

**VERTICAL COORDINATION OPTIONS AND HORTICULTURAL PRODUCE
SUPPLY CHAIN PERFORMANCE AMONG SMALLHOLDER FRENCH BEANS
PRODUCERS IN MURANG'A SOUTH SUB-COUNTY, KENYA**

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**A Thesis Submitted to the Graduate School in Partial Fulfilment of the Requirements
for the Master of Science Degree in Agribusiness Management of Egerton University**

EGERTON UNIVERSITY

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DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has not been presented in this university or any other for the award of a degree.

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DEDICATION

This thesis is dedicated to my lovely parents, siblings and friends for their support and prayers.

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ABSTRACT

Global agri-food systems have undergone rapid transformations towards higher concentration and closer vertical coordination to meet increasing requirements on food quality, safety and traceability. Vertical coordination options, namely contracts, middlemen, and spot market transactions, have facilitated smallholder participation in high-value chains. However, despite their potential to link farmers to markets, there is a dearth of information on the joint effects of different vertical coordination options on horticultural supply chain performance. Using data from 215 households randomly selected from Murang'a South Sub-County, and applying a multivariate probit (MVP) model; a generalized ordered logit (gologit); and a multinomial endogenous switching regression, this study sought to determine the factors that influence the choice of vertical coordination options and evaluate the influence of vertical coordination options on the adoption of GLOBALG.A.Ps, in addition to estimating the effects of contract and non-contract vertical coordination options on the smallholder French beans' farmers gross margin. The results show that firstly, the likelihood of choice of vertical coordination options increased with the gender of the decision-maker, off-farm income and farming experience at a 1% significant level each. The adoption index results demonstrate that contracted farmers had a 64% compliance level compared to 34% for their non-contract counterparts. Secondly, the GLOBALG.A.P uptake status was significantly and positively correlated with education level, training, farming experience, group membership and vertical coordination options, and lastly, farmers who sold in all the three vertical coordination options reported gross margins of KES 22,565 (ATT) per season. Accordingly, it follows that smallholder French bean farmer's socio-economic circumstances matter in shaping the choice of vertical coordination options and GLOBALG.A.P. uptake status. Moreover, diversifying vertical coordination options yield higher gross margins for smallholder French beans' farmers. These results imply a need to intensify training on new GLOBALG.A.P. measures, advocacy for enhanced group membership, and incentivizing farm business through farmers' participation in off-farm activities that generate the extra income needed to support fresh produce marketing.

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LIST OF ABBREVIATIONS AND ACRONYMS

ASDSP	Agriculture Sector Development Strategic Program
ATT	Average Treatment on Treated
ATU	Average Treatment on Untreated
ESR	Endogenous Switching Regression
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GGAI	GLOBALG.A.P. Adoption Index
GGAP	GLOBAL Good Agricultural Practice
GGAPs	GLOBAL Good Agricultural Practice standard
GOLOGIT	Generalized ordered logit model
HCD	Horticultural Crops Directorate
KNBS	Kenya National Bureau of Statistics
MESR	Multinomial Endogenous Switching Regression
MVP	Multivariate Probit Model
NACOSTI	National Commission for Science, Technology and Innovation
OLS	Ordinary least squares
TC	Total Cost
TR	Total Revenue
UK	United Kingdom
VCA4D	Value Chain Analysis for Development

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CHAPTER ONE

INTRODUCTION

1.1 Background information

Smallholder producers in many developing countries face several challenges in producing and marketing their produce. These challenges include inadequate credit, inputs, market information, and ineffective extension services, crucial pre-conditions for improving a commodity value chain (Abdul- Rahaman & Abdulai, 2020). The transformation of agricultural marketing systems remains low even after globalization and liberalization of trade in Sub-Saharan Africa. The low participation of farmers in the modern supply chain has been attributed to the lack of information on quality and food safety measures on the consumer side (Macharia *et al.*, 2016). For instance, retailers in the urban centers have been forced to import vegetables from keen countries such as South Africa, which are cautious about consumer demand. Similarly, mandatory process standards, growing demand for pest-free products, labeling, and adopting private standards are changing quality and procurement markets, thus posing threats to the low-resource endowed farmers (Asfaw *et al.*, 2010). According to Van den Broeck and Maertens (2016), rural marketing systems fail to adjust and fully respond to the market demand, which restrains farmers from participating in the export chain. Further, production and supply of highly valued produce always require high financial investments and close monitoring, which smallholder producers cannot meet (Kariuki, 2014).

Vertical coordination for Agri-food produce has been in place in the developed world and increasingly expanding in developing countries due to globalization and the liberalization of trade (Alemu *et al.*, 2012). Based on previous studies, several vertical coordination options such as spot market transactions, contracts, strategic alliances, cooperatives, joint ventures, and full vertical integration have gained sizeable attention in recent times. This is because they affect smallholder farmers' ability to benefit from participating in high-value chains (Ba *et al.*, 2019). In Africa, contract farming is the most used vertical coordination option by farmers in groups or individually (Bellamare, 2018). A survey in Ethiopia by Abebaw and Haile (2013) showed that vertical coordination in the agri-food supply chain contributes to transforming the traditional value chain into the modern value chain. Therefore, understanding the inclusiveness and the influence of various vertical coordination options on supply chain performance is crucial in improving smallholder farmers' welfare.

Globally, the production of horticultural produce has increased significantly in recent times. The production of fruits is about 868.1 million metric tons, while vegetables are about 1.1 billion metric tons. The major producers of vegetables and fruits globally are China, India, the USA, Brazil and Vietnam. China is the world's largest producer of fruits and vegetables, accounting for 24% and 45%, respectively (FAO, 2019). Production of French beans in China is about 10.7 tons per acre compared to the global production of 5.7 tons per acre. In Africa, the leading producers of French beans are DRC, Kenya, Tanzania and Uganda, respectively. Approximately 2.4 to 3.2 tons per acre of French beans have been reported in Kenya (Mwangi *et al.*, 2019; Petry *et al.*, 2015).

Horticultural exports are among the key drivers of Kenya's economic development. Recently, Kenya's horticultural farming has increased for crops such as French beans, tomatoes, mangoes, pineapples, passion fruits and other vegetables, earning farmers higher income (Ndung'u, 2015). As a result, horticulture is ranked the third-largest earner of foreign exchange after tourism and tea. Export vegetables constitute the second-largest output in the Kenyan horticulture industry, with cut-flowers coming first in value and volume. The value of vegetable exports is about 20% of the total fresh produce export, with French beans being the leading vegetable (Fresh Produce Exporters Association of Kenya, 2020). The major export destination for Kenya's vegetables has been the EU, with the main market for French beans being the UK, France, Germany, Netherlands, and Belgium (VCA4D, 2018). Although these present an opportunity for smallholder farmers to participate in the growing diversity of agri-food chains, smallholder farmers' participation in the highly valued market is still low. Therefore, measures geared towards enhancing the farmer's understanding of global demand in terms of quality, volume, delivery, traceability and food safety through vertical coordination options would enable smallholder farmers to benefit from the current market opportunity.

Like other Sub-Saharan countries, Kenya's agricultural activities are carried out in the rural areas where about 70% of the population are smallholder farmers (Onyango, 2019). Agriculture contributes to a 31.4% reduction in rural poverty and employs about 60% of the population (World Bank, 2019). According to Mwangi *et al.* (2019), it is approximated that 80% of the French bean producers are smallholder farmers. Production of French beans in Kenya is mainly for export, accounting for 70% of the vegetable export (HCD, 2018). The bean is exported as either canned or fresh beans. The leading French beans producing counties in terms of volume are Kirinyaga, Machakos and Murang'a, respectively (HCD,

2018). Among the 47 counties, Murang'a County is the only region with French beans as a priority value chain in its strategic plan (ASDSP, 2022). Previously, studies have focused on the importance of a single contract type (resource providing), whereas in reality, smallholder farmers face a continuum of inclusive vertical coordination options. Therefore, this study seeks to understand the influence of various vertical coordination options on French bean supply chain performance.

