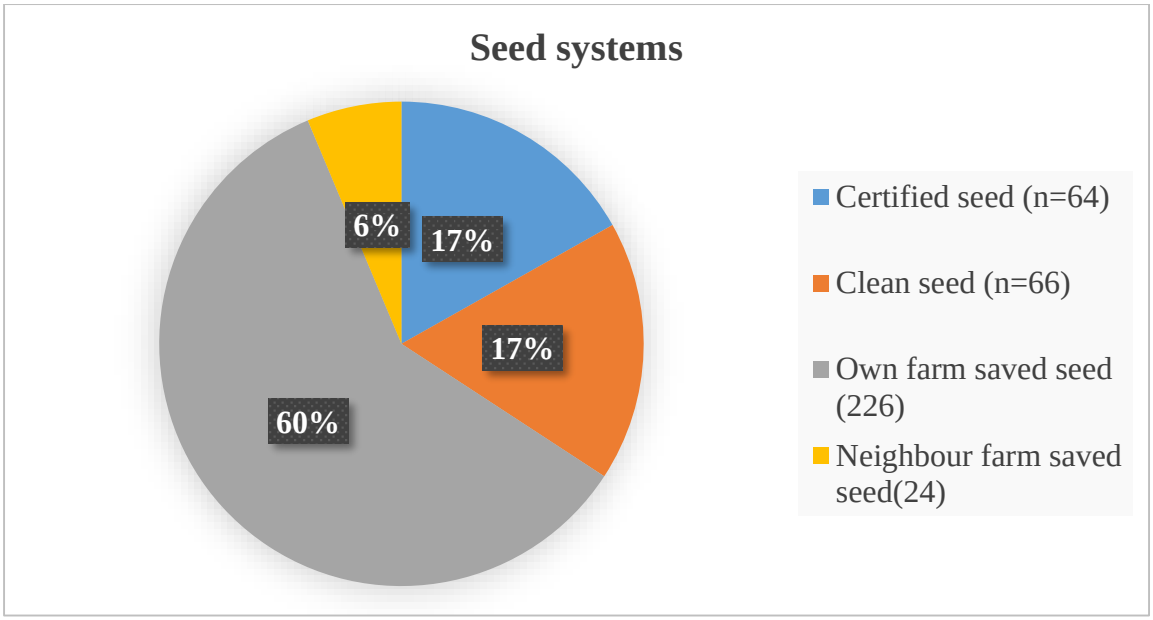

Figure 3: Seed Systems used in Molo Sub-County

The agripreneurs stated different reasons why they did not use certified seed potato. The main reason (73%) reported was lack of the certified seed potato, mentioning that majority of the time they needed certified seed potato but they could be told it is out of stock or one needs to book five months before. The other reasons mentioned included agripreneurs not knowing where to access the seed as well as knowing but the place but the distance being far. A smaller percent (2%) stated that they use other seeds because they could not afford the certified seed potato. The main sources of certified seed potato stated were; ADC Molo, AgriCo East Africa limited and Charvi limited. Some agripreneurs had more than one source of certified seed potato. The main source was ADC Molo (83%) followed by AgriCo East Africa (16%) then Charvi limited (1%). These is shown in Figure 4. Other sources of certified seed potato mentioned were, KC Seed cooperative, KARLO Tigoni as well as Kisima farm in Meru County. Agripreneurs who sourced certified seed potato from these seed dealers reported that they only sourced there only when they failed to get seed from the main three sources stated.

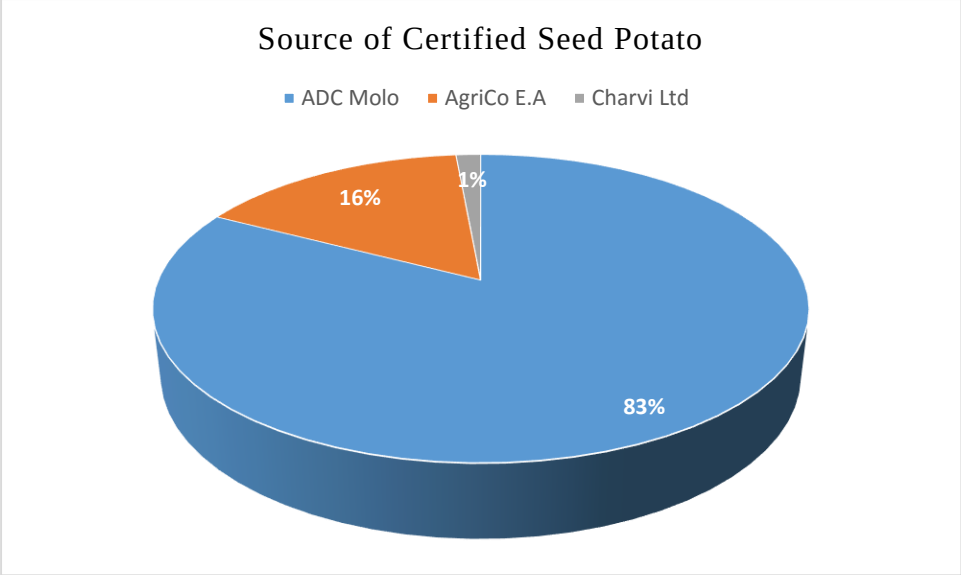

Figure 4: Sources of Certified seed potato in Molo Sub-County

The Social-economic characteristics considered in characterizing the seed potato systems included age, location, sex (men), annual income , group membership, access of credit, years of schooling and years in potato farming. Awareness of clean and certified seed as well as growing clean seed as an enterprise were also used.

Categorical variables used for the study are shown in Table 5. The results revealed that there was a significant relationship ($P \leq .01$) between sex, location, growing of clean seed as an enterprise, awareness of clean and certified seed and the seed potato system used by the agripreneurs. Majority of the agripreneurs that used own farm-saved seed were female (62%) while majority of those who used certified seed potato were male (24%). This is because women generally have fewer resources and lower control of productive resources such as capital hence they cannot afford costlier certified seed potato as their planting material (Mudege *et al.* 2015).

Agripreneurs from Molo ward had the highest number of those using certified seed potato (29%) and lowest of those using own-saved seed. Molo ward was leading due to its proximity to ADC Molo, a certified seed producer hence agripreneurs from there are more aware of certified seed potato. Majority of the respondents, 313 agripreneurs (82%) were aware of certified seed potato. None of the agripreneurs who did not know about certified seed potato used it as a planting material. Turi and Marioshoni wards had majority of those using own farm-saved seed at 74% and 62% respectively. Amongst those that used own farm saved seed (226), a majority (81%) of agripreneurs were not aware of certified seed potato. Seventy-four (74%), 62% and 60% were from Turi, Marioshoni and Elburgon wards, respectively, that used

own-farm saved seed potato. This was also the case for those who are aware, (55%) and use own-farm saved seed potato. The dominant reason (73%) the agripreneurs gave for not using certified seed was lack of the certified seed. This confirms that there is inadequate supply of quality seed potato in the country as Kaguongo *et al*., (2013) stated that farmers were willing to pay for high quality seed but its supply does not meet the demand found out.

