ANALYSIS OF CONTRACT FARMING PARTICIPATION AND PROFITABILITY AMONG SMALLHOLDER SORGHUM FARMERS IN LAIKIPIA COUNTY

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DECLARATION

Student's Declaration

This thesis is my original work and has not been presented in any other University for the award of a degree.

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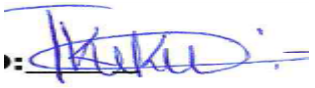
Signature …  …… Date ……30/8/2024…….

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DEDICATION

My research output is dedicated to all agricultural stakeholders dedicated to improving the value smallholder farmers get from their products.

ACKNOWLEDGEMENTS

It has not been an easy task to complete this research work. To my wife Victoria, much gratitude for being a life partner and supporter of my vision. To my supervisors; Dr. Eric Bett, and Dr. Gabriel Mwenjeri of Kenyatta University, thank you for your guidance, direction, and patience as they walked with me through the journey of writing this thesis.

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ABBREVIATIONS AND ACRONYMS

ASAL	: Arid and Semi-Arid Land
CF	: Contract Farming
CDP	: County Development Plan
CBA	: Cost-Benefit Analysis
DH	: Double Hurdle
EABL	: East African Breweries Limited
EAML	: East African Malting Limited
FAO	: Food & Agriculture Organization
GAP	: Good Agricultural Practices
GM	: Gross Margin
GDP	: Gross Domestic Product
IFPRI	: International Food Policy Research Institute
IRR	: Internal Rate of Return
KALRO	: Kenya Agricultural & Livestock Research Organization
KNBS	: Kenya National Bureau of Statistics
MOALF	: Ministry of Agriculture Livestock & Fisheries
MLR	: Multiple Linear Regression
NPV	: Net Present Value
OF	: Organic Farming
ROI	: Return on Investment
SSA	: Sub-Saharan Africa

ABSTRACT

Agricultural productivity and profitability should be improved to enhance incomes and food security among smallholder farmers. The Laikipia County government has been deliberately putting effort into encouraging smallholder sorghum producers to embrace contract farming (CF) to mitigate market failures linked to spot markets that are a result of information asymmetry. However, empirical studies on participation decisions in CF among smallholder sorghum farmers are limited. The study examined determinants of participation decision and intensity, and profitability of CF among smallholder sorghum farmers in Laikipia to bridge the information gap. Multistage sampling was used, and the research first used purposive sampling to pick Laikipia West and East sub-counties as the study sites. The second stage was random sampling to identify small-scale sorghum farmers within specific wards. The data was collected from 188 sorghum farmers between the years 2016 and 2017 using a semi-structured questionnaire. The research used a double hurdle (DH) model to determine the decision to participate in CF as well as the intensity of participation. Multiple linear regression (MLR) assessed the determinants of profitability among smallholder sorghum farmers. The results revealed that the significant determinants of CF participation were land ownership, distance to a major town, land acreage, group membership, and the number of extension visits, which significantly influenced the decision to participate in CF. Participation intensity in CF was influenced by farming experience, extension access, credit, and land tenure. CF participants attained an annual profit of Kes 57,170 per acre with a value of 1.69 for return on investment (ROI). Age, education, and land size influenced profitability among the CF non-participants. Education, land size, and credit access determined CF participants' profitability. The study concluded that land tenure was a motivating factor that influenced the decisions of sorghum producers in CF to participate due to the security of tenure. Smallholder sorghum production under contract farming was a profitable business. Credit accessed through the CF scheme increased participation intensity and profitability in sorghum farming. The study recommends that the County government of Laikipia improve on the extension services to augment those offered by the East Africa Malting Limited agents. The County government should assist as many farmers as possible in acquiring land title deeds, which increases their enterprise profitability. The Necco Fosa Cooperative Society agents and Laikipia county extension providers ought to work together to inspire CF non-participants to join the CF scheme to access credit.

CHAPTER ONE: INTRODUCTION

1.1 Background

Contract farming (CF) can be explained as an official arrangement between a producer and a purchaser established and agreed upon before the production of specific quality, quantity, standards, and date of delivery of a product at an agreed fixed price (Mugwagwa et al., 2020; Setboonsarng, 2008). The five models adopted in CF are informal, nucleus, centralized, intermediary, and multipartite. The most popular is the centralized model, in which a buyer acquires large volumes of agricultural produce from numerous producers. Provision of services such as transport, inputs, and extension are offered in form of credit (Eaton & Shepherd, 2001; Mugwagwa et al., 2020). Contract farming's importance globally has been due to the need for strengthening vertical coordination between agribusiness firms and producers.

In Sub-Saharan Africa (SSA), smallholder farmers experience various challenges that lower their productivity and profitability. As such, improved CF is important in reducing these problems (Amede et al., 2023; Oya, 2012). For a long time in SSA, written formal contracts have not been used especially by smallholder farmers but existed for large and commercial farmers, mainly for the export businesses because it is linked to labor-intensive crops, standards, and technologies in which the scheme calls for hired labor or skills (Meemken & Bellemare, 2020). Informal agreements have been used for years and are still accepted in many countries (Fafchamps, 2003). Over the years, this has changed and formal contracts are being used to enhance commercial farming. CF is proving to be successful for many African countries in enhancing productivity, profitability, and diversification; it is not necessarily the solution for many market failures in agriculture (Wainaina, Okello, & Nzuma, 2012).

In Kenya, marketing and production contracts for both crop and animal enterprises are being practiced for vertical integration. Contract farming in the livestock sector mainly deals with beef and poultry products (Mutura, 2015). In crops, CF is widely practiced in horticulture and field crops such as sugarcane, tea, coffee, tobacco cotton, canola, soya bean, barley, and lately sorghum.

In the mid-1980s, more than 230,000 households in Kenya were in CF arrangements for horticultural products, tobacco, oilseeds, tea, and sugarcane. By 2010, over 1 million farming households that produced vegetable crops, barley, dairy cattle, tea, coffee, sugarcane, and maize were engaged in contract farming. Since over 70% of the population in Kenya lives within the rural setup and depends on agriculture for livelihood, enhancing access to international and local markets might be a great strategy for achieving better livelihoods for the smallholder rural farmers (Giger et al., 2022; Mutura, 2015).

The current market demand for sorghum, especially for beer production overwhelmingly surpasses the quantities supplied by farmers (Okuthe et al., 2013; Orr et al., 2022). Sorghum production in Kenya rose from 140,000 to 150,000 metric tons from 2016 to 2017, representing an increase of 7.14%. However, in the same year, 94.4 Kt worth 18.7 million dollars of Sorghum was imported to meet the shortfall in demand, mainly from the United States, India, Tanzania, and Uganda (Njuguna, 2018).

In Laikipia County, canola, soya bean, sunflower, Rhode grass, and sorghum have mainly been grown under CF for the last five years (Ministry of Agriculture Livestock and Fisheries, 2015). However, sorghum has proved to yield better results due to its drought-tolerant nature, and this has seen a tremendous rise in the number of farmers growing the cereal in Laikipia. Therefore, Sorghum farmers have a higher advantage over other crops because they can meet the contracting agency's demand.

The CF is also a scheme to enhance forward and backward market linkage for agricultural production. There are proof and evidence that CF has positively impacted productivity and improved the welfare of farmers (Okuthe et al., 2013; Oya, 2012; Wainaina et al., 2012). In Laikipia, the County Government and other stakeholders like the East African Malting Limited are implementing a program on CF for sorghum production to advance smallholder farmers' productivity and profitability. Despite the recorded benefits, the Department of Agriculture (2017) reported that a few farmers (500) participated in the CF scheme in Laikipia.

1.2 Problem statement

Sorghum is a vital cereal crop utilized for food and forage, and it has increasingly been used commercially to replace barley in malting. In Kenya, the government and NGOs have actively promoted sorghum as an ideal crop for semi-arid regions due to its resilience to severe weather conditions. In Laikipia County, efforts to encourage sorghum farming have significantly increased smallholder farmers' productivity and profitability. Over the past five years, the acreage under sorghum production has expanded from 500 to over 4,000 hectares (Laikipia County Integrated Development Plan, 2017-2022). By the 2016/2017 cropping year, more than 3,500 smallholder farmers in Laikipia East and West sub-counties were engaged in sorghum farming, with an average yield of 1 ton per hectare (Department of Agriculture, 2017).

Contract farming (CF) has been introduced as a vertical integration scheme to create new market opportunities and increase smallholder farmers' incomes. The continuous demand by brewers to substitute barley with sorghum has led the county government and stakeholders, such as East African Malting Limited, to identify contract farming as a means to boost productivity and profitability, ultimately improving livelihoods.

Despite the benefits associated with contract farming in Laikipia, including insurance, credit access, input access, extension advisory services, and a ready market, only 500 smallholder sorghum farmers participated in CF in 2016/2017. By 2022, the plan anticipated that about 1,500 farmers would participate in CF in Laikipia East and West sub-counties and new partners such as Tower Sacco are currently providing credit facilities (Department of Agriculture Annual Crops Report, 2017). Although we have some studies, such as Mbaabu & Mbugua (2019) and Onyango et al. (2023), analyze the factors influencing farmers' participation and profitability in other parts of Kenya, determinants of sorghum CF in Laikipia have not been assessed to explain why there were only 500 CF participants of CF in Laikipia West and East sub-counties at the time of study in 2017. This study aims to fill the existing knowledge gap by investigating these factors.

1.3 Objectives

1.3.1 General objective

The overall research aim was to assess the determinants of participation and profitability of contract farming by smallholder sorghum farmers in Laikipia.

1.4 Specific research objectives

1. To describe the socioeconomic characteristics of smallholder sorghum farmers in Laikipia County
2. To assess the determinants of decision and intensity of participation in CF among smallholder sorghum producers in Laikipia County
3. To assess profitability and the determinants of profitability of sorghum production among the participants and non-participants of CF in Laikipia County

1.5 Research Questions

1. Which socioeconomic characteristics exist among smallholder sorghum farming households in Laikipia County?
2. Which factors determine the decision to participate in CF and the intensity of participation among smallholder sorghum producers in Laikipia County?
3. Which factors influence the profitability of sorghum farming among the participants and non-participants of CF in Laikipia County?

1.6 Justification

The first and second Sustainable Development Goals (SDGs) aim to eradicate poverty and hunger worldwide (Filho et al., 2021). However, achieving these goals faces significant challenges, especially in the Arid and Semi-Arid Lands (ASALs) of Sub-Saharan Africa (SSA). With 80% of its land classified as ASAL, Kenya is particularly affected due to its heavy reliance on rain-fed agriculture. Researchers have recommended sorghum production in these areas because it tolerates harsh climatic conditions (Okeyo et al., 2020).

Sorghum is a crop of immense economic value in Kenya and is ranked among the major staples. It is crucial to enhance sorghum productivity through sustainable means to achieve food security, as it provides a livelihood for many rural households. Schemes such as contract farming have been introduced to promote the acceptance and

cultivation of this crop in regions like Laikipia County. Reports indicate that contract farming has the potential to create stable sorghum enterprises, yet some farmers have not adopted the scheme (Laikipia County Integrated Development Plan, 2017-2022).

This study's results will benefit stakeholders and policymakers responsible for promoting contract farming practices. These insights will enable them to evaluate the success and challenges of current strategies, thereby enhancing their effectiveness. For smallholder farmers, the study will provide critical information to guide their decision-making regarding participation in sorghum contract farming, aiming to increase productivity and profitability sustainably.

Furthermore, this research will support agricultural policies targeting food security and productivity. It will assist in developing agricultural public-private partnerships by identifying the factors influencing participation and profitability in sorghum contract farming. The contract farming scheme partners—including the County Government of Laikipia, East African Malting Limited (EAML), and Necco Fosa Co-operative Society—will gain insights into the low uptake of contract farming. Understanding these barriers will help them devise strategies to encourage broader adoption and participation.

Additionally, this study will contribute to the broader body of knowledge on sustainable agricultural practices in ASALs, providing a model that can be replicated in other regions facing similar challenges. By addressing the economic and social barriers to sorghum CF, the research will offer practical solutions to enhance the livelihoods of smallholder farmers and promote sustainable agricultural development in Kenya and beyond.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

The chapter thoroughly examines the literature on participation and profitability in contract farming, and it also discusses theoretical and conceptual frameworks.

2.2 Methods used in measuring adoption of agricultural technologies

Econometric methodologies are central to assessing agricultural technology adoption, each offering a distinctive perspective on varied aspects of the adoption process (Abay et al., 2016). Probit models usually estimate binary outcomes, such as farmer technology adoption as a categorical dependent variable (Kimbi et al., 2020). Built on the assumption of a latent utility function influencing adoption decisions, these models excel at handling dichotomous variables (Feder et al., 1985). Logit models present a similar method yet utilize a logistic distribution for the latent variable, potentially yielding different outcomes due to its distinct functional form (Jose et al., 2020).

Tobit models are vital when the dependent variable is censored, such as when technology use is observed within specific limits. These models estimate adoption probability and use intensity (Lamichhane et al., 2018). Heckman selection models address potential sampling bias by independently modeling adoption decisions and extent, providing a more comprehensive understanding of adoption processes where non-random selection may be an issue (Certo et al., 2016).

The Double Hurdle model is valuableor analyzing adoption processes with two distinct stages (Cragg, 1971). This model effectively separates the decision to adopt from the subsequent level of adoption. Using a binary choice model and a truncated regression, the Double Hurdle model addresses challenges related to non-adoption and varying adoption levels. This study found it most appropriate to employ the DH model to analyze the participation and level of participation determinants.

2.3 Methods used in measuring profitability in agricultural settings

Understanding the financial health and long-term viability of a farming enterprise is essential. Various economic and statistical tools are used to analyze agricultural profitability. To gain a comprehensive understanding of a farming operation’s profitability and sustainability, the Cost-Benefit Analysis (CBA) method is employed (Akinyi et al., 2022). This approach examines both the costs and benefits of agricultural

ventures over time, considering both direct and indirect impacts. Advanced techniques such as Net Present Value (NPV) and Internal Rate of Return (IRR) are used within CBA to evaluate long-term projects. NPV determines the current value of future earnings, while IRR calculates the rate at which a project's net present value equals zero.

One of the most common methods is Gross Margin (GM) Analysis, which calculates the difference between a farm's total income and its variable costs (Djokoto & Zigah, 2021). This provides a basic snapshot of short-term financial performance. GM analysis is particularly useful for computing profit using cross-sectional data, making it a popular choice in agricultural studies (Detre et al., 2011).

2.4 Studies on participation and profitability in contract farming

Abdulai and Al-Hassan (2016) used the Heckman two-stage model to assess the effects of CF on soybean farmers' income in Ghana. Extension access, credit, and ready market for sorghum produce were significant determinants of CF participation. Further, they explained that farmers cultivating on smaller land sizes are most likely to participate in contract farming because of the frantic situations that keep them off commercial agriculture. The study identified that during market peaks, CF offers farmers non-competitive prices, thus denying them a chance to enjoy market prices. The study did not compare the profitability among the CF participants and participants.

Mwangi et al. (2020a) used a multidimensional adoption approach to assess the uptake and intensity uptake for improved sorghum varieties (ISVs) in Kenya. The intensity with which smallholder farmers participate in cultivating improved sorghum varieties was influenced by longer distances to the administrative centers and small cultivable land sizes. The study did assess the profitability of the enterprises.

Alulu (2020) assessed vegetable farmers' participation in CF and how participation in the scheme influenced their technical efficiency. The researcher identified the determinants of CF participation using a Probit model and the determinants of technical efficiency using stochastic frontier analysis (SFA). Although the research assessed CF participation and profitability, it did not consider the variables influencing the participation intensity among vegetable farmers.

Dubbert (2019) conducted a study using an endogenous switching model to acquire insights into cashew CF participation in Ghana. Participation in CF significantly increased net revenues, cashew yields, price margins, and labor productivity. Further, the study identified that small-scale farmers were the biggest beneficiaries of CF compared to their large-and-medium-scale colleagues. However, the study did not shed light on the intensity in which CF participants participated and the factors that led to such an extent.

Khanal et al. (2020) investigated how high-value crop CF would influence Nepal's profits and profitability. The study assessed the determinants of CF participation and the percentage increase in yields using the multinomial endogenous switching regression. Despite the survey assessing the net returns ha^{-1} (profitability) and assessing the determinants of CF participation, it did not go further to understand some of the factors that influenced the intensity of participation so that relevant measures could be taken.

