COMPARATIVE ANALYSIS OF GROUNDNUTS AND MAIZE SEED VALUE CHAINS IN SEMI-ARID AGRO-ECOLOGIES OF CENTRAL TANZANIA

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ABSTRACT

The groundnut sub-sector in Tanzania is characterized by low productivity compared to the maize sub-sector. Among other things, the low productivity is due to the use of low-quality seeds. This study is therefore attempted to compare the profit of groundnuts and maize seeds value chains in semi-arid agro-ecologies of central Tanzania. Specifically, the study mapped the seed value chain of groundnut and maize sub-sectors; compared the profitability of groundnut and maize seed farmers as well as seed companies operating under an out-grower scheme model by using a gross margin approach. Further, it assessed the factors influencing investment in the two seed sub-sectors using a binary logistic regression model. Generally, the study covered 291 respondents where 120 were groundnut seed farmers, 120 were maize seed farmers, 17 agro-dealers, 19 extension officers, 4 research institutes, 5 seed companies and 4 regulatory organizations. Both qualitative and quantitative methods of data analysis were employed. Using gross margin analysis, the study reveals that, groundnut seed farmers realize a high gross margin i.e a difference of 914 953 TZS compared to maize seed farmers. Also, seed companies operating under the out-grower model scheme realize higher gross margins than individual seed farmers. Results from binary logistic regression revealed that level of education, household size, frequency of extension services, and training has positive and significantly influence investment in the groundnut and maize seed value chain. For the improvement of the groundnut and maize seed value chain in the study area, the study recommends that the government should come up with policies aimed at subsidizing the cost of farm inputs such as fertilizer and pesticides to lower the cost of production.

DECLARATION

I, Gloria Vincent Kenjewala, do hereby declare to the Senate of the Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor is it being concurrently submitted for degree award in any other institution.

_____ _____

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The above declaration is confirmed by;

_____ _____

Prof. Reuben M. J. Kadigi Date

(Supervisor)

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DEDICATION

This work is dedicated to my mother Adelehema B. Mhagama, my late father Vicent B. Kenjewala, and my husband Peter M. Mhimba.

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LIST OF ABBREVIATIONS AND SYMBOLS

ACB	The African Centre for Biodiversity
AMCOS	Agricultural and Marketing Co-operatives Societies
ASA	Agriculture Seed Agency
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BCR	Benefit Cost Ratio
BLRM	Binary Logistic Regression Model
CIMMYT	International Maize and Wheat Improvement Center
CSB	Community Seed Bank
DUS	Distinctness, Uniformity and Stability
EGS	Early Generation Seeds
FAO	Food Agriculture Organization
FGD	Focal Group Discussion
GVC	Global Value Chain
ILO	International Labour Organization
INCRISAT	International Crop Research Institute for the Semi-Arid Tropics
IRR	Internal Rate of Return
ISSD	Integrated Seed Sector Development
ITC	International Trade Center
KIT	Karlsruhe Institute of Technology
LR	Logistic Regression
MoF	Ministry of Agriculture
NAIVS	National Agriculture Voucher Scheme
NBS	National Bureau Statistics
NGOs	Non-Government Organization
NPT	National Performance Trial
OPV	Open Polinated Variety
PM	Profit Margin
QDS	Quality Declared Seed
ROI	Return on Investment
SMEs	Small and Medium Enterprises
SUA	Sokoine University of Agriculture
TAAT	Technologies for African Agricultural Transformation
TARI	Tanzania Agriculture Research Institute
TC	Total Cost
TMA	Tanzania Meteological
TOSCI	Tanzania Official Seed Certification Institute
TR	Total Revenue
TVC	Total Variable Cost
UK	United Kingdom
URT	United Republic of Tanzania
VIF	Variance Inflation Factor

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agriculture occupies a very important place in the lives of Tanzanians as well as the national economy. Improving agricultural productivity and production is a prerequisite to sustaining Tanzania's smallholder farmers. This requires increased use of quality seed of improved and well-adapted crop varieties. Legume crops, particularly groundnut is critical in ensuring food, nutrition, and income securities of the majority of farming households (Lanteri and Quagliotti, 1997). However, groundnut productivity is low compared to maize. The low productivity is due to the limited availability of quality seed (Akpo *et al.,* 2014) and lack of interest in the production of legume seeds by potential seed producers, especially the private sector (FAO, 2010). For example, out of 65 registered seed companies in Tanzania, only seven seed companies have expressed interest in producing groundnut seeds. These include ASA, Temnar, Suba agro, Meru Agro, Alssem, Mbozi Highland Economic Group, and Iffa seed co. Most of the remaining seed companies are engaging in producing maize seeds.

Seeds are not only a strong foundation for food security but also important in strengthening the livelihood of small-scale farming communities by increasing agriculture productivity (KIT, 2014). Groundnut production is considered a profitable venture (Taru *et al.,* 2010), but in African countries, such as Tanzania, it is grown by smallholder farmers with less application of modern inputs (Taru et al., 2010). For

example, during the previous decade, groundnut production in Tanzania has not exceeded 8% of the word production (ITC, 2011).

Groundnut is one of the important crops grown in many parts of the World. It is a tropical legume crop commonly known as peanut or goober or monkey nut in the United Kingdom (UK). The crop is grown in semi-arid tropical and sub-tropical regions between 40°N and 40°S and it is important for both large and small commercial producers (FAOSTAT, 2016). Groundnut seed is a rich food source providing quality vegetable oil (48%-50%), protein (26%-28%), dietary fiber, minerals, and vitamins that are essential for the health of the livelihood (Pasupuleti *et al.,* 2013). Global peanut production has increased on average by 20% in the last 10 years (FAOSTAT, 2019). In 2017/2018, about 45.3 million metric tons produced, up from 43.1 metrics tons in the previous season translated to about a 5% increase (FAOSTAT, 2018).

In Tanzania, groundnut ranks second in oilseeds production after sunflower and is grown mainly in Dodoma, Mbeya, Shinyanga, Tabora, and Mtwara regions (URT, 2017). The total area planted in 2017 was 497 113 ha (1.2%) of total cropped area and the total harvest was 978 867 tons (URT, 2017). The available statistics show that about 2% of total global groundnut production grew in Tanzania especially under rain-fed conditions (ITC, 2015). In most cases, groundnuts produced in Tanzania have been consumed domestically in unprocessed form and smaller quantities in both forms (processed and unprocessed) are exported in neighboring countries such as Kenya and Uganda (ITC, 2015).

According to URT (2017), groundnut production in Tanzania has increased in recent years but still low compared to maize (Figure 1). For instance, the total maize production

in 2019 was 6 200 000 tons while groundnut production was 778 768 tons (FAOSTAT, 2020). The low productivity is associated with drought stress, non-availability of improved seed varieties (Daudi *et al*., 2018) and the prioritization of the crop in farming systems whereby maize, a staple cereal is given priority while groundnut is planted as a second crop in the season.

Similar to groundnut, maize is also one of the most important crops grown in Tanzania and a key staple food for the majority of the people in the country (FAO, 2015). According to URT (2017), the area under maize production in Tanzania in the 2016/17 production season was 6 067 996 ha with a total production of 5 766 984 tones. Over 80% of total maize produced in Tanzania comes from smallholder farmers and is grown for both subsistence and cash (FAOSTAT, 2016). Most of the maize produced in the Country (65% to 80%) is consumed locally (Bill and Melinda Gates Foundation, 2014).

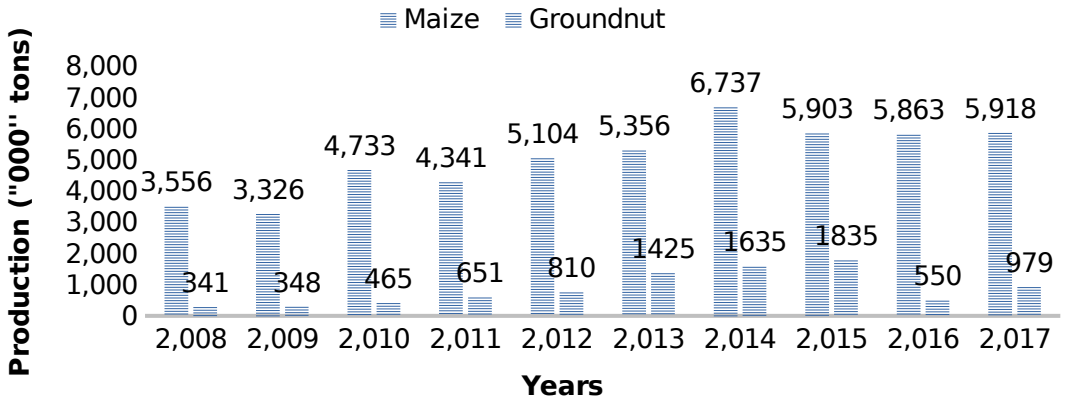


Figure 1: Groundnut and maize production trend

1.2 Seed Value Chain in Tanzania

According to KIT (2014), the seed value chain in Tanzania is limited and not well structured, and it mainly focuses on seed sector development. The major focus is on the

maize sub-sector while the other seed sub-sectors such as those of legumes which includes groundnut remain underdeveloped despite being important for the household livelihood.

In Tanzania, the majority of farmers use recycled seeds for these crops. The replacement rate for maize seeds takes up to three years (KIT, 2014) while for groundnut seed is more than three years. The seed value chain in Tanzania is hampered by inefficiencies in the supply and low purchasing power.

The groundnut seed sub-sector is characterized by a short and limited value chain relative to the maize seed sub-sector in Tanzania (KIT, 2014). This has motivated and served as a basis of this comparative study. This study aimed at: (i) Map the seed value chain of groundnut and maize, (ii) Compare seed producers' profitability between groundnut and maize seed value chain (iii) Assess factors influencing investment in the seed value chain of groundnut and maize.

1.3 Problem Statement and Justification

Groundnut and maize are important crops in ensuring food, nutritional and economic security for the majority of farming households in Tanzania (Willson and Lewis, 2015). However, the groundnut productivity has been constrained by the limited availability of quality seed of improved varieties compared to maize (Daudi *et al*., 2018). According to the National Bureau of Statistics, the maize production trend shows a steady increase since 2008 (Figure 1). The groundnuts production is relatively low compared to maize. For instance in 2017, the groundnut production was 1 ton/ha in 2017 compared to 3.1 tons/ha of maize (URT, 2017).

The efforts to address this challenge require a thorough understanding of how the value chain actors interact and gains from the interconnected seed value chain with attention to groundnuts seed and maize seed.

In Tanzania, few studies on groundnut and maize seed value chain have been conducted. Such studies include that of Madulu *et al.* (2016) which looked at Seed Value Chain to Support Sustainable Intensification in Tanzania, with a focus on legume and cereal crops. In their studies they found that, inefficient supply chains and low purchasing power were the two main challenges of seed markets in Tanzania. Daudi *et al.* (2018) who worked on groundnut production constraints, farming system and farmer preferred traits in Tanzania, in their study they found that, non availability of improved seed varieties, diseases and pest and drought was the major constraints of groundnut in Tanzania. Also, the study done by Katundu *et al.* (2014) found that the costs of seed and pesticides, farming hours, price of groundnut from previous season and cultivated land size significantly influenced groundnut production in Urambo district of Tabora region in Tanzania.

Despite the fact that these studies have addressed different components of groundnut seed value chain, little is known about contribution of groundnut seed production to the economy of smallholder farmers' vis-à-vis other seed production in Tanzania, specifically in semi-arid agro ecologies of central Tanzania. Therefore the study aimed at: (i) Map the seed value chain of groundnut and maize, (ii) Compare seed producers' profitability between groundnut and maize seed value chain (iii) Assess factors influencing investment in the seed value chain of groundnut and maize.

The findings of this study intended to inform strategies for strengthening the groundnut's seed value chain to enhance its commercialization. This would offer significant potential for improving farmers' incomes, food security and reduce poverty in the semi-arid agro-ecologies of central Tanzania.

1.4 Objectives of the Study

1.4.1 Overall objective

The overall objective was to compare groundnuts and maize seed value chain in enhancing performance of the seeds in semi-arid agro-ecologies of central Tanzania.

1.4.2 Specific objectives

i. To map the seeds value chain of groundnuts and maize in semi-arid agro-ecologies of central Tanzania,
ii. To compare seed producers' profitability among maize and groundnut seed value chains in the study area and,
iii. To assess the factors influencing investment in groundnut and maize seed value chains.

1.4.3 Research question

i. Who are actors in groundnut and maize seed value chain?

1.4.4 Study hypothesis

i. There is no statistical significant difference of profit between groundnut and maize seed value chain and,

ii. Socio economic factors of investors do not influence investment decisions in the groundnut/maize seed value chain**.**

1.5 Organization of the Dissertation

This dissertation contains five chapters. Chapter one is the introduction, problem statement and justification, objectives, research question and hypotheses. Chapter two presents literature review. Chapter three presents the approach and methodologies used in the study. Chapter four presents the findings and discussion. Chapter five presents the conclusion and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Definition of Key Terms and Concept

2.1.1 Value chain concept

The Value chain concept initially was popularized by Michael Porter in the 1980s as a tool for enhancing the competitiveness of enterprises to attain a competitive edge. It then expanded to cater for the larger units such as industry sub-sectors. Also, Kaplinsky and Morris (2000) define value chain as the full range of activities that are required to bring a product or service from conception, through the different phases of production, delivery to final consumers, and final disposal after use. According to KIT *et al.* (2006) value chain is a specific supply chain where actors actively find the opportunity to support each other to increase both efficiency and competitiveness. Actors invest time, money, and effort and build relationships with each other to reach a common goal of satisfying consumers' needs. According to Hellin and Meijer (2007), a value chain consists of enabling environment, service providers, and actors such as input suppliers, producers, processors, traders, wholesalers, exporters, retailers and consumers.

2.1.2 Value chain governance

According to Bair (2008), value chain governance means inter-firm relationships and institutional mechanisms through which market coordination of activities in the chain is achieved. In Global Value Chain (GVC) analysis, it refers to the process of organizing activities to achieve a certain functional division of labour along a value chain resulting

in the specific allocation of resources and distribution of gains (Kaplinsky, 2000; Ponte, 2007).

Value chain governance also refers to how control is exercised within the chain, reflecting the relationships between different actors (Marshal et al., 2006). It helps in determining the sustainability of the overall chain and the accountability of benefit distribution; and also, influences how production capacities are improved. According to Kaplinsky and Morris (2001), value chain governance has four stages that are setting rules; monitoring adherence to the rules; supporting other actors in the chain to be able to adhere to the rules; and imposing sanctions where rules are violated. Good value chain governance ensures the interactions between firms along the value chain are efficient and effective (Purnomo *et al.*, 2009). According to ILO (2006), four types of value chain governance are market-based, balanced networks, directed networks, and hierarchy.

Therefore, governance within global value chains is an important determinant of how value is controlled and distributed along a value chain and how it ultimately affects livelihoods (Schreckenberg *et al*., 2006; Belcher and Schreckenberg, 2007). Particular determinants include how access to a market is governed to determine how, where and when actors participate in a value chain, how and where funnels for technical assistance enter the chain, and who and which stages of value chains are promoted for policy initiatives (Keane, 2008; Purnomo *et al.*, 2009).

2.1.3 Seed value chain analysis

The use of improved varieties has a high potential for farmers. A father of the Green Revolution, Norman Borlaug, publicized the importance of using improved seed in the

1960s. In his research in Mexico, he found that new wheat varieties are more resistant to pests and diseases. When complementary inputs were applied, the new seeds produced two to three times more food than previously varieties. The improved inputs lead to a high harvest, ideally to higher profit. Using a new fertilizer or a disease-tolerant seed variety can increase production.

In the value chain, inputs can be viewed as more than just the way to increase production. A combination of new inputs and new markets can result in a new product (Guenette, 2006). Guenette explains that using the right fertilizers and right seeds can produce newly certified products and/or technology. While the product is the same, but the market perception of it may be different. He further explains that improving input supply is more than just new fertilizer and seeds. It is also about innovative ways to merge input supply into the value chain and make the chain more competitive.