Agripreneurs who attended trainings, exhibitions or seminars about potato production used better quality of seed potato as their planting materials. The total number of agripreneurs who attended trainings on potato production were 276 (73%) and those who did not attend were 104 (27%). Majority (42%) of the agripreneurs who attended the trainings, seminars or exhibitions on potatoes used certified seed potato as planting material. Out of the agripreneurs who did not attend any training, seminar as well as exhibitions concerning potato production, the highest number (68%) used own farm-saved seed potato. This confirms that access to information about potato production from seed producers (e.g., ADC Molo) increases chances of farmers being aware as well as using the right planting materials as Kamau, (2019) also reported.

Out of 380 agripreneurs, only 76 (20%) had acquired credit within one-year' time that is from June 2018 to June 201**9**. A good number (41%) of agripreneurs who had acquired credit were using certified seed potato with the highest number of those who had not acquired credit (63%) using own farm-saved seed. Only 14 % of clean seed producers acquired credit for their seed potato enterprises. Majority (30%) of the agripreneurs who had acquired credit got it from farmer groups. This results are similar to findings of Kamau (2019) who reported that only 18.6% of potato farmers in Nakuru acquired credit, majority did not acquire.

Out of the 380 respondents, 189 (49.7%) were aware of clean seed potato while 191 (50.3%) were not aware. Being aware of clean seed potato contributed to its usage while being unaware contributed to usage of own farm-saved seed potato as well as neighbour's farm-saved seed potato. Agripreneurs in Molo Sub-County who were not aware of clean seed potato majorly used own-farm saved seed potato (93%). If the agripreneurs were aware of clean seed, it increased chances of them using certified seed potato, 33% used certified clean seed compared to 1% who were unaware of clean seed potato but used certified seed potato.

Being a member of potato group, increased chances of using certified seed potato as well as clean seed potato. Thirty three percent (33%) of the agripreneurs in Molo Sub-County were members of Potato groups while 67% were not in any potato group. Some of the groups that the agripreneurs are members included; Turi green, Giteru Potato growers, New Molo

Cooperative, Kapsita community based organization (CBO), Sigowett Self Help Group, green Vision Self Help Group as well as Turi-Wendani farmers group. The groups had a common objective of accessing potato production information easily. Out of agripreneurs who were members of potato groups, 31% used certified seed potato as their planting material against 11% who used same seed and were not members of potato group. A larger percent (67%) who used own-farm saved seed potato were not members of any potato group. This is an indication that being in a potato group, farmers can access information easily and use improved technologies in potato production such as high quality seed.

Table 6: Chi Square Test Results for Categorical Variables Characterizing Seed Potato Systems

	Certified seed (n=64)	Clean seed (n=66)	Own farm saved seed (n=226)	Neighbour's farm saved (n=24)	Chi =value	P-value
	%	%	%	%		
Sex					14.238	0.003***
Female	10	20	62	8		
Male	24	14	57	5		
Location					30.253	0.000***
Molo	29	17	50	3		
Turi	8	14	74	4		
Marioshoni	8	19	62	11		
Elburgon	13	19	60	9		
Aware of certified seed					28.472	0.000***
Not aware	0	7	81	12		
Aware	20	19	55	5		
Aware of clean seed					198.720	0.000***
Not aware	1	0	93	6		
Aware	33	35	26	6		
Attended training on potato					69.182	0.000***
Not attended	7	17	68	7		
Attended	42	17	37	4		
Member of Potato group						

Not a member	11	17	67	6	28.140	0.000***
A member	31	19	43	8		
Acquired credit					27.849	0.000***
Not acquired	13	18	63	6		
Acquired	41	14	39	5		

*****Indicates significance at 1% probability level**

One-way Analysis of Variance (ANOVA) was used to test whether there was a significant difference between the seed potato system used for independent variables that were captured as continuous. This included; age, annual income, total land size under seed potato, days seed can stay in store, years of schooling and potato farming. The results tabulated in Table 6 shows there was a statistical difference between annual income ($P \leq .01$), land under seed ($P \leq .01$), years in school ($P \leq .1$) as well as in potato farming ($P \leq .1$). The mean age of agripreneurs, using certified and clean seed were 45 and 49 years respectively. Agripreneurs who used own farm-saved seed had a mean age of 47 years. Certified seed potato users were relatively younger than the users of other seed potato systems. This is probably because certified seed potato has new technologies such as such as the use of tissue cultured cuttings and mini-tubers, that are yet to be well understood by older farmers compared to younger people that are more adept to engage with new technologies. There was however, no significant difference between the mean age of farmers and seed system used.

Significant statistical difference between seed system used and mean years of schooling were observed at higher probability level of significance ($P < 0.1$). Certified seed potato users had a mean of eleven (11) years of schooling compared to own farm saved seed with a mean of nine (9) years. The lowest schooling time was seven (7) years for those who used neighbours farm saved seed potato. Certified seed potato users had spent more years in school hence increasing their likelihood of being more aware of the benefits and able to use certified seed potato. This is an indicator that level of education has a relationship with seed potato system used by agripreneurs. The target agripreneurs for seed potato multiplication should be those who relatively have a higher level of education.

The average years in potato farming of agripreneurs who used certified seed was seven (7) while those who used own farm saved seed was nine (9) years. This could imply that the use of certified seed is a recent as adoption due to extension efforts by ADC Molo and the Ministry of Agriculture Livestock and Fisheries. Significant statistical difference between seed system used and mean years of potato farming was observed at higher probability level of significance ($P < 0.1$). Clean seed potato and own- farm saved seed potato users had relatively many years in potato farming. This implies that for long period, farmers in Molo Sub-County have been using own-farm saved seed potato. This has been followed by adoption of certified and clean seed potato use.

The highest and second highest average annual income were for agripreneurs using certified seed potato as well as clean seed potato. On average, the lowest annual income was

for agripreneurs who used own farm-saved seed potato. This means high-income earners of about 48,000/- per month (577,000/- Ksh/ year) were likely to use high quality seed potato compared to agripreneurs who were low income earners (234,000 to 276,000/- Ksh/year). Certified seed potato is relatively expensive compared to clean seed potato and own-farm saved seed potato. Significant statistical difference between seed potato system used and annual income were observed at a lower probability level of significance ($P < 0.01$). Clean seed potato farmers had a mean annual income of 323,320 Ksh (26,917 Ksh/ month). This finding provides us with an indicator of which farmers to target when engaging in training and providing technical and financial support to seed production enterprises. The right famers to target are the high-income earners since they can easily adopt the technology of seed potato multiplication, their financial freedom is high.

Agripreneurs' who used certified seed potato had the highest mean land area under seed potato compared to other seed system farmers. This means those who invested in seed potato enterprises used certified seed potato and had access to bigger land sizes with mean of 1.2 acres. Significant statistical difference between seed system used and land size under seed were observed at a lower probability level of significance ($P < 0.01$). This implies that agripreneurs in Molo Sub-County can adopt seed potato multiplication enterprises since it requires relatively large amount of land size.

Certified seed potato were stored for longer periods of up to 161 (5 months), compared to 95 (3 months), 108 (3.4 months) for clean and farm- saved seed potatoes. This means that, certified seed farmers invested in storage facilities and was able to keep his / her seed until an appropriate planting or selling time. However, there was no statistical difference between the mean storing time and seed system used.