Gopala et al. (2018) studied the determinants of participation in poultry CF in India. They looked at the motivating factors that drive farmers into the CF scheme. The three main motivation factors for CF participation included zero market risks, quick and regular returns, and less working capital requirement than CF non-participation. The research, however, omitted the CF participation decision, intensity, and profitability of the poultry enterprise due to CF participation being omitted in the study. The study also missed the determinants of CF participation intensity and profitability.

Rondhi et al. (2020) assessed the determinants of broiler CF in Indonesia using a Logistic regression. The study found that agricultural education, farmer groups, population, land size, and farmer education were the positive determinants of CF participation, while access to cooperative services influenced participation negatively. The intensity and profitability of participation attributable to CF were missing in the study, thus leaving out an essential element of the research that would give a holistic meaning to the findings.

Muroiwa et al. (2018) studied the factors affecting CF participation decisions in tobacco in Zimbabwe using a binary Logistic regression. Female tobacco farmers were found to have a lower likelihood of participating in CF than male farmers. Access to education

services and farming experience positively influenced CF participation. The study did not assess profitability from CF participation and issues of participation intensity. Comparing profitability among CF participants and non-participants can help to determine if the scheme causes a significant difference in profits (Alulu, 2020).

Tuan (2012) evaluated the effect of CF participation among farmers in Vietnam through a literature review and a small case study. The research found increased income among the CF participants. The study also found a significant gap in agricultural training at the community and district levels. However, the study did not review the factors affecting both decision-making and intensity of participation. Also, the study omitted the profitability comparison among the participants and non-participants of CF.

Ambetsa et al. (2021) evaluated the profitability gained by farmers in the participation of contracted services offered by selected sugarcane factories in Western Kenya. The services include cash credit, transport, extension education, agrochemicals, fertilizer, and seed cane. The study determined a difference in the profitability of sugarcane farming among CF participants and non-participants. It used multiple linear regression (MLR) to assess the profitability determinants among the contracted sugarcane farmers. The study, however, omitted the assessment of the decision to participate in CF and the intensity of participation.

Research by Sambuo (2014) in Tanzania assessed the influence of tobacco CF on farmers' income at Urambo. The research utilized Heckman's two-stage method to analyze participation decisions and factors influencing CF participation decisions. The study concluded that CF is essential but inadequate to improve farmers' income exclusively; thus, farmers should also add off-farm investments into their income-earning portfolio. The study, however, failed to investigate the intensity of CF participation, compare the profitability among CF participants and non-participants in tobacco farming, and determine the factors influencing the intensity and profitability.

A report by Kumar et al. (2018) for the International Food Policy Research Institute (IFPRI) examined the influence of CF on farmers' income on pomegranate, okra, and onions. The study assessed the impact using the propensity score matching (PSM) method. The research also evaluated factors influencing participation and profits. The study did not consider the intensity of CF participation and the intensity determinants.

Swain (2018) assessed the factors determining the CF participation intensity among hybrid paddy rice and gherkin producers in India. The intensity of CF participation was measured using family labor and land allocated to the two crops. The study recommended that an ideal way to increase the intensity of participation is via increasing landholding size and improving the education levels of farmers. The study failed to assess the CF participation decision and its profitability for the three crops.

In research to assess the existence of asymmetric information in CF participation in the tobacco sector, Rondhi et al. (2020) sampled 113 farmers in Indonesia. The study used the probit model to estimate the determinants of tobacco CF participation. The study revealed that youthful farmers cultivating more extensive land are mostly expected to participate in CF compared to male and female tobacco farmers. The study failed to assess the profitability differences between the participants and non-participants of CF.

Brandão and Schoneveld (2021) assessed the labor inclusivity challenges and constraints in CF of oil palm in Brazil. The study estimated a Probit model by estimating the determinants of CF participation in the oil palm sector. It used an endogenous switching regression to assess the factors affecting the CF participation intensity, which was measured through labor allocation among the participants. The research did not go further to determine profitability among the participants and non-participants of CF.

Mbaabu & Mbugua (2019) assessed the profitability determinants in sorghum CF in Meru. Multiple linear regression was used to estimate the influence of various factors on CF profitability. The study concluded that CF increased farmers' income and that smallholder farmers should be subjected to several agricultural pieces of training to understand the scheme. The study did not cover participation and intensity before assessing the profitability.

Maindi (2017) studied the extent to which farmers in Murang'and marketing groups participated in avocado production. A double hurdle analysis was used, and results noted that 14-16 members were ideal for a farmers' group, and among the key determinants of group participation included trust index, group size, age, and farm size, among others. Profitability due to participation in the scheme was not assessed in this study.

Olwande and Mathenge (2012) studied participation in markets among Kenyan poor rural dwellers. The research used a double hurdle approach analysis. The study disclosed that market participation in selected commodities differed significantly between non-poor and poor households, with low market participation being experienced a lot among poor families. However, the study did not demonstrate the profitability due to participation in a market channel.

A study conducted by Mutai et al. (2013) in Nakuru, Kenya, assessed the socioeconomic factors influencing grain farmers' decisions and intensity of participation in the warehouse receipt system. A double hurdle model was used. It was clear that group membership and land size influenced participation intensity, while off-farm income, gender, and land size influenced participation. The study did not take into consideration the profitability of participation or non-participation.

Fischer and Qaim (2014) used the double-hurdle approach in a study of collection action for smallholder banana farmers in Kenya. The research concluded that member benefits and labor availability influenced the participation of farmers in group and collective marketing activities. The study failed to incorporate the assessment of the profitability of the scheme in the research.

Adeoti et al. (2014) analyzed market participation for small maize farmers of Oyo state, Nigeria, by employing a double hurdle approach to identify four options for marketing. Results revealed the farm gate selling as the most popular among farmers. Education, road conditions, bags harvested, and group participation influenced farmers' participation in the market. The study failed to give the economic benefits of market participation and non-participation.

Kiwanuka and Machethe (2016) analyzed the participation of smallholder farmers in the Zambian dairy sector using a double-hurdle model. The research found that household head, rearing culture, and milk sold quantity, among other factors, determined the choice of participation among dairy farmers in CF. The study did not consider profits from milk sold under the CF scheme.

Ekepu et al. (2017) assessed the involvement of farmers in collective actions in sorghum farming in Soroti Uganda. The study established that extension services and gender were the most significant factors in building functional farmers' associations

and groups, even with vast financial and human resources. The importance of these two factors cannot be overlooked in strong farmer organizations' formation. The intensity and profitability of CF participation were missing from the study.

Sigei (2014) used a Heckman model in his study to determine market participation by small-scale pineapple farmers. Education, gender, and yields were among the factors found to be significant in participation decisions while on the other hand price information, vehicle ownership, and yields influenced the outlet used for the pineapple market. The study focused on only pineapple farmers participating in the market but did not consider profitability.

Gicheha et al. (2015)used a two-stage Heckman regression analysis to study farmer participation in collective marketing in western Kenya. It was revealed through the study that the participation decision and intensity of farmers in collective marketing activities were determined by bird price, household head age, off-farm employment, distance to extension sources, credit access, land size, and household head education level.

Tolno et al. (2015) studied the role of organizations in enhancing potato farmers' income. The probit model showed access to credit, land size, household head age, ownership, and extension significantly influenced group participation. The results demonstrated that farmers in organized groups have the advantage of increased production and incomes. The study did not consider profitability due to participation in farmer groups.

Mwambi et al. (2016) studied whether contract farming improved income earned from smallholder avocado production in Kenya. The study revealed that participation in CF is insufficient to improve farm incomes. Although the study concluded that CF is necessary but insufficient to raise the income earned by smallholder farmers, it failed to consider the enterprise's profitability among the CF participants and non-participants.

Bolwig et al. (2009) studied the economics of CF amongst smallholder organic farming households in tropical Africa and examined the effects on revenue of organic contract farming. The research used the ordinary least squares (OLS) regression and the Heckman selection model. Results demonstrated that revenue was positively influenced by participation in CF activities and organic farming. However, The current study

utilized a double hurdle method to measure decision and intensity to adopt CF, yielding more accurate results than OLS.

Zalkuwi and Giroh (2014) studied the profitability analysis of sorghum production in India. The profitability of production in the selected six states of India was compared using the cost concept. Andhra Pradesh had the highest profitability, resulting from improved gross and net incomes and sorghum production net return.

Baiyegunhi and Fraser (2009) conducted research in Kaduna state, Nigeria, to assess the profitability of sorghum production. Gross margin calculation was employed to estimate the profitability among small-scale and large-scale farms in sole sorghum production. Empirical results revealed that sorghum producers made profits based on cost-effectiveness.

2.5 Research gap

A review of the existing contract farming (CF) studies revealed several critical gaps this study comprehensively addressed. Many studies have utilized robust methodologies such as the Heckman two-stage and double-hurdle (DH) model to assess participation decisions and intensity (Abdulai & Al-Hassan, 2016; Gicheha et al., 2015). However, many of these studies did not extend their analysis to compare CF and non-participants' profitability. For example, studies by Abdulai & Al-Hassan (2016), Fischer & Qaim (2014), and Sambuo (2014) focused on participation decisions and intensity but neglected the comparison of profitability. This research comprehensively examined participation and intensity and the profitability implications for both CF and non-participants. It provided a complete understanding of CF's economic effects, demonstrating the study's thoroughness and rigor.

Several studies have explored the determinants of CF participation and its impact on profitability (Alulu, 2020; Khanal et al., 2020). However, these studies often overlook the intensity of participation and the factors influencing it. For instance, Dubbert (2019) and Kumar et al. (2018) identified positive outcomes from CF participation. Still, they did not explore the intensity of participation, leaving a gap in understanding how deeply farmers engage in CF and what drives this engagement. By investigating both the decision to participate in CF and the extent of participation, this research contributed to

a more subtle understanding of farmer involvement in CF and the factors driving it. This knowledge can inform strategies to enhance farmer engagement in CF.

While some studies have utilized advanced econometric methods, their application could be more consistent across different research areas. For example, Gicheha et al. (2015) used Heckman's two-stage model to analyze participation decisions and intensity, but the aspect of profitability was not addressed. Studies by Swain (2018) and Tuan (2012) assessed participation intensity but did not consider the initial participation decision or the resulting profitability. Our research differentiated itself by employing a consistent methodological approach to analyze the decision to participate and the level of participation in CF. Combining this with an analysis of profitability determinants can provide a more robust and detailed understanding of CF dynamics.

Many studies focus narrowly on specific aspects of CF, such as participation decisions or profitability, without considering the broader context. For instance, studies like those by Brandão & Schoneveld (2021) and Mbaabu & Mbugua (2019) did not integrate their findings into a broader understanding of how CF affects farmers' livelihoods holistically. Our research adopted a holistic perspective by examining the interconnectedness of participation, intensity, and profitability within the broader context of farmers' livelihoods. The holistic approach provided a more comprehensive understanding of CF's impact and can inform strategies for improving its outcomes.

2.6 Theoretical framework

Drawing on the rational choice theory (Redfield, 2013) and Neumann-Morgenstern's utility maximization theory (Kontek, 2010), this study expects to observe a positive correlation between sorghum contract farming (CF) participation and increased productivity and profitability. The rational choice theory suggests that farmers rationally make decisions, choosing CF to improve productivity and profitability. Similarly, Neumann-Morgenstern's utility maximization theory indicates that individuals undertake activities that maximize expected gains (utility), a measure of satisfaction or happiness derived from a particular choice. As a result, this study assumes that farmers make decisions regarding CF participation based on utility maximization.

We find robust frameworks for understanding agricultural decision-making when we examine rational choice theory and Neumann-Morgenstern's theory of utility maximization. However, comparing these theories to alternative theories is essential to fully grasp their strengths and weaknesses and provide a comprehensive understanding of the two theories. For example, behavioral economics incorporates psychological insights into economic models and recognizes that individuals may act irrationally due to biases (Shi, 2023). This view suggests that cognitive biases could influence farmer decisions, which may lead to suboptimal choices. Yet, while behavioral economics offers a nuanced understanding of decision-making, it may not always possess the predictive precision of rational choice and utility maximization models (Raj, 2023). The latter theories assume consistent and coherent decision-making, enabling structured behavior modeling and prediction.

In 1979, Kahneman and Tversky introduced prospect theory, which suggests that people place different values on gains and losses, departing from the expected utility theory (Kahneman & Tversky, 1979). Farmers may prioritize potential losses over gains regarding CF, affecting their participation decisions. While prospect theory offers valuable insights into decision-making under uncertainty and risk, it complicates the simple analysis provided by rational choice and utility maximization theories. These latter theories assume rational behavior and utility maximization, simplifying economic modeling in agricultural contexts.

Institutional economics underscores the impact of institutions and social norms on economic behavior (Raudla, 2014). Market structures, legal frameworks, and cultural norms may shape farmers' decisions related to conservation farming. While this broader context is crucial, institutional economics often overlooks the individual-level focus of rational choice and utility maximization. These theories create a microeconomic foundation for systematically and quantitatively analyzing individual farmer decisions.

Sociological theories emphasize the influence of social networks, cultural values, and collective behavior on decision-making (Granovetter, 1985). Farmers' participation in CF might be influenced by peer pressure, social learning, and community norms. Despite the significance of these factors, sociological theories often need more rigorous mathematical modeling for predicting individual behavior. Rational choice and utility

maximization offer a more systematic approach to understanding and modeling individual economic decision-making.

In summary, while behavioral economics, prospect theory, institutional economics, and sociological theories offer valuable understandings of decision-making, rational choice theory, and Neumann-Morgenstern's utility maximization theory provide a coherent and practical framework for comprehending farmer involvement in sorghum CF. These theories' emphasis on rational behavior and utility maximization allows for precise modeling and prediction of economic behavior, making them particularly applicable and confident in the conclusions of this research. Therefore, this study settled for the rational choice theory and Neumann-Morgenstern's utility maximization theory.

2.7 Conceptual framework

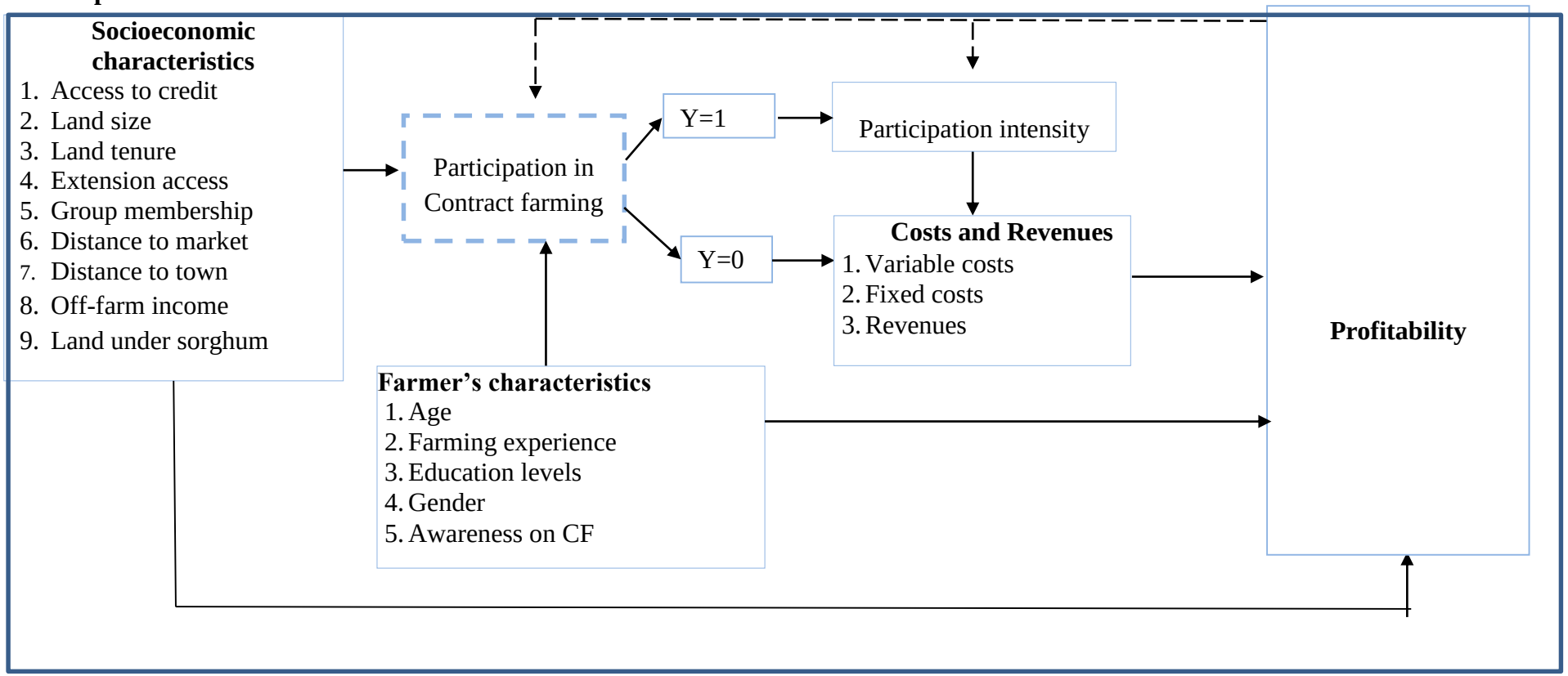

Figure 1.1: Conceptual framework display of the interaction among various variables
Source: Modified from Fischer & Qaim (2014)
Key: ⟶ Direction of influence ⟶ Feedback effect

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Study area

This research was conducted in Laikipia County, located in the South Rift region of the country, and covers an area of 9,462 km^2. The county's population was 541,985 persons by 2018, according to the 2019 population census projections (County Government of Laikipia, 2019). Out of the total landmass, arable land constitutes approximately 1,984 km^2, non-arable land constitutes about 7,456 km^2, and urban areas constitute around 243.3 $km^{2,}$ with the average landholding being 3.33 ha. The county receives an average of 400mm to 700mm of rainfall annually and a mean annual temperature between 16^0c and 26^0c (Ogega, 2017). Laikipia County was selected because it is one of the ASAL counties where sorghum farming is being promoted as a commercial and food crop by the county government, KALRO, and EABL (KALRO, 2020; Muchiri et al., 2020). Therefore, this study found it fit to assess the effects of CF on sorghum farming profitability.