For instance, a value chain approach aiming to improve access to inputs could identify input suppliers who have access to small-scale farmers and create a certification system that turns an input supply depot into an agricultural information hub. The small-scale producer will gain access to improved inputs, while the input supplier gains greater business through a new role. A value chain analysis can also help to explain the connection between actors in a particular chain of production and distribution and it shows who adds value and where along the chain. In addition, it helps to identify pressure points and make improvements in weaker links where returns are low (Schmitz, 2005).

2.1.4 Value chain mapping

Chain mapping means creating a visual representation of the connections between actors in the value chain (ILO, 2009). It has very practical implications for a value chain initiative, which are:

i. It helps to understand the process by which a product moves through different stages until it reaches the final consumer. Understanding these different stages in a value chain is also a precondition for identifying challenges that are preventing the achievement of a certain goal.

ii. It helps in identifying and categorizing key market actors. A value chain map also can be used in projects to invite market actors to various events and workshops, arranging interview appointments with them, or forming groups comprising key market actors.

iii. A value chain map can show which other supporting organizations are available, and which value chain stages they concentrate their services on.

iv. If the initial goal of the value chain is to explore market opportunities, value chain maps can show different market channels through which products and services reach the final customer. These maps can also provide additional information on the relevance of individual market channels and the nature of relationships (e.g., number of competitors, size of the market, number of workers, value chain governance, etc.)

v. Furthermore, it helps companies investing in new markets to orient their activities, i.e. to identify important stakeholders, competitors, possible marketing or supply channels, and weak links in the chain.

2.1.5 Theory of profit maximization

According to Dutta and Radner (2003) the profit maximization theory assumes that farmers are profit maximizing economic agents and are thus efficient producers. The process of decision making of farmers involves production and consumption aspects, another theory like the risk-averse farmers theory argues that poor small farmers are necessarily risk-averse and they attempt to increase family security rather than maximize profit (Mendola, 2005). Rweyemamu (2001) argues that as small-scale farmers operate in a household economy, consumption and production decisions are assumed to be independent. A small-scale producer is assumed to choose to allocate resources to a business which will maximize their profit.

2.2 Tanzania Seed Sector Development

Until the early 1990s, the Tanzanian Government had a monopoly on the seed sector. Crops variety were released by public agricultural research institutions and distributed through a public seed company called Tanzania Seed Company (TanSeed). Under TanSeed, Government favored maize production by providing subsidies and seeds to farmers. As such, farmers were encouraged to invest in maize production at the expense of other crops. The 1989 National Seed Industry Development Programme set out to reduce state control in the seed sector, allowing private seed companies to operate in the country. Among them were Corteva Agriscience, East African Seed, East-West Seed, Pop Vriend Seeds, East African Seed, East-West Seed, Pop Vriend Seeds, and Rijk Zwaan. Since then, the private sector has strongly moved into maize seed production and trade (KIT, 2014). Seed companies have started importing maize hybrid seed, as well as

some sorghum hybrids (70% of all were certified seed). The seed for other crops such as rice and legumes continue to be produced by small local seed companies. The program further encouraged diversification in crop production including groundnut, cassava, sorghum, and millet. However, the maize input subsidies such as NAIVS introduced in 2008 still were in favor of maize production over other crops such as groundnut. The Tanzania seed sector is comprised of both the formal and informal sectors. The formal sector comprises both public and private sector investors.

Despite the efforts of the government and other agricultural stakeholders to increase seed production of OPVs and legume such as groundnut, their production remains low. For example, until today there are only 18 groundnut improved varieties released. For maize, there are 193 improved varieties available in the market (TOSCI, 2020). Again, the differences are attributed to having policies that favor maize production compared to other crops. Table 1 present the number of groundnuts and maize varieties available in the Tanzania market.

2.3 Seed System in Sub-Saharan Countries

According to Van Amstel *et al.* (1996), a seed system consists of physical, organizational, and institutional components that determine seed supply and use in qualitative and quantitative terms. An efficient seed system involves a complex combination of public sector support and private sector commercial activities. The public sector plays a bigger role in plant breeding and some aspects of regulations while the private sector plays role in seed multiplication, processing, and distribution (Minot *et al.*, 2007). However, Seed systems can vary by type of targeted farmer (small-scale or commercial), crop production systems (self-pollinating, cross-pollinating, or vegetatively propagated crops), and geographic location (ACB, 2015).

Seed delivery systems can be formal or informal. According to Wekundah (2012), there are three groups of seed supply systems in Africa, which are formal seed supply system, informal seed supply system, and integrated seed supply system. However, ACB (2015), argues that seed systems are generally classified as being formal, informal, and semi-formal. Despite differences in these seed systems, the degree of integration between them in sub-Saharan countries is significant (Etwire *et al.*, 2013).

2.3.1 Formal and informal seed system

Formal seed system consists of public sector research institutions, public and private sector agencies producing and marketing seed, and organizations responsible for seed certification and quality control (Setimela *et al.*, 2004). The formal seed system has formal regulation to maintain varietal identity and purity, and physical, physiological, and sanitary quality (ACB, 2015). Moreover, Setimela *et al.* (2004) argue that there are two models of seed systems that operate within the formal seed system, the state or parastatal model and the private sector model. Under the state model, researchers provide breeder seed to a parastatal or state agency to multiply on state farms or contract seed growers. Hence, all activities that include seed cleaning, marketing, and processing are performed by state agencies. While under the private model, researchers provide breeder seed to be multiplied into the foundation and commercial seed. Hence, private companies and farmer cooperatives do seed processing and marketing. Therefore, the formal seed sector provides about 10-20% of seed requirements by most African governments (Wekundah, 2012).

In Tanzania, the seed system is monitored and supervised by the Government through the National Seed Committee which is responsible for providing advice on the formulation of the National Seed Policy and coordination of the seed industry. On the other hand, the Tanzania Official Seed Certification Institute (TOSCI) also plays a major role in monitoring and supervising the seed industry. The main function of TOSCI is to control seed certification and all phytosanitary issues within the Country. Nevertheless, in 2006 the government launched Agricultural Seed Agency (ASA) whose task is to produce, process, and market both basic and certified seeds. Since trade liberalization in Tanzania private sector has engaged in the formal seed system. Hence, a growing number of private companies such as Kibo Seed Co. Ltd, Seed Co., Pannar, Pioneer, Monsanto, and Suba Agro have ventured into the seed industry in Tanzania.

Informal seed system is unstructured and unregulated where activities conducted are neither monitored nor supervised by any public or private institution (Etwire et al., 2013). Under such a seed system, the seeds are more easily accessible and cheaper but are of inconsistent quality. Informal seed system supplies about 80% of seed needs of smallholder farmers in most African countries hence proving to be the key seed source for their staple crops. According to Wekundah (2012), an Informal seed system constitutes channels such as saved seeds, seed exchanges among farmers, and/or local grain/seed market.

2.4 Theoretical Framework and Empirical Methods

In this section the theoretical framework and empirical methods of each specific objective i.e To map the seeds value chain of groundnuts and maize in semi-arid agro-ecologies of central Tanzania, to compare seed producers' profitability among maize and groundnut seed value chains in the study area and to assess the factors influencing investment in groundnut and maize seed value chains will be discussed.

2.4.1 Theoretical framework of sub-sector mapping

A subsector is a vertical grouping of enterprises involved in the production and marketing of one well-defined product or several closely related products (Boomgard *et al.,* 1992). A commodity subsector does not necessarily lie strictly within one particular sector; it can cut across other sectors. For example, cotton is grown in the agriculture sector, shipped in a factory by the transport sector, processed in the manufacturing sector, and so on. The key is the network that is based around a common

raw material or a common output. An essential tool for the analysis of this system is the subsector map.

The map illustrates the flow of products from producer to consumer in quantitative, graphic terms, as well as the interrelationship among participants in the subsector. Several components should be illustrated in the map: namely markets, functions, participants and channels. Markets are the final destination of the product which can be defined either by location such as domestic or international or by the type of consumer. Meanwhile, functions includes step that the product goes through during the production and distribution system. Participants are the key actors and their roles within the subsector. Participants are the key actors and their roles within the subsector while channels are made up of participants, differentiated by technologies, functions and linkages.

According to Lusby (1999), subsector analysis is a process that: Examine the relationships between enterprises that produce, procure, process, and distribute goods within a single product group. It identifies the constraints and opportunities facing these enterprises along with potential support initiatives to address them. It also identifies sources of leverage where support initiatives can have the greatest impact.

Today, subsector analysis is taken as very similar to value chain analysis (indeed the terms are often used interchangeably). However, advocates of the Global Commodity Chain school of Value Chain Analysis see subsector analysis as being restricted to

activities within national boundaries (Wildt *et al.,* 2006). Moreover, subsector analysis remains an important tool in any subsector program (Lusby, 1999). It enables program designers to get a clear grasp of what's going on between the different actors (large and small) in a particular industry. It enables them to determine what the major constraints/ opportunities are for increased growth and provide the basis for identifying support initiatives that can impact large numbers of MSEs. Thus, subsector analysis can be used in the context of many kinds of development programs.

2.4.2 Empirical studies on value chain mapping

Tadesse (2019), employed a value chain mapping method to map a seed value chain of finger millet in Debub Achefer Wereda, Ethiopia, where the seed value chain actors and their functions in the chain were identified as well as their dynamic interrelationships. The seed value chain map was developed and based on the map over 80 of marketed finger millet seed product is directly flow from producers to farmers and producers have more power for making initial price. Also, Erbaugh *et al*. (2010) mapped the seed value chain of sorghum and finger millet in Zambia. In their study, chain mapping involved delineating the flow of seed from seed producers to seed users. The chain actors, who transact the seed as it moves along the chain, their respective roles, and the inter-relationships among them were identified. Value-adding practices and returns thereof, constraints faced by supportive organizations, and how they responded to the promotional effort and the prevailing enabling environment were explored. The study found that both enabling environment and support services affect the seed value chain. Also, Kulwijila *et al.* (2018) mapped the grape value chain in Dodoma. In their study they used the sub sector mapping analysis to map the grape value chain linkages

between actors, activities and flow of the product in the value chain. Their results indicated that the key actors were input suppliers, producers, processors, wholesalers, retailers and consumers. Relationship among actors was very weak because no farmers and traders associations were identified. Moreover Magabe (2016) mapped the sesame value chain in Masasi District, Mtwara Region, Tanzania. In his study, the key actors involved in the production and marketing were identified, including the channels used to pass the product until it reaches the ultimate final consumers. To facilitate the mapping of the value chain, an initial map was drawn using the data collected through key informants' discussion. After getting detailed data collection, the map was adjusted. The results show that the key actors of sesame value chain include input suppliers, farmers, traders, commission agents and exporters.

Thus, in this study, value chain mapping was adopted to identify key actors in the seed value chain, their functions, and the inter-relationships among them. Moreover, supportive services and enabling environments were explored.

2.4.3 Theoretical Framework on Gross margin (GM)

Profitability of the enterprises can be measured in various ways such as Gross Margin (GM), Benefit-Cost Ratio (BCR or B/C), Return on Investment (ROI), Internal Rate of Return (IRR) and Marketing Margin (MM) (Turuka, 2000). However, Kotler and Armstrong (2006) argued that there is no adequate way of measuring profitability in the marketing sector. Their study in marketing exclusives and professionals found that 68% of marketing executives face difficulties in measuring the profitability of investment and

73% of them reported that there is an adequate profitability measurement tool. However, the GM is an important measure of resource efficiency in small and Medium Enterprises (SMEs).

Gross margin is a difference between gross return and the total variable cost, which can be expressed in normal value, ratios, or as a percentage of return (Debertin, 1993). In constructing gross margins, fixed costs are ignored, since they are considered to be incurred regardless of the level of the enterprise undertaken (Rural Solutions, 2012). The normal profit obtained is the last payment the owner of the enterprise would be willing to accept for performing the entrepreneurial functions. Thus, receiving a normal profit is important to keep the owner from withdrawing the capital and managerial effort and putting it into another alternative business (Kotler and Armstrong, 2006).

Using GM as a measure of profitability has disadvantages such as failing to deduct the opportunity costs for the money invested in the enterprise (Debertin, 1993). Also, it fails to account for the variation of fixed costs and making allowances of costs for depreciation and obsolescence of fixed assets (Ponte, 2002).

According to Phiri (1991), GM is the most satisfactory measure of resource efficiency to Small and Medium Enterprises (SMEs). It indicates the financial health of enterprises and shows the deep insight into trader' management efficiency of the enterprises (Hammod, 2001). Therefore, without adequate GM received by traders, their ability to pay operating costs and hence their business sustainability is jeopardized (Hammod, 2001). Thus, an estimation of enterprise profitability of groundnut and maize seed will harmonize the attitude of seed producers, politicians, and policymakers toward groundnut and maize seeds production.

2.4.4 Empirical studies on gross margin

In the study conducted by Akpo *et al.* (2020), gross margin analysis was used to analyze the profitability of groundnut seeds production in Benin. In their analysis, they found that groundnut seeds production is a profitable venture. Further, they pointed out that high price of improved seeds and recently released varieties are among the main factors hindering the majority of smallholder farmers from using new varieties to improve productivity. Also, Magabe (2016) employed gross margin to determine the gross margin received by actors along the value chain in Masasi District, Mtwara Region, Tanzania. The findings also show that, farmers had a gross margin of 323.64 TZS per kg, while traders had a gross margin of 581.57 TZS per kg which was relatively higher than that of farmers. Daniel (2015) also used gross margin along all Irish potato value chain in Njombe urban and Wanging'ombe district. The results indicated that processors earn highest gross margin compared to traders and farmers. Farmers in the study area earn a lowest gross margin compared to other actors.

In this study, the Gross margin method was used to identify the profitability of groundnut and maize seeds production for seed farmers and seed companies operating under the out-growers model scheme.

2.4.5 Theoretical Framework on Logistic regression

The objective of logistic regression (LR) is to estimate the regression coefficients in a model (dependent and independent variables). LR deals with dichotomous variables (Menard, 2002). With logistic regression, independent variables can be numerical or categorical, but dependent variables are usually coded as dummy variables i.e 0 for an

event not occurring and 1 for an event occurring (Summer, 2012). LR determines the impact of multiple independent variables presented simultaneously to predict the membership of one or other of the two dependent variable categories (Menard, 2002). According to Summer (2021), the simple logistic model is based on the linear relationship between the natural logarithm (In) of the odds of an event and a numerical independent variable as presented below:

$L=In\ (0) = In\ (p/1-p) = \beta0 + \beta1X + Ɛ$……(1)

Where, Y = is binary, it presents the response, coded as 0/1 for failure/success

P = Proportion of success, O = Odds of the event, L = In (odds of event), X = independent variable, β0 and β0 = Y intercept and the slope, respectively, Ɛ = random error.

According to Menard (2002), LR has two uses. The first is to predict group membership. Since LR calculates the probability of success over the probability of failure, the results of the analysis are in the form of an odds ratio. The second is to provide knowledge of the relationships and strengths among the variables. (e.g., marrying the boss's daughter puts you at a higher probability for job promotion than undertaking five hours of unpaid overtime each week).

2.4.6 Empirical studies on logistic regression

Monela (2014) investigated the access to and adoption of improved seeds by smallholder farmers in Tanzania. The study employed logistic regression to analyse the impacts of improved seed related factors on the chances of farmers adopting the seeds. This includes the cases of maize and rice seeds in Mbeya and Morogoro regions. The study found the highest positive impact on the chances of smallholder farmers adopting improved maize and seeds were land for rice production (Wald statistic = 51.772, p <

0.001) and farmers' awareness of improved seeds (Wald statistic = 8.515, $p < 0.01$). It was concluded that land size and farmers' awareness of improved seeds were the factors influencing smallholder farmers to adopt improved maize and seed.

Also, a study done by Kalineza *et al.* (2001) investigated factors influencing the adoption of soil conservation technologies in Gairo district, Tanzania by using binary logistic regression. The study revealed that farmers' knowledge of soil conservation and land ownership are the factors influencing the adoption of soil conservation technology.

Moreover, a study conducted by Mignouna *et al.* (2008) investigated the adoption of new maize (IRM) and production efficiency in western Kenya by using binary logistic regression. The study revealed that adoption of IRM significantly increased maize output and household size decreased inefficiency along with farm size.