Table 7: ANOVA Test for Continuous Variables of Seed Systems Used

Seed Systems	Certified	Clean	Own farm saved	Neighbour Saved	One -Way Anova	
	Mean	Mean	Mean	Mean	F-value	P-value
Age (Years)	48.141	48.530	46.765	48.292	1.030	0.418
Years in school	10.781	8.045	9.265	7.375	1.590	0.068*
Years in potato farming	7.203	9.045	8.606	9.333	1.390	0.101*
Annual Income (KES.)	577,373	323,220	235,939	275,500	1.800	0.000***
Land under seed (acres)	1.203	0.015	0.031	0.042	56.180	0.000***
Days seed stored	161.600	94.786	108.000	100.000	1.150	0.353

***Indicates significance at 10% and (***) at 1% probability levels**

4.3 Nature of Seed potato Enterprise Investments

Out of the 380 respondents, only 17% grew clean seed potato as an enterprise. A bigger number (83%) were growing ware potato for markets. This means that less than 20 % of potato farmers in Molo Sub-County (a ratio of 1:5), supplied seed potato to the other farmers. Five seasons were used to find out the nature of investments made in clean seed potato enterprises. The main investments were production related that is on soil testing, seed, fertilizer, labour, and pest and disease control. Other investments were made on seed storage and marketing including transportation of produce from farm to store or to market. Majority (33%) of the agripreneurs who grew clean seed as an enterprise invested for one season. Thirty percent (30%) of the agripreneurs stated that they learnt about clean seed potato enterprise by end of

2017 from seed potato CARP+ project of Egerton University. This is the reason why majority had invested for only one season. The minimum acreage of seed potato the agripreneurs' started with was 0.25 acres and the maximum was four acres. Majority (69%) of the clean seed potato agripreneurs' did not increase land under seed over the observed period of five seasons. The agripreneures' were operating under the same scale as they started the seed potato enterprises. This is because most of the farmers had limited land size hence increasing the scale of production was a challenge. Only 19 % of the agripreneurs had increased their land under seed potato to a mean of one acre. Significant statistical relationship between number of seasons produced and change of land size under seed were observed at a lower probability level of significance ($P \leq .01$). Majority (47%) of agripreneurs who increased land under potato had grown seed potato for five seasons. Agripreneurs who were still operating under same scale as they started had majorly grown seed potato for one season. The results of the Chi square test are shown in Table 8 below.

Table 8: Chi Square relationship between seasons and change of acreage

Seasons of seed potato farming	One	Two	Three	Four	Five	Chi=value	P-value
	%	%	%	%	%	23.994	0.002***
Increased acreage	5	16	21	11	47		
Decreased acreage	0	0	0	0	100		
Still operating the same scale	45	27	18	2	7		

*****Indicates significance at 1% probability level**

The results indicated that 47 % of investors in seed potato business remained in the business by the fifth season (3rd year, 2019) with another 11% and 21 % still multiplying seed potato to the third season, respectively. This means that the seed business is sustainable and promising considering a cumulative of 79% had grown to a third season. Figure 5 below depicts decreasing trends in mean investment costs from KES 167,000 in season one of 2017 to 82,960 Ksh in season five of 2019. This is because initial investment is usually high, consisting of fixed cost that does not recur in following seasons. The main fixed investment noted among

agripreneurs of Molo Sub-County was cost of building a seed potato store. Cost of buying certified seed was variable but it was not incurred every season.

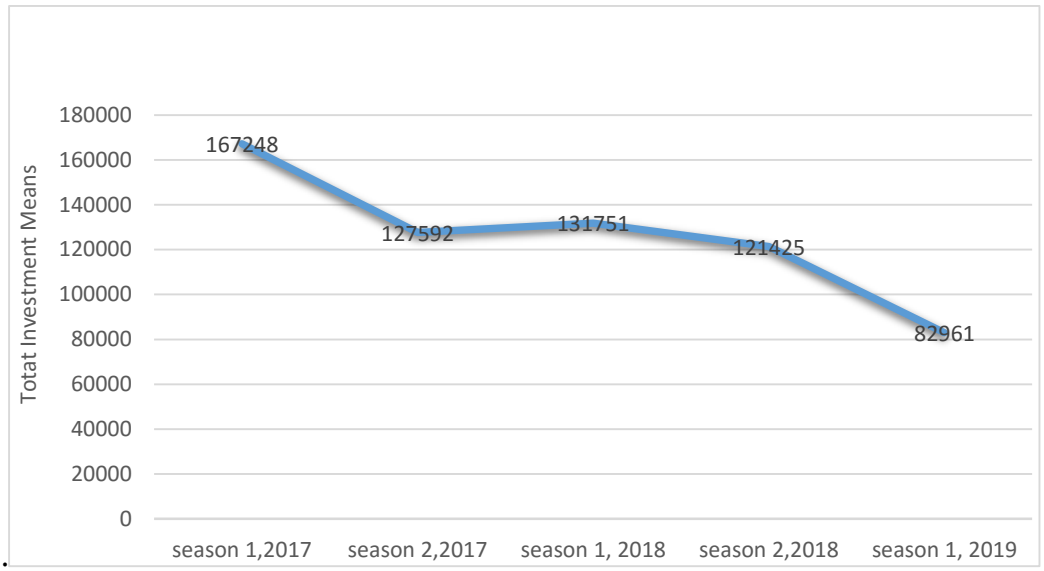

Figure 5: Trend of Investment cost (KES) in Clean seed by Molo agripreneurs in five Seasons of 2017 to 2019

Few agripreneurs (7%) had previously tried seed businesses as shown in Figure 6 below

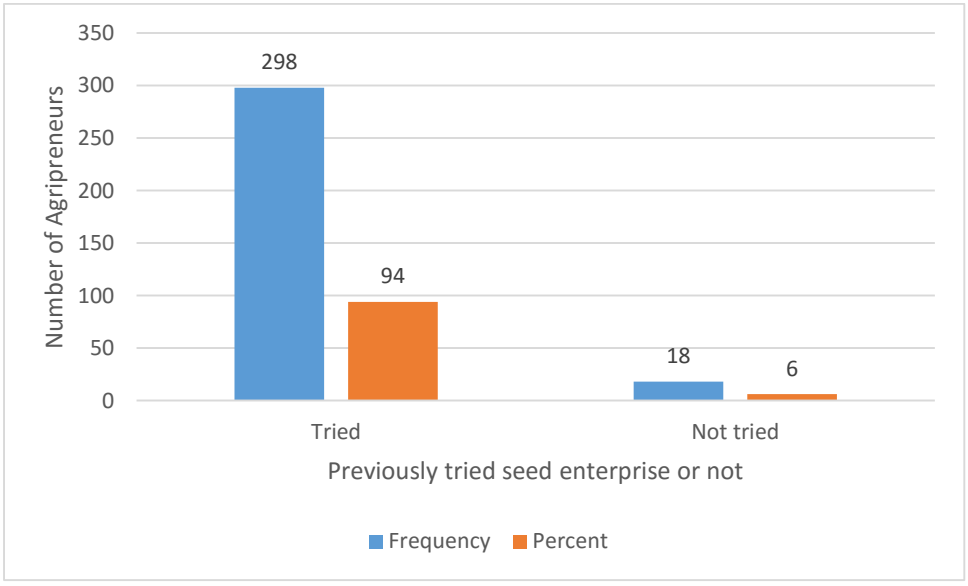

Figure 6: Presentation of whether Agripreneurs Tried Seed Potato Enterprises Previously

From the agripreneurs' who had previously tried seed potato enterprise, their main business models were selling of positively selected seed potato, farm saved potato and certified seed potato. Out of those who tried seed business before, majority (39%) were selling positively

selected seed potato. Very few agripreneurs (11%) were involved in selling certified seed potato as shown in Figure 7.