1.2 Statement of the problem

Despite structural adjustments such as globalization, deregulation, privatization and market liberalization, smallholder farmers still find it challenging to participate in the global markets. This is because of the range of barriers that reduce their incentives for participation. The poor economic conditions have caused these challenges, imperfect input and output market, the high transaction cost involved in searching for the buyer and poor coordination. With the increasing demand for food quality, safety, and GLOBALG.A.P. requirements, various vertical coordination options have emerged in the horticultural supply chain. Apart from the spot market and contract farming, middlemen have also influenced smallholder participation in the high-value market. However, little is known about the influence of these coordination options on supply chain performance jointly. Therefore, this study seeks to understand the influence of various vertical coordination options on French bean supply chain performance.

1.3 Objectives

1.3.1 General objective

This study's general objective is to enhance greater participation in profitable vertical coordination options for improved income among smallholder French beans farmers in Murang'a South Sub-County.

1.3.2 Specific objectives

- i. To determine factors that influence smallholder French beans farmers' participation in different vertical coordination options in Murang'a South Sub-County.
- ii. To evaluate the influence of vertical coordination options on adopting GLOBALG.A.P.s among smallholder French beans farmers in Murang'a South Sub-County.

- iii. To estimate the effects of contract and non-contract vertical coordination options on the gross margin of smallholder French beans farmers in Murang'a South Sub-County.

1.4 Research questions

- i. What factors influence smallholder French beans farmers' participation in different vertical coordination options in Murang'a South Sub-County?
- ii. What is the influence of vertical coordination options on the adoption of GLOBALG.A.Ps among smallholder French beans farmers in Murang'a South Sub-County?
- iii. What are the effects of contract and non-contract vertical coordination options on the gross margin of smallholder French beans farmers in Murang'a South Sub-County?

1.5 Justification of the study

Horticultural exports are among the key drivers of economic development in Kenya. French beans production is one of such lucrative agribusiness that can transform the lives of rural communities. French beans production is labor-intensive and thus can create employment and generate income for rural households. In Murang'a County, French bean production is one of the three priority value chains that the county aims at enhancing sustainable quality improvement. Vertical coordination options are perceived to influence smallholder participation in the high-value market. By exploring various vertical coordination options on supply chain performance, this study provides necessary information on the coordination options that improve smallholder farmers' welfare. The study findings provide valuable information for appropriate policy formulations.

1.6 Scope and limitations of the study

The study focused on smallholder French beans farmers in Murang'a South Sub-County. Murang'a is one of the major french beans production in the country. French beans market is relatively well developed, although they operate side by side with the middlemen and spot market. The language was the major limitation encountered.

1.7 Operational definition of terms

Smallholder farmer: This is a producer with 0.5 to 2 acres of arable land ownership.

Vertical coordination: The alignment of direction and control across production/marketing systems segments. The factors aligned and controlled are quantity, quality, price and terms of exchange.

Performance: Measuring gross margin achieved per acre and the adoption status of GLOBALG.A.Ps for contract and non-contracted farmers.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of vertical coordination options

Many studies have argued that vertical coordination strategies lie along a continuum running from spot market to full vertical integration. There are five major vertical coordination options: Spot markets are the simplest, and the intensity of coordination is low. The unseen hand of the market determines the price and broadly accepted standards. The parties involved only engage in price discovery and decide whether or not to enter into the transaction. In this sense, the opportunity to exercise control occurs entirely *ex-ante* to the transaction. The *ex-post* control decision is whether to repeat the transaction with the same party in the future (Peterson *et al.*, 2001). The second strategy is specification contracting. This consists of advanced agreements committing farmers and buyers to specific transactions. They include market contracts where buyers stipulate market specifications such as quality, quantity, pricing and timing while leaving production choices to farmers. In resource-providing contracts, farmers are provided with essential inputs and sometimes production advice (Vroegindewey *et al.*, 2018). The intensity of control is more than that related to the spot market. The parties involved exercise control through the *ex-ante* negotiation of contract specifications and mutually agreed on incentives for meeting the terms (Peterson *et al.*, 2001).

The third portion of the continuum is the relation-based alliance, defined as an exchange relationship in which the firms involved share risks and benefits emanating from mutually identified objectives. The parties agree to work closely together and thus find means to resolve internal differences and concerns as they remain independent entities. The intensity of coordination is higher than that of the spot market and specifications contracting. When benefits fail to materialize, the alliance is likely to dissolve because of the ease with which both parties could walk away (Vroegindewey *et al.*, 2018). A strategic alliance is an example of this vertical coordination option.

The equity-based alliance is the fourth position along the continuum. It involves shared equity assets among the parties in an exchange relationship. The existence of the new formal organization intended to conduct transactions is one of the distinguishing features of this form of alliance. The defining of decision rights and responsibilities is more precise than in a relation-based coalition. Although the ability to walk away has been reduced, the control

is decentralized among the ownership parties. The parties still maintain their separate entity, allowing them to walk away if they desire. In this strategy, the *ex-ante* activities focus on the legal formation of the new entity, while the *ex-post* control is through the board of directors that sets policies and procedures for executing all transactions (Bitsch *et al.*, 2020). Agricultural cooperatives and joint ventures fall under this alliance.

Full vertical integration is the final portion of the continuum, which involves a combination of two or more separable stages of production and marketing under common ownership and management. These stages include production, distribution, sales and other economic practices (Ayinde *et al.*, 2017). It is characterized by centralized decision-making, high asset specificity and extensive information sharing. The advantage is that farmers can reduce transaction costs related to searching for buyers. For *ex-ante* in this case, the control process involves negotiating the formal centralized *ex-post* governance structure. The *ex-post* control aims to achieve effective governance policies and procedures for the centralized entity (Peterson *et al.*, 2001).

2.2 Overview of French beans production

The global production of French beans is estimated to be 5.8 million tons from 855,000 ha. China is the world's largest producer of French beans, with an approximate output of 2.0 million tons per year. The European Union produced 664,000 tons, Turkey produced 515,000 tons, Northern Africa produced 312,000 tons, and tropical Africa produced approximately 75,000 tons per annum (FAO, 2019). French beans are an important export food crop in Kenya after tea and pineapple. The production is carried out on a small scale by producers on farms ranging from 0.5 acres to 2.0 acres. Production rates have increased and surpassed those of several other important food crops (Njenga, 2019). The area under cultivation of French beans increased by 3%, from 4,572 ha in 2013 to 4,707 ha in 2016 (USAID, 2019), while the output and value increased by 9% and 15%, respectively, from 112,409 tons to 122,666 tons and KES 4.4 to 5.04 billion. The leading counties in production were Kirinyaga, Machakos and Murang'a (HCD, 2018). The production is primarily for export, with a small quantity consumed locally.

2.3 Supply chain performance measurement

Supply chain performance is defined by the supply chain profitability, which has only one source of revenue: the end-user (Panchalavarapu, 2003). Performance measurement systems have a large number of performance indicators in practice. An adequate performance measurement system (PMS) must be developed to assess supply chains' success. A PMS is defined as a system that allows a firm to monitor the relevant performance indicators of its produce, services, and manufacturing processes in real-time (Rosenau *et al.*, 1996). Performance indicators are the criteria used to assess the performance of agricultural products, services, and manufacturing processes. Furthermore, performance indicators are operationalized process characteristics that compare a system's efficiency and effectiveness to a norm or target value (Van der Vorst, 2005). Supply chain performance indicators can either be financial or non-financial. Several researchers have evaluated existing performance measurement frameworks using a set of criteria to select an appropriate set of performance indicators (Deshmukh, 2009; Gunasekaran *et al.*, 2001; Moazzam *et al.*, 2018; Prakash *et al.*, 2017; Van der Vorst *et al.*, 2013; Varma & Beamon 1999). For instance, Van der Spiegel (2005) developed a criterion-based approach for selecting appropriate food quality measurement frameworks. The six quality dimensions used to evaluate performance measurement frameworks were product quality, availability, costs, flexibility, reliability, and service. In this study, supply chain performance was measured by gross margin and adoption of GLOBALG.A.P.s among smallholder farmers.