3.2 Study design and sampling procedure

This study utilized a cross-sectional research design to explore the factors influencing smallholder sorghum farmers' decision-making regarding contract farming (CF) participation and the subsequent effect on their profitability in Laikipia County. By gathering data from a diverse sample at a specific time, this design provides a comprehensive snapshot of the current status of CF among sorghum farmers (Nangobi & Mugonola, 2018). This approach is appropriate for analyzing the connections between variables influencing farmers' involvement and profitability in CF.

The selection of the respondents included in the sample was done through multistage sampling. The study opted for multistage sampling because of its ability to effectively handle the complications of extensive and varied populations, such as sorghum contract farmers across Laikipia County (Wu et al., 2023). This approach enabled an orderly transition from more expansive Laikipia county areas to Laikipia East and West sub-counties, ensuring that the selected sample is a realistic representation of the entire contract farmers in Laikipia. To begin with, Laikipia West and East sub-counties were selected using purposive sampling since many stakeholders were heavily promoting sorghum CF in these regions. Secondly, four wards within the two sub-counties were

selected by random sampling. They included Ngobit and Umande wards of Laikipia East sub-county and Olmoran and Salama wards of Laikipia West sub-county. The study used the County Department of Agriculture checklists to identify small-scale farmers who grow sorghum within the sampled wards.

3.3 Sample size

The number of smallholder sorghum farmers in Laikipia West and East sub-counties was estimated at 3,500 (Ministry of Agriculture Livestock and Fisheries, 2015). The study employed Cochran's formula (Heinisch, 1965) by using population to calculate the size of a sample as follows:

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

Notably, p = 0.5, n=size of the sample, N=population size, and e = level of precision of 7% with a 95% confidence level. The study sample was 192 farmers from the calculation of the sample size is as follows;

$$\frac{3500}{1+3500(0.07^2)} = \text{n= } 192$$

The study used probability proportion to size to allocate 57, 38, 41, and 56 respondents to Ngobit, Umande, Olmoran, and Salama wards, respectively.

3.4 Data collection

Information from respondents was collected using semi-structured questionnaires. The enumerators were subjected to training before the onset of the survey. Most of them understood the local dialect that most farmers in Laikipia County use. The government agricultural officers, with knowledgeable village elders, assisted the enumerators in accessing households. The research involved only four cases of nullified questionnaires due to the many unanswered questions.

3.5 Econometric framework for analysis per objective

3.5.1 Determine and describe the socioeconomic characteristics of farmers growing Sorghum

Descriptive statistics were used to elaborate on the household's socio-economic characteristics to achieve this objective.

3.5.2 Determining the factors influencing both participation decision and intensity in sorghum contract farming

This study used a double hurdle (DH) model to analyze objective two. The double hurdle method parametrically assumes a generalized Tobit model developed by Cragg in 1971. According to (Cragg, 1971), participation decision and its level are in two levels; first, a farmer has to decide whether to participate, and the second level is the intensity of participation. The model by Cragg is in this method:

$D^*_i = \alpha Z_i + V_i$ ……..……... (3.2)

$Y^*_I = \beta X_i + U_i$ ……..... (3.3)

where Di = {1, if Di* > 0; 0 if Di* ≤ 0} and Yi = {Y*, if Y_i > 0 and Di*> 0; 0, if otherwise}

Di* – latent variable if a farmer participates in CF and makes the level 1 and 0 if otherwise

Zi – vector of variables explaining the participation decision in CF (credit access, farm size, gender, education, age, contact with extension services, land size, etc.)

Y^*_I – variable describing the level of farmer participation in CF, i.e., acreage allocated to sorghum growing under CF;

X_i – a range of variables that influence the CF participation level

V_i & U_i – stochastic error terms

3.5.3 Determining the factors affecting the profitability of Sorghum contract farming

The study specified the annual cost of inputs used for sorghum production per acre to calculate the total production costs in the study;

Total production cost (TC) = Total fixed cost (TFC) + Total variables cost (TVC)..… (3.4)

Total annual variable cost per acre included those incurred on equipment, input, chemicals, labor cost, post-harvest, and transportation, among others. The total fixed

cost included land rent among the sorghum farmers who leased and the opportunity cost (OC) of land forgone for not hiring out the portion of land under sorghum among the farmers with land ownership. The output was calculated as the total value of sorghum yield.

Gross margin (GM) analysis calculation per acre helped determine sorghum profitability farming under CF and those not participating (Barnard & Nix, 1979). The following calculations were done to get profitability;

Total revenue (TR) per acre = Total sales from (sorghum) + Total sales from stover……. (3.5)

The gross margin (GM) = TR –TVC ……. (3.6)

Net farm income (NFI)/Profit (π) = GM –TFC ..... (3.7)

Return on investment (ROI) = NFI/TC …..……..……..… (3.8)

To determine factors that influence profitability for smallholder sorghum farmers, a multiple linear regression (MLR) analysis was employed. Profit was the dependent variable that was regressed against different independent variables. A logarithmic functional model was used and the equation is as follows;

$$LnY = X_0 + Q_i + \ldots + X_j Q_j + \mu_i \quad \ldots\ldots (3.9)$$

where LnY = natural logarithm of profit; X_0 = intercept term; ($Q_1 - Q_i$) represent the independent variables while (X_1-X_i) represents the coefficients of ($Q_1 - Q_i$) respectively. The study transformed profit into natural logarithms since profit has to have a linear relationship with the explanatory variables. Because some profit values were so large, transforming them into natural logs helped solve this problem and the possible issue of heteroskedasticity. The transformation also helped interpret the coefficients as percentage changes in profit caused by explanatory variables. Then, μ_i is the disturbance term that caters to unseen random effects. An assumption made in this model was that errors are independently and normally distributed as $\{N(0, \sigma^2)\}$ and conditional on Q_i. Table 3.1 presents the variables used for all the objectives, their descriptions, measurement units, variable types, and the model in which the variables were used.

Table 3.1: Variables fitted in the econometric models and the description

Variable	Description of each the variable	Measurement unit	Variable type	Specific model
	Research dependent variables			
Participation	Whether a household participates in sorghum CF	1= Yes 0=No	Dummy	DH
Intensity	Level or intensity of participation in CF	Acres	Continuous	DH
LnProfit	The natural logs of annual profit from sales through CF per acre	Kenya shillings	Continuous	MLR
	Independent variables			
Age	Age of the HH head	Years	Continuous	DS, DH, MLR
Gender	Gender of the HH head	1=Male 0=Female	Dummy	DS, DH, MLR
Education level	HH head education	1=None 2=Primary 3=Secondary 4=Tertiary 5=Adult literacy	Dummy	DS, DH, MLR
Extension	The sum of agricultural extension visits for the past year	Number of times	Continuous	DS, DH
Group membership	Whether a farmer was a group member and active or not	1=Yes 0=No	Dummy	DS, DH, MLR
Distance to market	Distance from HH to the nearest market	Kilometers	Continuous	DS, DH, MLR
Distance to town	Distance of the household from the nearest town	Kilometers	Continuous	DS, DH, MLR
Land tenure	Land tenure	1=Owned title 0=Leased	Dummy	DS, DH, MLR
Land size	The total land size owned by a household	Acres	Continuous	DS, DH, MLR
Farming experience	Farming experience of the HH	Years	Continuous	DS, DH
Access to credit	Whether a HH sought credit	1=Yes 0=No	Dummy	DS, DH, MLR
Land under sorghum	The area of land under sorghum	Acres	Continuous	DS, DH
Awareness on CF	If a sorghum farmer is aware of CF	1=Yes 0=No	Dummy	DS
Off-farm income	If a farmer earned off farm income	1=Yes 0=No	Dummy	DS, DH, MLR

Note: HH = Household head; DS = Descriptive statistics; DH = Double hurdle model; MLR = Multiple linear regression

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

The chapter presents the study results and their discussion. The general study objective was to analyze factors influencing smallholder sorghum farmers' participation and profitability in contract farming in Laikipia County. The first sub-section involves the description of different demographics and socioeconomic characteristics among the farmers in the county. The other subsection consists of a discussion on econometric modeling, including Cragg's double hurdle (DH) model and the multiple linear regression (MLR), which assessed participation (with intensity) and profitability determinants, respectively. The second subsection also discusses the findings of cost, revenues, and profitability.

4.2 Socioeconomic characteristics among smallholder sorghum farmers in Laikipia County

The socioeconomic characteristics (continuous variables) of the sorghum smallholder farmers in Laikipia County are summarized in Table 4.1. A t-test was run on the socioeconomic characteristics to detect differences among the participants and non-participants of contract farming. Appendices 1-4 show the findings of multicollinearity between variables such that distances from the HH to the product market and the nearest town are not collinear.

Table 4.1: The socioeconomic characteristics of continuous variables

Variable	CF Non-Participants (N=105)		CF Participants (N=83)		P-Value
	Mean	Std. Dev	Mean	Std. Dev	
Age	45.81	12.93	46.34	10.76	0.765
Education level	3.27	0.82	3.45	0.72	0.119
Farming experience	9.13	6.12	9.04	5.66	0.912
Land size	3.95	3.00	6.73	6.09	0.000***
Land under sorghum	1.34	0.09	2.24	1.99	0.004***
Distance to market	4.41	2.56	3.79	2.19	0.084*
Distance to town	27.10	12.11	12.94	8.03	0.000***
Extension	0.029	0.218	2.012	1.581	0.000***

***, **, and *** = 10%, 5% and 1% significance level**

Source: Author's survey data, 2019

The household head age among the CF non-participants and participants was approximately 46 years. A CF study within the tropic conducted by Bolwig et al. (2009) shows that the mean age of participants and non-participants was 46 and 47 years. It indicates that sorghum farmers in Laikipia County were middle-aged and had meaningful insights on matters pertinent to sorghum enterprise (Mwangi et al., 2020b). Many of these farmers have accumulated years in sorghum farming and general cultivation of other crops in the County over the years, which means that many of them were eligible for CF.

The average education attained by the household heads in sorghum production enterprises was under category 3, equivalent to high school education (see the codes in Table 1.1). The levels of education among the participants and non-participants of sorghum CF are depicted in Figure 4.1 below.

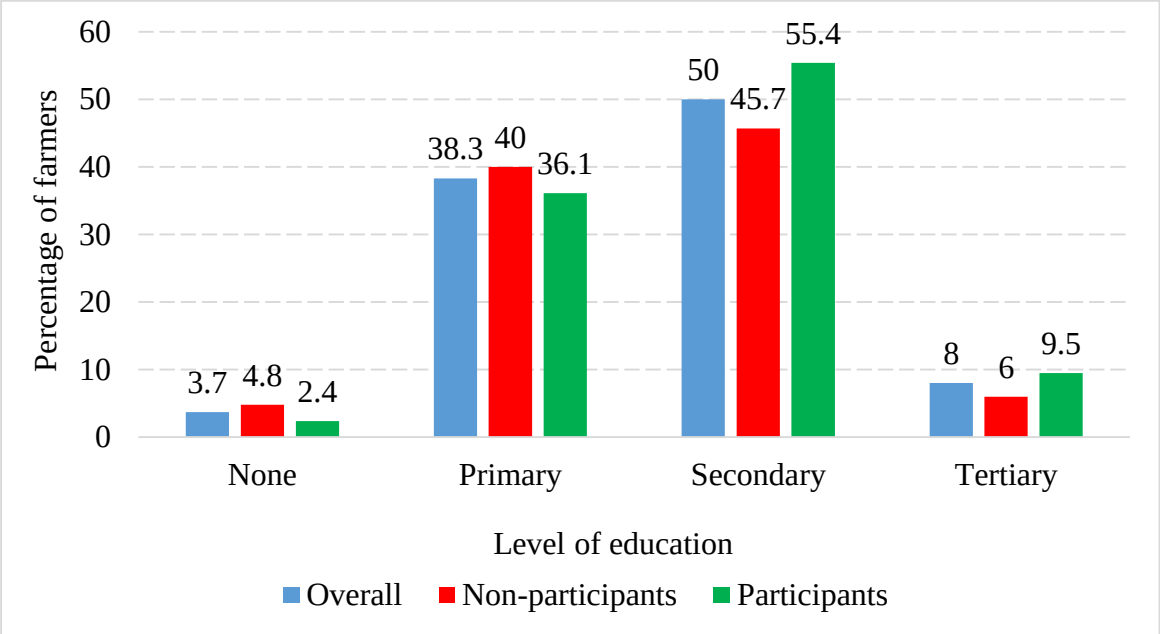

Figure 4.1: The level of sorghum farmers' education

Many farmers with secondary and tertiary education participated in the CF scheme. There was no significant difference in education level among CF participants and non-participants; thus, it is clear that all sorghum farmers in the county had attained formal education (Table 4.1). Wainaina et al. (2012) found similar findings where most of the participants and non-participants of poultry CF in Kenya had attained high school education. As such, literacy levels made it easy for contracting agents and farmers to engage in issues of quality and quantity, thus resulting in increased farmers'

participation in CF (Muroiwa et al., 2018; Rondhi et al., 2020). In the current research, Laikipia County farmers are literate enough to apply the necessary managerial practices in the enterprise and analyze the current technologies and market dynamics that pertain to sorghum enterprises. This is demonstrated by some statistics pertinent to sorghum production in the County. As such, in the recent past, the area under sorghum cultivation has been expanded from 500 Ha to over 4,000 Ha in Laikipia East and West (Laikipia County Integrated Development Plan, 2017-2022). Sorghum smallholder farmers growing the crop have also risen to over 3,500 with an average production of 1 T Ha^{-1} (Department of Agriculture, 2017).

The farming experience among the two groups was 9 years. These are the number of years when individual sorghum farmers in Laikipia County made independent decisions to engage in sorghum production as an enterprise. Musara et al. (2019) found over 10 years of farming experience among sorghum farmers in Zimbabwe, which positively influenced the intensity of participation in sorghum farming in semi-arid areas. An accumulation of approximately 9 years in sorghum production and sales in Laikipia County gave farmers more insights regarding sorghum enterprise due to different dynamics such as weather, market, and productivity that they have gone through. This translates to good CF enterprises that will satisfy the requirements of the contracting agencies (Muroiwa et al., 2018).

Experienced farmers also understand the improvement of technology over the years. For instance, they have embarked on improved sorghum varieties (ISV) such as Gadam, Sila, Serena, and Seredo as shown in Figure 4.2. Seredo was the most popular variety among other varieties produced. Figure 4.2 demonstrates that most CF non-participants produced Seredo while most participants produced Sila. Overall, the majority of sorghum farmers produced the Seredo variety. The adoption of these ISVs shows that many farmers can meet the demand of CF for specific sorghum quantities and qualities.