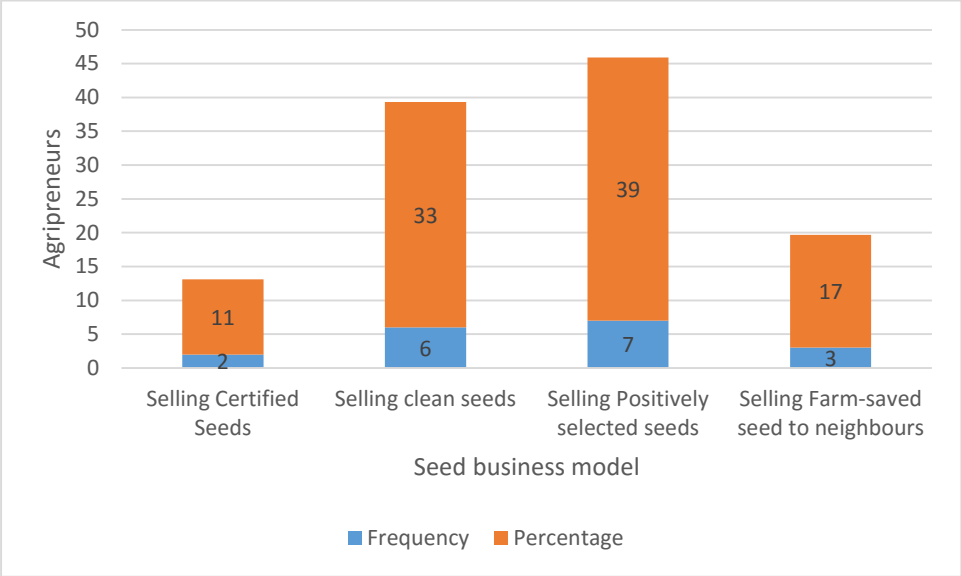

Figure 7: Presentation of percentage and frequency of Agripreneurs against seed business models.

Several reasons were stated as to why some changed the business model and others quit as shown in Table 8. The main reason of changing the business model was fear of the Kenyan seed certifying authority, KEPHIS (57%) since they do not recognize positively selected seed as suitable for trading. Some agripreneurs (17%) stated they ran out of operating capital and quit seed potato business.

Table 9: Reasons for quitting seed potato business

What were the reasons for quitting?		
	Frequency	Percentage
Changed to other model	6	26
I ran out of operating capital	4	17
Fear of KEPHIS	13	57

4.4 Double Hurdle Model Fitting

To determine the factors that influence participation of agripreneurs' in clean seed potato enterprises and investment levels, Double hurdle model. This was appropriate model for this study because it assumes that agripreneurs are faced with two hurdles in any agricultural

decision making process (Cragg, 1971). The two-step model allows different mechanisms to determine the discrete probability of participating in seed potato enterprises and the level of investment. It is assumed that some independent variables may affect differently the decision to participate in seed potato at all and the decision on the level of investment. It allows these outcomes to be determined by a separate processes through incorporation of a probit model in the first tier and a truncated normal model in the second.

Whether estimations are obtained simulteneously or in one regression at a time, the results are identical because of the separability of Cragg's likelihood function (Burke, 2009). The model makes estimation comprehensive, the results do not change. The main advantage of using craggit is its ability to facilitate postestimation analysis and interpretation. The Double Hurdle model approach, and specifically Craggit model, has been widely considered in studies on participation or uptake of agricultural technologies and the level of commercialisation after uptake (Mignouna *et al*. 2015; Wang *et al*. 2016; Hsueh and Kasperski, 2018; Burke, 2019).

4.5 Factors Influencing Agripreneurs' Participation in the Multiplication of Clean Seed Potato

The first stage of the model had a binary dependent variable, whether an agripreneur was investing in clean seed enterprise or not investing. Participating in clean seed potato multiplication was coded 1= Yes while not participating in clean seed potato multiplication was coded 0=No. Therefore, the stage results showed the factors influencing the probability of investing in clean seed potato. A pairwise correlation test was done to drop correlated explanatory variables.

The results of the first tier depicted that sex, age, years spent in school, household members, access to seed store, years in potato farming, seed selling price, attending trainings and frequency of extension services to respondents, significantly influenced decision to participate in seed potato enterprises as in Table 10.

Table 10*:* Tier-1-Factors influencing growing of clean seed potato enterprise

Variable	Coefficient	Standard Error	Z	P>z
Sex of respondent	0.650	0.043	2.410	0.061*
Ward of residence	0.258	0.233	1.110	0.267
Age of respondent (years)	0.064	0.042	2.520	0.082*
Years spent in school	0.290	0.113	2.560	0.010**
Household members	-0.240	0.133	-1.800	0.072*
Main source of income	0.146	2.202	0.520	0.603
Access to seed store	0.884	0.646	2.370	0.071*
History of seed business in family	0.625	0.730	2.220	0.026**
Years in potato farming	0.064	0.046	2.390	0.066*
Seed selling price per 50kg bag	0.182	0.001	3.710	0.000***
Acquired Credit	0.550	0.597	0.920	0.357
Attended training	0.724	0.905	2.140	0.032**
Times got extension service	0.724	0.279	2.590	0.010**
Group membership	0.182	0.624	0.290	0.770
Logged annual income	-0.270	0.305	1.060	0.288
Total land under seed	0.972	0.463	-0.890	0.376
Constant	-9.643	4.930	-1.960	0.050
Number of observations=380				
Wald Chi^2=29.61				
Prob> Chi^2=0.020				
Log Likelihood=-66.577				

***Indicates significance at 10% (*), 5% (**) and 1% (***) probability levels, respectively**

Sex of the agripreneurs' had a significant influence on decision to participate in clean seed potato enterprises only at a higher probability level of significance ($P \leq .1$). Being male increased the probability of participating in clean seed potato by 65 %. This was so probably because male agripreneurs have better networks in society which place them in better positions to get more information and new production techniques compared to females (Mudege *et al.* 2015). This result is consistent with findings from a study by Mudege *et al.* (2015) in Malawi, which found out that, although both men and women were involved in ware and seed potato production, men were more involved in seed potato production and marketing. The study reported that men had more access to knowledge and information through trainings unlike

women. Men were worried about allowing women attend the trainings because they believed they would not understand. The extension officers also invited household heads, allowing more men participation since they headed many households. Mulate *et al.* (2018) in Ethiopia also noted that women played limited roles in local seed production activities because their position in leadership and decision-making was not appreciated.

A unit increase in age of agripreneurs' by one year increased the probability of investing in *clean seed potato* enterprises by 6.4%, although at a ($P \leq .1$) level of significance. To invest in seed potato enterprise, one requires experience in production, as well as more resources. Relatively older agripreneures have more experience in crop production and are more resource endowed compared to younger ones (Akudugu *et al*., 2012). These results are consistent with a study done by Nwibo and Alimba (2013), in which age had a positive influence on determinants of investment decision among agribusiness investors in South East, Nigeria. They attributed this to the fact that relatively older investors above 60 years have a high efficiency in production and they can handle difficulties that can arise from farm related enterprises. However, these results contrasted with those of Demisse (2010) in Ethiopia, where an increase in age by one year was found to have a negative influence on smallholders being involved in local based seed system. On the other hand, Hagos *et al*. (2018) found out that an increase in age of smallholder farmers' involvement in seed production, Ethiopia negatively influenced their decision.