2.4 Empirical literature

2.4.1 Factors that influence smallholder's participation in vertical coordination options

Using a binary logistic regression model in Indonesian vegetable market participation, Maspaitella *et al.* (2018) found that education level, age, land size, family size and farmer group association were statistically significant in determining supermarket contract participation. These findings were similar to those of Schipmann and Qaim (2011), where the logit regression showed that age and household size statistically influenced women's membership in a farmer cooperative. However, irrigation method, farm experience, distance to the market, average price, access to credit, extension service, and market information were not statistically significant. The income obtained from vegetable farming correlated positively with market participation. The authors suggested that prioritizing agricultural development strategies would increase farmers' involvement in the high-value market. These

options included improving the technical innovations and empowering collective actions through farmer groups or cooperatives. In their study, the authors assumed that contract farming was homogenous, where farmers decided whether to participate or not. This approach is restrictive where multiple vertical coordination options are available; hence this study employed a multivariate probit to overcome this weakness.

Wollni *et al.* (2012) used a bivariate probit model to identify the determinants of farmers' participation in written and verbal contracts in the Costa Rican pineapple sector. The model results indicated that older, more educated farmers in group organizations were more likely to participate in a formal contract scheme. On the other hand, farmers with off-farm activities and access to credit from other sources were less likely to participate in formal contracts. Furthermore, the more experienced farmers and the lesser the period a farmer had interacted with the buyer, the less likely they engaged in a formal agreement. The study also observed that participants in the verbal contract were more likely to be less educated and in younger households with a larger number of male adults. Finally, the findings revealed that land size was not significant in either of the equations, and hence there was no evidence for excluding the smallholder farmers from verbal and written contracts. Thus, the model in this study is appropriate where there are two mutually inclusive outcomes.

Using the double hurdle model in the study of farmer's participation in the Zambian dairy interlocked contractual arrangement, Kiwanuka *et al.* (2016) found that smallholder's decision to participate in this arrangement was influenced by milk price, proximity to a water source, land size, ownership of non-land asset, net income, access to market information, number of lactating animals and ownership of improved breeds. The marginal effect indicated that any extra improved breed to the herd was associated with a 58.4% increase in the household probability of engaging in the program. Likewise, the increase in the processors' prices led to a rise in the households' probability of participating by 50.4 %. Similarly, access to market information and an increase in the value of non-land assets was associated with an increase in households' prospect of participating in the program. However, the limitation was that it only focused on one vertical aspect, the contract option. Therefore, this study included other vertical coordination options in the analysis to inform policymakers appropriately.

Carillo *et al.* (2017), in their survey on the choice of vertical coordination options, used a probit model which included; economic characteristics of the household, farm

structure, and social-demographic features. The results indicated that various factors influenced a farm to be vertically coordinated as follows; large land size, high education level of the producer, household income, and product certification presence. The findings further showed that households headed by a male were more likely to be vertically coordinated. This was consistent with findings found by Nyaupane and Gillespie (2011), where the probit results showed that age, education level and income affected the producer's choice of a market outlet. The limitation of this study is that the authors assumed that farmers had only one market choice to decide whether to participate. Therefore, this study included more market options to improve the drawback mentioned.

In a similar study on factors influencing marketing decisions, Carillo (2016) used a linear regression model in the Italian Pasta supply chain. The findings indicated that gender and age did not affect the type of market option selected, and hence both coefficients were statistically insignificant. However, the education level or the number of training attended increased vertical coordination levels of the producers. The results showed low participation of smallholders in contractual arrangements as processors were discouraged from including them due to their inability to meet quality and quantity requirements. Consequently, other scholars argued that food companies prefer to work with medium and large producers (Singh, 2002). This model assumes linearity in parameters, while in reality, parameters are not always constant across time units.

Trifkovic (2016) used a multinomial logit model to analyze the predictions of different vertical coordination mechanisms in Vietnam. From the findings, the choice of vertical coordination options was determined by transaction cost, weak contract enforcement, social norms, trustworthiness, perceptions, reliability, age and education level of the household. The study found that young and more educated farmers had greater opportunities to benefit from contracts, as observed by Barrete *et al.* (2012). Abasimel (2020) recommended interventions toward rural education, training and improving financial institutions to facilitate market access in a similar survey. This model is appropriate when individuals only choose a single option from the established mutually exclusive choices. However, the model also assumes independence of each choice and hence does not allow correlation between them. This study overpowered this weakness by using a multivariate probit model.

In examining the implication of contract farming for welfare and food security in China, Islam *et al.* (2019) used a probit model to determine factors influencing farmers' participation in contractual arrangements. The results from the study indicated that land size did not seem to be a barrier to smallholder participation. The factors that influenced farmers' participation included distance to the input and output market, farming experience, herd size, family member marital status, the price received before the contract, and access to credit and extension services. Using a similar model in the analysis of factors that influence farmer participation in a cooperative in Germany, Pascucci *et al.* (2012) found that the number of cooperatives within the vicinity of the farmer, wealth and better networking had positive impacts on horizontal integration decision. These studies focused on one vertical coordination option, whereas this study included other vertical coordination options as a basis of analysis.

A Multivariate probit model was used to determine factors that influence farmers' preference for pepper market outlets. In their study, Wosene *et al.* (2018) found that the sampled household made their choices depending on the following factors; farmer's experience, frequency of the extension contacts, education level, value addition, total livestock owned, quantity of pepper and distance to the market. The author further found that market contracts and consumer market outlets had a complementary relationship. The findings in this study were in line with that of Burkitbayeva and Swinnen (2020), who also found that extension service contributed to developing the farmer's skills and knowledge, hence adopting a closely coordinated supply chain. This model stands to be appropriate for the proposed study because it allows smallholder farmers to choose more than one option simultaneously.

In a study on determinants of market participation among smallholder pineapple farmers, Sigei *et al.* (2014) used Heckman's two-stage selection model (Heckman, 1979) to determine the decision to participate and the extent of participation in a high-value supply chain. The model involved two stages; firstly, the selected equation was estimated using a probit model and secondly, the ordinary least squares regression method was used to estimate the outcome equation. The findings indicated that age, gender, marketing experience, price information, group marketing, yield and education level influenced farmers' participation in high-value markets. The results showed that 53% of the producers were under contracts while 43% did spot market transactions. The two-tailed results revealed that age was statistically significant at 1%, indicating that market participants' mean age was less than non-participants. This result is consistent with Barrett (2010), who also concluded that the young

people participated more in the market because they were more receptive to new ideas and less risk-averse than older people. One weakness of this model is that it performs poorly when the normality assumption is violated.

2.4.2 Influence of vertical coordination options on the adoption of GLOBALG.A.Ps

Using duration analysis, Wollni *et al.* (2012) found that 81% had adopted GLOBALG.A.Ps and 34% Sustainability standards from the number of farmers who had signed contracts. Contrary to this, 89% of farmers with no contract agreement and 61% with verbal contracts did not adopt good agricultural practices to upgrade their production process. The results indicated that participation in formal and informal contracts had significant and positive effects on adopting good farming practices.

In a recent study on the impact of contract farming on the adoption of standards, Islam *et al.* (2019) used a food safety standard adoption index at the farm level to estimate smallholder compliance with food safety practices. The survey gathered information on good agricultural practices, including hygiene levels in the milking area, hygiene within the premises, milk storage hygiene, record keeping, animal health maintenance, and hygiene in the surrounding environment. The study further identified minimum and maximum scores among the household to develop a standard index for compliance. The results showed that participation in contracts increased the adoption of standards by 9 %.

In assessing standards and vertical coordination in Pangasius aquaculture, Trifkovic (2014) used a Likert scale to determine farmers' application of standards at the farm level. The study found that the prevalence of processor-owned farms' measures was 35%, household-owned farms at 20%, and precisely 40% of the contracted farms applied standards. The standards under the survey included GLOBALG.A.Ps, Aquaculture Stewardship Council (ASC), Safe Quality Food (SQF), British Retail Consortium (BRC) and Hazard Analysis and Critical Control Points (HACCP). Thus, the overall distribution of standards was skewed towards large farms. This observation is consistent with that by Okello and Swinton (2007), who noted that smallholder green bean farmers in Kenya faced difficulties complying with food standards.