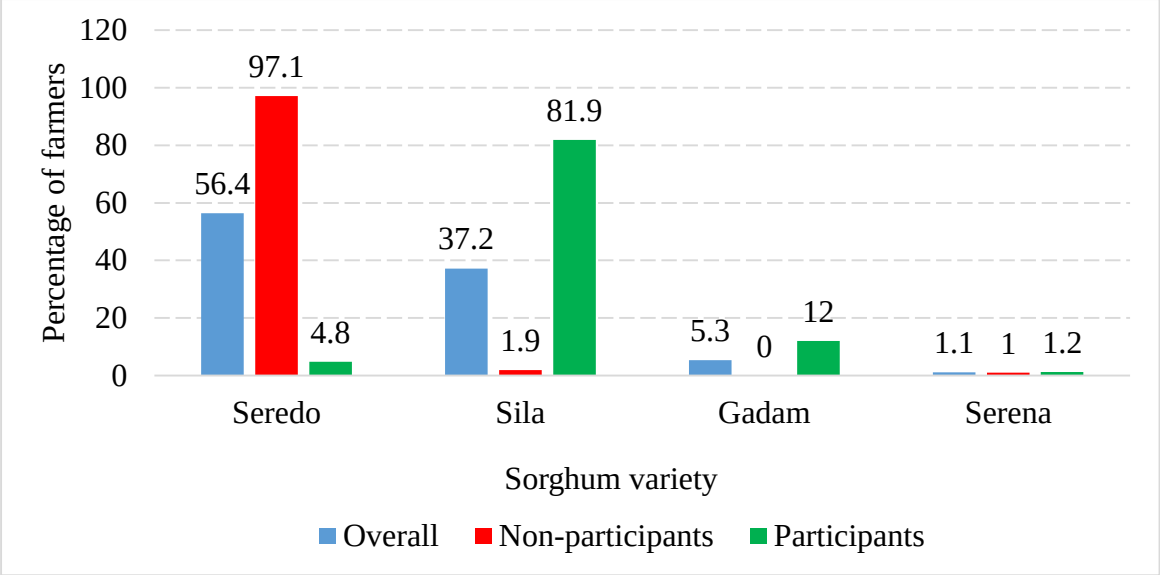

Figure 4.2: Sorghum variety grown in Laikipia county

A strong significant difference existed in total land acreage and acreage under sorghum varieties ($p<0.01$) (see Table 4.1). Similar findings were found among avocado farmers in Kandara, where the CF participants had larger plots of land under the avocado crop than their non-participating counterparts (Mwambi et al., 2016). Okeyo et al. (2020) also found similar findings for the participants and non-participants of sorghum farming in Siaya. The significantly higher acreage among CF participants over non-participants in the current research reveals the benefits these groups of farmers accrued from CF in Laikipia County. As such, a higher acreage among the CF participants shows that these sorghum farmers are willing to incur the cost of extra production resources (Okeyo et al., 2020). This may involve leasing extra land in case a farmer does not have adequate space to expand the plots under sorghum production due to the benefits accrued from contract farming.

The CF non-participant sorghum farmers were approximately 4.4 Km from the market, which was significantly ($p<0.10$) longer than the 3.8 Km that CF participants traveled to access the market for their sorghum produce. Teshome and Tegegne (2020) found similar findings in *teff* enterprise participation in Ethiopia. The distance from HH to the nearest market differs from that of proximity to the closest town because some produce collection centers are close to home while some farmers sell the sorghum at the farmgate points. Proximity to the market for sorghum contract farmers in the county might have increased their motivation to allocate more resources to sorghum

enterprises. One of the motivations is a reduction in the transportation cost incurred in accessing the market for product sales and input purchases.

The CF participants of sorghum farming were about 13 Km from the nearest towns, significantly ($p<0.01$) shorter than the 27 Km for non-participants who traveled to access the towns. Kiwanuka and Machethe (2016) found similar findings among CF participants and non-participants in the dairy industry of Zambia. The towns in Laikipia include Nyahururu, Rumuruti, Kinamba, Nanyuki, Sopili, and Salama. These towns are sources of various social services that sorghum farmers need, including information from agricultural offices, seed companies, and other governmental and non-governmental agencies. The CF sorghum farmers close to these towns also enjoy improved infrastructure, such as roads that aid in simple access to various government services such as those from land offices and private agents, and agrochemical companies. Many agricultural shows are also conducted around these towns. Therefore, CF participants have an added advantage regarding gaining updated sorghum information due to their proximity to major towns.

The non-participants of CF in sorghum production accessed significantly ($p<0.01$) fewer extension services than their participating counterparts. Mwambi et al. (2016) and Rondhi et al. (2020) reported similar findings where the CF participants in different enterprises accessed more extension services than the non-participants. The data collected in the current research revealed that non-participants had made almost no (0.029) extension contacts with the extension providers. In comparison, the participants had made at least two contacts. Since the participants were relatively closer to the major towns (where the providers are most located) than their non-participating counterparts, the extension officers often visited the farms from either the private or public extension offices. Some of the non-participants of CF sorghum farming are in far-flung areas with poor road infrastructure, making it difficult for extension agents to visit.

The socioeconomic characteristics (binary variables) results for the sorghum smallholder farmers in Laikipia County are summarized in Table 4.2.

Table 4.2: Socioeconomic characteristics for the dummy variables

Variable	CF Participation				
	Outcome	**Non-participants (N=105)**	**Participants (N=83)**	**Pearson Chi^2(1)**	**P-value**
		Freq (%)	Freq (%)		
Gender of HH head	Female	30 (28.6%)	20 (24.1%)	0.476	0.490
	Male	75 (71.4%)	63 (75.9%)		
Group membership	No	52 (49.5%)	10 (12%)	29.46	0.000***
	Yes	53 (50.5%)	73 (88%)		
Access to credit	No	83 (79%)	54 (65.1%)		
	Yes	22 (21%)	29 (34.9%)	4.588	0.032**
Awareness on CF	No	79 (75.2%)	0 (0%)		
	Yes	26 (24.8%)	83 (100%)	107.71	0.000***
Ownership of title	No	104 (99%)	15 (18.1%)		
	Yes	1 (1%)	68 (81.9%)	130.84	0.000***
Off-farm income	No	86 (81.9%)	60 (72.3%)		
	Yes	19 (18.1%)	23 (27.7)	2.471	0.116

***, **, and *** = 10%, 5% and 1% significance level**

Source: Author's survey data, 2019

The CF non-participants who headed their families among the sorghum smallholder households were 71% male. Their numbers were not significantly different from 76% of those men who headed their families among the participants. In a study of contract farming of avocados in Kandara, Mwambi et al. (2016) found that the proportion of males among the CF participants and non-participants was 71% and 63%, respectively. The HH head gender matters a lot in farming, especially because HH heads are the primary decision-makers who greatly influence the adoption of new technologies or schemes such as contract farming (Alulu, 2020).

Regarding group membership, the CF non-participants who belonged to organized social groups accounted for 51%, while the participants accounted for 88%. A significant difference existed in the participation in organized groups among CF non-participants and participants ($p<0.01$). Overall, 33% of sorghum farmers in Laikipia did not belong to any organized social group or association. The findings correspond with those of vegetable CF farming in Western Kenya, where 39% of the farmers did not have a membership in any group (Alulu, 2020). As shown in Table 4.3, most (49.5%) of the CF non-participants did not belong to organized groups or associations. Most CF participants belonged to farmer groups (34.9%) and welfare clubs (26.5%). Laikipia

farmers who belong to groups can benefit from them, as Teshome et al. (2020) show. Smallholder farmers who belong to such groups participate in CF because they get credits and agricultural information that are healthy for profitability (Teshome et al., 2020). They also get government services such as clustered training for organized groups.

Table 4.3: Group types where farmers belong

Group type	Overall (N=188)		Non-participants (N=105)		Participants (N=83)			
	Freq	%	Freq	%	Freq	%	χ^2	P-value
None	62	33	52	49.5	10	12	29.46	0.000***
Farmers	40	21.3	11	10.5	29	34.9	16.56	0.000***
Women	42	22.3	28	26.7	14	16.9	2.57	0.117
Youth	2	1.1	2	1.9	0	0	1.6	0.504
Faith-based org.	1	0.5	1	1	0	0	0.8	1.000
Community-based org	2	1.1	1	1	1	1.2	0.28	1.000
Savings and credit	15	8	8	7.6	7	8.4	0.42	1.000
Welfare club	24	12.8	2	1.9	22	26.5	25.19	0.000***

***, **, and *** = 10%, 5% and 1% significance level**

Source: Author's survey data, 2019

The number of sorghum CF non-participants who accessed credit for sorghum enterprises was lower than that of the participants who accessed credit in Laikipia County. There was a significant difference in credit access among participants and non-participants ($p<0.05$). On average, all the farmers who accessed credit in Laikipia county were less than 40%, which concurs with Ghana's cashew nut CF farmers(Dubbert, 2019). Farmers with credits who belong to CF can affordield-enhancing technology without worrying about the produce market (Azumah et al., 2016). The sources of credit among both groups are presented in Figure 4.3 below.

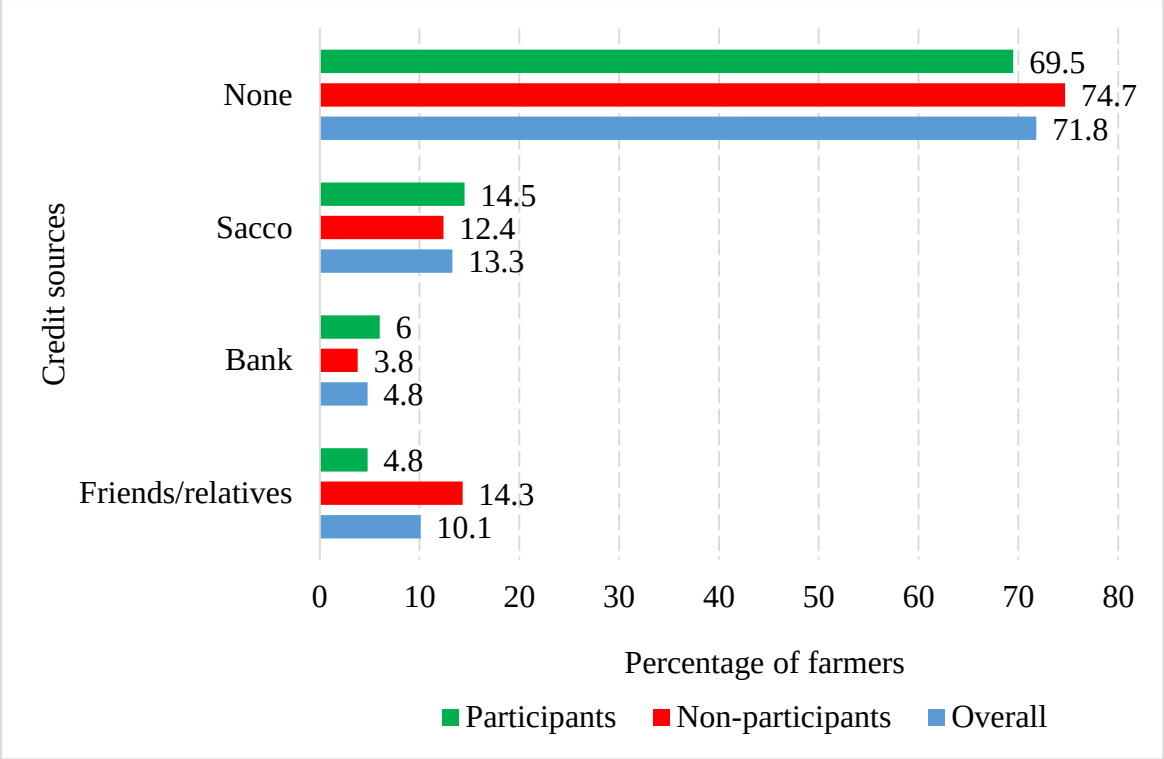

Figure 4.3: Sources of credit for sorghum enterprises

From Table 4.2, the CF non-participants (25%) who were aware of CF significantly differed ($p<0.01$) from that of participants (100%). This means, on average, all the farmers in Laikipia who were aware of CF were 58%, which concurred with 59% found by Arouna et al. (2021) on CF in Benin. The current study reveals that not all sorghum farmers in Laikipia County have received information about CF. East African Malting Limited should put more effort into disseminating information on CF. In general, Figure 4.4 shows that most of the sorghum farmers received information on contract farming from field days and extension officers. In addition, about 47% of the CF non-participants mentioned that they did not receive any information concerning sorghum varieties.

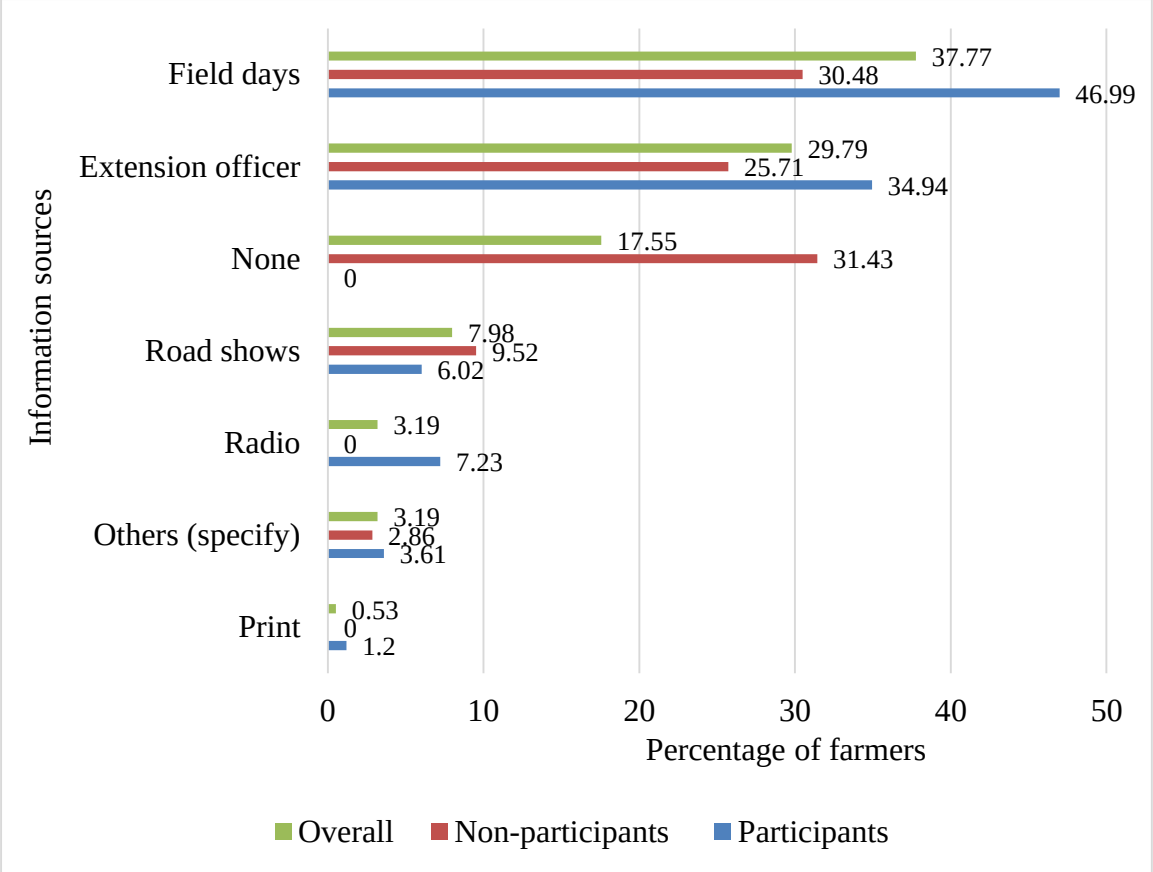

Figure 4.4: Sources of information about CF

The sorghum CF non-participants who owned land and had their title deeds were significantly ($p<0.01$) less than the participants (Table 4.2). Overall, a few sorghum farmers within the county owned arable land, as shown in Figure 4.5. Only 1% of the non-participants of CF farmers owned land with title deeds, which is close to 6% of farmers in the Ghanaian Kumasi area (Amponsah et al., 2016). A contracting agency may be motivated to contract farmers with the security of tenure for long-term engagements (Ncube, 2020). The leased land can be a demotivating factor for both the contracting company (EAML) and the sorghum farmers to engage in contract farming.