The number of years the agripreneurs spent in school positively influenced ($P \leq .05$) their decision to invest in clean seed potato enterprises by 29%. A unit increase in time spent in school increased the probability of investing in *clean seed potato* enterprise by 30%. This can be attributed to the fact that education equips agripreneurs with information and knowledge to make informed decisions related to seed potato. The findings are similar with that of Sebatta *et al.*(2014) in Uganda, who noted that secondary school level farmers were more likely to be involved in potato production and marketing.

The number of people living with and depending on the agripreneurs, negatively influenced ($P \leq .1$) the decision to invest in seed potato enterprises by 24%. A unit increase in the number of the people in a household decreased the probability of investing in *clean seed potato* enterprises by 24%. This could be because large population sizes need more food, hence, agripreneurs with large families may give priority to ware potato production, hence, reduced investments in seed potato enterprises. These findings were in contrast with those of Hagos *et al.* (2018), who found out that a large family size positively influenced decision to be involved

in seed production. This was explained to be caused by the fact that large family size provided labour, hence, easy to manage seed production activities properly.

Having access to a seed storage positively influenced (P≤.1) the decision to invest in *clean seed potato* enterprise by 88.4%. Agripreneurs with access to seed potato store had a relatively higher probability of investing in seed potato enterprise. Seed potato storage is a crucial input when one is in seed potato production. These results corroborated with those of Yami *et al*. (2013), who opined that access to inputs as well as training positively and significantly influenced farmer's decision to participate in bread wheat seed and seed potato multiplication.

Agripreneurs with previous experience in seed business had greater probability (P≤.05) of making the decision to invest in *clean seed potato* enterprises than their counterparts by 62.5%. This is an indication that agripreneurs who are already in seed potato business should be supported to expand their seed production capacity. This is because they have learnt through experience and it would be easier to build on their successes while correcting their mistakes in seed enterprise. These results are consistent with those of Nwibo and Alimba (2013), who found out that household history influenced decision to invest in agriculture related enterprises. People tend to adopt what they have seen others doing in the past or something they are aware of from acquiring information (Hagos *et al.*, 2018). Therefore, agripreneurs who had a previous experience in seed potato or any other seed business had a higher probability of investing in *clean seed potato* enterprises.

Experience in potato farming influences (*P*≤.1) the decision to invest in seed potato enterprise by 6.4%. An increase in experience of the agripreneur by one year increased the probability of investing in seed potato enterprise. This means agripreneurs with more experience in potato farming have higher ability to invest in seed potato enterprises than those with less experience, because, they have more knowledge and skills. Our finding is supported by the findings of Bukul (2018) who found out that an increase in farmers experience by one year, increased probability of producing potatoes. They attributed this to; farmers with experience in potato production produce more because they have more skills and information.

A selling price of a 50 kg bag of seed potato had an influence (*P*≤.01) on the decision to invest in *clean seed potato* enterprises at a lower significance level by 18.2%. Agripreneurs responded to relatively good prices because it translated into increasing their incomes. The agripreneurs reported selling approximately 50 kg bag of clean seed potato from US$ 15-20

depending on seed demand. The producer's goal is to maximise profit and this can be achieved through cost reduction or increased revenue (Debertin, 2012). The finding was in agreement with that of Akudugu *et al.* (2012), who reported that the decision to invest in any enterprise is affected by the benefits attained as well as costs incurred. This was reported to be due to farmers' being likely to adopt agricultural production technology that gives more benefits.

Access to and attending trainings on potato farming positively influenced the decision to participate in seed potato enterprise ($P \leq .05$) by 72.4%. This may be because agripreneurs who attended trainings got in contact with extension officers and were always updated with new technologies as well as production methods than those who did not attend. These results were consistent with those of Yami *et al*. (2013) and Hagos *et al*. (2018), who reported that attending trainings positively influenced farmers decision to produce seed. They attributed this to; getting training equipped farmers with information, hence, improving seed production.

The number of times the agripreneurs got extension services positively influenced ($P<.05$) the decision to invest in seed potato enterprise by 72.4%. This implies that agripreneurs who access the extension services gain more knowledge, hence increased investment in seed potato business than those who get the services less times. These results were similar to those of Yami *et al*. (2013) and Hagos *et al.* (2018), who underscored the role of extension services in bridging gaps that exist between agripreneurs practices and technical knowledge. It was, however clear that, extension personnel on the ground were insufficient to provide this essential service.

4.6 Factors Influencing Agripreneurs' Level of Investment in the Multiplication of Clean Seed Potato

Average amount of investments for five seasons were used as the dependent variable in the second hurdle. The first and second seasons considered were the crop cycles of year 2017. The third and fourth were the two crop cycles of year 2018. Lastly, the fifth season used was the first crop cycle of 2019, immediately before the data collection period. The results are shown in Table 11.

Table 11: Tier-2- Factors influencing levels of investment in clean seed potato enterprises

Variable	Coefficient	Standard Error	Z	P>z
Years in potato farming	0.035	0.012	2.910	0.004***
Number of seasons produced	0.216	0.054	4.040	0.000***
Total land under seed (acres)	-0.123	0.091	-1.350	0.018**
Total soil testing cost	0.000	0.000	0.460	0.646
Logged annual income	-0.464	0.141	-3.280	0.001***
Total marketing cost	0.000	0.000	-0.990	0.324
Acquired credit	0.216	0.170	1.270	0.000***
Times got extension service	0.185	0.049	3.810	0.000***
Group registration fee	0.120	0.010	-1.030	0.034**
Logged training cost	0.025	0.024	1.020	0.309
Logged cost of building seed store	-0.002	0.015	-0.150	0.877
Acres started producing	0.510	0.111	4.580	0.000***
Constant	9.925	0.195	50.900	0.000
Number of observations=380				
Wald Chi^2=29.61				
Prob> Chi^2=0.020				
Log Likelihood=-66.577				

***Indicates significance at 10% (*), 5% (**) and 1% (***) probability levels, respectively**

Years in potato farming positively influenced (P≤.01) the level of investment in *clean seed potato* enterprises by 3.5%. Thus an increase in time of potato farming by one year, increased the amount of money invested in clean seed potato enterprise. The influence of experience on amount invested is attributed to the fact that agripreneurs' who had been in potato farming for long, knew the right investments for seed potato enterprise as well as contact with partners who could offer the services and products. This includes, but is not limited to; soil testing, trainings as well as seed potato storage. Our finding conforms to findings from CIP (2011) analysis done in Eastern Africa to determine factors that influence investments in seed potato, it was reported that countries whose farmers had more experience in potato production tended to invest more into the business.

However, the present study's focus was on the gross production costs of investments and not in acreage or expansion of the business. The small scale initial investments (of over

KES 160,000) was higher than the subsequent second and third seasons' production costs, which was attributed to knowledge and experience gained. With success in the initial investment, it is hypothesized that it is then possible for successful farmers to grow their seed potato business, by investing more capital for expansion, when and if access to more funds was secured.