In addition, the logistic regression model which is a choice modal for determining the probability of an individual making one choice rather than an alternative, has been adopted in this study in determining the factors influencing investment in the seed value chain of groundnut and maize seed sub-sector in semi-arid agro-ecologies of central Tanzania. The applicability has taken into consideration the assumption that an investor may consider either to invest or not to invest in the seed value chain.

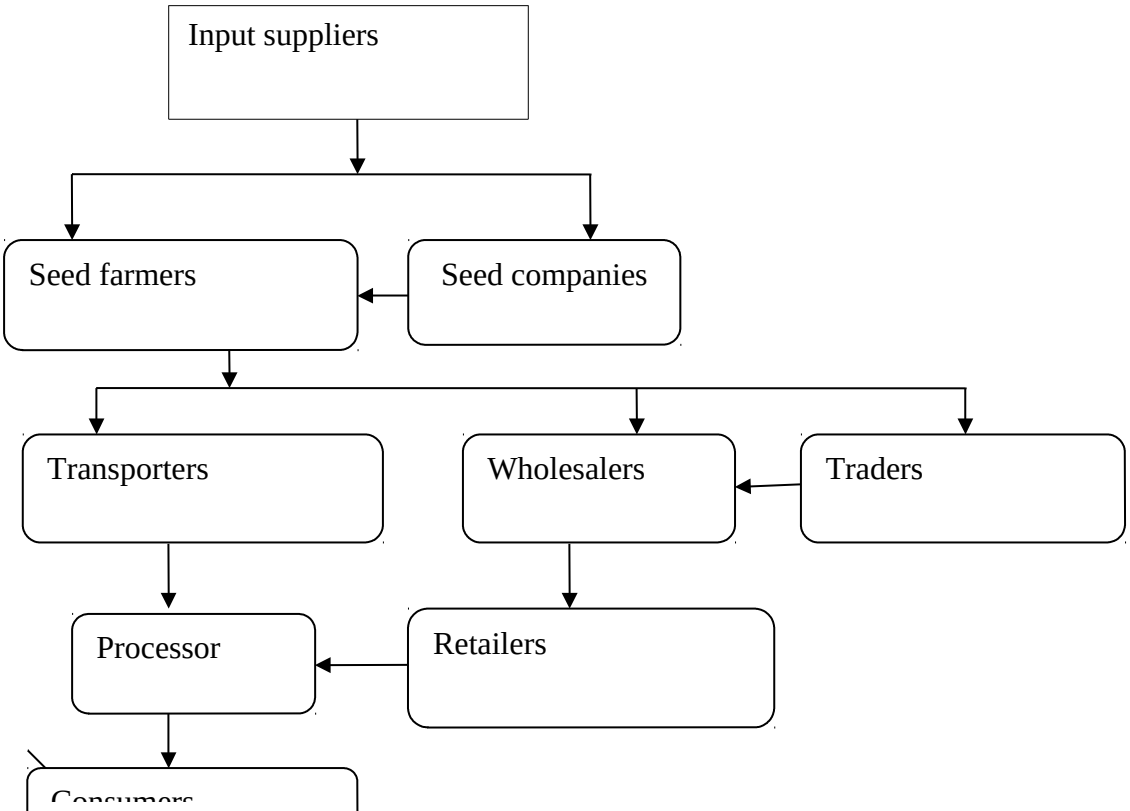
2.5 Gaps in Literature

The literature review section has presented a number of studies on groundnut and maize value chains. However, most of these studies did not focus on comparing the seed components. In addition, from the review of previous studies, we have uncovered that

there is inadequate information on seed value chain on groundnut and maize for better understanding of the challenges and opportunities. The study is therefore aimed at filling the gap.

2.6 Conceptual Framework

The study adopted and modified conceptual framework that was developed by (Hellin and Meijer, 2006), which has the component of the value chain. The value chain starts with input suppliers to groundnut and maize seed farmers and seed companies to traders, wholesalers, retailers and ends up with consumer of groundnut and maize seeds as shown in Figure 2. According to this framework, a farmer as well as seed companies sells seeds to traders and wholesalers. Wholesalers and traders they finally sell seeds to retailers and consumers. In addition, the wholesaler can supply the seeds to the retailer who, in turn, sells the crop to final consumer. It is argued that the number of variables in the study area determines the farmer's gross margins.



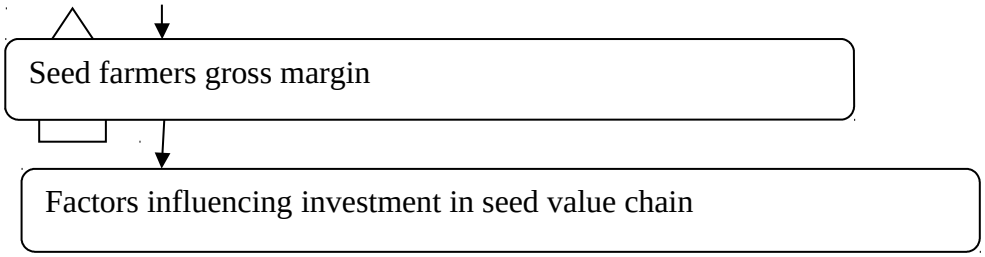


Figure 2: Conceptual framework

Source: Modified from by Hellin and Meijer (2006)

CHAPTER THREE

3.0 STUDY APPROACH AND METHODOLOGY

3.1 Description of the Study Area

The study was conducted in three districts namely Kongwa, Babati, and Bahi. These areas were chosen because they are among the major groundnut and maize growing districts in Tanzania. Different stakeholders across the value chains in these Districts were engaged extensively to map the value chains and develop the strategy for improving its functionality.

Kongwa District is among seven Districts of the Dodoma Region. It is bordered to the North by Manyara Region, the East by Morogoro Region, the North by Mpwapwa District, and the West by Chamwino District. According to the 2012 Census, the

population of the Kongwa district was 309, 973. Crops cultivated in Kongwa District include groundnuts, sesame, sunflower, cashew-nuts and castor oil seeds. The Labour force engaged in agricultural farming is about 89.84% (NBS, 2012), whereas farmers are of about 85.12% and livestock keepers are about 4.72%.

Babati District is among seven districts of the Manyara Region. Babati District lies between Latitude 30 and 50 South of the Equator and Longitude 350 and 370 East of Greenwich. Neighboring districts are Monduli in the North, Karatu in the North-West, Mbulu in the West, Hanang' in the South-West, Kondoa in the South, and Simanjiro in the East. According to Tanzania Meteorological Agency (TMA) data, the District receives rainfall twice a year and according to the Population and Housing Census of August 2012, the District had a population of 312392. Crops grown in Babati District are maize, beans, sorghum, millet, cassava, leguminous crops, banana, sweet Irish potatoes, fruits, coffee, pigeon peas, groundnuts, sesame, sugarcane, cotton, sunflower, wheat, maize, seed beans, and vegetables.

Bahi District is one of seven districts of the Dodoma Region. It lies between Latitude 05o 57' 10''South and Longitudes 35o 18' 43'' East. The District is bordering to the north by the Chemba District, the northeast and south by Chamwino district, on the east by Dodoma district, and to the west by Singida region. Bahi District has an area of 5948 square kilometers. According to the 2012 Tanzania censor, the population of the Bahi District was 221 645. The economic activities in Bahi District include agriculture and mining, commerce, and forestry. The most important crops grown are groundnut, maize, sorghum, millet, sweet potatoes, cassava, rice, sunflower, pulses, and peas.

3.2 Study Design

The research design for this study was cross-sectional, where data were collected at a single point in time. The reason for choosing this design is due to its flexibility, economical and ease to work on data and information extraction (Bailey, 1994). It is also suitable for description purposes as well as the determination of relationships between variables (William, 2002). Therefore, cross-section design is deemed appropriate.

3.3 Sampling Unit and Sample Size

Based on the sample size formula by Yamane (1976) for infinite populations and Kothari (2004), generally, the study covered 291 respondents. The formula used to get the sample size was n = (Z2 * p (1 - p))/ d2.

Where, n= Sample size, Z = Standard normal distribution which is 1.96 or approximately 2.0 and corresponds to 95% confidence interval; p = estimated variance (0.5) d = Level of precision (5%).

The sampling unit for this study included the groundnut farmers (including groundnut seed farmers), maize farmers (including maize seed farmers), District Extension Officers), Agro-dealers, research Institute staff, seed companies, and regulatory organizations. Generally, the study covered 291 respondents where 64 and 62 were groundnut and maize seed farmers respectively; 56 and 58 were groundnut and maize farmers respectively; 17 agro-dealers, 19 extension officers, 4 research institutes, 5 seed companies, 4 regulatory organizations, and 2 Community Seed Bank. The sample size is reasonably large especially in conformity with Bailey's (1994) argument that around 30 cases seem to be the bare minimum for studies in which statistical data analysis is to be done. In addition, the choice of this sample size is realistic due to limited time and funds but fulfills the requirements of the study for meaningful analysis.

3.4 Sampling Techniques

Purposive, simple random and snowball sampling techniques were used in this study. Villages were selected purposively based on both those having better access to inputs and those having limited access to inputs. The summary of the sampled villages by Region, District, and Ward is presented in Table 1. A simple random technique was used to select groundnut and maize farmers. Snowball technique was used to select agro-dealers, CSB and extension officers. The technique was adopted because members of the population were not previously identified and were difficult to allocate and contact (Spreen, 1992). Snowballing is a non-probability sampling technique in which a researcher makes initial contact with a small group of people who are relevant to a research topic and then uses this to establish contact with others (Bryman, 2008). The purposive sampling technique also was used to select seed companies and regulatory organizations.

Table 1: Sampled villages

Region	District	Ward	Village
Dodoma	Kongwa	Sagara	Sagara B
		Mlali	Mlali Iyegu
		Ng'humbi	Ng'humbi
		Kibaigwa	Kibaigwa
Dodoma	Bahi	Ilindi	Ilindi
		Mundemu	Nguji
		Bahi	Bahi Sokoni
		Nondwa	Zejele
Manyara	Babati	Galapo	Gedarmal
		Kameyu	Gewal
		Magugu	Magugu
		Secheda	Secheda

3.5 Data Collection Method

3.5.1 Primary data

Data used in this study were largely primary data collected from the samples of respondents using three kinds of questionnaires, Focus Group Discussion (FGD), and semi-structured interviews with key informants. The questionnaires were designed for groundnut and maize small-scale producers (farmers) and agro-dealers. The questionnaires were administered by the researcher. A total of two (2) FGD were conducted involving 11 men and 8 women in total. A structured questionnaire and FGD guide were administered to producers/farmers and agro-dealers but semi-structured interviews were conducted to key informants (i.e producers, aggregators and policy agencies).

3.5.2 Secondary data

These are data obtained from literature sources or data collected by other people for other purposes. According to (Saunders *et al.,* 2004), secondary data provide second-hand information and include both raw data and published ones. In this study, information on agricultural production, seed varieties available in the market and population were obtained from reading various publications from the Ministry of Agriculture.

3.6 Data Analysis

To achieve outputs of each specific objective, both quantitative and qualitative methods of data analysis were carried out. The analysis included descriptive statistics (mean,

standard deviations, maximum and minimum) and content analysis was used to describe the general characteristics of the data. In addition, value chain mapping was done to identify the key actors in groundnut and maize seed value chains. The quantitative analysis involved the use of Gross Margin (GM). The profit margin was computed to measure the profitability of the seed producers (farmers) of groundnut and maize.

3.6.1 Value chain mapping

According to Hellin and Meijer (2006), a value chain map is a conceptual and practical tool that helps to identify issues that may be hindering or enhancing the function of the chain and institutions and organizations providing services that different chain actors need to make informed decisions. The study identified a market map that is made up of three interlinked components namely seed value chain actors, the enabling environment and service providers.

In this study, the value chain mapping was done as a flow chart. A chain mapping involved delineating the flow of seed from input suppliers to seed users. The chain actors and their respective roles as well as the inter-relationships among them were identified. In addition, service providers and the enabling environment were explored. Other data collected includes; prices and farmers' yield farmer's production costs, crop varieties found in farmer's field, and rationale behind the choice of these varieties. Data were collected using structured questionnaires, checklists, Focus Group Discussion, and Key Informant Interviews.

3.6.2 Gross margin analysis

Gross margin is the difference between total revenue and total variable costs (Rogan, 2004). It was used as a measure of enterprise profitability and means of selecting farm plans. The size of gross margin depends on the market structure, services provided, market price, perishability of the product, and the distance between producers and consumers. It can also, be influenced by market information, especially for short-run margins. The Gross Margin Analysis (GMA) is used for planning and analysis of projects by advisors, consultants, researchers and producers (Rogan, 2004). In this study, GMA was used to estimate profit for groundnut and maize seed producers. The calculation was done through the following formula:

GM = TR – TVC…..…….…… (2)

Whereby: GM = Gross Margin; TR = Total Revenue; TVC = Total Variable Cost

3.6.3 Binary logistic regression model (BLRM)

Binary logistic regression model (BLRM) allows analysis of different individual characteristics when confronted with two choices. It estimates the probability of individual i choosing an activity j or in particular investment decision in groundnut and maize seed sub-sector (invest or not invest in the current case) given some set of explanatory variables. The BLRM can be used to predict a dependent variable, based on continuous and/or categorical independent variables, where the dependent variable takes two forms.

Logistic regression does not assume a linear relationship between the dependent variable and independent variables but requires that the independent variables be linearly related to the logit of the dependent variable (Gujarati, 1992). Pundo and Fraser (2006)

explained that the model allows for the interpretation of the logit weights for the variables in the same way as in linear regression. In this study, investors have two choices which are; to invest or not to invest in groundnut and maize seed sub-sectors.

3.6.3.1 Model specification

A Logistic Regression model was used to assess factors that influence investment in the groundnut and maize seed value chain. The binary logistic regression was used to estimate the model that:

$$P(IVSTDi) = \beta 0 + \beta 1AGE + \beta 2GENDER + \beta 3EDL + \beta 4HHS + \beta 5FOES + \beta 6LS + \beta 7TRN + \beta 8CRT + \beta 9DTN + \varepsilon \quad \ldots\ldots(2)$$

Where P (IVSTDi)= 1 If investor invest in groundnut/maize seed value chain

0 If an investor did not invest in groundnut/maize seed value chain

P (IVSTDi) = The probability of the i^{th} investor to invest in this case, the binary variables were used to depict the probability of the investors' engagement in groundnuts/maize seed value chain (dependent variable);

β0 = is the model intercept which shows the probability of the investors to invest in groundnut/maize seed value chain given no influencing factor;

β1…9= The coefficient of independent variables that shows the marginal effect of a unit change (positively or negatively) of the independent variable on the probability of investing in the groundnut/maize seed value chain; and

Ɛ = Error term.

The hypotheses tested were as follows:

Ho: $\beta 1 = \beta 2 = \ldots = \beta 9 = 0$ this shows that the regression coefficients of the independent variables are equal to zero, meaning that there is no effect of the independent variables on the dependent variable

Hi: $\beta 1 \neq \beta 2 \neq ... \neq \beta 9 \neq 0$, this implies that the regression coefficients of the independent variables are not equal to zero; therefore, there is either a positive or negative effect of the independent variables on dependent variables.

3.6.3.2 Justification of the econometric model

The binary logistic regression model is useful in analyzing data where the researcher is interested in finding the likelihood of a certain event to occur. Using data from relevant explanatory variables, binary logistic regression is used to predict the probability of occurrence or not, and not necessarily involving a numerical value for a dependent variable (Gujarati, 1992). The research analyses the probability of investment decision on groundnut/maize seeds value chain with given independent variables influences. Empirical evidence shows that the relationship between dependent and independent variables can be explained and determined using several methods (Mohammed & Ortmann, 2005). Such methods, among others, include the linear regression and logistic regression models. However, the binary logistic regression has been chosen in this study because it has more advantages especially when dealing with qualitative dependent variables which take two values. The description of the hypothesized variables with the expected signs is as shown in Table 2.