In examining the impacts of contract farming on food safety in Nepal, Kumar *et al.* (2016) used a food safety adoption index at the farm level to estimate farmers' compliance with good agricultural practices. The study gathered information from producers on 45 different GLOBALG.A.Ps. These measures included recordkeeping, site management, nutrition management, propagation material, water management, plant protection and postharvest management. The survey did an objective response from producers on whether they followed all the measures or not. The responses were then summed up, and an aggregate

score on good agricultural practices was created. The findings indicated that contract farming appeared to positively affect the adoption of standards compared to spot market transactions. The compliance level for contracted farmers was 33.9% more than their counterparts, which was 27.9%. The study recommended that to increase access to the high-end market, many efforts were needed to enhance food safety compliance among ginger-cultivating households.

2.4.3 Effects of participation in contract and non-contract vertical coordination options on gross margin

Alemu *et al.* (2016) used a propensity score matching technique to assess the impacts of coordination on the beehive supply chain in Ethiopia. Producers on contract and those on cooperatives were the treated observations matched with one or several spot market producers. The effects of contracts and cooperatives on income were then calculated as a weighted difference in the outcome between treated observations and matched controls. The study revealed that farmers on contracts realized higher returns due to access to technology and skills. Moreover, better contract conditions motivated producers to supply large amounts to the market. Many studies have proposed this model as the best option next to randomization and experimental design in solving selection bias (Palmer-Jones, 2010). Matching on propensity score has been suggested as a valid method if the set of potentially relevant characteristics is large. However, this model does not consider unobserved variables such as farmer entrepreneurial skills, network embeddedness, and risk aversion, which could also affect the outcome.

In analysing the impact of contract farming on rice supply chain performance in Ghana, Kanburi *et al.* (2019) used endogenous switching regression to estimate the impact of contract farming on output and net income. The results showed that the estimates for the average treatment effects on the treated (ATT), average treatment effects on the untreated (ATU) and heterogeneity effect (HE) showed the impact of contract farming on net income and yield. The treated and the untreated estimates accounted for the selection bias arising from the fact that contract farming and non-contract farming could be different. The findings further revealed that contract participation significantly increased output and net income. Similar results were pointed out by Sopheak (2015). The policy recommendation from the survey included introducing contract management strategies to boost rice production, educated farmers to be targeted for contracts since their propensity to participate is high, and finally, encouraging contract farming as a means of promoting technology adoption. This study used MESR because it estimates individual and combined choices.

In examining the impact of contract farming on high-value crops, Khanal and Mishra (2018) used a multinomial endogenous switching regression model to estimate the effect of adopting different contract forms on ginger farmers' net returns. The findings indicated that in all the high-value marketing outlets, (ATT) and (ATU) were positive, suggesting that farmers recorded higher gross margins regardless of the contract type adopted than participating in non-contract options. However, maximum returns (ATT) were realized by participating in contract form with output market conditions rather than contract farming with input conditions. The study suggested that policymakers should introduce the benefits of using all forms of contract farming and provide extension services to smallholder producers, especially the older farmers living in remote areas. This study adopted this model because it can evaluate the alternative combinations of options and individual practices.

In a review of contract farming in rice growers in Benin, Maertens *et al.* (2017) used a linear regression model to study rice producers with and without contracts. The regression analysis showed that the average income was similar between contract and non-contract producers. However, the findings indicated significant gains from contracting. The explanation for this is that farmers on contracts gained more from management assistance and the credit provided by the contracting firm. Consequently, the income from contracted farmers was slightly higher than those with no contracts. Besides, contracting resulted in area expansion, increased intensification, yield improvement, output growth and improved commercialization.

Birthal *et al.* (2009) used the ordinary least squares (OLS) model to evaluate farm-level impacts of vertical coordination on the food supply chain in India. The standard treatment model was adopted to account for biases that could arise from comparing the average revenues from both contract and independent producers. The findings indicated that producers on contracts achieved a higher net income than the independent producers due to the reduced cost of acquiring inputs and disposal of the milk. There was no significant difference in the production cost for independent and contract producers as significant transaction costs occurred in the supply chain, which gave those on contract an upper hand. OLS assumes linearity in parameters which is not always the case.

A multiple regression model was used to assess the impacts of alternative vertical coordination options for the development of smallholder farmers in Zimbabwe. Mudavanhu *et al.* (2016) found that the production of tomatoes under contract was associated with

significantly higher income than spot market transactions. Trading in the spot market involved an additional cost in accommodation and transportation of the produce. The study concluded that producing on a contract was more profitable and effective than the spot market. The research further recommended that the government facilitate the development of the smallholder horticulture sector through increased capital access, an improved road network that links the rural and urban areas, enhanced research institutions, frequent farmer training by the extension officers and reduced information asymmetry so that farmers can use timely information to make production and marketing decisions.

2.5 Theoretical framework

Transaction cost theory

This study utilized the transaction cost theory. The theory provides insights into the development of closer vertical coordination in the agri-food sector. The approach recognizes that a buyer and a seller incur costs when conducting a transaction. The cost may arise because of bounded rationality, opportunism, information asymmetry and asset specificity when the neoclassical assumption of perfect information is relaxed (Eggertson *et al.*, 1990). Transaction cost constitutes fixed and proportional costs (Key & Janvry, 2000). The proportionate cost varies with inputs and output quantities transacted, including time spent and transport cost. On the other hand, fixed cost is incurred while identifying a suitable buyer regardless of the amount of input and output transacted. These costs include searching for the buyer, gathering market and price information, and identifying the types of coordination available in the market. Proportional transaction cost increases the cost of production while reducing the output revenue.

This study incorporated the effects of proportional transaction cost on prices received and paid in both output and input markets, respectively. The proportionate cost paid for the input and output market was denoted by t_{il}^p and t_{iq}^p respectively. The real price for the input market is $P_i' = P_{il} + t_{il}^p$ and the real price received by a farmer i is $P_{iq}' = P_{iq} - t_{iq}^p$. Fixed transaction cost was represented in input and output market as t_{il}^f and t_{iq}^f respectively, and input quantity as ϕ , a farmer i whose primary objective would be to maximize gross income was:

$$Y^* = \max [q_i (p_{iq} - p_{iq}^p) - \phi (p_i + p_{il}^p) - t_{iq}^f - t_{il}^f] \quad (2.1)$$

2.6 Conceptual framework

The conceptual framework in Figure 2.1 shows the interrelationship of key variables of the study. A smallholder's decision to participate in any vertical coordination options is influenced by social-economic and institutional factors. The social-economic factors include; age, gender, education level, household size, farm size, household farm income and farming experience. Institutional factors such as access to credit, distance to the market, access to extension service, prior price information, group membership and farming experience were also expected to influence the choice of vertical coordination options and gross margin.

Household characteristics such as age, gender and education level were assumed to positively affect the choice of vertical coordination options, yield and adoption of GLOBALG.A.Ps. For instance, older, highly educated, and male-headed households are more likely to participate in contracts than non-contract transactions. Farming and marketing experience was also expected to influence the choice of vertical coordination options, yield and adoption of standards. A well-experienced farmer in both production and marketing is likely to be exposed to quality and food safety standards and, hence, is associated with keen observation of good agricultural practices.

Farm characteristics such as farm size and distance from the farm to the market were also expected to influence the choice of a vertical coordination option. The study hypothesized that farmers far away from the market are likely to choose a close vertical coordination option to reduce transaction costs. Institutional factors such as access to credit from external sources were assumed to affect the choice of vertical coordination and adoption of standards. Smallholder farmers with access to credit were expected to observe GLOBALG.A.Ps due to the financial aid received. The choice of a vertical coordination option was conceptualized to affect output and gross margin received by smallholder farmers. A close vertical coordination option is associated with a timely flow of information and well-informed decision-making among the actors. Proper coordination of activities within the supply chain improves the supply chain performance.