The number of seasons that the agripreneurs produced seed potato, had a positive influence ($P<.01$) on the amount invested. An increase in number of seasons produced increased the level of investment by 21.6%. This result collaborates that of Kaguongo *et al.* (2008) who opined that the number of seasons that farmers produced potato influenced the amount of money invested. In relation to this, agripreneurs who produced seed potato for more than one season invested more money than those who had done only one season. This is in agreement with CIP (2011) report.

An increase in annual income had a negative feedback influence ($P\leq.01$) on amount invested in *clean seed potato* enterprise. The negative correlation between income and investment level in seed enterprises among Molo agripreneurs would be attributed to the fact that as income raises, one invests in non-agriculture related enterprises. This finding corresponds to that of Onoja and Emodi (2014) who reported a negative correlation between annual income and amount invested in agribusiness enterprise. The negative correlation of annual farmer income with agri-business investments can be attributed to a number of factors, such as, improving ones living status, taking a child to a better school, lack of more land to rotate or expand the seed potato acreage or chosing a less complicated business as well as the probable demand for much higher investment cost (e.g., hiring better skilled labour, mechanization and better storage requirement) in the next business development phase.

Acquistion of credit significantly and positively influenced ($P\leq.01$) the amount invested in *clean seed potato* enterprise by 21.6%. Access to credit enables agripreneurs to buy required inputs in seed potato enterprises; hence, it is reasonable that acquiring credit would lead to increased amount of money invested in seed potato production. This finding suported that of Manishimwe *et al*. (2019), who reported that acquring credit helped farmers to pay for agricultural servicesand inputs, hence, increased level of production in Rwanda.

The frequency of getting extension service significantly and positively influenced ($P\leq.01$) amount of money invested in clean seed potato enterprise by 18.5%. Increasing the number of times that an agripreneur got extension services by one unit, increased amount

invested in seed potato by by 18.5%. This can be atrributed to getting more exposure to modern potato production technologies, hence, increased production. CIP (2011) also noted that strong extension service system led to more investment in seed potato.

The initial land size to be put under seed potato production by the agripreneurs, had a positive influence (P<.01) on the level of investment in *clean seed potato* enterprise by 51%. If the initial land size increased by 1 acre from one agripreneur to another, the amount invested increased by 51%. This would be because the more the land under clean seed potato, the more the production costs incurred, including agricultural chemicals (seed, labour, pesticide, fungicide and fertilisers) costs. This result are in line with finding of Bukul (2018) who reported that an additional land allocated for potato production increased amount of money invested.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATION

5.1 Conclusions

i. The seed potato systems used in Nakuru included clean seed (17%), certified seed (17%) own-farm saved seed (60%) and neighbours farm-saved seed (6%). The dominant seed system was use of own farm-saved seed.

ii. A decreasing trend was noted between average investment seeds in seed potato enterprise from KES 167,248 in 2017 to KES 82,961 in 2019.

iii. The results of the first tier depicted that sex, age, years spent in school, access to seed store, years in potato farming, seed selling price, attending trainings and extension services frequency of respondents, significantly and positively influenced the decision to invest in seed potato enterprises. On other hand, number of household members negatively and significantly influenced the decision to invest in clean seed potato enterprise.

iv. The number of years in potato farming, scale of production, credit acquisition and frequency of getting extension services positively and significantly influenced investment levels in clean seed potato production. Annual income had a negative significant influence on level of investment.

5.2 Recommendations

i. Efforts to strengthen seed potato value chain and promotion of high quality seed potato should be increased since higher number of ware potato producers are using farm-saved seed.

ii. More support is needed to the existing clean seed growers and all the potential seed growers as a decreasing trend in amounts invested was noted. It was noted that agripreneurs stop their seed production due to strict KEPHIS regulation. This raises a policy concern on importance of revising the seed potato regulations and maybe recognizes clean seed potato as tradable seed.

iii. The County governments and private investors should consider all the factors that influenced decision to participate in seed potato enterprises. Youth and women should be empowered with required resources because their contribution in seed enterprises as men do would lead to increased seed potato supply. Availability of seed stores, credit products specific to potato farming and more training and extension services would

encourage more agripreneurs to participate in seed potato production hence increasing supply

iv. Medium to large-scale potato farmers with over 570,000 Ksh- annual income should be encouraged to invest in production of seed potato. Agripreneurs in seed potato are required to make investments in groups, extension services as well as trainings.

5.3 Suggestion for Further Research

This study only focused on factors underlying agripreneurs investment decisions and levels of investment in clean seed enterprises. There is a need to undertake a study to evaluate the factors that affect successive phases of investments in seed potato enterprise and measure the performance of seed potato enterprises

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

Statement of Consent

I am Redempter Mbula Mutinda pursuing Master of Science degree in the faculty of agriculture, department of agricultural economics and agribusiness management at Egerton University. I am carrying out a research project on ***Factors Underlying Agripreneurs' Participation and Level of Investment in Clean Seed Potato Enterprises in Molo, Nakuru.*** The purpose of this study is purely academic and more so to contribute to the understanding of the seed potato enterprises among potato agripreneurs in Nakuru County. Respondents are requested to voluntarily and honestly participate in answering this questionnaire and are assured any information shared will be strictly confidential. The interview may last for approximately 30 minutes. Your participation will be greatly appreciated. Your privacy will be protected maximum extent allowed by law.

If in the future you have any questions regarding to the study and the interview, or concerns or complaints I welcome you to contact Redempter Mbula Tel: 0737711635 Email reddzmutinda@gmail.com

May I continue to ask you the questions? By continuing this interview, you indicate your willingness to voluntarily participate in the study.

Consent mark _____

Introduction

I am Redempter Mbula Mutinda, pursuing Master of Science Degree in the Faculty of Agriculture; Department of Agricultural Economics and Agribusiness Management at Egerton University. I am carrying out a research project on ***Factors Underlying Agripreneurs' Participation and Level of Investment in Clean Seed Potato Enterprises in Molo, Nakuru County.*** The purpose of this study is purely academic and more so to contribute to the understanding of the seed potato enterprises among potato agripreneurs in Nakuru County. Respondents are requested to voluntarily and honestly participate in answering this questionnaire and are assured that any information shared will be strictly confidential. The interview may last for approximately 30 minutes. Your participation will be greatly appreciated.

Section A: General Information about the Respondent

<table>
<tr>
<td>A.1 Household ID
……..</td>
<td rowspan="3">A.5 What is your age in complete years?.....

A.6 How many years have you spent in school?