	Description of the Variables	Values	Expected sign
	Dependent variable		
IVSTD	Investment decision	1 = Invest in seed value chain, 0 = Otherwise	+/-
	Independent variables		
AGE	Age	Number of years	+/-
GENDER	Gender	1=Male, 0= Female	+/-
EDUL	Education	Number of years in school	+
HHS	Household size	Number of household members	+
FOES	Frequency of extension services	Number of times per year	+
LS	Land size	Number of hectares	+
TRN	Training	1=Yes, 2= No	+
CRT	Access to credit	1= Yes, 2= No	+
DTM	Distance to the market	Number of kilometers	-

Table 2: Variables used in the binary logistic regression model

3.7 Limitations of the Study

It was difficult to get some of the respondents especially agro-dealers, extension officers, research institution staff, seed companies, and TOSCI staff members in the study area since the majority were busy with other economic activities. Therefore, the researcher was supposed to make an appointment. The language barrier was another problem because some seed farmers were unable to understand and speak Swahili well. In overcoming this limitation, the researcher had to use research assistants who spoke both Swahili and indigenous languages. Since the majority of the household do not keep records, it was difficult to get some information especially information on the costs of some inputs and services. To minimize errors, the researcher had to be more careful so as to get accurate and reliable information through review of various accounts and documents and triangulation of data made by households. Also, some respondents were a bit reluctant to provide some sensitive data such as land size owned and revenues. This might be associated with believes that this information was asked for taxation purposes.

To overcome this limitation, an assurance was given to them that the information will be treated with high confidentiality.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Seed Chain Actors in the Groundnut and Maize Seed Sub-Sectors

This section defines seed chain actors, their functions in the value chain and describes the chain relationships. A map of the seed value chain for groundnut and maize is shown in Figures 3 and 4 respectively. The seed sub-sector ranges from seed production to seed users performing different functions including seed production, quality assurance, processing and distribution. Chain actors come from both the formal and informal sectors. The formal sector refers to seed production by public organizations and private companies using breeder seed, established protocols to maintain quality, and mechanical processing, yielding seed that is tested and labeled for commercial sale (Rusike *et al.*, 1997). The informal seed sector refers to the system where farmers and or/farmer groups produce, obtain, maintain and distribute seed resources from one growing season to the next (FAO, 1998). The formal sector generally operates on a national scale, while the informal sector is more localized.

4.2 Mapping Groundnut and Maize Seed Value Chain

Seed companies, CIMMYT, and TARI are among key organizations that play a vital role in plant genetic resource conservation. Private seed companies and Sokoine University of Agriculture (SUA) are among the major actors in the development and evaluation of groundnut/maize varieties. Agricultural Seed Agency (ASA) and some private seed companies are involved in the production of early generation seeds (EGS). Private seed companies and ASA multiply the foundation seeds to produce certified seeds while

community or local seed producers multiply foundation seeds to get quality declared seeds (QDS). Company agents, the agricultural and marketing co-operatives societies (AMCOS), local producers, non-governmental organizations (NGOs), agro-dealers, and the company marketing department engage in the marketing and distribution of seeds to farmers and farmers associations.

Both value chains, however, lack services related to business development and finance access information that should be provided by the extension officers. The gaps should be addressed to increase the efficiency of the system. TOSCI oversees the seed imports, production of pre-basic, basic, and certified seeds, conducts NPT and DUS, and oversees the agro-dealers seed stock. The Seed Unit of the ministry gives permits seed imports and engage in a variety of releases. Ministry of Agriculture also offers plant variety protection to breeders. Figures 3 and 4 present the map of the groundnut and maize seed value chain respectively in semi-arid agro-ecologies of central Tanzania.

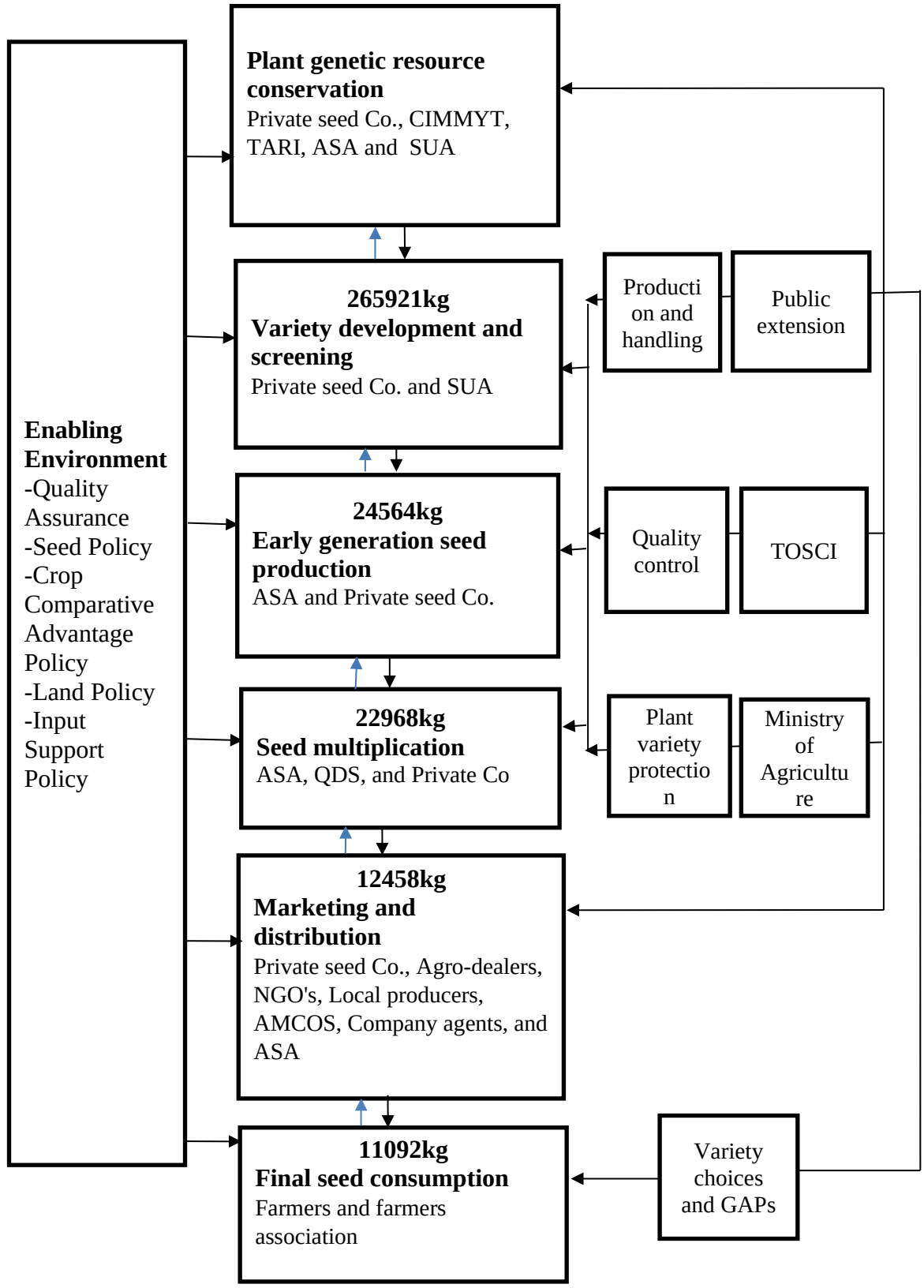


Figure 3: Maize seed value chain in semi-arid agro-ecologies of central Tanzania

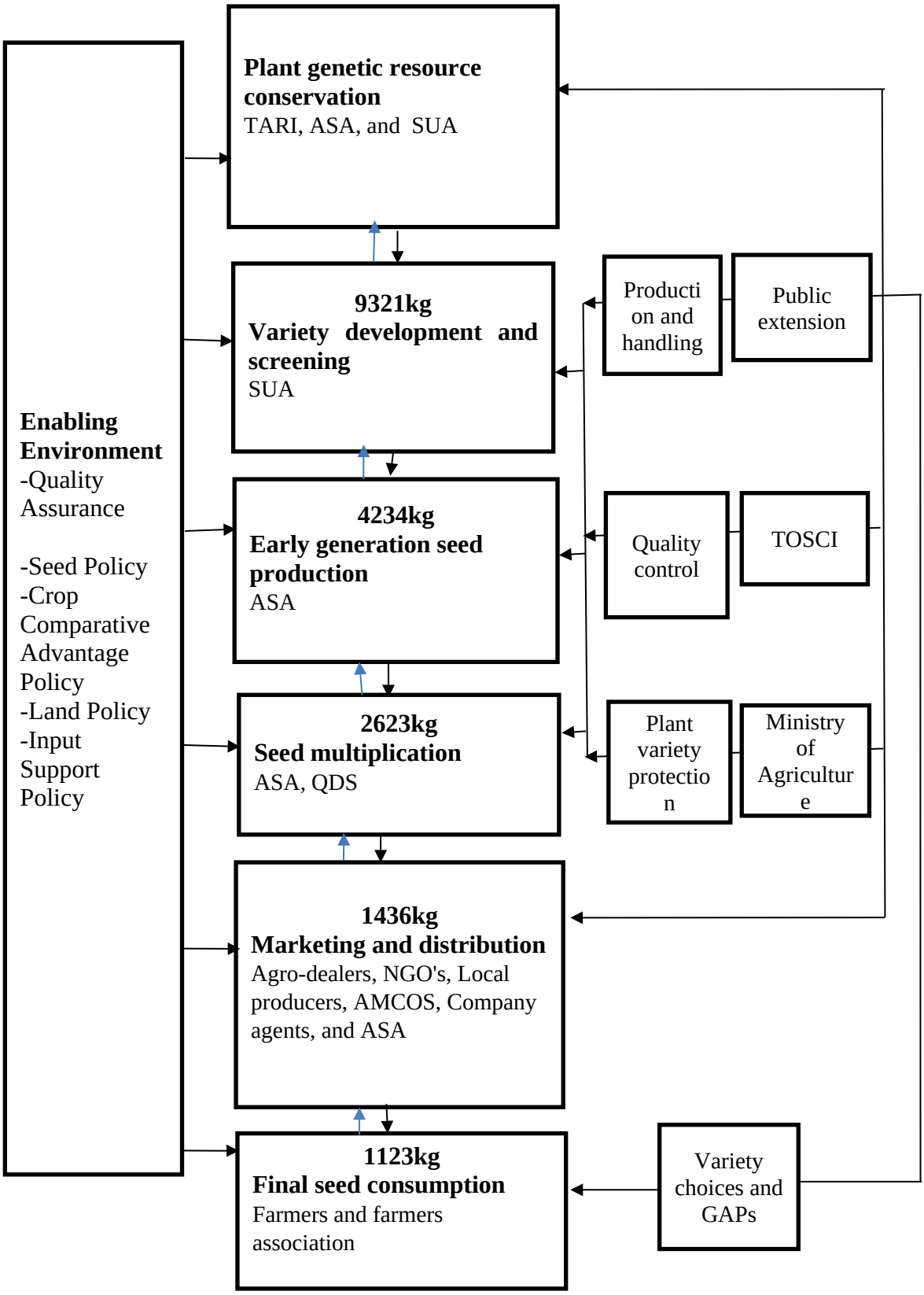


Figure 4: Groundnut seed value chain in semi-arid agro-ecologies of central Tanzania 32 534kg, 31 896kg, 31 453kg, 30 943kg

4.2.1 Seed farmers

Among the groundnut and maize seed farmers interviewed, 64 and 62 of them were involved in producing groundnut and maize seed respectively. The rest, 56 and 58 respondents were engaging in crop production of groundnut and maize respectively. Those who were not engaged in seed production were the seed consumers. Seed farmers on the other hand were consumers too since they consume the remained seeds after the sale.

4.2.1.1 Socio-economic factors of groundnut and maize seed farmers (producers)

The socio-economic characteristics of the households surveyed are presented in Table 3 and show that 68.8% of groundnut seed farmers are women and 31.3% are men; while for maize 71% are men and 29% are women. This can lead to the conclusion that groundnut seed production in the study area was dominated by women while maize seed production was dominated by men. The high involvement of women in groundnut seed production compared to men makes the groundnuts to be regarded as a women crop (Katundu *et al.,* 2014). Men are highly involved in maize seed production to alleviate poverty. It is worth noting that most of the male household heads are involved in agriculture to improve the economic conditions of their households. The participation of both sexes in seed production shows its importance in both as an income-generating activity and food security.

The majority of groundnut seed farmers had ages ranging from 20 years to 74 years, and it was 46.8 years on average. The majority of maize seed farmers had ages ranging from 24 years to 66 years and was 45 years on average. Moreover, for both groundnut and

maize, the adult group (36-55 years) occupied 57.8% and 62.1% respectively. Youth are less involved in the production of both groundnut and maize seed. The high involvement of the adult group in the seed production could be due to the seed production needs of the matured and energetic people with a pool of knowledge in its production. Also, due to the nature of the crops being labour intensive (Abubakari *et al.,* 2013). Adults have enough labour supply from the family compared to the youth and elders for undertaking different farming activities like planting, weeding, and harvesting. Similar results were also observed by Mwakimata (2018) on "Gendered Yield Gap Analysis in Groundnut Production in Tanzania". The study by Mwakimata revealed that 62% of groundnut farmers were adults with their ages ranging from 36 to 60 years. Also, Monela (2014) found that maize production is dominantly produced by the adults with their ages ranging from 31 to 45 years.

The findings of this study also revealed that the average number of years of the farmers attended formal education was 7.52 and 7 for groundnut and maize seed farmers respectively (Table 3). This implies that, most of the seed farmers in the study area have attended primary education and this enabled them to easily acquire basic knowledge and farming skills if such opportunity is provided.

The study also reveals an average household size of 5 and 7 members for groundnut and maize seed farmers respectively. Among the groundnut seed growing households, 70.3% and 29.7% have less than or equal to 6 members and above 6 members respectively (Table 3) while among the maize seed growing households, 59.2% and 40.8% families have less than or equal to 6 members and above 6 members respectively. The labour demand has contributed to this high number of household members since the majority of the interviewed seed farmers use family labour in the seed production process (Table 3).

Table 3: Socio-economic characteristics of groundnut and maize seed farmers in the study area

Demographic variable	Categories	Groundnut	Maize
Sex	Male (%)	31.1	71
	Female (%)	68.8	29
Age	Young (less than 35)	20.3	17.6
	Adult (36-55)	57.8	62.1
	Elder (Above 55)	21.9	20.3
Education level	Number of years	7.52	7
Household size	≤ 6 Members	70.3	52.9
	> 6 Members	29.7	40.8

4.2.1.2 General characteristics of groundnut and maize seed farmers

As presented in Table 4, the mean plot size owned by groundnut and maize seed growers was 3.3 hectares and 2.2 hectares respectively. The total area under cultivation for groundnut seed farmers was 2.5 hectares (77.3 percent of total owned land). The area under groundnut and maize seed production was 0.8 Ha (24.24 percent of total owned land) and 1.44 Ha (65.5 percent of total owned land) respectively. The findings are similar to that of Akpo *et al.* (2020) who found that the average plot size used to produce groundnut seed by farmers was 0.8 ha. The results show that despite the groundnut seed farmers owning big farming land compared to maize seed farmers, they allocate a small portion for groundnut seed production compared to maize seed farmers. This indicates that groundnut seed farmers allocate more land in the production of other crops/seeds than maize seed farmers.

Table 4: Land ownership and area under cultivation

Seed crop	Mean land owned (ha)	Mean area of land under cultivation (%)
Groundnut	3.3	24.4
Maize	2.2	65.5

Seed farmers in the study area were also engaging in the production of other crops. Approximately 85.9% and 96% of groundnut and maize farmers respectively, planted other crop varieties besides groundnut and maize as presented in Figure 5. Diversifying production for both groundnut and maize farmers aims at mitigating risks due to climatic change. Thus, in case of crop failure due to drought, farmers can benefit from the more drought-tolerant crops. As presented in Figure 5, pigeon pea is the most alternative crop cultivated by maize farmers (29.5%), followed by common bean (28%). The findings showed that 4% of maize farmers grew maize as the only crop, while for groundnut farmers, none of them grew groundnut crop alone. The most cultivated alternative crop was maize, which accounts for 19.8%, followed by sunflower (19.2%) and sorghum (18.5%). The diversification of crops by both groundnut and maize farmers enhances income security. Figure 5 below show crops and percentage of groundnut and maize seed farmers who cultivate the crop.