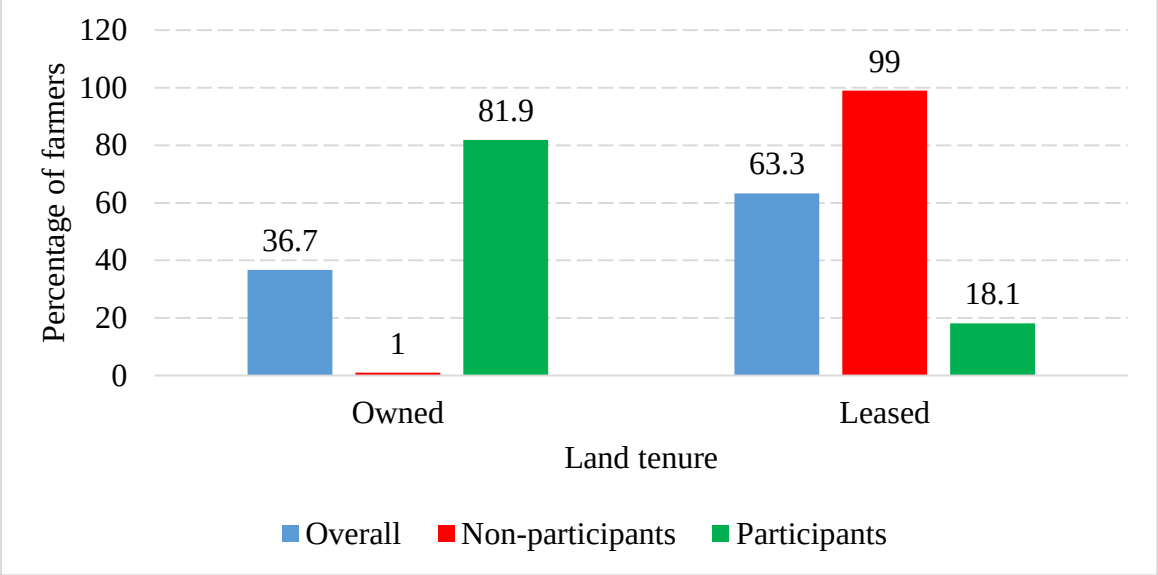

Figure 4.5: Land tenure among the sorghum farmers

Off-farm income did not significantly (p=0.116) differ between participants and non-participants of sorghum contract farming (Table 4.2). Some farmers with off-farm income engaged in the expansion of other non-farm business portfolios in the major towns of Nyahururu, Rumuruti, Nanyuki, and Kinamba, among others. The findings of Alulu (202) and Azumah et al. (2016) revealed that off-farm income might benefit CF among smallholder farmers in acquiring the necessary farming inputs and information.

4.3 Econometric model results

The subsection gives the results of the econometric modeling, including the findings of Cragg's double hurdle (DH) model and the multiple linear regression (MLR). The profitability findings are also presented under this subsection.

4.3.1 Model specification tests

To check on the specification errors in Cragg's double hurdle model, the analysis looked for the significance of hat squared (_hatsq). An assumption of the null hypothesis that stated *no specification error* was made. As a fundamental rule, an insignificant _hatsq p-value helps research not to reject the null. Thus, the model specification is correct. The test results (see Appendix 1) show that the value of _hatsq was insignificant, confirming the correctness of the model specification. A variance inflation factor (VIF) test was done to check multicollinearity. The general rule is that values must be less than 10 for the individual and the mean VIF to confirm the absence of the multicollinearity problem in the data. The results confirm the absence of

multicollinearity because both individual and mean VIF values were below 10. A Cooks D test was run to check on the influence of big outliers or an observation on the predicted values or the overall model. An outlier problem is depicted by a D value greater than one (D>1). The results reveal no problem with the influence of outliers in the model because the mean, minimum, and maximum values of Cook's D were less than one (D<1). The normality tests on the dependent variables in the truncated and multiple linear regression models are presented in Appendices 2 and 3. The goodness of fit was tested on the Probit model, and the insignificant P-value confirmed the goodness of fit (Appendix 1).

4.3.2 Determinants of participation decision and intensity in sorghum CF among smallholder farmers in Laikipia County

The factors that influenced the adoption and intensity of participation in sorghum CF were done using Cragg's double hurdle model (see Table 3.1). The model gave a Chi^2 value of 211.61. In contrast, the likelihood ratio (LR) value was strongly significant ($p<0.01$), confirming a rejection of the null hypothesis assuming that the values of the independent variables coefficients are simultaneously zero. It is a clear depiction that the independent variables in the double hurdle model can explain the likelihood and intensity of participation of sorghum farmers in Laikipia County participating in CF. The first hurdle used Probit to compute the marginal effects (dy/dx), which predicted the real magnitude of the explanatory variables that affected farmers' participation decisions in CF. The second hurdle involved using a Truncated model where the coefficients were used to explain the intensity of participation in CF among smallholder sorghum farmers.

Table 4.4 summarizes the findings of the first hurdle in Cragg's model, where five explanatory variables influenced participation decisions. They include land tenure, land size, distance to a major town, belonging to a social group, and extension contacts, which significantly influence the decision to participate.

Table 4.4: Probit estimates on the decision to participate in contract farming among sorghum smallholder farmers in Laikipia County

Variable	dy/dx	Std. Err.	z	P>z
Dependent				
Participation				
Independent				
Age	0.001	0.002	0.62	0.534
Education level	0.025	0.024	1.04	0.299
Gender	-0.001	0.032	-0.03	0.977
Land tenure	0.228	0.051	4.45	0.000***
Farming experience	-0.005	0.004	-1.2	0.232
Land under sorghum	0.014	0.004	3.15	0.002***
Distance to town	-0.003	0.001	-1.9	0.058*
Off-farm income	-0.043	0.044	-0.99	0.323
Group membership	0.093	0.051	1.82	0.068*
Credit access	-0.040	0.036	-1.1	0.270
Extension	0.177	0.045	3.92	0.000***
Distance to market	-0.004	0.004	-0.88	0.378
Model summary				
N	188			
Log-likelihood	-23.219			
LR chi^2 (18)	211.61			
Prob. > χ^2	0.000			
Pseudo R^2	0.8200			

***, **, and *** = 10%, 5% and 1% significance level**

dy/dx = marginal effects

Land tenure positively influenced the probability of participating in CF among smallholder sorghum producers in Laikipia County ($p<0.01$). The marginal effect value depicts that as a farmer acquires a title deed (freehold tenure), the probability of deciding to participate in sorghum CF would increase by 22.8% *ceteris paribus*. This means that the leasehold regime significantly reduces the probability of sorghum CF participation. Ogeto et al. (2013) reported that many farmers who did not participate in sorghum production in Nakuru County were those under a leasehold tenure regime. The research noted that leaseholds contribute to tenure insecurity, which negatively influences the effectiveness of farming activities. Dlamini and Masuku (2011) confirmed that tenure security improves land through access to facilities such as credit. As such, farmers are encouraged to participate in CF as they know they are secure and can produce to the maximum due to access to yield-improving facilities without worrying about losing their land. According to Dlamini and Masuku (2011), mechanization is also high in a freehold regi, and it improves agricultural output, which

can help farmers under CF meet their contractual demands. Thus, a farmer under this regime has a higher probability of engaging in CF because they do not fear that, at some time, they might lose their land. The current study's findings concur with Akumu et al. (2020) but contradict those of Okeyo et al. (2020), who explained that farmers under leasehold are under constant pressure to recover the rent. Thus, they have to increase yield and make a profit.

Land acreage under sorghum significantly ($p<0.01$) influenced participation in sorghum CF. An additional acre in sorghum production increased the probability of farmers participating in CF by 1.4% *ceteris paribus*. Many studies have shown that an extra acreage under the control of a farmer increases the likelihood of adopting yield and profit-enhancing schemes and technologies (Akpan et al., 2012; Okoffo et al., 2016; Teshome & Tegegne, 2020; Timu, Mulwa et al., 2014). The findings concur with those of (Katengeza et al., 2012; Akumu et al., 2020; Mbaabu & Mbugua, 2019; Okeyo et al., 2020) but contradict those of (Abdulai & Al-Hassan, 2016; Leung, Sethboonsarng, & Stefan, 2009). Abdulai & Al-Hassan (2016) explained that farmers with smaller farm sizes are pushed to adopt contract farming due to the frantic situations that keep them off commercial agriculture. Contract farming comes in handy to help them pursue commercial activities.

Distance to a major town negatively influenced the participation decision in sorghum CF ($p<0.1$). An additional kilometer reduced the probability of participating in CF by 0.3%. Several authors show the advantages of farmers being closer to towns Akpan et al., 2012; Kunzekweguta, 2016; Mwangi et al., 2020a). According to these authors, farmers close to the market are more likely to access production inputs and updated market and technology information than their counterparts in areas far from towns. According to Mwangi et al. (2020a), farmers in areas far from town are more likely to experience the disadvantages associated with a far distance to town, such as low access to updated information and technology. Contracting organizations in towns may incur high costs for accessing farmers in remote areas, reducing the amount of information that sorghum farmers get about CF.

Group membership had a positive influence on CF participation in Laikipia County. The influence was weak and significant at a 10% level ($p<0.1$), where a participant of CF is more likely to have belonged to a group than the non-participating counterparts

by 9.3%. The findings relate well with Ogeto et al. (2013). It is expected that membership in an organized group or association would increase farmers' decision to adopt new technologies or participate in new schemes such as contract farming because of the increased uptake of new information that is shared within the group (Katengeza et al., 2012). The current study findings contradict those reported by (Katengeza et al., 2012). Their explanation for what was observed is that most of the farmers who belong to organized groups/associations usually have several benefits that accrue from membership. Some of the benefits include the ability to lobby for government support services and group marketing that have bargaining power over the market prices of their produce due to collective action.

Extension contacts were a positive determinant of smallholder sorghum farmers' participation in CF ($p<0.01$). An additional contact between an agricultural officer and a sorghum farmer implied an increase in the probability of the farmer deciding to participate in contract farming by 17.67%. Comparable results were reported by Abdulai & Al-Hassan (2016),Mbaabu & Mbugua (2019), and Rondhi et al. (2020). The researchers found out that CF participants are taught various agricultural management skills in crop production that enable them to increase their yields such that they are capable of meeting the quantities required by the contracting company. The study by Rondhi et al. (2020) to assess the determinants of participation decisions in broiler farming in Indonesia, reported that extension education instills knowledge that assists farmers in the implementation of new technologies among other new schemes. Contract farming can be a new scheme that can help farmers to cope with agricultural risks associated with sorghum farming. In this regard, extension education that disseminates information about the new scheme can positively influence the probability of farmers deciding to participate in such interventions. Agricultural education mostly helps farmers to increase their productivity. With increased production, farmers may look for ways to reduce marketing risks, and thus they may end up participating in CF which offers a ready market all year round.

The second hurdle evaluated the determinants of CF participation intensity among smallholder sorghum farmers in Laikipia County. The intensity of participation was assessed through the acreage of land that was allocated for sorghum production under contract farming. The truncation model showed that four explanatory variables

significantly influenced the CF participation intensity. They include experience, extension access, credit, and land tenure (Table 4.5).

Table 4.5: Determinants of CF participation intensity among sorghum producers in Laikipia county

Variable	Coef.	Std. Err.	z	P>z
Dependent				
Intensity				
Independent				
Age	-0.053	0.056	-0.94	0.349
Gender	-0.243	0.933	-0.26	0.795
Farming experience	0.193	0.111	1.75	0.081*
Education level	0.920	0.728	1.26	0.207
Distance to market	-0.151	0.011	-1.39	0.016**
Land size	0.035	0.076	0.46	0.643
Distance to town	-0.015	0.052	-0.28	0.777
Group membership	0.982	1.620	0.61	0.544
Extension	2.170	1.266	1.71	0.086*
Credit access	2.149	0.830	2.59	0.010***
Land tenure	-2.682	1.103	-2.43	0.015**
Off-farm income	-0.060	0.986	-0.06	0.952
Model summary				
Log-likelihood	-155.386			
_cons	2.421	4.012	0.6	0.546
/Sigma	2.548	0.340	7.51	0.000***
Wald chi^2 (13)	26.320			
Prob. > χ^2	0.015			

***, **, and *** = 10%, 5% and 1% significance level**

dy/dx = marginal effects

The farming experience was a positive determinant of the intensity of CF participation among the participants ($p<0.1$). This indicates that an additional year in sorghum farming increased the intensity of CF participation by 0.19%. The farming experience was a determinant of participation intensity in adopting new technologies among sorghum farmers (Musara et al., 2019). In the current research, a plausible explanation for the positive influence of sorghum farming experience is that HH heads had over 9 years of farming experience. Experience enhances farmers' capability of commercializing sorghum production due to their ability to use and process any relevant information for the enterprise. With this experience, farmers are confident they can produce the quantity in the contractual agreement. Therefore, it becomes relatively easy for CF participants with over 9 years of experience to expand their land under

sorghum production sustainably. Other studies that found similar results include (Dlamini & Huang, 2019; Mwangi et al., 2020a; Weyessa, 2014).

The intensity of CF participation was negatively influenced by the distance from HH to the market ($p<0.05$), implying that an extra Kilometer to the sorghum collection center reduced the intensity of CF participation by 0.15%. The findings agree with Musara et al. (2019) and Mwangi et al. (2020a). Musara et al. (2019) attribute the influence to the extra cost of transporting the produce to the collection centers of the contracting agency.

Access to agricultural extension education significantly increased the intensity of participation in CF at a 10% level ($p<0.1$). The findings imply that among the CF participants, smallholder sorghum farmers who accessed extension education increased the acreage of the crop under contract farming by 2.17%. In the current study, it was expected that as CF participants access agricultural education, they would increase acreage under sorghum produced through contract farming. Several studies found similar findings (Dlamini & Huang, 2019; Katengeza et al., 2012; Musara et al., 2019; Mwangi et al., 2020a; Ogeto et al., 2013; M. Rondhi et al., 2020). They allude that due to the extension information flow that would enlighten sorghum farmers about CF and good agricultural practices, farmers would increase their intensity of participation in the scheme by allocating more land acreage to sorghum production under contract.

Credit access was a positive determinant of CF participation intensity among the participants at a 1% level ($p=0.01$). The findings imply that a CF sorghum producer who accessed credit increased the farmer's participation intensity in the scheme by allocating more land to sorghum production. The findings are consistent with those of Nonvide (2020) in Benin. Nonvide (2020) asserts that credit access empowers households to afford and purchase inputs in time. In this line of argument, sorghum CF participants can expand their land under sorghum since they can meet the costs associated with the expansion process. However, the current study's findings contradict those of Hiko et al. (2020) and Mwangi et al. (2020a) in sorghum and improved sorghum varieties production in Ethiopia and Kenya, respectively. These studies found that as farmers accessed credit, the intensity of sorghum production reduced significantly. According to Mwangi et al. (2020a), a negative influence of credit access on land allocated to sorghum means that farmers may utilize money on other lucrative activities either on a farm or off-farm at the expense of sorghum enterprise.

Land tenure negatively influenced the intensity of CF participation at a 5% level ($p<0.05$). The findings imply that as CF participants acquire security of tenure, they reduce the acreage under sorghum by 2.68%. These findings are unexpected and contradict Ogeto et al. (2013) who assert that households owning land may expand sorghum production at their discretion. In the current study, the negative influence of land tenure on CF participation intensity could be linked to households having the discretion to switch to other more fashionable and valuable crops that may fetch reasonable prices due to market dynamics.

4.3.3 Profitability of sorghum farming and its determinants

Table 4.6 displays the findings of annual profits that smallholder sorghum producers made per acre. A t-test was run to determine the differences in costs and returns among CF participants and non-participants. The annual total variable cost (TVC) per acre constituted 81.46% and 80.11% of the total production cost among the participants and non-participants of sorghum CF. The findings of the CF non-participants concurred with the findings of Zalkuwi & Giroh (2014), Vihi et al. (2019), and Idisi et al. (2019), who found the TVC contributed 85.55%, 86.07%, and 82.32% of the TC in the production of sorghum in different parts of Nigeria, respectively. In the current study, the contribution of TVC to TC among the CF participants was slightly higher for the CF participants than for non-participants, perhaps due to the increased intensification associated with contract farming.