……
A.7 Ward
1 Molo
2 Turi
3 Marioshoni
4 Elburgon</td>
<td></td>
</tr>
<tr>
<td>A.2 Name of the respondent?
……..
A.3 Telephone number
……...</td>
<td>A.8 How many household members live permanently in the compound?.....</td>
</tr>
<tr>
<td>A.4 Sex
1=Male 0=Female</td>
</tr>
</table>

Section B: Information on Agripreneur's Economic and Institutional Characteristics

B.1 Main sources of income (Circle all that apply) 1 Farming 2 Employment 3 Business 4 Remittances 5. Others (Specify)…….. **B.2** Estimated total annual income (Ksh)…….	**B.4** Do you have access to seed store? 1=Yes 0=No **B.5** Do you store seed potato ? 1=Yes 0=No **B.6** If yes in B.4, what type of seed store? 1=Cold Store 2= Diffused light store 3=Traditional store 4=others Specify **B.7** Who owns the store? 1= Self 2= Group 3= Government 4= Others (Specify)
B.3 Where do you get money to finance potato production? 1= Own savings 2= Family members 3 =Group 4 =Others (Specify)……	**B.8** How long can the seed potato stay in store before going bad for planting? (days)……..
	B.9 What is the nature of your enterprise? 1= Sole-proprietorship 2=Partnership 3= Family

Section C: Information on Potato production

<table>
<tr><td>C.1 Do you grow ware potato?
1= yes 2= No</td><td rowspan="2">C.5 How many years have you been farming potatoes?.....
C.6 Total farm size accessed (Acres)…….
Owned farm size for seed potato……
Rented farm size for seed potato…….
Family farm size for seed potato……..</td></tr>
<tr><td>C.2 If yes, what potato varieties do you grow?
1=Shangi
2=Nyayo
3= Tigoni
4= Jelly
5=Others
(Specify)……</td></tr>
<tr><td>C.3 Why do you grow the variety (ies) selected
above?
1=It has a ready market
2=for processing
3= Easy to access seed
4= higher purchase price than others
5= high yielding
6=Early maturity
7= others (specify)…….</td><td>C.7 What is the acreage of seed potatoes grown on average?.....

C.8 Where do you get labour for potato farming?
1= Family members
2=Group members
3= Hired labour
4= others (specify)
…….</td></tr>
<tr><td>C.4 For what purpose are you farming ware potato? (Tick all that apply)
1=Home Consumption
2=for income
3 =others (Specify)……</td><td>C.9 If you hire labour what is the estimated cost per season (Ksh.)?.....

C.10 Do you know about certified seed potato?
1= yes 0= No</td></tr>
</table>

C.11 If yes, do you normally plant certified seed potato? 1= Yes 0=No	**C.18** If yes, what type of certified seed potato planting material do you use? 1= C2 seed 2= C3 seed 3=Apical root cuttings 5=others (specify)…….
C.12 If No what type of seed do you use? 1= Clean seed 2= Own Farm-saved 3=Neighbours Farm-saved 4= Others (specify)	
C.13 If No in question C.10 above, what are the reasons? 1=Lack of certified seed 2= the seed is expensive 3= I don't know where to get the seed 4=where I can access the seed is far 5= I use other types of quality seed (specify) …….	**C.19** Where do you source your planting seed potato? 1= AD**C** Molo 2=Charvi ltd 3= AgriCo EA 4=Others (Specify)……..
	C.20 Which varieties do you grow for seed? 1=Shangi 2=Markies 3= Karibu Kenya 4= Jelly 5= others (specify)……..
C.14 If yes in question C.10, where do you source your certified seed? 1= ADC Molo 2= AgriCo EA 3 Charvi Ltd 4 Others (specify)…….	**C.21** Why do you grow these varieties? 1=Cheaper to grow 2=easy to access seed 3=High demand for seed 4= the only available 5=Good storage quality 6= others (specify)……
C.15 After how many seasons do you get/buy new seed? 1= One season 2= Two seasons 3=Three seasons 4 = More than three	
C.16 Do you know about clean seed potato? 1= Yes 0= No	

C.17 Do you grow clean seed as an enterprise? 1=Yes 0=No **C.22.** If no in question **C.17**, what are the reasons? 1= Not interested 2= Poor markets 3= I tried before and failed 4= Others Specify……	
C.23 Have you ever tried Seed enterprise Previously? 1=yes 0=No **C.24** Has anyone in your family ever tried seed potato enterprise? 1=Yes 0=No	**C.27** When did you stop the seed enterprise? 1= Less than 1 year ago 2= 1 – 2 years ago 3=More than 2 years ago
C.25 What was the seed business model? 1=Selling Certified Seeds 2=Selling clean seeds 3=Selling Positively selected seeds 4=Selling Farm-saved seed to neighbours **C.26** Are you still operating the same business model? 1= Yes 0= No	**C.28** What were the reasons for quitting? 1=It was not profitable 2= Changed to other model (Specify) 3= I ran out of Operating Capital 4= Others(Specify)

Section D: Information on Investments made on seed potato

D.1 Activity	D.2 Quantity	**D.3 Unit cost**	**D.4Total cost**
Land leasing	Acres		
Land preparation	Acres		
Purchase of seed	Bags(50kg)		
Seed transport	Ksh		
Planting labour	Man/day		
Weeding labour	Man/ day		
Harvesting labour	Man/day		
Fungicide	Litre/Kg		
fertilizer	Litre/Kg		
Pesticides	Litre/Kg		
Herbicides	Litre/Kg		
Packaging material	Bag		
Transportation of harvested potato	Ksh		
Building DLS			
Soil testing	Per test		
Marketing Cost			
Group registration fee			
Training on potato fee			

Section E: Information on Yield and Marketing of Seed potatoes

E.1 What is the average 50kg bags of seed potato produced per season?.....	**E.4** Who are the main buyers of your clean seed? 1= Neighbours 2= other seed growers 3= others (specify)……
E.2 What is the average 50kg bags of seed potato sold per season?.....	**E.5** Why do you choose the buyer(s) named above? 1=Gives better prices 2=under contract 3= the only proximate buyer 4= others (specify) ……
E.3 What is the average price per 50 kg clean seed potato in Ksh. ?	**E.6** How do you find the organization of seed potato markets? 1=Very good 2 = good 3= average 4= Poor 5 = very poor

Section F: Credit Access, Group Membership and Training

F.1 Do you need credit in your farm operations? 1=yes 0=No **F.2** Have you ever acquired any credit in the last one year? 1=Yes 0=No	**F.4** What was your reason for borrowing? 1=Buy production inputs 2= Medical bills 3= School fees 4=others (Specify)……
F.3 What was the source of the credit? 1= Commercial banks 2=SACCO 3= Microfinance institutions 4. =Informal lenders 5. Farmer group 6. Others (specify)…….	**F.5** What was the amount borrowed (KSH.)?..... **F.6** What was the interest rate?.....

F.7 From the amount borrowed, approximately how much was used in seed potato production (Ksh.)? _____	**F.11** If yes, which topics were discussed or what was demonstrated? 1= Production of potatoes 2. Marketing of potato 3. Seed potato multiplication techniques 4= seed potato systems 5= seed potato certification process by KEPHIS 6 = Others (Specify)……..
F.8 If no in **F.2** what was the reason (s)? 1= No collateral 2. Defaulted on previous loan 3. High interest rate 4. Not aware of credit facilities 5. Others (Specify)	
F.9 Where do you get information on potato production? 1=Family, Neighbours, Friends 2=Government extension Services 3=agro-input dealers 4=Mass media 5=research and training institutes 6=NGOs 7=Group members 8= Others(Specify)	**F.12** How many times do you get the trainings in a year on average?.....
	F.13 Are you a member of any potato group? 1=Yes 0=No
	F.14 If yes what is the name of the group (s)……
	F.15 Is the group registered? 1=Yes 0=No
F.10 Have you ever attended any training, seminar, exhibition on potato? 1=Yes 0=No	**F.16** What is the main objective of the group? …….
	F.17 How many times do you meet in a month ?1=once 2=Twice 3=> 2 3= Only meet when need be

Section G: Information on Entrepreneur Related Factors

On a scale of 1 to 5 (1- Strongly agree, 2- agree, 3-neutral, 4- disagree, 5- strongly disagree), please indicate in what way you agree with the following statements relevant to entrepreneurial behaviour on your seed potato enterprises