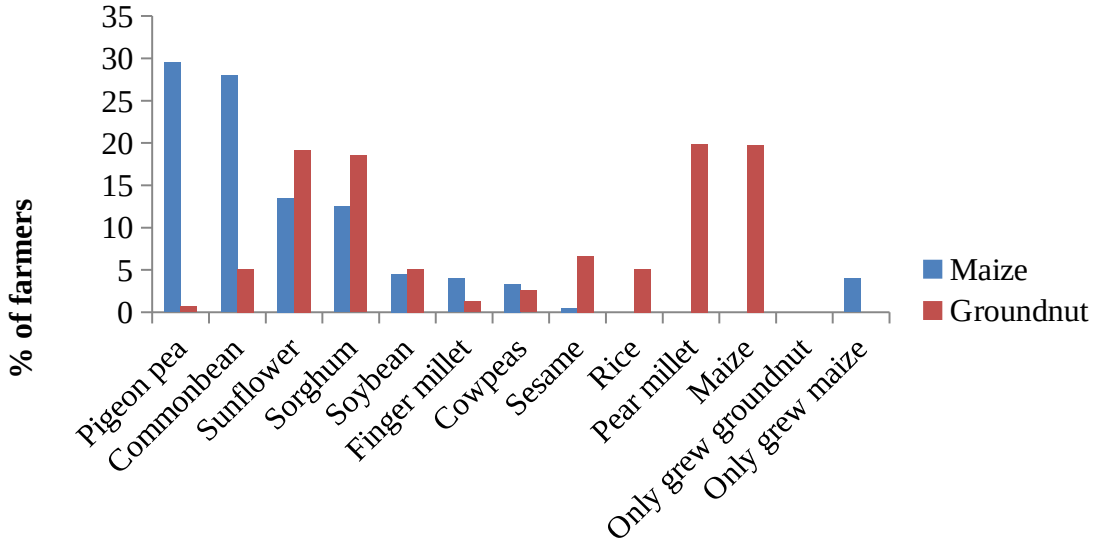


Figure 5: Other crops cultivated by groundnut and maize seed farmers

Further, the result indicated that a total of three groundnut and 18 maize seed varieties were prevalent in the study area. The groundnut varieties cultivated in the study area

includs Mangaka, 2009; Mnanje, 2009, Pendo and Fraser, 2006. All three groundnut seed varieties were recently released. Therefore, farmers are more attracted to cultivate them because of the traits they acquire.

The common maize varieties cultivated in the study area included: Chapa kind, Kilima, Pioneer, SC Simba, Local variety, Punda Milia, DK, Lubango hybrid, Tembo, H614, Meru Agro, Tumbili, HB513, Nyani, Sumset, Kiiro, Pannar, Zamseed and Tumbili.

The current study also reveals six seed suppliers in the study area as presented in Table 5. The research institutes i.e. TARI and INCRISAT were the main groundnut seed suppliers while agro-dealers were the main maize seed suppliers to the seed farmers in the study area. Agro dealers are mainly engaged in supplying certified seeds sourced from seed companies. Groundnut seed farmers get their seeds from research institutes because agro-dealers rarely stock groundnut seeds in the study area.

Table 5: Seed suppliers in the study area

Name of the seed supplier	Groundnuts (%)	Maize (%)
Agro-dealers	10.9	12.3
Research Institute e.g. TARI and INCRISAT	29.7	12.3
Community Seed Bank	20.3	12.3
Seed Company	1.6	12.3
NGOs	23.4	12.3
Government project	14	12.3

Figure 6 show the percentage of maize farmers that used pesticides, manure, and chemical fertilizers in the 2018/19 production season. This study revealed that 59% of maize farmers use fertilizers, while 19% use pesticides and only 5.9% use manure. Groundnut farmers in the study area did not use chemical fertilizers, herbicides,

pesticides, or manure compared to maize farmers who use all of the inputs except herbicides in their production.

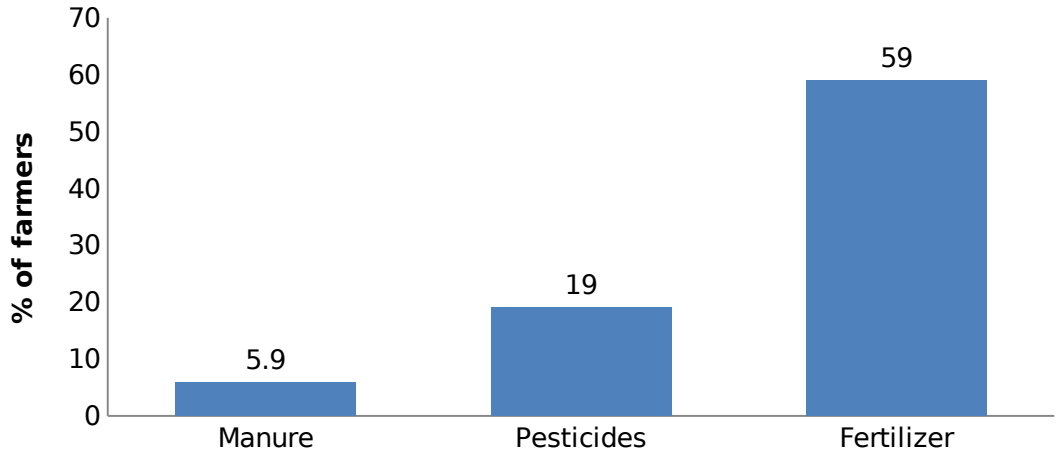


Figure 6: Percentage of use of fertilizer, pesticides, and manure by maize seed farmers

The major reason for not using the inputs was because they do not see the need of using the inputs. Farmers who do not see the need of using these inputs may need extension education services. The distance was another major concern that was cited by non-users of input. According to the study done by (Mailena *et al.,* 2013), optimal input use has a significant effect on profit. Therefore, extension concerning optimal input use should be emphasized to improve the economic efficiency and profitability of the groundnut and maize seed production.

Moreover, the study revealed different sources and types of information to farmers as presented in Table 6. The three main sources of information of improved maize varieties types were extension officers (30.1%), Agro-dealers/traders (29.5%), and other farmers (24.53%). As presented in Table 6, the majority of maize farmers (40.2%) received information on the crop management practices, followed by 29.7% who received information on the improved varieties that are ideal for growing in the area.

On the other hand, the three main sources of information on improved groundnut varieties were extension officers (58.3%), Media (14.8%), and other farmers (12.66%). The majority of the farmers (52.6%) received information on the crop management practices, followed by 29% who received information on the improved varieties that are ideal for growing in the area. The majority of the farmers were getting information from extension officers since most of the farmers were living together with these people. According to the study, the majority of the extension officers were helping smallholder farmers in various ways, including giving them information concerning crop management practices, information on the improved varieties that are ideal for growing it the area, information on market requirement of seed, quality standard of seed and market for seed production. This finding is supported by Babu *et al.* (2011) which found that the major constraints facing farmers in accessing information were poor availability, poor reliability, lack of awareness of information sources available among farmers, and untimely provision of information.

Table 6: Types of information and information providers in the study area

Type of information received by farmers	**Groundnut (%)**	**Maize (%)**
Crop management practices	52.6	40.2
The improved variety that is ideal for growing in the area	29.0	29.7
Market requirement of seed	4.8	12.7
The quality standard of seed	5.9	9.1
The market for seed produce	7.7	8.3
Information providers		
Extension officers	58.3	30.2
Other farmers	12.7	24.5
Traders/Agro-dealers	5.1	29.5
Media	14.8	11.3
NGO	-	1.9
TARI	9.1	2.5

The major challenges faced by maize seed farmers as presented in Table 7 include low prices (46.8%) and lack of market (35.5%). Other challenges reported as "other" include poor storage facilities and seeds that are not suitable for a particular location.

Table 7: Marketing challenges faced by maize seed farmers

Challenges	Frequency	Percentage
Low price	29	46.8
Lack of market	22	35.5
Others	11	17.75
Total	**62**	**100**

Table 8: Marketing challenges faced by groundnut seed farmers

Challenges	Frequency	Percent
Lack of market	34	53.2
Low price	13	20.3
Poor storage facilities	17	26.5
Total	**64**	**100**

Storing harvest to sell in the next season is constrained by the availability of modern storage facilities by groundnut farmers in the study area. As presented in Table 9, about 76.6% and 69.9% of groundnut and maize seed farmers respectively store their harvests in a residential house. In addition, 79.7% and 67.8% of groundnut and maize seed farmers have not seen any innovative storage technologies in the community for the past five years.. Shepherd (1993) insists that storage for sale in the next season would increase the profitability of farm products only when there is the use of innovative storage technology.

Table 9: Use of storage facilities over past five years by groundnut and maize seed farmers

Variables	Groundnut (%)	Maize (%)
Warehouse	10	18.4
Crib	6.1	3.2
Traditional granary	2.1	2.7
Plastic drums	5.2	5.8

Residential house	76.6	69.9
Innovation seen		
Yes	79.7	67.8
No	20.3	32.2

4.2.3 Agro-dealers

About 70.5% of the interviewed agro-dealers were men while 29.4 were women (Table 10). All agro-dealers in the study area sell other agricultural inputs in addition to seeds. Most of the surveyed agro-dealers have been operating their businesses for an average of 8 years and operating in their stalls. In addition, the agro-dealers interviewed did not store groundnut seed because of the low market experienced. Others reported that they may store groundnut seed only if the certified seed will be available from seed companies. Majority of the agro-dealers (75%) sourced seeds from seed companies. The rest acquired them from private distributors. Further, the study found that the majority of the agro-dealers (34.3%) would stock a variety preferred by farmers and on-demand. The agro-dealers incentive is profit maximization, as such, they would stock farmers' favorite varieties from certain companies regardless of improved varieties from other seed companies. This is further influenced by the easy access of the variety (20%) from seed companies or wholesalers provided that they would get it at a reasonable price to be able to realize profits (14.3%).

Table 10: Gender characteristics of agro-dealers in the study area

Gender of Agro-dealer	Frequency	Percentage
Men	12	70.5
Women	5	29.4
Total	**17**	**100**

Furthermore, agro-dealers reported facing challenges in seed selling businesses as presented in (Table 11). The challenges include internal challenges like inadequate

working capital (55.6%), failure to timely meet farmers' seed demand (22.2%) and inadequate storage (22.2). External challenges were high competition from non-agro-dealers (23.3%), high seed price (15.2%), poor credit support (19.17%), inadequate support with relevant seed information (19.17%) and Inadequate seed to satisfy farmers' demand in time (23.16%).

Table 11: Internal and external challenges faced by agro-dealers in the study area

Challenges	Percent
Internal challenges	
Inadequate cash to buy stock	55.6
Failure to timely meet farmers' seed demand	22.2
Inadequate storage	22.2
External challenges	
High competition from non-agro-dealers	23.3
High seed price	15.2
Not enough support with credit	19.17
Not enough support with relevant seed information	19.17
Inadequate seed to satisfy farmers' demand in time	23.16

4.2.4 Public sector

The Ministry of Agriculture is the main public sector actor in the seed value chain through Tanzania Agriculture Research Institute (TARI). In seed production, TARI works with the Agricultural Seed Agency (ASA) to ensure high-quality seeds are available to farmers at an affordable price. The function of ASA includes expanding seed production and distribution networks to facilitate the accessibility of seed by farmers. In addition, ASA has a leading role to ensure increased private sector participation in the seed industry development through the establishment of public-private partnerships and/ or joint ventures in seed production and distribution. Thirdly, ASA is mandated to engage in demand stimulation activities of certified seed by farmers; and strengthen

research capacities for breeding and development of varieties that address farmers' specific needs and/or demand.

Other government departments involved in seed production and distribution include Tanzania Official Seed Certification Institute (TOSCI). TOSCI is responsible for the certification and promotion of quality agriculture seed produced or imported into the country for sale to safeguard farming from poor or fake seeds from vendors of farm inputs. The primary role of TOSCI is seed quality certification that encompasses seed testing, seed inspection, variety testing, and release. The government institution is also involved in conducting pieces of training including seed systems, informal seed sector development, seed trade control, and coordination of the seed industry. In addition, through its inspectors, the organization is responsible for certification of pre-basic, basic, and certified seed classes. They also audit the inspection of quality declared seed (QDS). Another research institution involved in agricultural research in support of seed is Sokoine University of Agriculture (SUA) that is actively involved in breeding variety development and production of pre-basic seed.

4.2.5 Seed companies

Five seed companies were interviewed i.e Beula Seed Company, Iffa Seed Company, Suba-agro, Temnar Seed Company Limited, and Krishna Seed Company, and all were owned by men. Most of them are located in Arusha. 51.75% of the seed companies are engaging in the production of hybrid maize. The seed companies that supply seeds in the study area acquired their germplasm through imports (CIMMYT, 44.4%) and Kenya

Seed (11.1%), own production (11.1%), TAAT (11.1%), and within the country (ASA, 22.2%). It was also found that these seed companies use different pathways to disseminate certified seeds as presented in Table 12. The pathways are well developed and therefore many farmers have the advantage of acquiring seeds from any of the channels.

Table 12: Pathways in which certified seeds move from companies

Pathway	Percentage (%)
Seed Company to Agro dealers	28
Seed Company to Company outlets	18
Seed company to Agro dealers/Agents	9
Seed Company to AMCOs	9
Seed Company to Farmer associations	9
Seed Company to Farmers	9
Seed company to Individual farmers and Company shops	9
Seed Company to NGOs	9

The majority of the seed companies (28%) supply seeds directly to agro-dealers. Others supply to a combination of agro-dealers and agents, AMCOs, company outlets, farmers and farmer associations and a combination of farmers and company shops.

4.2.5.1 Types of out-growers, strengths, and challenges involved by seed companies

The study also found that three types of out-growers were used in the study area i.e large scale farmers, medium-scale farmers and smallholders. In terms of strengths of using out-grower, 50% of the companies liked the out-grower model of seed multiplication due to the cost-sharing benefit. The other 50% of the seed companies reported that they used out-growers as a risk-sharing model. As such, they increase the protection of investment because, in case of a botched multiplication process, the company may only lose the foundation seed.

The majority (i.e 75%) of the seed companies did not engage smallholder farmers. Most of the companies (33.3%) indicated that out-growers lacked financial resources, compelling the seed companies to engage in almost all activities despite the contractual agreements. Side selling, poor seed quality due to poor isolation and the contamination

of improved varieties with other varieties were the other problems that the seed companies faced.

4.2.5.2 Challenges faced by seed companies

Eighty nine percent of seed companies reported delays in the issuance of stickers by TOSCI consequently delaying the timeliness of planting in the high-risk areas. The delays are contributed by the execution of seed transport notice and understaffing. The companies were not contented with the taxing of maize seed production business because taxes increase seed prices for end-users. Consequently, high prices cause low adoption of improved varieties and eventually higher food insecurity. Also, seed companies reported that the process of seed release is unnecessarily long, which delays the benefits that farmers derive from new varieties.

In terms of seed production challenges, the first challenge was the difficulty in access to land and thus the seed companies do not have enough land for seed multiplication. Second, climate change has resulted in low rainfall consequently making seed multiplication a great challenge. Third, seed companies lack enough contract farmers as out-growers because the majority of the farmers in the region are resource-constrained smallholders.

4.2.5.3 Promotion channels, pricing strategies, and competition

Various seed promotion channels were used by different seed companies as presented in Table 13. First, field demonstrations were commonly used by some seed companies. Second, others used a combination of promotion events that include field days, training of maize farmers, and partnerships with agro-dealers. Third, company agents used

mouth-to-mouth tactics to convince farmers to switch to the company's newly developed seed varieties. Fourth, others used partnerships, for instance, offering a vehicle to enable agro-dealers to make a certain amount of seed sales. Fifth, company agents visited individual farmers, gave them free packs to verify the seed aspects on their own; mostly in the high potential areas. Lastly, some seed companies visited AMCOs and trained them on seed choices as well as agronomic and postharvest handling of crops.