Table 4.6: Sorghum farming profitability in Laikipia County

Variable	Non-participants	Participants	P-value
Variable costs (Kes)			
Seeds	1876.30	2602.32	0.022**
Fertilizers	7116.54	9340.42	0.118
Herbicides/Pesticides	1948.70	3795.29	0.020**
Labor	8546.82	10159.02	0.302
Storage costs	242.31	718.26	0.076*
Market costs	683.72	981.35	0.012**
Total Variable Cost (TVC)	**20414.39**	**27596.66**	**0.054***
Fixed costs (Kes)			
Rent on land /OC	5070.01	6280.24	0.057*
Total fixed costs (TFC)	**5070.01**	**6280.24**	
Total production cost (TC) = (TVC+TFC)	**25484.40**	**33876.90**	**0.011****
Returns			
Sorghum sold (90kg bags)	11.46	24.12	0.003***
Sorghum price per 90kg bag	3000	3400	
Sorghum sales (Kes)	34380	22008	0.020**
Stover sold (tons)	1.44	1.86	0.214
Stover price per ton	4770	4860	
Stover sales (Kes)	6866.97	9039.60	0.047**
Total revenue (TR)	**41246.97**	**91047.60**	**0.012****
Gross Margin (GM) = (TR-TVC)	**20832.58**	**63450.94**	
Profit/Net farm income (NFI) = GM-TFC	**15752.57**	**57170.70**	
Return on investment (ROI) = NFI/TC	**0.62**	**1.69**	

***, **, and *** = 10%, 5% and 1% significance level; OC = opportunity cost of the portion of land under sorghum**

From Table 4.6, fertilizers and labor were the greatest contributors to the total variable costs (TVC) incurred in smallholder sorghum production. For instance, among the participants of CF, fertilizers, and labor constituted 33.84% and 36.81% of TVC respectively. Storage costs were the least contributors to TVC at 2.6%. A study by Vihi et al. (2019) that evaluated the profitability among smallholder sorghum producers in the Plateau State of Nigeria found similar results. The study found that fertilizer costs contributed 38.51% of the TVC. In other studies, labor was the biggest contributor to TVC. For instance, Zalkuwi & Giroh (2014) and Idisi *et al*. (2019) found that about 60% and 70% of TVC resulted from labor costs. The findings of these studies show how mechanization is needed to reduce the cost of hiring many employees in sorghum production activities, from land preparation to storage. Additionally, the storage cost was the least contributor to TVC, probably because many sorghum farmers own

sorghum stores that help them gather their produce before transporting it to the market collection centers.

Herbicides and pesticides contributed to TVC by about 13.75% and 9.56% among the CF participants and non-participants, respectively. Farmers under CF could afford more chemicals for pest and disease control compared to their non-participating counterparts; thus, the expenses that are incurred in contributing to TVC are higher among the participants. In a study by Idisi et al. (2019) to evaluate the profitability of sorghum farming among smallholder farmers in the Abuja area of Nigeria, the agrochemicals, including herbicides and pesticides, contributed to TVC by 11.19%. The cost of agrochemicals is important for the enterprise because sorghum faces several pests and diseases (Mundia et al., 2019). The latter study shows how critical it is for farmers to switch to improved sorghum varieties (ISV) that are pests and disease-tolerant.

The cost of seeds contributed to TVC among the CF participants and non-participants by approximately 9.42% and 9.19% of the TVC, respectively. Vihi et al. (2019) reported similar findings where the cost of seed contributed to TVC by about 10%. The cost of seed may be reduced if farmers embrace the quality declared seeds (QDS) that authorized farmers produce. As such, the quality of seeds will be retained while the cost of production will be reduced significantly. Additionally, most of the non-participants of CF may have incurred less cost in seeds, probably due to the recycling of previously planted seeds. The major problem with the consecutive recycling of seeds is the dwindling of hybrid vigor. Farmers lose the potential to achieve optimal output and quality.

Market costs contributed to about 3.56% and 3.35% among the CF participants and non-participants respectively. The CF participants may have incurred more marketing costs due to the increased output that may require significantly more trips to the collection centers than the trips made by their non-participating counterparts. Zalkuwi and Giroh (2014) revealed that smallholder sorghum producers specializing in sorghum production in the Nigerian Adamawa State incurred marketing costs contributing to about 5.4% of the TVC. These costs include those incurred during the transportation of the product to the market and the cost of moving to the major towns to create market engagements before the harvesting is done.

The total fixed costs (TFC) were incurred by smallholder sorghum farmers who paid rent for leasing land and opportunity cost (OC) of owning land (for those who did not lease). TFC contributed 18.54% and 19.89% of the total production costs among the CF participants and non-participants. The results are in harmony with Vihi et al. (2019), Idisi et al. (2019), and Zalkuwi & Giroh (2014), who found that TFC contributed to TC by 13.93%, 17.68%, and 14.43%, respectively. In the current study, the fixed costs among the CF participants are higher than those reported in the studies mentioned above. A plausible explanation could focus on the availability of a market for sorghum produce such that sorghum farmers are motivated to lease more land to increase the output.

The revenue collected from the sales of sorghum significantly differed among the participants and non-participants of contract farming (CF) at a 5% level ($p<0.05$). The CF participants produced more sorghum than their non-participating counterparts, probably due to the services they received from the agronomists of the contracting company and the motivation they received from a ready market. The CF participants sold significantly more tons than their non-participant counterparts ($p<0.05$). The total revenue (TR) that the CF participants achieved from the sales of both sorghum and stover was Kes 91047.60, significantly higher than Kes 41246.97 that the non-participants received. It is an adequate sign that CF significantly increases profitability in sorghum production.

The return on investment (ROI) was 1.69 and 0.62 among the CF participants and non-participants respectively. The ROI achieved by the participants was comparable to 1.59 and 1.07 that Idisi et al. (2019) and Zalkuwi & Giroh (2014) found, while that of non-participants agreed with 0.91 found by Vihi et al. (2019) found in different parts of Nigeria. In these findings, the net gains outdo the total production costs by more than 100%. Among the CF participants, the investment gains exceed the TC by more than one and a half times. All indicators show that CF among smallholder sorghum farmers is a lucrative initiative and that farmers must be encouraged to partake.

The results of profitability determinants in smallholder sorghum farming in Laikipia County are summarized in Table 4.7.

Table 4.7: Factors affecting profitability for sorghum smallholder farmers in Laikipia County

Variable	Pooled			Non-participants			Participants		
	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value	Coef.	Std. Err.	P-value
Dependent LnProfit									
Independent									
Age	-0.0075*	0.0044	0.063	-0.0130**	0.0055	0.029	0.0028	0.0071	0.752
Gender	-0.0780	0.1001	0.261	-0.1718	0.1357	0.390	-0.0511	0.1446	0.296
Education	-0.0452	0.0661	0.796	-0.1864**	0.0768	0.365	0.2127*	0.1101	0.091
Distance to Market	-0.0383**	0.0157	0.028	-0.0263**	0.0195	0.022	0.0309	0.0246	0.104
Group membership	0.0824**	0.039	0.016	0.4332	0.2876	0.323	0.0628	0.042	0.613
Off-farm income	0.0866	0.1135	0.549	0.2153	0.1623	0.993	-0.0514	0.1553	0.541
Land size	0.0957***	0.0187	0.000	0.1325***	0.0304	0000	0.0749***	0.0242	0.001
Credit	0.1988*	0.1025	0.042	-0.1085	0.1641	0.796	0.4516***	0.1329	0.003
Land tenure	-0.0423	0.1181	0.438	-1.7115	0.5974	0.253	0.0933	0.1857	0.403
_cons	9.7000***	0.3547	0.000	10.4706***	0.4146	0.000	8.1551***	0.616	0.000

***, **, and *** = 10%, 5% and 1% significance level**

From the pooled and CF non-participants' data, their profitability in sorghum production enterprises reduces as farmers advance in age. The decline was significant at a 10% level ($p<0.1$) such that an increase in age by one (1) year reduced profits by less than 1%. Teshome et al. (2020) also found that farmers' profits were negatively influenced by age in the Central Rift Valley of Ethiopia. The study alluded that younger heads of households can accept new technologies without obstruction better than their elder counterparts. Adopting technologies improves operation efficiency and reduces costs associated with outdated production technologies, thus increasing profit margins. Advancing in age reduces farmers' capacity to cope with challenges in agricultural production and manual work. However, Mwangi et al. (2020b) revealed that HH head age influenced profit efficiency positively. In such a case, the farmer's age is presumed to come with experience that might reduce unnecessary costs in production, thus increasing profitability in sorghum farming.

The CF non-participants' profitability lowered with education, implying that as a farmer moves from one level to another, for instance, from secondary to tertiary education, their profitability dropped by 18.64%. Similarly, Sanyang (2014) reported that the profitability of rice producers was reduced with the increase in education. The

study gave a plausible explanation that farmers tend to put more weight on non-farm-related income-generating activities as they achieve higher education levels. Eventually, the profit margins get narrow. On the contrary, the CF participants significantly increased profitability by 21.27% by advancing education to the next level. Akpan et al. (2013) reported similar findings in cassava production in Niger. The research mentioned that HH heads with higher education levels can understand crop production and market dynamics, eventually increasing productivity and profits.

Distance to the market was as expected, reducing profits significantly at a 5% level ($p<0.05$). The findings in Table 4.7 show that an extra kilometer from home to the nearest significantly reduced the profit of sorghum enterprise in Laikipia County by 3.8%. The results were in harmony with Mwangi et al. (2020b), Ntabakirabose (2017), Okeyo et al. (2020b), and Teshome et al. (2020). The studies explain that the longer distances from the HH to the market increase a farmer's variable costs. This implies that apart from the costs of buying inputs, an extra cost of logistics to access the markets for the product reduces the profit margins. In the current study, a plausible explanation for the reduced profits is that longer distances to the market could be the difficulty that a farmer faces when selling their produce attributable to transport costs and poor access roads in the rural areas of Laikipia County.

Membership in an organized group or association significantly influenced the profitability of sorghum enterprises at a 5% level ($p<0.05$). The findings imply that joining an organized group increased smallholder sorghum farmers' profits by 8.24%. Farmer members who belong to groups can seek government services more efficiently than individual farmers. For instance, if a farmer belongs to a producer or farmer group, they can seek agricultural training from the government and non-governmental organizations easily compared to an individual farmer seeking the same services. The results of the current coincide with Teshome et al. (2020). A group of farmers can enhance information flow and technology adoption among sorghum farmers in Laikipia County. In this regard, farmers in groups can produce efficiently so that their cost of production is minimized while the output is maximized. High output increases the revenue farmers receive, and they can offset the minimized expenses, thus increasing profit margins.

The land size was a positive determinant of profitability. It influenced profits at a 1% level ($p<0.01$), implying that farmers with an extra acre would increase profits by 9.57%, 13.25%, and 7.49% for the pooled sample, non-participants, and participants, respectively. When farmers afford the inputs required in sorghum production, they can expand their output as they expand their land under the crop. These findings are in harmony with the findings of Wickramaarachchi and Weerahewa (2018) in Sri Lanka. Large land sizes enjoy economies of scale such that the per-unit cost of production is scaled down. For instance, mechanization becomes expensive on small pieces of land, such as a quarter of an acre, but it becomes of the essence when the acreage increases. In our study, the mean acreage under CF was more than 2 acres, which may have influenced the use of mechanization. Additionally, the current research contradicts Okeyo et al. (2020) and Teshome et al. (2020), who found contrary findings to this study. In their cases, farmers who expand land cannot manage crop production due to the costs involved, while farmers with small sizes can comfortably intensify their production.

Farmers who accessed credit increased their profitability significantly. The influence was significant at 10% ($p<0.1$) and 1% ($p<0.01$) levels for the pooled sample and CF participants, implying that if a farmer accessed credit, the profits increased by 19.88% and 45.16%, respectively. Ahmed et al. (2015), Haile (2015), Ntabakirabos (2017), and Mwangi et al. (2020b) reported comparable findings. Credit comes in handy when farmers cannot afford some inputs, including mechanization. Inputs such as fertilizers and improved seeds enhance agricultural yields; in that regard, sorghum farmers can maximize their yields and revenues. A study by Karani-Gichimu et al. (2015) clarified that households with an obligation to repay credit usually work hard to optimize their output, which translates to an improvement in revenue. In this study, an increase in income means that farmers will increase their gross margins. However, if farmers are not monitored in their production, they might use credit for other enterprises unrelated to sorghum production, thus not increasing profitability as expected.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR POLICY ACTION

5.1 Introduction

The chapter entails the study summary, conclusions, and recommendations. The findings of every objective guided the drawing of conclusions and recommendations. The policy actions are suggested based on the factors influencing participation and profitability from Cragg's DH model and MLR, respectively.

5.2 Summary

The first objective was to describe the socioeconomic characteristics of smallholder sorghum producers in Laikipia County. It was done descriptively using descriptive statistics, and bar and column graphs supported the Table findings. Different continuous variables differed significantly between participants and non-participants of CF. They include land size in acres ($p<0.01$), distance to market in kilometers ($p<0.1$), kilometers to town ($p<0.01$), and extension contacts ($p<0.01$). Some binary variables differed significantly among the two groups, including group membership ($p<0.01$), extension service ($p<0.01$), credit access ($p<0.05$), awareness of CF ($p<0.01$), and ownership of title ($p<0.01$).

The second objective was to evaluate the determinants of decision and extent of participation in contract farming among smallholder sorghum farmers. The objective was analyzed using a double hurdle model. Five factors influenced participation decision into CF, including land tenure ($p<0.01$), land size ($p<0.01$), distance to town ($p<0.1$), group membership ($p<0.1$), and extension education contacts ($p<0.01$). Four factors influenced the level/intensity of participation in CF including farm experience ($p<0.1$), extension education access ($p<0.1$), access to credit ($p<0.01$), and land tenure ($p<0.05$).

The third objective assessed profitability determinants of sorghum CF among smallholder producers in Laikipia County. Profit was assessed using the gross margins while factors influencing profitability were determined using multiple linear regression. The total variable costs (TVC) ($p<0.1$), total fixed cost (TFC) ($p<0.1$), and total production cost (TC) ($p<0.05$), differed significantly among the participants and non-participants of CF. Total revenue (TR) earned by the CF participants differed significantly from that of non-participants of CF at a 5% level ($p<0.05$). The return on

investment (ROI) was 0.62 and 1.69 among the CF non-participants and participants respectively. Five factors influenced the profitability of smallholder sorghum production (for the pooled sample) in the county including age ($p<0.1$), distance to the market ($p<0.05$), group membership ($p<0.05$), land acreage ($p<0.01$), access to credit ($p<0.1$). The profitability of sorghum production among the non-participants of CF was significantly influenced by explanatory variables of included HH head age ($p<0.05$), education ($p<0.05$), and land size ($p<0.01$). Among the CF participants, the significant factors included HH head education ($p<0.1$), land size ($p<0.01$), and access to credit ($p<0.01$).

5.3 Conclusions

In the conclusions section, the study observed from the first objective's descriptive statistics that farmers' educational level played a significant role in their comprehension of information related to contract farming, especially among those with secondary education. Non-participants of contract farming preferred the Seredo variety, while participants predominantly preferred the Sila variety. Non-participants often had farms farther from the market and major towns than participants. Contract farming participants had greater access to agricultural extension services compared to non-participants. Additionally, most sorghum farmers who were part of social groups participated in contract farming, and those with access to credit were more likely to participate. Participants who acquired credit often did so through organizations like Necco Fosa. Sorghum farmers commonly received information about contract farming from field days and agricultural extension officers. Most contract farming participants were landowners.

Moving on to the second objective, it was evident that various factors influenced the decision-making process and the intensity of participation in contract farming. The study found land tenure to be a motivating factor for farmers, providing them with a sense of security and encouraging maximum output without the fear of losing their land. Farmers with more extensive landholdings were also motivated to produce under contract farming due to reduced market risks, as contracting companies offer a ready market for their produce. However, distance to town reduced the probability of farmers participating in contract farming, limiting their access to government and private sector services. Surprisingly, group membership only sometimes led to participation in

contract farming and, in fact, reduced the probability of farmers joining such schemes. Farmers in groups often gained more benefits and thus did not switch to contract farming. The influence of extension officers was substantial in farmers opting for contract farming.