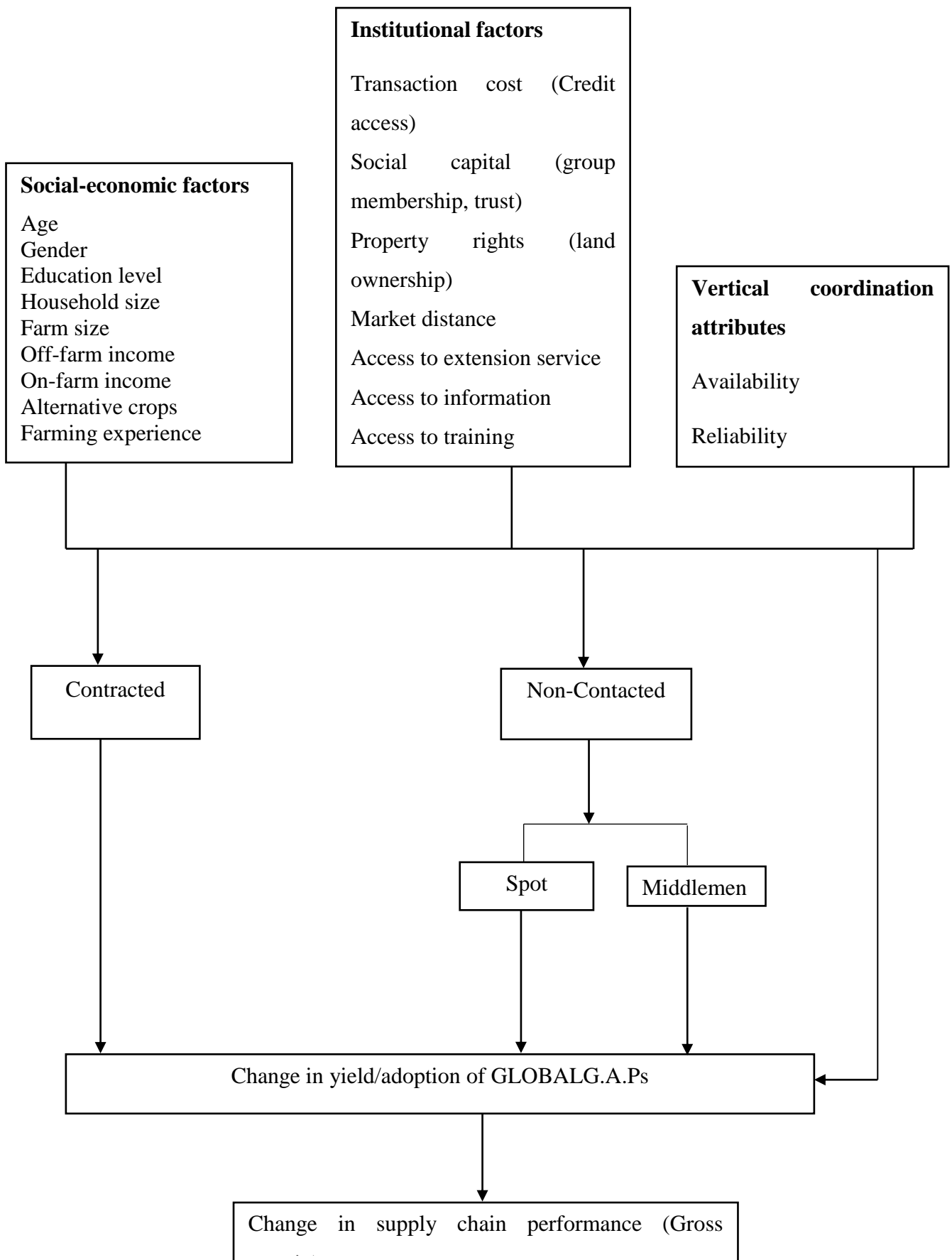


Figure 2.1: Conceptual framework

CHAPTER THREE
FACTORS INFLUENCING THE CHOICE OF VERTICAL COORDINATION
OPTIONS AMONG SMALLHOLDER FRENCH BEANS PRODUCERS

Abstract

With market liberalization and the introduction of the new GLOBALG.A.Ps measures, several vertical coordination options have emerged, presenting smallholder farmers with multiple market outlets. The choice of any vertical coordination options is likely to be entwined by farm, farmer and vertical coordination attributes. Yet, selecting an appropriate market outlet for delivering farm produce is not clear-cut. This study used a multivariate probit model on data from a random sample of 215 farmers to determine factors that influence the choice of vertical coordination options among smallholder French beans producers in Murang'a South Sub County. The results indicate that the choice of a vertical coordination option was significantly influenced by the gender of the household decision-maker, household size, education stock of a household, group membership, extension service, training access, farming experience, off-farm income, credit access, distance and market reliability. This implies that the promotion of collective action as an institutional tool for linking farmers to high-value markets, matters. These networks will aid in sharing knowledge, increasing borrowing power and thus, producers can improve French bean quality as required by the market. Financial institutions should also develop policies that favor credit acquisition at affordable rates. Further, the role of extension agents should be strengthened, and more training on GLOBALG.A.Ps should be done.

3.1 Introduction

In recent times, the significance of cereals and other staple food crops is declining in developing countries, with high-value commodities receiving an increasing demand (Mehdi *et al.*, 2019). High-value products are commodities with high economic returns, such as cut flowers, fruits, vegetables, meat, milk and fish. Vegetable production being labor-intensive is considered an income-generating activity that fits well with smallholder agricultural development (Dilamini *et al.*, 2019). French beans is one of the most crucial export vegetable produced by smallholder farmers in Kenya. Besides, it has a short life cycle, thus ensuring income flow throughout the year. The French beans market has recently expanded, as seen in Kenya's supermarket shelves and wholesale markets.

Structural changes in the agri-food supply chain, development of institutions for vertical coordination, and growth of high-value commodities present opportunities for smallholder farmers (Nandi *et al.*, 2017). In developed countries, vertical coordination options are well developed: thus, farmers make rational decisions on the market outlet choice. However, in Sub-Saharan countries, particularly Kenya, vertical coordination options are weak, and as such, enforcement and choices are also spurious for smallholder producers. In addition, smallholder producers' farm produce is small in quantities that require aggregation. The aggregators are limited to buying companies or producer marketing organizations (PMO), most organized around a specific buyer or an NGO market-linked PMO. As a result, the supply chain has become an essential strategy for guaranteeing quality and reliable sourcing of fresh fruits and vegetables globally. Procurement between the producer and the buyer is usually based on observable features like size, volume and color (Nandi *et al.*, 2017). The choice to sell is not mutually exclusive. Producers would prefer to sell a large proportion of their output to the primary buyer while the rest to other buyers (Muthini *et al.*, 2017).

Besides, market liberalization has given smallholder farmers chances to diversify their production to target high-value markets, for instance, export and processing oriented markets. However, in liberalized markets, individual farmers lose negotiation power and are usually exploited by buyers due to imperfect information (Muthini *et al.*, 2017). Farmers also face behavioural uncertainty due to the perishable nature of some agri-food products (Ciliberti *et al.*, 2020). Therefore, Smallholder producers' participation in high-value markets remains a significant constraint. Empirical studies have shown that farmers need support from private and government sectors to access appropriate market channels (Aleria Negeri, 2017; Poole, 2017).

Appropriate market channels are an integral part of market participation decisions. Households' decisions to sell in different marketing outlets significantly affect income. Several factors are likely to influence farmers' decision to participate in any market outlets, including market access, prices, resource endowment and transaction cost (Abera, 2016; Tarekegn *et al.*, 2017). Understanding these factors is fundamental in pinpointing possible interventions necessary to assist farmers in maximizing benefits derived from production and marketing activities. Further, the information could help develop strategies required to mitigate the effect of some challenges, thereby facilitating smallholder producers' market entry and increasing their probability of running a lucrative crop investment (Abate *et al.*, 2019). Besides, it increases income and alleviates poverty among rural households (Emran & Hou, 2013; Hung & Bokelmann, 2019). Every market outlet is characterized by different risks, cost structure, profitability and other necessities. These features are essential to smallholder farmers who aim to access profitable channels (Win *et al.*, 2015). Muricho *et al.* (2015) suggested that understanding the association between market outlets is essential in profiling the channels and creating policy interventions cautiously designed to benefit the farmer.