Table 13: Promotion channels used by seed companies

Promotion channel	Percent (%)
Field demonstration	41
Promotion event	21
Mouth to mouth tactics	13.3
Partnerships	11
Providing free seed packs	6.3
Training	7.4

All the companies reported that they faced competition in the seed business with some brands such as Seed Co, Pannar, and Monsanto dominating the market. Many seed companies are concentrating on low-risk areas such as Arusha. Some companies are competing in terms of pricing, especially because most of them access their base stock from within Tanzania. Some companies can release new varieties very often while others cannot due to economies of scale. As a result of competition, some companies experience carry-over stocks while others suffer a reduction in market share. To counter the heightening competition, although not so popular, some companies reduce prices depending on demand, especially in high-risk areas. Giving tips to shopkeepers and facilitating the agro dealer with a pickup truck seemed to work well for the companies as it was reported to increase the adoption of the companies' seed varieties. The truck would be transferred to the agro-dealer after making sales of a certain volume of seed sales. Agro dealers and shopkeepers were also trained on selling tricks and given support

materials like brochures, which they would use to convince farmers to purchase the particular seed varieties. Some companies used volume discounts to agro-dealers, which helped the agro-dealers in promoting particular varieties.

The study revealed that strategic partnerships were key to enhance the penetration of improved varieties in the high and low-risk areas. Most of the companies i.e. 50% suggested that hybrid varieties would penetrate the dry areas if different stakeholders are involved in partnerships. Some companies reported that currently, TARI has concentrated on high potential areas such as Arusha and Mbeya thus the high-risk areas such as Kongwa needed more attention.

In addition, among 65 registered seed companies in Tanzania, only seven seed companies showed interest in producing groundnut seeds which are ASA, Mbozi Highland Economic Group Temnar, Suba agro, Alssem, Iffa seed co and Meru Agro, most of the seed companies show interest in maize.

4.3 Service Provider

In most effective value chains, the actors who constitute the chain are supported by business and extension services from other enterprises/units. These efforts offer services such as input supplies (seeds, fertilizers, pesticides, herbicides, irrigation, etc.), technical support including training and regulations, market information (prices, trends, buyers, and suppliers), financial services (such as credit), transport, etc. There is a need for all the chain actors to access these services effectively and efficiently. The study developed

a Market Map framework to map these services that support, or could potentially support, the value chain's overall efficiency.

Farming households need facilitation to effectively produce quality seeds and also product markets. The facilitation services examined here include (a) access to input suppliers, b) access to financial or credit services c) access to agricultural information and d) access to the market. In this study access to support services was looked at from the point of view of household seed farmers while acknowledging the need for support services by other actors.

4.3.1 Knowledge of the location of support services

Seed farmers were asked to indicate whether they knew the location of some of the facilities relevant for their farming business and consequently, this might affect their farming business. Most seed farmers in the study area admitted knowing where facilities were located (Table 14). The commonly known facilities were input suppliers, financial services providers, and agricultural information centers, while the location of the product markets was least known by both groundnut and maize seed farmers. This indicates that quite a reasonable proportion of seed farmers was not marketing their products or was using their homestead for marketing their products as noted by the study team during the survey.

Table 14: Knowledge of the location of support services in the study area

Facilities	Groundnut		Maize	
	Knowledgeable (%)	Non-Knowledgeable (%)	Knowledgeable (%)	Non-Knowledgeable (%)
Input suppliers	92.2	7.8	94	6
Financial	94.3	5.7	89.9	10.1

service providers				
Agricultural information	87.6	12.4	93.4	6.6
Product market	56.8	43.2	75.3	24.7

4.3.2 Distribution of households using support services

The study found out that, response varied according to the type of service. Financial services were the least used support services by both groundnut and maize seed farming households with 85.9% and 83.9% of the respondents as non-users respectively (Table 15). The second least used facility was the agriculture information with 37.4% and 40.8% of non-users for groundnut seed and maize seed respectively. For the groundnut seed sector, produce markets and agriculture information were the commonly used facilities with 78.4%and 62.6% of users respectively. For maize, product market and input supplier were the commonly used facilities with 89.1% and 87.1% of users respectively.

Table 15: Percentage of households using support services in the study area

Type of service	**Groundnut seed sector**		**Maize seed sector**	
	User (%)	**Non-users (%)**	**Users (%)**	**Non-users (%)**
Input suppliers	54	46	87.1	12.9
Financial service providers	14.1	85.9	16.1	83.9
Agricultural information	62.6	37.4	59.2	40.8
Product market	78.4	21.6	89.1	10.9

4.3.3 Reasons for not using facilities

Of the respondents that knew the location of the services were not using them, a follow-up question technique was applied to ask them to give the main reason for not using

these services (Table 16). Reasons varied from the location is too far, no need of use and other reasons. Of those that were not using the financial services available in the area, the major reason given for not using them was that they did not qualify for credit as most of them were resource-poor households with no collateral to use for borrowing (Larson *et al.*, 2006). Another reason was that they did not see the need, while another reason was the services were too expensive since they were charged a high-interest rate by commercial banks of more than 18%. Another reason given for not accessing credit was the location being too far (Table 16). For those respondents that were not using the input suppliers, the major reason was that they did not see the need of using the input markets. This group of seed farmers who may not see the need of using other inputs may need extension education service. The distance was another major concern that was cited by non-users of input markets.

A major reason for not using formal agricultural information centers was that they did not see the need. The reason could be that these farmers relied more on other farmers as a major source of information. Public extension service has been the main source of agricultural information over the years, along with traditional mass media such as radio. However, extension officers in the study area are not adequate to meet the farmer's demand. Another reason was that the location of services was too far. Those that did not see the need to use product markets may not have any marketable surplus or buyers who came to their homestead.

Table 16: Reasons for households not using support services among groundnut and maize seed farmers

Type of services	Reason for not using the services	Rank	Percent
Input suppliers	Too far	3	13.3
	Did not see the need	1	53.4

	Others	2	33.3
Financial service providers	Too far	4	9.2
	Too expensive	3	18.4
	Did not see the need	2	32.1
	Did not qualify	1	40.3
Agricultural information	Too far	2	23.4
	Did not see the need	1	56.3
	Others	3	20.3
Product market	Too far	2	21.2
	Did not see the need	1	63.3
	Others	3	15.5

4.3.4 Distance to support services

Seed farmers, in the study area, face difficulty in accessing supporting services due to poor roads. For instance, the distance to input suppliers ranges from 0 to 60 km for groundnut seed farmers and 0 to 48km for maize seed farmers. Distance to financial services ranged from 0 to 95 for groundnut and 0 to 90 for maize seed farmers with an average of 5.2 and 4.87 for groundnut and maize seed farmers respectively. The nearest support services were the product marked which was averaged 2.6 and 4.52 km for groundnut and maize seed farmers. Distance to the nearest agriculture information Centre which was averaged 5.8 to 4.47 from farming household (Table 17).

Table 17: Distances to the nearest support services in km (Maize seed sub-sector)

Type of support service	Mean (n=62)	Std. Deviation	Minimum	Maximum
Maize				
Agriculture input suppliers	4.7	1.58	1	48
Financial services providers	4.87	9.9	1	90
Agriculture information providers	4.47	4.54	1	25
Product market	4.52	5.04	1	8
Groundnut				
Agriculture input suppliers	4	2.1	1	60

Financial services providers	5.2	3.81	1	95
Agriculture information providers	5.8	4.23	1	38
Product market	2.6	4.54	1	12

4.3.5 Extension services

In the study area, actors admit to collaborating with public extension officers. Among the farmers interviewed, 79.7% and 85% of groundnut and maize farmers respectively have access to extension services (Table 18). Public extension officers provide information on market requirements of seed production. On the other hand, all the seed companies interviewed and agro-dealers admitted to provide free extension services to the farmers they serve.

Table 18: Proportion of farmers with access to extension services in the study area

Access to extension services	Frequency	Percent
Groundnut	51	79.7
Maize	52	85
Total	**103**	

4.4 Profitability Analysis for Groundnut and Maize Seed Producers

Profitability analysis was done to calculate gross margins of seed producers i.e., farmers and seed companies. The gross margins for the two seed value chains (i.e., profit margins of groundnut and maize farmers) were compared. The results show that the gross margin per acre for groundnut was higher than that of maize by 914 953 TZS (Table 19). On the other hand, the gross margin accrues by seed farmers is higher than that of seed companies operating under the out-grower scheme model as shown in Table 20.

Furthermore, the independent sample t –test was used to compare the two gross margins to find out whether or not there are no significant difference in profitability yielded by groundnut and maize seed farmers. The analysis (Appendix 11) addressed the hypothesis that groundnut and farmers do not differ in their profitability, the t-statistic under the assumption of unequal variance has a value of 2.576, and the degree of freedom has a value of 75. 968 with an associated significance level of 0.008. This suggests that there is enough evidence to reject the null hypothesis in favour of the alternative hypothesis, that is, there is a significant difference between the two profitability from groundnut and maize farmers with the P-value <0.008.

Overall, seed production is a profitable business that has been demonstrated and widely reported for a variety of crops, including groundnut seed production (Akpo *et al.,* 2020), legumes seed (Katungi *et al*., 2011). This is a major prerequisite input for achieving food security in Tanzania.

Table 19: Costs, revenue, and gross margins of groundnut and maize seed producers (farmers) per hectare

Variable	Groundnut	Maize
Variable Cost (TZS)		
Seed	131 100.00	120 791.35
Fertilizer	-	106 000
Pesticides	-	69 301
Packaging material	10 000.00	10 000.00
Land preparation	31 605.26	30 403.76
Fertilizer application labor	-	31 456.65
Planting	30 605.46	32 403.5
First weeding	30 068.97	31 302.07
Second weeding	30 318.18	31 000.29
Harvesting	36 482.76	27 400.44
Stripping	39 211.11	-
Shelling	18 000.00	24 660.41
Transportation	45 500.00	49 500.21
Seed certification	-	-
Total Cost	**402 892**	**564 220**
Revenue		

Total yield (kg/ha)	921	2 466.04
Average selling price (TZS)	2 200	516.04
Total revenue (TR)	**2 026 200**	**1 272 575.28**
Gross margin (TR-TC)	**1 623 308**	**708 355**

Table 20: Gross margin of seed companies operating under out-growers scheme model

Variable	Value
Total Cost (TC) (TZS/ha)	**306 666.67**
Revenue	
Mean Yield (kg/ha)	740.00
Payback price (TZS)	1 626.67
Total Revenue	**1 205 215.80**
Gross Margin (TR-TC)	**898 549.13**

4.5 Analysis of Viability of Groundnut Seed Production

The benefit-cost ratio analysis showed the viability of both groundnut seed production and maize seed production business with all ratios higher than 1 (Table 21). Groundnut seed production by farmers showed the highest BCR.

Table 21: Benefit-cost ratio (BCR)

	BCR of Groundnut seed production	BCR of maize seed production
Farmers	5.03	2.3
Seed companies	1. 9	3.9

4.6 Multicollinearity Diagnosis

Multicollinearity is the problem that occurs when two or more predictors in the model are correlated and provide redundant information about the response. Variance Inflation Factor (VIF) was used to test for the presence of multicollinearity problems. A VIF greater than 2 is usually considered problematic. In the analysis, the largest VIF was 1.407 and 1.586 for groundnut and maize farmers respectively as shown in Table 22. This means there is no problem with multicollinearity. Normality test was also done, the result of skewness for variables used analysis in both groundnut and maize farmers was

normally distributed since Z-values were between -1.96 to +1.96 as shown in Appendix 10.

Table 22: Multicollinearity diagnosis

Variables	Groundnut farmers (VIF)	Maize farmers (VIF)
AGE	1.256	1.586
GENDER	1.126	1.088
EDUL	1.161	1.405
HHS	1.182	1.322
LS	1.183	1.296
FOES	1.232	1.570
TRN	1.255	1.335
CRT	1.407	1.147
DTM	1.327	1.192

4.7 Factors Influencing Investment in Groundnut and Maize Seed Value Chain

The Binary Logistic Regression Model **(**BLRM**)** was used to determine the investment decision, by examining the effects of explanatory variables on the likelihood of investment in the groundnut/maize seed value chain. Normality test was done by looking at skewness. Table 23 and 24 summarize the socio-economic factors hypothesized to influence investment decisions in the groundnut and maize seed value chain respectively. As it can be seen from the table, the specified binary model fits well the data as measured by Pseudo – R^2 (Cox and Snell = 0 .545 and Nagelkerke = 0 .739) for groundnut seed and Pseudo- R^2 (Cox and Snell = 0 .517 and Nagelkerke = 0 .701) for maize seed. The high values of Pseudo – R^2 which are 54.5%, and 73.9% for Cox and Snell and Nagelkerke respectively for groundnut seed; and Pseudo – R^2 which are 51.7%, and 70.1% for Cox and Snell and Nagelkerke respectively for maize seed, suggest a good predictive ability of the model and implying that the explanatory variables included in the model explain well the variation in the dependent variable. According to Louviere *et al*. (2000), Pseudo-R^2 sometimes though rarely, reaches values as high as that of R^2 in linear regression; therefore, the presented Pseudo – R^2 is still

considered having a good fit. Furthermore, the Chi-square statistic shows the model is highly significant for both groundnut seed and maize seed analysis at 5% ($p < 0.05$) level of significance, indicating that coefficients for all variables included in the model are jointly different from zero. All these confirm that there is a relationship between the dependent variable and explanatory variables included in the model.

Moreover, the important thing in the BLR model for any choice analyst is to describe the overall test of a relationship, in this case, a relationship between the dependent and independent variables. The existence of a relationship between the dependent and independent variables is based on the statistical significance of the final model chi-square termed model fitting information (Table 23). In this analysis, the model reveals that the probability of the model chi-square (50.421 and 46.592 for groundnut and maize seed analysis respectively) was 0.000, less than the level of significance of 0.05 ($p< 0.05$).

Table 23: Model fitting information for groundnut and maize seed analysis

Model	-2log Likelihood	Chi-Square	df	Sig
Groundnut seed (Final)	35.224	50.412	9	0.000
Maize seed (Final)	39.44	46.592	9	0.000

With this regard, the hypothesis that socioeconomic characteristics do not influence investment decisions among investors was rejected. The result in Tables 23 and 24 indicates that some predictor variables influence investment decision significantly. For the groundnut seed sector, three factors were statistically significant at a 5% significance level. The results indicate that the probability of investment decision is significantly and positively influenced by education level, frequency of extension services, and training at a 5% significance level (Table 23). With maize seed sector, the results indicate that

education level, household size, frequency of extension services, and training significantly and positively influenced investment decision at 5% significant level (Table 24). The positive coefficients for these variables imply that an increase in any unit may result in an increase in investments in the groundnut seed value chain.

The number of years the respondent spent in school positively influenced ($p<0.05$) their decision to invest in groundnut and maize seed value chain by 72.9% and 69.6% respectively (Table 23 and 24). A unit increase in time spent in school increased the probability of investing in groundnut and maize seed value chain by 72.9% and 69.6% respectively. This can be attributed to the fact that education equips respondents with information and knowledge to make informed decisions related to groundnut seeds. Therefore, stakeholders in the groundnut sector should focus on encouraging people with relatively low education levels to take up the groundnut seed sector. Capacity building through targeted extension services can be used to enhance the skills of interested investors who may not have high levels of education. This can also target young people who are unemployed and encourage them to take up the venture. Our finding is similar to those of Mutinda *et al.* (2020) in Kenya, who noted that secondary schooled level farmers were more likely to be involved more in seed potato enterprise.

The number of times the respondent accessed extension services positively influenced ($p<0.05$) the decision to invest in groundnut and maize seed value chain by 128.4% and 163.7% respectively (Table 23 and 24). This implies that respondents who access extension services gain more knowledge; hence increase investment in the groundnut/maize seed value chain than those who get the services fewer 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. Extension services should be strengthened to increase the rate of knowledge dissemination on the groundnut and maize seed value chain. Investors, on the other hand, should be sensitized to participate in these learning opportunities.