The third objective revealed a promising finding whereby smallholder sorghum production under contract farming was found to be quite profitable. The study showed a significant difference in the profits earned by participants in contract farming compared to non-participants. This insight provides a positive revelation on the potential benefits of contract farming for smallholder sorghum production, which can be encouraging for the audience. Hence, it is clear that engaging in CF can be a profitable endeavor in sorghum production.

In terms of factors influencing profitability, the research suggests that younger farmers tended to be more profitable, possibly because they were more open to adopting new technologies compared to older farmers. Farmers who had to travel longer distances to the market were more likely to join groups, which proved advantageous. Group membership likely facilitated information exchange and technology adoption among sorghum farmers in Laikipia County, leading to profitable outcomes for CF participants. Farmers with larger land holdings may have benefited from economies of scale, helping to lower production costs and increase profits. Access to credit enabled farmers to obtain inputs such as fertilizers and improved seeds, resulting in higher agricultural yields, thus maximizing their output and income.

5.4 Recommendations

The study found several motivating factors that attract smallholder sorghum farmers to CF. Gaps were also detected from the research findings. This calls for all the stakeholders in sorghum value chains to play their roles right. The study offers the following recommendations to different stakeholders;

1. The County Government of Laikipia can improve on the extension services to augment the few contacts offered by the East Africa Malting Limited agents so that more farmers can join the scheme. This is underpinned by the fact that many households received no information about CF and training about sorghum farming and thus they did not engage in the CF initiative that proved profitable.

Training should focus on sorghum enterprise to motivate the intensity to which farmers participate in CF.

2. The Department of Social Services of Laikipia County government should support formal or informal farmer groups. In this regard, farmers in welfare and farmer groups should be trained to allow more ideas about contract farming to increase the probability of more farmers joining the initiative to increase their profitability. This is because groups were unexpectedly found to have a weak influence ($p<0.1$) on farmers' probability of participating in CF. The descriptive findings show CF non-participants who belonged (52) to social groups equally compared with those who did not belong (53) to any group.
3. The county government should reach out to the national government to ensure that as many farmers as possible attain security of tenure, which increases their probability of improving their enterprise profitability. This is because land tenure was a motivating factor that influenced farmers' CF participation decisions due to the security of tenure.
4. The county extension officers and Necco Fosa Cooperative Society agents should join forces to inspire more households to access credit since more than 65% did not borrow the money and that credit significantly increased the profitability of the enterprise under CF. Necco Fosa Cooperative Society comes in handy because it is part of the CF scheme through the County government to provide credit to farmers registered under the CF scheme. If the action is taken, the creditors (Necco Fosa Cooperative Society) will recover their money from sorghum sales and the farmers will remain with a substantial profit.

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APPENDICES

Appendix I: Probit model diagnostic tests

a) Goodness of fit

```
. probit CFParticiaption Age Gender EducationLevel FarmExper Sorgum_Land DistMkt DistTown SocialGrp NoTyms CreditAc LandTenure Offfarm
> income

Iteration 0:   log likelihood = -129.02148
Iteration 1:   log likelihood = -27.963566
Iteration 2:   log likelihood = -21.582004
Iteration 3:   log likelihood = -18.713155
Iteration 4:   log likelihood = -18.100597
Iteration 5:   log likelihood = -17.952372
Iteration 6:   log likelihood = -17.886936
Iteration 7:   log likelihood =  -17.87248
Iteration 8:   log likelihood = -17.870143
Iteration 9:   log likelihood = -17.869695
Iteration 10:  log likelihood = -17.869613
Iteration 11:  log likelihood = -17.869599
Iteration 12:  log likelihood = -17.869597
Iteration 13:  log likelihood = -17.869597

Probit regression                               Number of obs     =        188
                                                LR chi2(12)       =     222.30
                                                Prob > chi2       =     0.0000
Log likelihood = -17.869597                     Pseudo R2         =     0.8615
```

CFParticiaption	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Age	.0108203	.0357679	0.30	0.762	-.0592836	.0809242
Gender	-.6851009	.699531	-0.98	0.327	-2.056157	.6859546
EducationLevel	.1540274	.4190494	0.37	0.713	-.6672944	.9753493
FarmExper	-.0672732	.0928835	-0.72	0.469	-.2493214	.1147751
Sorgum_Land	.5893962	.3120167	1.89	0.059	-.0221452	1.200938
DistMkt	-.0147211	.1058276	-0.14	0.889	-.2221394	.1926971
DistTown	-.0504243	.0253296	-1.99	0.047	-.1000693	-.0007792
SocialGrp	-2.388419	1.752546	-1.36	0.173	-5.823347	1.046508
NoTyms	6.749598	578.2553	0.01	0.991	-1126.61	1140.109
CreditAc	-11.3046	1156.513	-0.01	0.992	-2278.029	2255.42
LandTenure	15.36727	1156.515	0.01	0.989	-2251.361	2282.095
Offfarmincome	-1.297621	1.061851	-1.22	0.222	-3.378812	.7835696
_cons	-.5352773	2.513369	-0.21	0.831	-5.461391	4.390836

```
Note: 22 failures and 66 successes completely determined.

. estat gof

Probit model for CFParticiaption, goodness-of-fit test

      number of observations =       188
 number of covariate patterns =       188
           Pearson chi2(175) =        49.75
                 Prob > chi2 =         1.0000
```

An insignificant P-value confirms goodness of fit

b) Multicollinearity

```
. reg CFParticiaption Age Gender EducationLevel FarmExper Sorgum_Land DistMkt DistTown SocialGrp NoTyms CreditAc LandTenure Offfarminc
> ome
```

Source	SS	df	MS	Number of obs	=	188
				F(12, 175)	=	60.15
Model	37.3110795	12	3.10925662	Prob > F	=	0.0000
Residual	9.0453035	175	.051687449	R-squared	=	0.8049
				Adj R-squared	=	0.7915
Total	46.356383	187	.247895096	Root MSE	=	.22735

CFParticiapt~n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age	.0008121	.0022745	0.36	0.721	-.003677	.0053011
Gender	-.035205	.0396383	-0.89	0.376	-.1134357	.0430257
EducationLevel	.0049769	.0263151	0.19	0.850	-.046959	.0569128
FarmExper	-.0070003	.0042754	-1.64	0.103	-.0154383	.0014378
Sorgum_Land	.0659371	.0119878	5.50	0.000	.0422778	.0895964
DistMkt	.0114979	.0071139	1.62	0.108	-.0025422	.025538
DistTown	-.008051	.001815	-4.44	0.000	-.0116332	-.0044689
SocialGrp	-.0599084	.0417205	-1.44	0.153	-.1422486	.0224318
NoTyms	.0800265	.0153362	5.22	0.000	.0497587	.1102943
CreditAc	-.0445917	.0400815	-1.11	0.267	-.1236971	.0345137
LandTenure	.6234129	.0492035	12.67	0.000	.5263042	.7205217
Offfarmincome	.0173242	.0445367	0.39	0.698	-.070574	.1052224
_cons	.2282117	.1543384	1.48	0.141	-.0763925	.5328158

```
. vif
```

Variable	VIF	1/VIF
Age	2.69	0.371327
FarmExper	2.64	0.379459
LandTenure	2.05	0.488826
DistTown	1.98	0.504325
NoTyms	1.79	0.560215
EducationL~l	1.53	0.651729
DistMkt	1.41	0.709441
SocialGrp	1.40	0.714629
Sorgum_Land	1.34	0.745985
Offfarminc~e	1.25	0.798923
CreditAc	1.16	0.865692
Gender	1.12	0.896320
Mean VIF	1.70	

```
.
```

c) Specification error

```
. reg CFParticiaption Age Gender EducationLevel FarmExper Sorgum_Land DistMkt DistTown SocialGrp ExtensionAc NoTyms CreditAc LandTenur
> e CFAaware Offfarmincome
```

Source	SS	df	MS	Number of obs	=	188
				F(14, 173)	=	72.77
Model	39.6268525	14	2.83048947	Prob > F	=	0.0000
Residual	6.72953045	173	.03889902	R-squared	=	0.8548
				Adj R-squared	=	0.8431
Total	46.356383	187	.247895096	Root MSE	=	.19723

CFParticiapt~n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age	.0015986	.0019806	0.81	0.421	-.0023107	.0055079
Gender	-.048537	.0345457	-1.41	0.162	-.1167222	.0196482
EducationLevel	.002284	.0228321	0.10	0.920	-.0427812	.0473493
FarmExper	-.0056711	.0037288	-1.52	0.130	-.013031	.0016887
Sorgum_Land	.051287	.0106473	4.82	0.000	.0302717	.0723023
DistMkt	.0014651	.0063106	0.23	0.817	-.0109906	.0139207
DistTown	-.0042409	.0016503	-2.57	0.011	-.0074981	-.0009836
SocialGrp	-.0775642	.0365027	-2.12	0.035	-.1496122	-.0055162
ExtensionAc	.2448741	.0613467	3.99	0.000	.1237898	.3659584
NoTyms	.0287241	.0165191	1.74	0.084	-.0038808	.061329
CreditAc	-.0153197	.0351413	-0.44	0.663	-.0846806	.0540411
LandTenure	.4106213	.0517041	7.94	0.000	.3085693	.5126734
CFAaware	.2634597	.041376	6.37	0.000	.1817929	.3451265
Offfarmincome	.0129097	.0386877	0.33	0.739	-.063451	.0892703
_cons	.0732015	.1357356	0.54	0.590	-.1947095	.3411124

```
. linktest
```

Source	SS	df	MS	Number of obs	=	188
				F(2, 185)	=	544.78
Model	39.6278588	2	19.8139294	Prob > F	=	0.0000
Residual	6.72852415	185	.036370401	R-squared	=	0.8549
				Adj R-squared	=	0.8533
Total	46.356383	187	.247895096	Root MSE	=	.19071

CFParticia~n	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	1.020281	.1256398	8.12	0.000	.7724096	1.268152
_hatsq	-.0201903	.1213893	-0.17	0.868	-.2596756	.219295
_cons	-.0007626	.0198337	-0.04	0.969	-.039892	.0383668

An insignificant P-value of _hatsq confirms no specification error

Specification correctness (Log-likelihood)

Log-likelihood for Probit=-23.219 with P<0.0001, meaning that the explanatory variables collectively explain the variation in participation

Appendix II: Truncated model diagnostic tests

a) Multicollinearity

```
. reg CFLandAcre Age Gender FarmExper EducationLevel DistMkt LandAcres DistTown SocialGrp NoTyms CreditAc LandTenure Offfarmin
> come
```

Source	SS	df	MS	Number of obs	=	188
				F(12, 175)	=	13.83
Model	665.721492	12	55.476791	Prob > F	=	0.0000
Residual	701.835688	175	4.01048965	R-squared	=	0.4868
				Adj R-squared	=	0.4516
Total	1367.55718	187	7.31314	Root MSE	=	2.0026

CFLandAcre	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age	-.0165246	.0201173	-0.82	0.413	-.0562284	.0231791
Gender	-.200267	.3494131	-0.57	0.567	-.8898731	.4893391
FarmExper	.0113624	.0381047	0.30	0.766	-.0638415	.0865662
EducationLevel	.0471901	.2317229	0.20	0.839	-.4101411	.5045213
DistMkt	.0934429	.0622829	1.50	0.135	-.0294794	.2163652
LandAcres	.2388502	.0662026	3.61	0.000	.1081919	.3695085
DistTown	-.0482289	.0158305	-3.05	0.003	-.0794722	-.0169855
SocialGrp	-.2221831	.3675188	-0.60	0.546	-.9475227	.5031566
NoTyms	.4773507	.1358876	3.51	0.001	.2091613	.7455402
CreditAc	.646707	.3581001	1.81	0.073	-.0600438	1.353458
LandTenure	1.274922	.4345022	2.93	0.004	.4173828	2.132461
Offfarmincome	.2129318	.3946514	0.54	0.590	-.5659571	.9918207
_cons	1.045282	1.360477	0.77	0.443	-1.639773	3.730337

```
. vif
```

Variable	VIF	1/VIF
Age	2.72	0.368311
FarmExper	2.70	0.370663
LandTenure	2.06	0.486379
DistTown	1.94	0.514395
NoTyms	1.81	0.553663
LandAcres	1.58	0.634366
EducationL~l	1.53	0.652158
SocialGrp	1.40	0.714552
DistMkt	1.39	0.718137
Offfarminc~e	1.27	0.789452
CreditAc	1.19	0.841503
Gender	1.12	0.895010
Mean VIF	1.72	

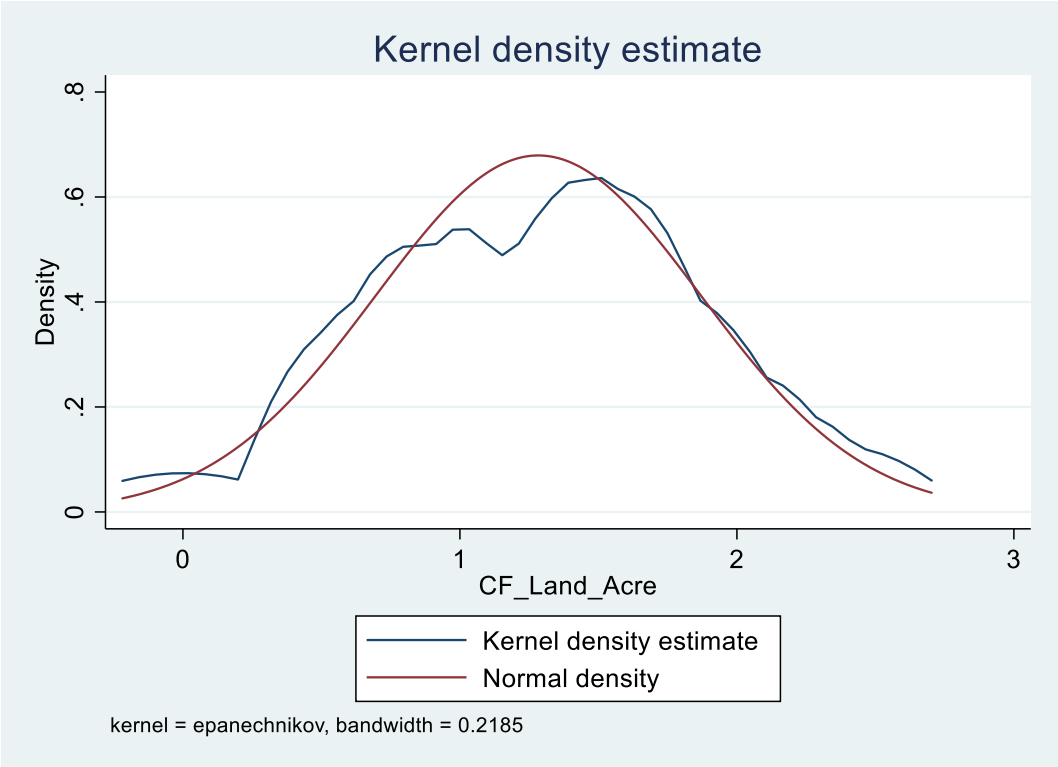
b) Specification error

```
. linktest
```

Source	SS	df	MS	Number of obs	=	188
				F(2, 185)	=	89.08
Model	670.896026	2	335.448013	Prob > F	=	0.0000
Residual	696.661155	185	3.76573597	R-squared	=	0.4906
				Adj R-squared	=	0.4851
Total	1367.55718	187	7.31314	Root MSE	=	1.9406

CFLandAcre	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	.7700018	.2101279	3.66	0.000	.3554468	1.184557
_hatsq	.0486793	.0415273	1.17	0.243	-.0332487	.1306072
_cons	.0879827	.2136902	0.41	0.681	-.3336003	.5095658

c) Normality



Appendix III: Multiple Linear Regression diagnostic tests

a) Multicollinearity

```
. reg LnProfit Age Gender EducationLevel DistMkt SocialGrp Offfarmincome LandAcres CreditAc LandTenure
```