Research on determinants of smallholder market choice has attracted the attention of many empirical studies in recent times (Daniso *et al.*, 2021; Endris *et al.*, 2020; Kiprop *et al.*, 2020; Mehdi *et al.*, 2019; Mulbah *et al.*, 2021; Slamet *et al.*, 2017; Tura & Hamo, 2018). Given the potential of Murang'a County in French beans production, these study results are essential in providing vital information concerning appropriate vertical coordination options. Therefore, this study contributes to the literature by determining the factors influencing French beans channel choice among smallholder farmers.

3.2 Methodology

3.2.1 Study area

The study was conducted in Murang'a South Sub-County. The total area of Murang'a South Sub-County is 456.9 sq. Kilometers with a population of 184,824 people (KNBS, 2019). The Sub-County is located between Longitudes 37 ° 08' 60" East and Latitude 0 ° 43' 0" North. Murang'a South Sub-County comprises 6 wards, namely Kimorori, Makuyu, Kamahuha, Ichagaki, Nginda and Kambiti. The area receives an annual average rainfall of 1164 mm and an annual temperature of 19.8 °C. It experiences long rains in March, April and May, with short rains being recorded between October-November. Agriculture is the main economic activity in the region, and it contributes to about 57% of the county's population income. The major cash crops in the county include tea, coffee, avocados, mangoes and macadamia. Horticultural crops include French beans, tomatoes, cabbages, kales and spinach, while food crops include bananas, maize, sweet potatoes and cassava (County Government of Murang'a, 2018).

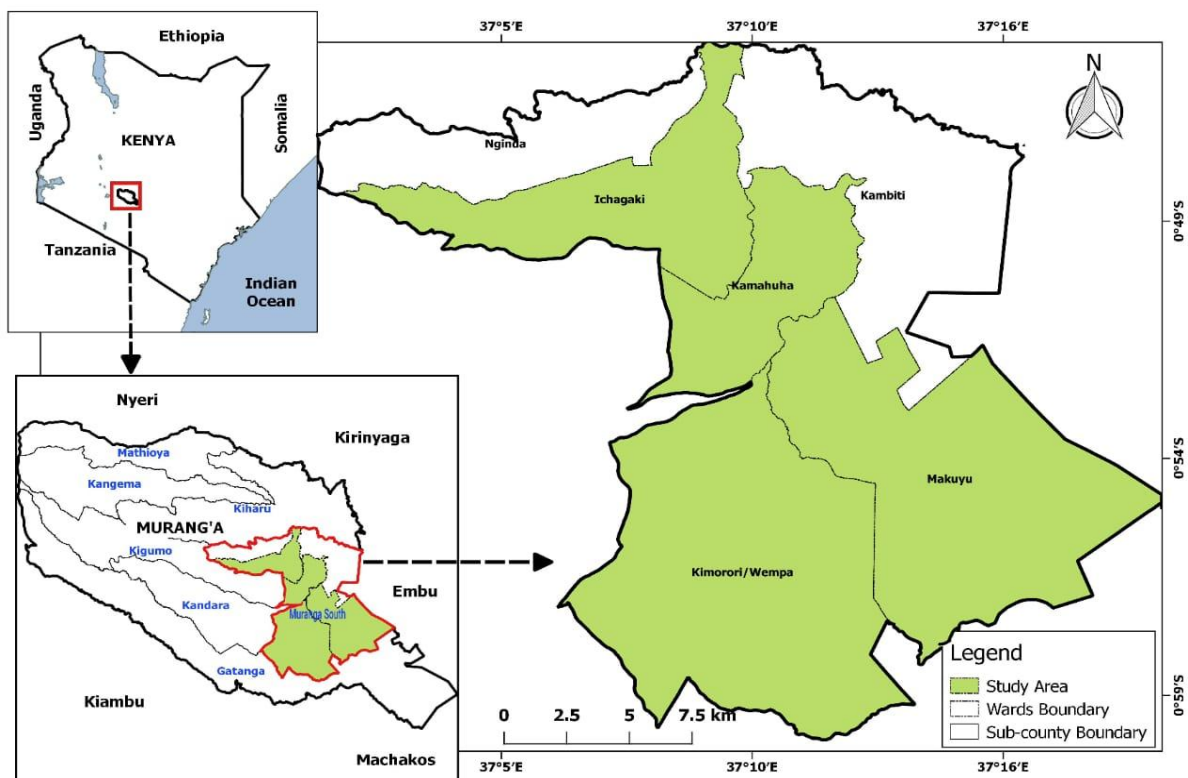


Figure 3.1: Map of Murang'a South Sub-County

Source: Egerton University Department of Geography (2020)

3.2.2 Research design

The study used a cross-sectional research design. This design is helpful for this study because data were collected once from a diverse group of respondents. Also, much information is obtained in a relatively short period (Sedgwick, 2014).

3.2.3 Target population

The unit of study was smallholder French beans producers in Murang'a South Sub-County. The respondents included males and females who are key decision-makers in a household.

3.2.4 Sample size determination and sampling procedure

A multistage sampling technique was employed in this study. In the first stage, Murang'a County was selected purposively since French beans are one of the three priority value chains that the county is promoting. It is also one of the few counties where the export of horticultural produce is a significant economic activity. Murang'a South Sub-County was purposively selected at the second sampling stage because it leads in French beans production and has the highest number of smallholder farmers. In the third stage, four wards, namely, Kamahuha, Makuyu, Kimorori and Ichagaki, were purposively selected based on the production level. In the fourth stage, two management systems (contract and non-contract farming) were purposively selected from each production ecology. Yamane (1967) suggested that when the study area's population size is known with certainty, the following formula is appropriate to determine the sample size.

$$n = \frac{N}{1 + N(e^2)}$$
$$n = \frac{937}{1 + 937(0.06^2)} = 214.3 \approx 215 \quad (3.1)$$

where n is the sample size, N is the total population of interest and e is the allowable margin of error. This gives a sample size of 215 respondents. French beans farmers were proportionately selected since the population in each ward was not equal in size. Finally, simple random sampling was used to select the respondents.

Table 3.1: Target population and distribution in each ward

Sub County	Ward	Target population	Proportionate	Sample
Murang'a South	Kamahuha	345	0.37	80
	Ichagaki	281	0.30	64
	Kimorori	182	0.19	41
	Makuyu	129	0.14	30
Total		937	1	215

Source: (Murang'a South Sub-County MOALF, 2020)

3.2.5 Data collection method

The study used primary data collected through a semi-structured questionnaire. The questionnaire had both open and closed-ended questions. The study also employed face-to-face interviews with the respondents as a means of data collection. The data collection method aimed to assess the relationship between various coordination options and the performance of the French beans supply chain.

3.2.6 Description of variables for the choice of vertical coordination options

Age (*Age*) of the production decision-maker was hypothesized to positively influence the choice of vertical coordination option. As farmers get older, the probability of choosing a reliable and profitable market is likely to increase. Older age is associated with knowledge accumulation on marketing trends and high risk-aversion, and thus farmers involve in highly coordinated vertical coordination options like contracts to avoid losses. Similarly, Koech (2015) noted that age positively influenced the choice of market facilitators among smallholder producers. However, Slamet *et al.* (2017) reported that age negatively influenced smallholder participation in supermarket channels. According to Slamet *et al.* (2017), younger producers tend to be more innovative, quick decision-makers and have the ability to adjust to new market requirements.