Household size was positively influenced ($p<0.05$) the decision to invest in maize seed value chain by 46.3% (Table 23). A unit increase in the number of people in a household increased the probability of investing in the maize seed value chain by 46.3%. This could be because of labour demand in the seed sector. These findings are similar to those of Hagos *et al.* (2018), who found out that large family size positively influenced the decision to be involved in seed production. This was explained to be caused by the fact that large family size provided labor, hence, easy to manage seed production activities properly.

Access to training on groundnut/maize farming positively influenced the decision to invest in groundnut/maize seed ($p<0.05$) by 12 % and 40.7% (Table 23 and 24) respectively. This is because the farmers who attend training got in contact with extension officers and were always able to receive new information on new technologies as well as new production methods as opposed to those who did not have access. Based on these findings, the null hypothesis that socio-economic factors of investors do not influence investment decision in the groundnut/maize seed value chain was rejected.

The results are consistent with those of Mutinda *et al.* (2020) who reported that access and attending training positively influenced the decision to invest in potato seed enterprise. Also, the results are similar to those of Yami *et al.* (2013) and Hagos *et al.*

(2018), whose results reported that access to training positively influenced farmers' decision to produce seed.

This implies that training is important to convince and provide knowledge on the practicability of groundnut/maize seed production. Therefore, research and training institutes that focus on the improvement of groundnut/maize production should develop modules on groundnut/maize seed production as a way of providing knowledge to farmers about seed production. This can be done in collaboration with government and non-governmental institutions.

Table 23: Factors influencing investment in groundnut seed value chain in semi-arid agro-ecologies of central Tanzania

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
AGE	.099	.051	3.802	1	.051	1.104
GENDER	-.233	1.089	.046	1	.830	.792
EDUL	.729	.289	6.369	1	.012	2.072
HHS	.419	.234	3.208	1	.073	1.521
LS	-1.259	1.646	.585	1	.444	.284
FOES	1.284	.605	4.506	1	.034	3.612
TRN	.120	.050	5.718	1	.017	1.128
CRT	.350	.817	.183	1	.669	1.419
DTM	-.002	.004	.240	1	.624	1.002
Constant	-17.891	11.904	2.259	1	.133	.000

Note: Number of observations 120
Pseudo R2: Cox and Snell = 0 .545 and Nagelkerke = 0 .739

Table 24: Factors influencing investment in maize seed value chain in semi-arid agro-ecologies of central Tanzania

Variables	B	S.E.	Wald	df	Sig.	Exp(B)
AGE	-.042	.038	1.224	1	.269	.959
GENDER	.308	.993	.096	1	.756	1.361
EDUL	.696	.262	7.061	1	.008	2.006
HHS	.463	.210	4.892	1	.027	1.590

LS	-.781	1.526	.262	1	.609	.458
FOES	1.637	.635	6.636	1	.010	5.138
TRN	.407	.167	5.904	1	.015	1.502
CRT	.211	.777	.074	1	.786	1.235
DTM	-.001	.003	.132	1	.717	.999
Constant	-6.070	8.861	.469	1	.493	.002

Note: Number of observations 120

Pseudo R2: Cox and Snell = 0 .517 and Nagelkerke = 0 .701

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study aims to compare groundnut and maize seed value chain in semi-arid agro ecologies of central Tanzania. Specifically, the study mapped the groundnut and maize seed value chains, compared seed producers' profitability among maize and groundnut seed value chains and assessed the factors influencing investment in the seed value chain in semi-arid agro-ecologies of central Tanzania. The analysis of quantitative and qualitative data collected from the survey was done using gross margin analysis, binary logistic regression and descriptive statistics such as frequency, multiple responses analysis and independent-samples t-test statistics.

The first objective was to map the seed value chain of groundnut and maize in semi-arid agro-ecologies of central Tanzania. The findings reveal 13 actors in the chain who perform different functions. The actors in the chain range from plant genetic resource conservation, variety development and screening, early generation seed production, seed multiplication, marketing and distribution, and final seed consumption. The actors identified were ASA, CIMMYT, AMCOs, NGOs, SUA, TARI, company agents, private see companies, local producers, agro-dealers, local multipliers (QDS), and farmers and farmers association. Also, the study found that public extension services and the Ministry of Agriculture were the main service providers identified in the study area.

The second objective was to compare seed producers' profitability among groundnut and maize seed value chains. Based on the results from this study, the null hypothesis that

there is no significant difference of profit between groundnut and maize seed value chain was rejected in favour of the alternative hypothesis. In other words, the study found that groundnut seed value chain is a more profitable enterprise than maize seed value chain in the study area. This is because groundnut seed had a gross margin of 914 953 higher than that of maize seed. The higher gross margin could be due to the high price groundnut seed farmers receive. Moreover, the findings show that seed companies operating under the out-grower model scheme earn a high gross margin compared to individual seed farmers. This could be due to the use of good farming techniques by seed companies which increase the harvest. Furthermore, the study found that both groundnut and maize seed enterprises are viable businesses to be undertaken since they both have BCR greater than 1 i.e 5.03 for groundnut and 2.3 for maize.

The third objective was to assess the factors influencing investment in the groundnut and maize seeds value chain. The findings reveal that education level, household size, extension services and training were the major factors influencing investment in the seed value chain of groundnut and maize in the study area. Based on the findings, the null hypothesis that socio-economic factors of investors do not influence investment decision in the groundnut/maize seed value chain was rejected.

5.2 Recommendations

Based on the findings of the study, the following recommendations are made for the improvement of sustainable groundnut and maize seed value chain in semi-arid agro ecologies of central Tanzania. The government through the Ministry of Agriculture should improve access to extension services, enhance access to credit and enhance access to a better market in order to improve the groundnut and maize seed value chain

in the study area. Additionally, there is a need to establish by-laws to guide the co-existence of farmers and pastoralists, and seed production.

For the improvement of groundnut and maize seed value chain in the study area, the study also recommends that the government should come up with policies aimed at subsidizing the cost of farm inputs such as fertilizer and pesticides so as to lower the cost of production.

In addition, programs aimed at advancing improved seed varieties and modern farming equipment/tools should be supported so as to improve productivity and yields, which would in turn bolster gross margins at farm level. Further, policies aimed at lowering market transaction costs, by providing market information and formation of farmer organizations/associations will enable actors to participate and benefit from the value chains. Moreover, the government should strengthen transportation infrastructure, this would ensure higher prices and facilitate the dissemination of market information and products.

Furthermore, the study suggests that the provision of education and strengthening extension services may attract more investors in both the groundnut and maize seeds value chain. Furthermore, access to better seed storage facilities by seed producers will enable them to receive a better price for their produce.

5.3 Area for Further Research

The study recommends that research on other factors than social-economic factors which influence investment in the seed value chain should be undertaken.

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APPENDICES

Appendix 1: Matrix analysis of operators in the groundnut and maize seed value chain

Activities	Operators	Indication of performance	Issues in enabling environment
Plant genetic resources and variety development	TARI-Hombolo-Eliud Kogola/Happy Daidi		
Early generation seed production	TARI-Happy TOSCI-		
Seed multiplication	TARI; Seed companies-Mtwara		
Marketing and dissemination	Seed companies; NGOs		

Appendix 2: Matrix analysis of service providers in the groundnut and maize seed value chain

Activities	Providers	Indication of performance	Issues in enabling environment
Extension service	DAICO-Kongwa and Bahi		
Variety testing and release	TARI; TOSCI ASA		
Quality assurance in seed production	TOSCI/ASA		
Quality assurance in seed commercialization	TOSCI/ASA		
Business management services	Seed companies		
Financial services and	Seed companies		

management			
Marketing information and promotion	Seed companies		

Appendix 3: Questionnaire for surveying groundnut and maize seed farmers

A: Background information

Name of respondent	
Date of interview	
Region	
District	
Ward	
Village	
Are you growing groundnut as a seed or crop?	1= seed, 2=crop
Are you growing maize as a seed/crop?	1=seed, 2=crop

B: demographic characteristics of the respondent

No	Type of crop	Name of a household member	Sex (Codes A)	Age (Number of years)	Education level (Number of years attended in school)	Household size
1	Groundnut					
2	Maize					
3	Codes A 1 = Male 2 = Female					

C: Other social-economic information

1. Which class of seed did you grow?.....
2. If yes to question (1), for how long have you been groundnut/maize seed (years)
3. How many acre (s) of land do you own? …….
4. How many acre (s) of land was under groundnut/maize seed? …….
5. Did you rent land for groundnut/maize seed production during production season?

   1= Yes, 2= No

6. If Yes, how many acres (s) did you rent?.....
7. What is the unit cost of renting land per acre? (TZS) …….
8. Is cultivated land under irrigation? 1= Yes, 2= No
9. Besides groundnut/Maize seed production, are you also engaged in seed production of any other crop? 1= Yes, 2= No
10. If Yes, which crop? (Mention) ……
11. How many groundnut/ Maize varieties did you plant as part of seed multiplication in the 2017/18 season?..... (Mention them) ……..
12. Input information

No	Type of input	Did you use the input? 1 = Yes; 2 = No	If No, why? (Mention reason for not using)	Input supplier (Mention)	Quantity purchased and used per ha	Input cost (TZS)	Distance from homestead (km)	Reliability of input supplier (1 = Yes; 2 = No)	Challenges in accessing the input (Mention)
1	Seed								
2	Fertilizer								
3	Herbicides								
4	Insecticides								
5	Pesticides								
6	Sacks								
7	Labour								
8	Manure								

13. What are some of the opportunities in the groundnut/maize input supply system?
14. Please tick the farming equipment/tools you have. You may add to the list if necessary

    1= Hand hoe 2 = Oxen Plough 3 = Tractor 4 = Other (Specify)……

15. Approximately what was the total amount of groundnut/maize seed you produced last year? .....kg.

16. Costs incurred in producing groundnut/maize seed? Please complete the table below;

	Field activities									
	Land preparation	Fertilizer application labour	Planting	First weeding	Second weeding	Harvesting	Stripping	Shelling	Transportation	Seed certification
Number of events										
Cost (TZS/ acre)										

17. Did you sell any groundnut/maize seed during the 2017/18 production season?

If Yes	If No,
What was the total quantity of crop produce sold?..... (kg)	Why
What was your average price for seed produce last seasons?.....	
How much did you seed the produce (TZS/kg) ……..	

18. To whom/where did you sell your produce? ……. 1=consumer, 2=Retailer, 3 = Wholesaler, 4 =Cooperatives/Unions, 5 =farmers, 6 =millers/processors, 7 =commission agents, 8 = Assemblers, 9=seed dialers, 10= government seed collectors, 11= others specify……..

19. What are the disadvantages of selling seed to this buyer? ……

20. Source of market information on groundnut/maize seed

Type of information	Do you get the information? 1= Yes, 2= No	If you get it, do you use it? 1=Yes, 2= No	Main service provider (specify)
Crop management practice			
The improved variety that is ideal for growing in the area			
Market requirement of seed			
The quality standard of seed			
The market for seed produced			

21. Distance to the nearest seed market from homestead (km)……
22. What means of transport do you use mainly to get to the village market? (circle) 1= Walking, 2= Bicycle, 3= Tractor, 4= Car, 5= Cart, 6= other (specify)…….
23. Distance to the nearest agriculture input suppliers from homestead (km)……
24. Distance to the nearest financial services provider from homestead (km)……
25. Distance to the nearest agriculture information providers from homestead (km)……
26. Were you involved in a groundnut/maize seed contract with any organization/individual during the 2017/18 production season? (circle) 1=Yes, 2= No.
27. Who were the buyers under contract farming arrangement? (Specify)……..
28. What were the marketing challenges faced by groundnut/maize seed marketing during the 2017/18 season?
29. Where do you store groundnut seed after harvest? (circle) 1= Warehouse, 2= Crib (kilindo), 3= Barns, 4= Traditional granary, 5= Plastic drums, 6= Residential house, = (Specify)……..

30. What was the main reason for storing groundnut seed using this method? (circle) 1= Cheaper, 2= Effective against storage pests, 3= Only one available, 4= Its traditional, 5=Given for free, 6= Others (Specify)……..
31. Did you store groundnut/maize seed in the 2018 marketing season?
32. How long did you store the marketed groundnut/maize seed (between harvesting and selling) in 2018 (Months)……..
33. Estimate the groundnut seed loss after harvest (before sale) (% of 2018 harvest) ……
34. What were the main causes of post-harvest losses in groundnut seed (Specify) 1= Storage pest, 2= High moisture content, 3= Pilferage/seepage, 4= Leaking storage facility, 5= Others (specify)
35. Do you store groundnut seed to get higher prices later in the season (circle) 1= Yes, 2= No

36. Is it generally profitable to store groundnut to sell later in the season? (circle) 1=Yes, 2=No
37. What are the main constraints that hinder your household from storing groundnut seed to sell later in the season (circle) 1= Low liquidity/small capital, 2= Limited storage space, 3= Inability to handle storage pests, 4= Shrinking of volume, 5= Loss due to pilferage, 6= Others (Specify)
38. Did you receive any training on groundnut seed production in the last three years? (circle) 1= Yes, 2= No
39. If yes,

Training coverage	Principles on seed production	Field isolation	Seed selection	Agronomic principles	Marketing and packaging	Group dynamics	Post-harvest crop management
1= Yes, 2= No							

40. How many times do you receive extension services per year?.....
41. Did you have access credit during the 2017/18 season? 1= Yes, 2= No
42. What are the credit institutions that provide credit? (Specify)……
43. How much did you harvest groundnut/maize seed during the 2017/18 season?.....kg (s)
44. What are the first most important problems you have in growing/ producing your groundnut/maize seed before harvest?
45. What kinds of interventions are required to improve the productivity of groundnuts in your area?

Appendix 4: Agro-dealer interview checklist

Name of respondent	
Date of interview	
District	
Location 1=Rural, 2= Urban	
Village	
Sex of owner 1= Male, 2= Female	

1. Do you own this agro-dealer shop 1= Yes, 2= No
2. If No, what is the relation the owner?.....
3. How many shops of this nature do you have? (specify).....
4. How many years have you been operating this business?.....
5. What type of inputs do your trade in?

	Do you sell? 1= Yes, 2= No	If No, why?
Groundnut seed		
Maize seed		
Herbicides		
Pesticides		
Fertilizer		
Drugs for livestock		
Farm implements		
Agro-machinery		
Reasons: 1= Low demand, 2= Agroecology not suitable for groundnut, 3= High price, 4= Not available, 5= Difficult to store, 6= Seed normally distributed for free		

6. Do you sell groundnut/maize seed via the village store? (circle) 1= Yes, 2= No
7. What are factors do you consider when stocking seed variety? (circle) 1= easy to get from seed companies, 2= Farmers like and request it, 3= Wholesaler good purchasing price, Others (specify)……
8. What modes of payments do you use to pay for stock and customers used to pay for improved seed varieties? (circle) 1= Cash, 2= Credit, 3= Both
9. Too much fake seed in the market, 4= Less improved seed, more saved seed, 5=

10. Do you offer groundnut/maize extension services to farmers who buy seed from your shop? 1= Yes, 2= No

11. If Yes, what services do you offer? (specify)…….

……

12. Do you work with any local extension workers? (circle) 1= Yes, 2= No

13. If yes, how?.....

14. Legal requirement to have a business license of this type (circle) 1= Yes, 2= No

15. Which type of groundnut/maize seeds do farmers prefer?

	Crop	Types
1	Groundnut	
2	Maize	
3	Codes - Groundnut 1= Tan, 2= Red, 3=Large seeded, 4=Medium seeded, 5= Small seeded, 6= Others (Specify) Codes – Maize 1= Flint, 2= Dent, 3= Tan Yellow, 4= Yellow, 5= Medium flat seeded, 6= Small rounded seeded, 7= Large flat seeded, 8= Others (Specify)	

Crop	March season	December season	Off-season
Maize			
Groundnuts			

b) Maize……

21. What percentage of sales is subsidized seed?

Crop	Government	NGOs	Other specify
Groundnut			
Maize			

22. Where did you buy the seed?

Crop	Seed company	Distributor/Whole seller	Other specify
Groundnut			

Maize			

23. What are the internal challenges do you face in seed selling businesses? (circle) 1= Inadequate cash to buy stock, 2= Limited knowledge of new technology, 3= Can't get enough seed that farmers want in time, 4= Inadequate storage space for maize seed, 5= Not enough money to hire staff, 6= Others (specify)……..
24. What are the external challenges do you face in the seed selling the business? (circle) 1= High competition from non-agro-dealers 2= No enough support with relevant seed information, 3= No enough support with credit, 4= High seed price 5= Others (specify)

Appendix 5: Seed company checklist

Name of respondent	
Date of interview	
Region	
District	
Ward	
village	
Sex 1= Male, 2= Female	

1. Where do you get your base stock for the development of varieties? 1= Research Institute (TARI), 2= ASA, 3= Others (Specify)

a) Groundnut……

b) Maize……

2. Is the variety development fully under your control? 1= Yes; 2=No**.**……..

a) Groundnuts……

b) Maize…….