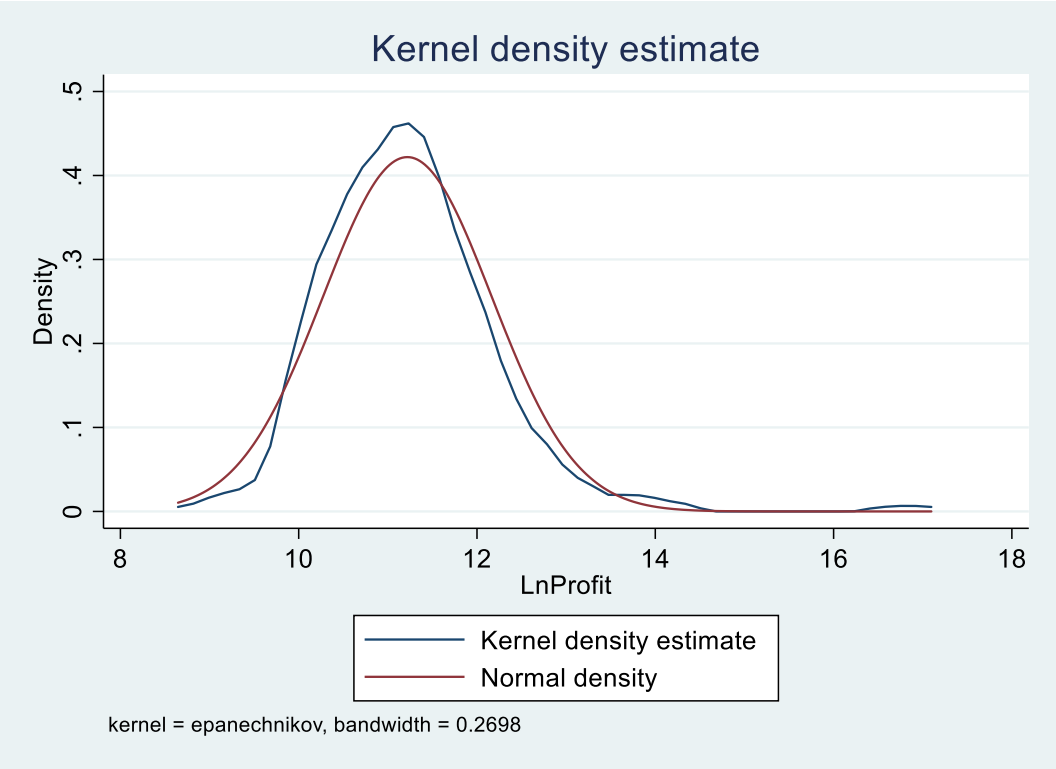
Source	SS	df	MS		
Model	67.1623539	9	7.46248377	Number of obs	= 186
Residual	98.244839	176	.558209313	F(9, 176)	= 13.37
				Prob > F	= 0.0000
Total	165.407193	185	.894092935	R-squared	= 0.4060
				Adj R-squared	= 0.3757
				Root MSE	= .74713

LnProfit	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Age	-.0027301	.0056609	-0.48	0.630	-.0139021	.008442
Gender	-.1443422	.1279332	-1.13	0.261	-.3968227	.1081382
EducationLevel	.0221338	.0853591	0.26	0.796	-.1463253	.1905928
DistMkt	.0451281	.0203549	2.22	0.028	.0049571	.0852992
SocialGrp	.0618435	.1358086	0.46	0.649	-.2061795	.3298664
Offfarmincome	.0872585	.1454841	0.60	0.549	-.1998593	.3743762
LandAcres	.1945514	.0236234	8.24	0.000	.1479299	.241173
CreditAc	.2123074	.1317815	1.61	0.109	-.0477679	.4723827
LandTenure	.1036845	.1332661	0.78	0.438	-.1593208	.3666898
_cons	10.11099	.4555649	22.19	0.000	9.21192	11.01007

```
. vif
```

Variable	VIF	1/VIF
Age	1.51	0.661666
EducationL~l	1.47	0.682302
LandAcres	1.43	0.697118
LandTenure	1.38	0.724161
SocialGrp	1.34	0.744618
Offfarminc~e	1.23	0.811087
CreditAc	1.15	0.868355
Gender	1.07	0.932899
DistMkt	1.06	0.943375
Mean VIF	1.29	

b) Normality



c) Specification error

```
. linktest
```

Source	SS	df	MS	Number of obs	=	186
				F(2, 183)	=	167.86
Model	107.053118	2	53.5265592	Prob > F	=	0.0000
Residual	58.3540746	183	.318874724	R-squared	=	0.6472
				Adj R-squared	=	0.6434
Total	165.407193	185	.894092935	Root MSE	=	.56469

LnProfit	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	1.111407	1.175491	0.95	0.346	-1.207851	3.430665
_hatsq	-.0048471	.0510878	-0.09	0.925	-.105644	.0959498
_cons	-.6370049	6.741981	-0.09	0.925	-13.93901	12.665

Appendix IV: Correlation of the independent variables in the DH model

```
. correlate Age Gender EducationLevel FarmExper LandAcres DistMkt DistTown SocialGrp NoTyms CreditAc LandTenure Offfarmincome
(obs=188)
```

	Age	Gender	Educat~l	FarmEx~r	LandAc~s	DistMkt	DistTown	Social~p	NoTyms	CreditAc	LandTe~e	Offfar~e
Age	1.0000											
Gender	0.0756	1.0000										
EducationL~l	-0.4271	-0.0110	1.0000									
FarmExper	0.7478	0.1595	-0.4188	1.0000								
LandAcres	0.3947	0.1233	-0.0699	0.4205	1.0000							
DistMkt	-0.0777	0.0726	-0.0263	0.0641	0.0162	1.0000						
DistTown	-0.0989	0.0312	-0.1449	0.0609	-0.1313	0.4732	1.0000					
SocialGrp	0.0895	-0.0894	0.0933	0.0737	0.2017	-0.1385	-0.3384	1.0000				
NoTyms	0.0701	0.1351	0.0530	0.0734	0.3410	-0.0352	-0.3729	0.4000	1.0000			
CreditAc	0.0868	-0.0930	0.0363	0.0734	0.3043	0.0757	-0.1583	0.1481	0.1812	1.0000		
LandTenure	-0.0415	0.0587	0.1293	-0.0067	0.2448	-0.1117	-0.4951	0.4637	0.6005	0.1311	1.0000	
Offfarminc~e	-0.1204	0.0916	0.4005	-0.1717	0.0759	-0.0032	-0.0874	0.0503	0.0002	-0.0400	0.1215	1.0000

Appendix V: Semi-Structured Questionnaire

HOUSEHOLD SURVEY 2018 ON THE ANALYSIS OF CONTRACT FARMING PARTICIPATION DECISIONS AND PROFITABILITY BY SMALLHOLDER SORGHUM FARMERS IN LAIKIPIA

This research is been carried out by a student pursuing a Master of Science Degree in Agribusiness Management and Trade of Kenyatta University. The broad objective of the study is to analyze contract farming participation decisions and profitability by smallholder sorghum farmers.

Questionnaire No (QNo)……..

Date: (dd mm yy)……

Household Name……

Respondent Name (Household head): ……..

Identifying Variables:

Enumerator: ……

Telephone number: …….

County: ……

Sub County: …….

Ward: ……

Location: ……

Sub-Location: ……

Village: …….

1.0 AWARENESS AND PARTICIPATION

(a)Variety grown	(b) Sorghum contract farming participation	(c) Awareness of CF **1=Yes 0=No**	(d) Which was your first source of information about Sorghum Contract farming? **1= Extensio**	(e)First time you participated in Sorghum contract farming (Year) ***Put N/A if the farmer has never***	(f) The Land initially put under Contracted sorghum that year (acres)	(g) Since you started planting Sorghum under CF have you	(h) If yes, give reasons ***If No,***
Gadam							
Sila							
Seredo							
Serena							
KARI							
Others							

2.0 CONTRACT FARMING PARTICIPATION INFORMATION

(a)Variety grown	(b) Did you grow any Sorghum under CF during 2017/2018 cropping season (Yes/No) If Yes, fill the rest of the table.	(c)Long season (March-September, 2017)		Short season (October-February, 2018)	
		Area planted (acres)	Land tenure status 1=Leased 2=Own	Area planted (acres)	Land tenure status 1=Leased 2=Own
Gadam					
Sila					
Seredo					
Serena					
KARI					
Others					

2.1 What are some of the general challenges you experience in Sorghum Contract farming?

Expensive inputs [ ] Lack of credit [ ] Transport challenges [ ] Lack of aggregation centers [ ] Lack of extension services [ ]Others specify [ ]

3.0 PRODUCTION OF SORGHUM

Cropping seasons	Quantity of sorghum produced (90) kg bags)	Quantity of stover sold (tons)	Quantity of sor-ghum sold (90) kg bags	Price per unit of stover (ton)	Price per unit of sorghum (bag) (Kes)	Total amount received (Kes)
Long season (March-September, 2017)						
Short season						

3.1 If you did not sell all the sorghum produced where you did take the rest?

Sold in local market [ ] Gave to animals [ ] did not meet the CF standards [ ] Others, specify [ ]

4.0 MARKET CHANNEL

Market channel	**Long season (March-**	**Short season (October-**
Contract farming		
Brokers		
Local market		
Others, Specify		

5.0 COST OF PRODUCTION

Input	Cost per unit **(Kes)**	Total units used in long season (**March – September 2017)**	Total cost of inputs used in the long season **(Kes)**	Total units used in short season **(October-February, 2018)**	Total cost of inputs used in short season **(Kes)**	Aggregated cost of the two seasons **(Kes)**
Land hiring						
Land preparation						
Seeds						
Planting fertilizer						
Basal top-dressing fertilizer						
Foliar top-dressing fertilizer						
Herbicide						
Pesticide						

Hired labor (Planting, weeding, spraying, harvesting, and threshing)						
Threshing						
Storage costs						
Transport to Market						

Units: Fertilizer=Kgs; Herbicides and pesticides=grams/ml; hired labor =per man day; animal power =per day; seed=Kgs

6.0 MARKET AND INSTITUTIONAL FACTORS

6.1 Did any household member access any type of credit for farming purposes in year (2018)?

If **Yes** fill the table below and if **No go to the next question 6.2**

Household Member (No)	Item credit **1=cash 2=kind**	Type of provider: **1=Bank 2=Sacco 3=Trader/shop 4=money lender 5=friends/relatives 6=Others, specify**	Amount **(Kes)** If kind estimate value	Borrowing date **(month and year)**	Repayment period **(months)**	Borrowing conditions	
						The interest rate in %	**Per: 1=day 2=Week 3=month 4=Year**

6.2 If you did not seek any form of credit, what was the reason? Tick as appropriately

1=No collateral [ ] 2= had outstanding loan [ ] 3= No information on credit sources [ ] 4= No account [ ]

5= Lender lacked cash [ ] 6= No need of credit [ ] 7=others (specify) [ ]

7.0 ACCESS TO EXTENSION SERVICES

7.1 Did you seek advice on sorghum contract farming in 2018?

1=Yes [ ] 0=No [ ]

If Yes, go to question 7.2, if No go to question 7.4

7.2 Who did you approach for the advice?

1= Government extension agent [ ] 2 = Private extension agent [ ] 3 = Lead farmer/ farmer organization 4 = Neighbor farmer 5 = Trade fairs and Shows 6= Radio/television [ ] 7 = Family/friend / Newspaper [ ] 8 = Field days/demonstrations [ ] 9 = NGO agent [ ] 10 = Research organization [ ] 12 = other (specify) [ ]

7.3 How many times in the year 2018 did you contact 7.2 above? [ ]

7.4 Why didn't you seek advice? **(Give up to 2 reasons)**

1=Long distance [ ] 2= Extension agents not available [ ] 3= don't need extension service [ ] 5= Other (specify) []

8.0 MEMBERSHIP TO FARMER GROUPS

Do you or any of your family members belong to any association?

1=Yes [ ] 0=No [ ] If yes fill the table and if No go to 8.1

Member ID	**Name of HH member**	**Type of association you belong to (Code A)**	**The function of the club or association (Codes B)**	**Role in the club (Code C)**

Codes A

1. Input/service association
2. Producer marketing association
3. Farmers group

Codes B

1. Produce/marketing
2. Input access/marketing
3. Seed production

Codes C

1. Chairman
2. Official
3. Leader

4. Women's group	4. Farmer extension group	4.
Member		
5. Youth group	5. Savings and credit	5.
Other, specify……..		
6. Faith-based organization	6. Welfare	
7. Community based organization	7. Tree planting & nurseries	
8. Savings and credit group	8. Soil & water conservation	
9. Welfare club	9. Input credit	
10. Government team	10. Other, specify……	
11. Water user's club		
12. Other, specify……		

8.1 If household head is not a member, why? (Give reasons)

1=Not interested [ ] 2=Resigned for personal reasons [ ] 3=Resigned since the organization was not useful [ ]

4=Finished his/her term [ ] 5=Unable to pay subscription fee [ ] 6= Time wasting by group 7=Group collapsed [] 8=others (specify) [ ]

9.0 TRANSPORT AND COMMUNICATION INFRASTRUCTURES

9.1 Distance to the nearest market/ shopping center ……..(Km) walking to time to the market …….…(Minutes/ hours)

Name of market/shopping center…….

9.2 Distance to the nearest administration center……. (Km) walking time to the center…….. (Minutes/ hours)

9.3 Distance to the nearest big town …… (Km) walking time to the town …...…..……..(Minutes/ hours)

9.4 (a) Type of road to market

1= Dirt road [ ] 2=Murram road [ ] 3=Tarmac road [ ]

(b) Quality of road

1=Bad [ ] 2=Good [ ] 3=Very good [ ]

9.5 Do you face any problems while marketing your sorghum through Contract farming? 1= Yes [ ] 0=No [ ]

If yes go to the next question, if No go to 10.0

9.6 What problems do you face while marketing your sorghum through Contract farming?

1=Poor roads [ ] 2=Price fluctuations [ ] 3= others (specify) [ ]

10.0 HOUSEHOLD SOCIOECONOMICS AND DEMOGRAPHY

Member ID	Name of HH member (start with Household head)	Year of Birth	Age (Years)	Gender (Code A)	Marital status (Code B)	Education level (Code C)	Years of schooling	Relationship to HH (Codes D)	Main Occupation (Code E)	Farmer labor participation (Code F)

Codes A **Codes B** **Codes C** **Codes D**

Codes E **Codes F**

1.Male 1. Monogamously married 1. None 1. Household head 1. Farming (crop+livestock) 1. Full time

0.Female 2. Polygamously married 2. Primary 2. Spouse 2. Salaried employment 2. Part time

3. Divorced/separated 3. Secondary 3. Son/daughter 3. Self-employed off-farm3. Not a worker

4. Widow/widower 4. Tertiary 4. Grandchild 4. Casual laborer

5. Never married (single) 5. Adult literacy 5. Other relative 5. School/college child

6. Separated 6. Hired worker 6. Herds boy/girl

7. Other, specify…… 7. Other, specify 7. Household chores

8. Non-school child

9. Other, specify……...

10.1 Household's head farming experience in years……...

10.2 Household head sorghum contract farming experience in years……

10.3 Household total land size……...acres

10.4 Household's total cultivated land……. Acres

Thank you for your cooperation

Appendix VI: Approval of Research Proposal

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 020-8704150

Internal Memo

FROM: Dean, Graduate School

DATE: 1st November, 2019

TO: Mr. Kelvin Thuku Muhia
C/o Department of Agricultural Economics

REF: A152/CE/26361/2014

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

We acknowledge receipt of your Research Proposal after fulfilling recommendations raised by the Graduate School Board of 26th June, 2019.

You may now proceed with your Data collection, subject to clearance with the Director General, National Commission for Science, Technology & Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking Forms per semester. The form has been developed to replace the Progress Report Forms. The Supervision Tracking Forms are available at the University's Website under Graduate School webpage downloads.

Thank you.

JULIA GITU
FOR: DEAN, GRADUATE SCHOOL

CC. Chairman, Department of Agricultural Science & Technology

Supervisors:

1. Dr. Eric Kiprotich Bett
C/o Department of Agricultural Economics
Kenyatta University

2. Dr. Gabriel Mwenjeri
C/o Department of Agricultural Economics
Kenyatta University

Appendix VII: Research Authorization

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 020-8704150

Our Ref: A152/CE/26361/2014

DATE: 1st November, 2019

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

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MR. KELVIN THUKU MUHIA – REG. NO. A152/CE/26361/2014

I write to introduce Mr. Kelvin Thuku Muhia who is a Postgraduate Student of this University. He is registered for M.Sc. degree programme in the Department of Agricultural Economics.

Mr. Muhia intends to conduct research for a M.Sc. thesis Proposal entitled, "Contract Farming Participation Decisions and Profitability by Small Holder Sorghum Farmers in Laikipia County Kenya."

Any assistance given will be highly appreciated.

Yours faithfully,

PROF. ELISHIBA KIMANI
DEAN, GRADUATE SCHOOL