Household size (*Hhsize*) was defined by adult equivalent. Lager household size and a higher dependency ratio could imply pressure on the household to provide food and other basic needs, thus reducing the chances of participation in high-value markets. On the other hand, a larger household size could also mean that the needed labor to produce additional French beans is available, thus increasing the household probability of choosing better market outlets. Similarly, Abu *et al.* (2016) found that household size had significant positive and negative effects on market participation decisions. However, Tura and Hamo (2018)

suggested that household size negatively influenced smallholder farmers' participation in wholesale outlets. The authors argued that bigger households assist each other in selling to direct consumers rather than the wholesale channels.

Gender (*Gender*) of the household size was postulated to influence the choice of a market outlet. Male-headed households were expected to have a higher chance of participating in contract markets than female-headed households. Males have superior access to technologies than females. Besides, males have a tendency to search for market alternatives than females. As a result, male-headed households would have a higher probability of choosing appropriate channels than female-headed households. This hypothesis is in line with Hirpesa *et al.* (2020), who reported that most females participated in the non-contract channel in selling milk as opposed to males in Ethiopia. According to Kihoro *et al.* (2016), males have a better decision-making ability within a household shaped by the norms and roles of males in the African setup.

The variable farm size (*Fsize*) was hypothesized to influence the farmers' choice of vertical coordination option. Resource-rich framers defined by large land size are more likely to associate with highly coordinated supply chains such as contracts. Consequently, contract agents prefer to deal with resource-rich farmers while informal channels such as middlemen with resource-poor farmers (Birthal *et al.*, 2017; Mehdi *et al.*, 2019; Slamet *et al.*, 2017). Contrary, Tura and Hamo (2018) found no significant effect of farm size on selecting wholesale, retail and consumer outlets.

Education stock (*Edu*) was postulated to influence the choice of vertical coordination option used by a farmer. Education is expected to facilitate entry into modern markets as it would motivate uptake of new market requirements. Literacy also increases the probability of choosing a contract market channel and decreases the selection of a spot market outlet. In addition, education places producers in a better position concerning access and synthesis of information resulting in an improved understanding of market dynamics and proper market selection decisions (Simon *et al.*, 2015).

Off-farm income (*Offincome*) was hypothesized to positively affect strategic market choice decisions. Marketing requires some initial cost, and therefore, off-farm income was expected to positively affect the choice of high-value market outlets. Off-farm income provides farmers liquidity for investment, acts as insurance against the risks incurred during farming and enables farmers to implement new technologies (Fentie & Rao, 2016). Equally,

Camara (2017) suggested that off-farm income can be used to procure inputs and increase the market-oriented probability.

Farming experience (*Fexp*) was postulated to positively influence farmers' decisions on contract choice as a marketing channel. More experienced farmers are expected to have more networks, which helps them get more information on reliable markets (Simon *et al.*, 2015). Moreover, producers who possess many years of farming experience better understand market opportunities and are less likely to be cheated since they know the market outlet dynamics (Maina *et al.*, 2015).

Group membership (*Grpm*) is a proxy for social capital and was postulated to positively correlate with participation in vertically coordinated supply chains like contracts. Horizontal coordination assists smallholder farmers in pooling resources to achieve economies of scale, thereby increasing their access to input and output markets. Group membership also aids farmers in attaining bargaining power thus, they can negotiate for better prices for their produce. This assertion conforms to previous studies that group membership has a positive association with the adoption of modern markets among farmers (Kiprop *et al.*, 2020; Sharma, 2015).

The number of training (*Notra*) received was postulated to positively influence the probability of selling through contract. Training equips farmers with knowledge and practical technical skills that enhance human capital. Farmers who acquire training attain export quality requirements and hence attract high-value channels. In addition, agricultural training influences the adoption level of new technology (Remya & George, 2016).

Similarly, access to extension services (*ExtAcc*) was expected to increase the likelihood of selling through the contract channel. Adopting new agricultural innovations such as contract farming requires technical advisory service from extension agents. This assertion is supported by Mounirou (2020), that contact with extension agents positively influenced the adoption of contractual arrangements at the producer level. Frequent extension contacts increase the ability of producers to acquire crucial market information and other relevant agricultural information. This information is necessary to increase their capacity to choose the best market channel for their produce (Endris *et al.*, 2020).

Distance to market (*Dist*) was hypothesized to positively influence the choice of contract vertical coordination option. Longer distances are associated with increased transport costs and the risk of spoilage. For these reasons, farmers are likely to choose market outlets

with economies of scale, such as contracts. Equally, Taregen *et al.* (2017) reported that farmers sold their output through market channels in their locality to reduce transaction costs. Also, Maina *et al.* (2015) noted that farmers prefer to work collectively to reduce transport costs.

The amount of credit received (*CrdtAcc*) was postulated to have a positive relationship with the selection of appropriate market outlets. Farmers with access to credit have the potential to produce more output and thereby can be able to sell bulk to outlets like contracts. Similarly, Abu *et al.* (2016) pointed out that credit access enables farmers to produce a marketable surplus of good quality, thereby increasing the chances of participating in high-value markets. Fischer and Qaim (2012) noted that farmers were more likely to choose dairy cooperatives as their marketing channel if they offered loans at relatively lower interest rates.

The reliability of the vertical coordination option (*Rel*) was hypothesized to influence market outlet choice. Market incentives such as a steady market positively affect contract market selection. Farmers will choose a channel that gives a consistent market to their produce to avoid losses. Similarly, Arinloye *et al.* (2015) argued that market incentives affected processing and export marketing channel choice.

3.2.7 Modeling strategy

A multivariate probit model was adopted for this study based on empirical studies reviewed. This model is preferred since it can simultaneously set out the influence of a set of explanatory variables on the choice of vertical coordination options while allowing the unobserved disturbances and different coordination options to be correlated (Belderbos *et al.*, 2004). Smallholder farmers in this study are faced with different vertical coordination options like contracts, middlemen and spot market transactions. The producer's decision for any vertical coordination option is based on utility maximization. This implies that the alternative choice requires different costs and benefits and hence different utility. Considering the possibility of simultaneous choices of vertical coordination options and the potential correlations among these coordination option decisions, a multivariate probit model stands to be appropriate. The model also helps to capture household variation in the choice of vertical coordination and to estimate several correlated binary outcomes jointly.

Other studies used a multinomial logit model in determining factors influencing the producer's vertical coordination choice. The use of this model is misleading because it

assumes individuals choose only one option from mutually exclusive alternatives. The choice of vertical coordination j is dependent on the selection of the other. This is because smallholder farmer's choice decisions are interdependent.

Empirically this model can be presented as follows:

$$Y_{ij}^* = \beta_{ij} X_{ij} + \varepsilon_i (j = Y_1, Y_2, Y_3) \quad (3.2)$$

where Y_{ij}^* is the latent variable, Y_{ij} is the observed dummy variable for all the options such as

$$Y_{ij} = \begin{cases} 1 & \text{if } j = Y_1, Y_2, Y_3 \\ 0 & \text{otherwise} \end{cases} \quad \forall j = Y_1, Y_2, Y_3 \quad (3.3)$$

where X_{ij} is a set of explanatory variables, β_{ij} are the coefficients to be estimated, $Y_{i1} = 1$ if a farmer chooses contract, 0 otherwise, $Y_{i2} = 2$ if a producer selects middlemen, 0 otherwise, $Y_{i3} = 3$ if spot market is chosen, 0 while ε_i is the error term.

In a multivariate approach, using various vertical coordination options simultaneously is possible. The disturbance terms jointly follow a multivariate normal distribution with a mean of zero and a variance normalized to unity, thus:

$$\begin{pmatrix} \varepsilon_{i1} \\ \varepsilon_{i2} \\ \varepsilon_{i3} \end{pmatrix} \dots N \left(\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{bmatrix} 1 & P_{i12} & P_{i23} \\ P_{i21} & 1 & P_{i23} \\ P_{i31} & P_{i32} & 1 \end{bmatrix} \right) \quad (3.4)$$

where P_i represents the correlation between different vertical coordination options, ε_{i1} to ε_{i3} are the error terms. The off-diagonal elements in the covariance matrix represent the unobserved correlation between the stochastic components of different vertical coordination options.