3. What proportion of budget do you allocate to the production of early generation seed?

a) Proportion……

b) Amount (TZS) ……

4. What proportion of the budget goes to seed multiplication to get certified seed?

a) Proportion……

b) Amount (TZS) ……

5. What is your model of seed multiplication to meet the required demand for certified seed? (circle) 1=Contractual (a. large scale farmers, b. small scale farmers, c. cooperatives/farmer), 2= Own production, 3= Other (specify)……

6. Are you engaging in an out-grower model scheme? (circle) 1= Yes, 2= No

7. If Yes, why……

8. If No, why……..

9. Are you promoting your groundnut/maize seed? (circle) 1= Yes, 2= No

10. If yes, what promotion channels are you using? (Specify)

    ……

    ……..

11. Do you use any pricing strategies? (circle) 1= Yes, 2= No

12. If yes, which are they? (Specify)……..

13.

14. Do you contract women and youth in your seed production business? (circle) 1= Yes; 2=No.

15. If yes, how many women and youth?

Crop	Women (number)	Youth (number)	Volumes (Kgs)
Maize			
Groundnuts			

16. Is your company involved in the production and selling of groundnut/maize seed?1= Yes; 2=No.

17. If yes, what percentage of the business represents

a) Groundnut……..

b) Maize……..

c) Others (Specify)…….

18. If yes, what type of varieties? (circle) 1= Hybrids, 2= OPV varieties, 3= Other (specify)

19. Describe your maize/groundnut seed distribution channel?

a) Groundnut ……

b) Maize……

20. What are the challenges in the distribution of your seeds? (circle) 1= Infrastructure, 2= Market information, 3= Policies, 4= Labour, Others (specify)……..

21. Do the research and extension departments support you with services in seed production? 1= Yes; 2=No

22. What kind of services?

Crop	Research	Extension
Maize		
Groundnuts		

23. Where do you get inputs (fertilizers, insecticides, etc) from?

Input	Source	Quantity	Price
Seeds			
Fertilizer			
Pesticides			
Others (Specify)			
Codes 1= Manufacturers, 2= Distributors, 3= Researchers, 4= Seed companies, 5= Others (specify)			

24. How much fertilizer/pesticides do you use per unit area for groundnut and Maize?

25. Do you have a seed processing unit for groundnut/maize? (circle)1= Yes; 2=No

a) Groundnut…….(circle)1= Yes; 2=No

b) Maize…….(circle)1= Yes; 2=No

26. If yes, what challenges do you face at this stage? (circle) 1 = Labour, 2= Machinery, 3= Packaging, 4= Others (specify)……..

27. What are the terms of payment between you and the agro-dealers? (circle) 1= Cash, 2= credit, 3= Others (specify)

28. What are the existing seed policies concerning the production of maize seeds?

29. What are the existing seed policies concerning the production of groundnut seeds?

30. Do these policies support your seed production business objectives? (circle)1= Yes, 2=No

31. If no, what are the challenges?

32. What are the existing regulations and guidelines governing the production of the different classes of seed?
33. Do these regulations support your seed production business objectives? (circle) 1=Yes 2=No
34. Are the existing government land policies conducive for you to maximize seed production? (circle)1=Yes 2=No
35. Are there any restrictions on the type of crops to grow in such land? (circle) 1=Yes 2=No
36. Do you have access to credit facilities? (circle) 1=Yes 2=No
37. If yes, what is the interest rate on the loan facility? (%) ……
38. Do you get extension support services in seed production? (circle) 1= Yes; 2=No
39. If yes what are these services? (circle) 1= Agronomic, 2= Postharvest, 3= Storage, 4= Marketing information, 5= Others (specify)
40. Is there a coordinated system to ensure you have access to market information on groundnut/maize seed demand?1= Yes; 2=No
41. What kinds of interventions are required to increase the acceptance of new improved varieties? (Specify)……..

Appendix 6: Community Seed Bank Questionnaire

Study basic information

District Name: ……
Village name: …….
Ward name……..
Club name: …….
Interviewer's Name: ……

Details of the respondent

Information about the respondent and household composition

Year the seed bank was formed	
Number of members in the community seed bank	
Men	
Women	

Section A: Land availability

1. Do you have land for cultivation or farming? ..... 1=Yes 0=No
2. How many plots do you have? .....
3. For every plot, please indicate the size and crop grown

Plot #	Size (acres)	Crop grown
1		
2		
3		
4		
5		
Crop grown: 1=maize, 2=groundnut, 3=sorghum, 4=millet, 5=beans, 6=pigeon peas 7=other (Specify)		

4. Please provide details about the seed you used for seed production in the 2017/2018 growing season

Crop	For how long (recycling)	Source of seed	Distance to the source (Km)	Amount paid for (Mk)	Amount of seed adequate for the household
Ground nut					
Maize					
Source of seed 1. Own stock 5. Seed bank 2. Fellow farmers 6. ICRISAT 3. Market 7. Other (Specify) 4. Agro-dealer					

5. Which source of seed do you prefer the most?

   ……

   Reason

   ……

   ……

6. Which source do you prefer the least? Reason

   ……

   ……

7. Was the seed readily available?

   1=yes 2=No

8. If No, why? 1= Not adequate, 2= Processing challenge, 3= Transport challenge, 4= Other (Specify).

9. Which among the following do you know? 1= Seed production principles, 2= Seed quality, 3= Seed business, 4= Post-harvest handling of seed 5= Other (Specify)

10. From the above, which ones do you need to be trained on? 1= Seed production principles, 2= Seed quality, 3= Seed business, 4= Post-harvest handling of seed, 5= Other (Specify)

11. How did you utilize the groundnut seed harvested in the last season?

Crop	Amount harvested (kg)	Amount returned to the seed bank (kg)	Stored as seed (kg)	Given as a gift (kg)	Consumed (kg)
Groundnut					
Maize					

12. How do you store your seed? 1= Traditional granaries, 2= House store, 3= Metal silo, 4= Drums, 5= Barrels, 6= PIC bags, 7= Others (specify)
13. Did you apply a post-harvest loss control measure? 1=Yes 2=N
14. If yes, which ones? 1= Insecticide, 2= Traditional, 3= Hermetic bags, 4= Others (specify)
15. Did you or any member of your family access seed from the seed bank? 1=Yes, 2= No
17. If no, please provide a reason 1= Other source, 2= Lack of trust, 3= No money, 4= Other (specify)

18. If yes, how many Kgs did you get? 1= < 5, 2= 5-10, 3= 10-20, 4= Other (Specify)
19. Was the seed accessed enough for your plot? Yes=1; No=2
20. what are the conditions for one to have access to seed from the seed banks? 1= Should be a member, 2= Should be from the village, 3= Should have money, 4= Others (specify)

21. How can you rate the quality of seed accessed from the seed banks? 1= High, 2= Medium, 3= Low, 4= Poor.
22. Please provide a reason for your rating? 1= Seed size, 2= Seed colour, 3= Shrivelled, 4= Other (Specify)
23. As a community seed bank, which organizations have you shared seed with? 1= Agric market cooperative, 2= NGOs, 3= Research, 4= Other (Specify
24. To your knowledge have other farmers benefited from the seed you shared? 1=Yes; 2=No
25. If you sold the Groundnut/maize harvested last season, provide the following information about the markets

34. What are the major challenges hindering the availability of quality seed? 1= Lack of foundation seed, 2= Lack of money, 3= Lack of market, 4= Lack of knowledge, 5= Other (Specify).
35. What can be done to overcome the challenges above? 1= Government support, 2= Donor support, 3= Training, 4= Good market, 5= Other (Specify)

Appendix 7: Seed regulatory organization interview checklist

Name of respondent	
Date of interview	
Region	
District	
Village	
Position in the organization	

1. What are the existing seed policies concerning the production of groundnut seeds? …….
2. What are the existing seed policies concerning the production of maize seeds?.....
3. Are these fully enforced? (circle) 1= Yes; 2=No
4. If no, what are the reasons?.....
5. Do seed producers adhere to these policies? (circle) 1= Yes; 2=No
6. Do you offer support services such as field inspection to seed producers? (circle) 1= Yes; 2=No
7. If yes, who pays for the fee? (circle) 1= Producer, 2= Government, 3= NGOs, Others (specify)
8. How much is the inspection fee per field?
9. Are the seed production standards common for maize and groundnut crops? (circle) 1= Yes; 2=No
10. If no, what are the standardization requirements?

11. Are there incentives to promote investment in the development of improved varieties?
12. Are the investors rewarded with intellectual property rights of groundnut and maize? (circle) 1= Yes; 2=No
13. Are there different quality assurance mechanisms for informal and formal seed systems? (circle) 1= Yes; 2=No
14. Are there different accreditation for the informal and formal seed producers (circle) 1= Yes; 2=No
15. Do you have in place quality management mechanisms to ensure the commercialization of seed and varieties follows agreed standards? (circle) 1= Yes; 2=No
16. If yes describe briefly…….
17. Are the quality mechanisms in terms of 1) quantity 2) quality 3) price 4) time (from date of packing to date of selling) (circle)1= Quantity, 2= Quality, 3= Price, 4= Price (from date of packaging to selling), 5= Others (specify)…….

Appendix 8: Extension officer interview checklist

Name of respondent	
Date of interview	
Region	
District	
Ward	
village	

1. Are you involved in the promotion of various management and seed quality at farmer's and community level fields? **1= Yes; 2=No.**
2. If yes, is maize and groundnut among the major crops? **1= Yes; 2=No.**…
3. Do you participate in the strengthening of informal seed systems through community seed banks and seed fairs, **1= Yes; 2=No.**
4. Are you involved in the organization of farmers into community-based seed production schemes for quality declared seed? **1= Yes; 2=No.**
5. If yes, is groundnut and maize among the crops included in seed production? **1= Yes; 2=No.**
6. How are the farmers organized to ensure required volumes are produced? (circle) 1=Household cluster, 2= By village,3= Others (specify)……
7. How long have you been training farmers on seed production? (circle) 1= Less than 1 year, 2= 1-2 years, 3= 2-5 years, Others (specify)
8. What challenges do you face when training farmers on:

Component	**Challenges**
Input acquisition	
Input use	
Postharvest	
Access to finance	
Business	
Marketing	
Challenges 1= Lack of expertise, 2= Lack of monetary resources, 3= Level of education, 4= Lack of collateral, 5= Others (specify)	

9. What can be done to overcome challenges related to:

Component	**Challenges**
Input acquisition	
Input use	
Postharvest	
Access to finance	
Business	
Marketing	
Challenges 1= Capacity building, 2= Access to finance, 3= Others (specify)	

10. Do you provide vital marketing information back to operators in seed companies for them to adjust products based on farmers' preferences? **1= Yes; 2=No.**

11. What type of market information do you provide? (circle) 1= Prices, 2= available market options, 3= Market trends, 4= Market requirements (quality standards), 5= Others (specify)

……

Appendix 9: Research Institutes Interview Checklist

Name of respondent	
Date of interview	
Region	
District	
Department	
Research Institute	

1. Do you have descriptors of the improved groundnut/maize varieties you have released in the last four years? (circle)1= Yes; 2=No

2. If yes, how do you make the information accessible to seed companies/seed producers? (circle) Training,2= Brochures, 3= Seminars, 4= Others (specify)

3. Do you have a catalog of various profiles of the recently released varieties? (circle) (circle)1= Yes; 2=No

4. If yes, who was consulted during the development of these profiles? (circle) 1= Farmers, 2= Breeders, 3= Socio-economist, 4= Gender specialist, 5= Others (specify)

5. Are the information on productivity potential and agroecological suitability of these varieties available? (circle)1= Yes; 2=No

6. If yes, in which form (circle) 1= Booklet, 2= Brochures, 3= Technical report, 4= File, 5= Others (specify)

7. How frequently do you collect germplasm to increase diversity in your program? (circle) 1= Quarterly, 2= Annually, 3= Biannually, 4= Others (specify)

8. Does your institution characterize and conserve germplasm for groundnut/maize? (circle)1= Yes; 2=No

9. If yes, where do you source germplasm from? (circle) 1= CGIAR, 2= Own collection, 3= Regional gene banks,4= USA gene banks, 5= Others (specify)

10. Which breeding approaches do you use in your program? 1= Conventional,2= marker-assisted breeding 3= Combined methods 4= Others (specify)

11. How many breeding populations for groundnut/maize do you initiate per year? (circle) 1= <20, 2 = <403=<60, 4= Others (specify)

12. Do you use modern tools in the development of new varieties? (circle)1= Yes; 2=No

13. If yes specify…….

14. How many generation advances does your program do per year (specify)?

15. Which are the key traits that you prioritize in your breeding program? (circle) 1= Disease resistance, 2= Pest resistance, 3= Quality (nutrition, colour, taste, grain size), 3= Abiotic stress tolerance, 4=Yield 5= Others (specify)

16. Once a variety is released, who takes over the seed production and its promotion? (circle) 1= ASA,2= Seed companies, 3= Community seed banks, 4= Others (specify)

17. Who is involved in quality regulation? (circle) 1= Zonal inspectors 2= District inspectors, 3= Others (specify)

18. Which classes of seed do you produce? And at what quantities per season? (circle) 1= Nucleus, Basic/foundation, Basic/foundation Certified Others (specify)

19. Do you supply early-generation seed (EGS)? (circle)1= Yes; 2=No

20. If yes, what quantities per year? (circle) 1= < 1 tones, 2= < 2 tones,3= Over 3 tonnes, 4= Others (specify)

21. Does your institution advocate for decentralized seed production and distribution? 1=Yes 2=No

22. If yes, what support does it offer? (circle) 1= Farmer organization, 2= Establishment of innovation platforms 3= Others (specify)

23. Do you involve farmers in the promotion of improved varieties? 1=Yes 2=No

24. If yes, how do you engage them? (circle) 1= On-farm trials, 2= Individual farmer consultations, 3= farmer group consultations 4= Others (specify)

25. Do you scale out select improved varieties? (circle) 1=Yes 2=No

26. If yes i) which approach do you use? (circle) 1= Demonstrations, 2= Field days, 3= Mass media, 4= Others (specify)

27. In your opinion, which are the major challenges to avail improved seed of groundnut/maize to farmers? (circle) 1= Weak policy environment, 2= Disconnect between EGS and commercial class seed development, 3= Lack of involvement of farmers in variety, 4= Weak institutional framework, 5= weak link between utilization of products and markets,6= Others (specify)

Appendix 10: Normality test

Variables used in binary logistic regression	Skewness (Z-values) Groundnut	Maize
Age	-0.459	-1.183
Sex	0.829	0.412
Education level	-0.410	0.234
Household size	0.443	0.443
Land size	-0.338	0.93
Frequency of extension services	0.582	0.64
Training	-0.309	0.731
Access to credit	0.386	0.542
Distance to the market	-1.092	0.983

Appendix 11: Independent samples t- test gross margins for groundnut and maize seed farming

(ii) Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									lower	Upper
gross margin of tobacco and groundnut farmers	Equal variances assumed	20.132	.000	2.773	119	.007	618753.8798	223165.82169	176863.26383	1060644.49573
	Equal variances not assumed			2.576	75.968	.008	618753.8798	224528.48138	171632.42496	1065875.33461