Statement	**1**	**2**	**3**	**4**	**5**
Entrepreneurial behaviour on risk taking					
I am afraid to take risk to penetrate new markets					
The higher I take risk, the higher the returns					
I have creative mindsets to solve enterprise related problems					
I usually try new methods of production and marketing					
I change marketing strategy each year					
I add value to potato products in terms of sorting and grading before marketing in order to improve quality					
I have ability that enables me to complete a task or solve problems when arise					
I have the ability to influence potential agripreneurs to engage in seed potato agri enterprise					
I have the ability and willingness to search for information concerning production and marketing of seed potato					
I am willing to try new potato varieties					
I am willing to expand seed potato production					

On a scale of 1 to 5 (1- Strongly agree, 2- agree, 3-neutral, 4- disagree, 5- strongly disagree), please indicate in what way you agree with the following statements relevant to entrepreneurial motivation to start the enterprise

Statement	**1**	**2**	**3**	**4**	**5**
Motivation to start the enterprise					
I started the enterprise to make decisions independently					
I started the enterprise to be able to increase income					
I started the enterprise because it is more profitable compare to ware potato business					
I started the enterprise after quitting job to have personal freedom					

Section H: Information related to nature of seed enterprise

H.1 Which year did you start the seed enterprise?..... **H.2** How many acres did you start with in producing seed potato?..... **H.3** Have you increased the acreage? 1= Yes 2= No	**H.5** If No what happened? 1= Decreased the acreage 2= I am still operating on same scale 3= I closed down 4= others **H.6**. What was the total investment for the past seasons (2017,2018, 2019) in Ksh.? 2017…….. 2018…….. 2019……
H.4 If yes how many acres have you added? ……..	

THE END

THANK YOU FOR YOUR COOPERATION AND INPUT

APPENDIX 2: DOUBLE HURDLE MODEL RESULTS

craggit c16 a4 a7 a5 a6 a8 b1 b4 cx2 c5 e3 f2 f10 f12 f13 ln_b2 Land_total_seed , second (ln_Seed_i> nvest_average2 c5 No_season_prod2 Land_total_seed d14 ln_b2 d15 f2 f12 d16 ln_d17 ln_d13 h1_2)

Estimating Cragg's tobit alternative

Assumes conditional independence

initial: log likelihood = -<inf> (could not be evaluated)

feasible: log likelihood = -14983.616

rescale: log likelihood = -1963.047

rescale eq: log likelihood = -339.37718

Iteration 0: log likelihood = -339.37718 (not concave)

Iteration 1: log likelihood = -252.24884 (not concave)

Iteration 2: log likelihood = -231.53075 (not concave)

Iteration 3: log likelihood = -174.55462 (not concave)

Iteration 4: log likelihood = -114.054

Iteration 5: log likelihood = -76.212214

Iteration 6: log likelihood = -68.076745

Iteration 7: log likelihood = -66.741881

Iteration 8: log likelihood = -66.577422

Iteration 9: log likelihood = -66.576702

Iteration 10: log likelihood = -66.576702

Number of obs = 380

Wald chi2(16) = 29.61

Prob > chi2 = 0.0201

Log likelihood = -66.576702

Tier 1	Variables	Coef.	Std. Err.	z	P>z	[95% Coef.	Interval]
	a4	.6501866	0.043644	2.41	0.061	-1.102057	1.499379
	a7	.2583924	0.232756	1.11	0.267	-.197801	.7145858
	a5	.0639615	0.0420241	2.52	0.082	-.0184043	.1463272
	a6	.2899628	0.1131762	2.56	0.010	-.681415	.5117842
	a8	-.2394592	0.1329237	-1.80	0.072	-.4999849	.0210665
	b1	.145624	2.202335	0.52	0.603	-3.170872	5.462121
	b4	.8839495	0.6463867	2.37	0.071	-.3829452	2.150844
	cx2	.624474	0.730104	2.22	0.026	.1934964	3.055451
	c5	.0641394	0.0462947	2.39	0.066	-.1548754	.0265965
	e3	.002857	0.0007705	3.71	0.000	.0013469	.0043674
	f2	.5496113	0.5968763	0.92	0.357	-.6202446	1.719467
	f10	.937030	0.9046225	2.14	0.032	.1640029	3.710058
	f12	.7235258	0.2790935	2.59	0.010	-1.270539	-.1765127
	f13	.1824175	0.62416990	0.29	0.770	-1.040933	1.405768
	ln_b2	.2700579	0.3048069	1.06	0.288	-.8674684	.3273525
	Land_total_seed	1.971982	0.4632432	-0.89	0.376	.000	2.879922

	Constant	-9.643138	4.929968	-1.96	0.050	-19.3057	.0194223
Tier 2	c5	.0337247	0.0117905	2.91	0.004	.0106157	.0568338
	No_season_prod	.1917179	0.0568967	4.04	0.001	.0802024	.3032334
	Land_total_seed	-.1332089	0.0904658	-1.35	0.141	-0.3105186	.0441007
	d14	6.82E-06	0.0000685	0.46	0.646	-0.0001275	.0001411
	ln_b2	-.4636951	0.1147544	-3.28	0.001	-0.0479549	.4018742
	d15	-.0000468	0.0000439	-0.99	0.324	-0.0001329	.0000393
	f2	.2155807	0.1675866	1.27	0.000	-0.124883	.5320443
	f12	.184945	0.049211	3.81	0.000	-.0827954	.0865884
	d16	.1201819	0.0102843	1.03	0.034	-.0007391	.0003754
	ln_d17	.0252023	0.0237777	1.02	0.309	-.022321	.0787255
	ln_d13	-.0015227	0.0152736	-0.15	0.877	-.0259827	.0338887
	h1_2	.5094333	0.1109079	4.58	0.000	.1071789	.6516877
	_cons	7.812462	1.385541	5.64	0.000	5.096853	10.52807
	sigma _cons	.501091	0.0442906	11.31	0.000	.414283	.5878989

APPENDIX 3 : NACOSTI PERMIT

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FACTORS INFLUENCING AGRIPRENEURS' INVESTMENT DECISION AND LEVEL IN CLEAN SEED POTATO ENTERPRISES IN THE HIGHLANDS OF KENYA

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ABSTRACT

High quality seed potato (*Solanum tuberosum* L.) supply has failed to meet the growing demand estimated at 250,000 metric tonnes from 161,000 ha of ware potato for cultivation by 600,000-800,000 small-scale farmers in Kenya. Increased investments by private seed potato multipliers could alleviate the shortage of seed potato by enhancing availability and accessibility to quality seed, and bridging the supply that currently meets less than 5% of the demand. The objective of this study was to investigate factors that influence agripreneurs' investment decisions and level of investment in clean seed potato enterprise in the highlands of the Rift Valley, Kenya. The study was conducted through a cross-sectional survey of 380 agripreneurs. The Double hurdle (Craggit) model analysis revealed that training, frequency of extension services, family history in seed potato business, years spent in school and selling price, significantly ($P<.05$) influenced the probability of agripreneurs' decision to invest in clean seed potato enterprises in the highlands of Kenya. Initial land size put under seed potato production at the commencement of the enterprise, higher annual household income, number of cropping seasons, total land under seed potato and group membership fee also significantly ($P<.05$) influenced the decision and level of investment in clean seed potato enterprise.

Key Words: Double-hurdle, seed potato, *Solanum tuberosum*