The variables in Table 3.2 are selected based on related literature (Abu *et al.*, 2016; Camara, 2017; Dessie *et al.*, 2018; Dlamini *et al.*, 2019; Endris *et al.*, 2020; Mehdi *et al.*, 2019; Mulbah *et al.*, 2020; Simon *et al.*, 2015) and particular variables of interest for this study.

Table 3.2: Model variables hypothesized to influence the choice of vertical coordination option

Variable	Description	Measurement	Expected sign
Dependent			
Y_i	Choice of vertical coordination, 1=contract, 2=spot 3=middlemen	Categorical	
Independent variable			
Age	Age of HH head(years)	Continuous	+
Hhsize	Household size(adult equivalent)	Continuous	+/-
Gender	Sex of the household head, 1=male, 0=female	Dummy	+
Edu	Education stock (years of formal schooling)	Continuous	+
AccCrdt	Amount of credit (KES)	Continuous	+
Fsize	Farm size (in acres)	Continuous	+
Offincome	Off-farm income	Continuous	+
ExtAcc	Extension access	Dummy 1=yes, 0=no	+
Notra	Number of training	Continuous	+
Grpm	Group membership	Dummy 1=yes, 0=no	+
Dist	Distant to market (Kilometers)	Continuous	+/-
Fexp	Farming experience(years)	Continuous	+
Infoacc	Information access	Dummy 1=yes, 0=no	+
Rel	Reliability of the outlet	5 Likert=(SD to SA)	+

Note: SD means Strongly Disagree; D, Disagree; N, Neutral; A, Agree; and; SA, Strongly Agree

3.3 Results and discussion

3.3.1 Descriptive statistics

A household's socio-economic characteristics matter in marketing decisions. Tables 3.3 and 3.4 present descriptive statistics of the farm, farmer and vertical coordination attributes for continuous and categorical variables respectively.

Table 3.3: Descriptive statistics of farm, farmer and vertical coordination attributes for continuous variables

Variables	All (2015)	Contract	Non-Contract	t-value
	Mean	Mean	Mean	
Age	46.4(12.53)	46.9(12.66)	45.7(12.36)	-0.679
Education of the respondent	9.71(3.45)	10.17(3.74)	8.97(3.18)	-2.514**
Education stock	38.3(19.93)	37.4(19.87)	39.6(20.05)	0.774
Household size (number)	4.4(2.02)	4.2(1.94)	4.7(2.11)	-2.514**
Household size (adult equivalent)	3.9(1.78)	3.72(1.71)	4.2(1.85)	1.924**
Farm size (acres)	1.26(0.94)	1.33(0.95)	1.14(0.91)	-1.475
Land under French beans	0.4(0.29)	0.44(0.29)	0.35(0.29)	-2.311**
Farming experience	10.33(6.86)	13.75(6.28)	4.9(3.34)	-11.832***
Number of training	3.3(3.05)	4.8(2.86)	0.95(1.50)	-11.205***
Credit in KES	2604(9548)	3007(10857)	1964(70001)	-0.780
Distance to market center	3.8(1.86)	3.8(1.94)	4.0(1.72)	1.006
Availability of the channel	3.6(0.78)	3.8(0.66)	3.2(0.80)	-6.253***
Reliability of the channel	3.3(0.77)	3.6(0.68)	2.8(0.65)	-8.744***

Note: Figures in parenthesis are standard deviations associated with the means of the variables indicated.

***, ** denotes statistical significance at 1% and 5% level respectively.

Age of the household key production decision-maker indicates the age structure of the sample and population as a whole. The age of the sampled households ranged from 21 to 75 years. The mean age of the households surveyed was 46 years (Table 3.3). Households selling their produce through non-contract options were younger than their counterparts. The mean age of contracted farmers was 47 years, while that of non-contracted farmers was 45 years. Age plays a significant role in the adoption of new technology, and older farmers are

likely to be more experienced and thus receptive to closely coordinated market outlets like contract farming. Similarly, Mojo *et al.* (2017) found that older coffee farmers had a higher tendency to participate in contract farming because they had enough resources. However, Barnes *et al.* (2019) found that older farmers were less likely to adopt precision agricultural technology. The authors argued that age was potentially linked to the knowledge required to operate information-intensive technology.

The number of formal schooling defined education level. The mean number of formal education among farmers was 9.71 years (Table 3.3). The number of formal schooling was significantly higher for contracted farmers (10.17) years than for non-contracted farmers (8.97) years. The mean difference in the number of years spent in schooling was statistically significant at 5% level. This implies that producers who participated in the contract were more educated compared to those who participated in the non-contract option. However, education stock was slightly higher for non-contracted farmers (39.6) whereas those of contracted farmers was 37.4. The overall mean education stock for the households surveyed was 38.3. A higher number of formal schooling among the respondents means that they are more receptive to new management practices and technologies. Rao and Qaim (2011) also reported that more educated farmers were likely to adopt innovative production and marketing technologies relative to less educated farmers.

Household size is a proxy variable for the labor force and household dependency ratio. The results indicated that the mean family size of the sampled households was 4.4, with an adult equivalent ratio of 3.9. The contract option had a mean of 4.2 household members with an adult equivalent ratio of 3.7. On the other hand, the non-contract option had an average of 4.7 household members with an adult equivalent ratio of 4.2 (Table 3.3). The mean difference between the average household size and adult equivalent was statistically significant at 5% level. Larger households are associated with a high dependency ratio, which means that each household member in the productively active age bracket supports more than one household member in the productively inactive age bracket. These households are less likely to participate in contract options since they are likely to be poor. This view corroborates Mehdi *et al.* (2019) who reported that contract agents prefer to work with resource-rich farmers. Contrary to this view, Mmbando *et al.* (2015) argued that contract farming is labor-intensive and thus, larger households tend to participate in contracts to meet this labor requirement.

Land is an important production factor in rural areas. Farm size was assumed to be a good proxy gauge for wealth. About (80%) of the surveyed households owned land with contract farmers reporting (81%) while non-contracted producers (77%) (Table 3.4). The mean land size among farmers was 1.26 acres. Contracted farmers had large land size (1.33) acres than non-contracted farmers (1.14) acres. Land size influenced the total acreage under french beans production. The average land size under French beans was 0.40 acres. Contracted farmers had a slightly larger land size under French beans (0.44) as compared to their counterparts (0.35) acres (Table 3.3). This can be explained by the fact that farmers with larger pieces of land tended to devote more of their land to French beans production. Similarly, Mukiyama *et al.* (2014) noted that Thailand vegetable farmers with smaller land sizes were more likely to sell through non-contract options than contract options. Besides, Paltasingh *et al.* (2018) also found that total land owned by farmers enhanced the adoption intensity of modern rice technology.

The mean of farming experience was 10.33 years for the farmers. Contracted farmers had the highest number of farming experience (13.75) relative to non-contracted farmers (4.94) (Table 3.3). The association between farming experience and usage of vertical coordination options was statistically significant at 1% level. This implies that a longer farming period increases the likelihood of participating in the contract option, which matches the result of Lu *et al.* (2017).

The average distance to the output market was 3.8 kilometres with farmers selling their output through the non-contract option reporting a slightly longer distance (4.0) compared to the contract option (3.8) kilometres (Table 3.3). This implies that farmers located further away from the market were less likely to adopt contract farming. A possible explanation for this is that a longer distance is associated with high transport cost, which may not attract contract agents. Similarly, Aryal *et al.* (2020) found that the likelihood of adopting climate-smart agriculture decreased with increased distance to the market.

Concerning vertical coordination attributes, the availability of the channel had a slightly higher score (3.8) for the contract option, while the non-contract channel reported a score of 3.2. Regarding the reliability of the channel, the contract option maintained the highest score (3.6), whereas non-contract farmers recording a score of 2.8 (Table 3.3). This implies that the majority of the farmers participated in the contract option because it was available and reliable for selling their output. The mean difference between the averages of

the two attributes was statistically significant at 1% level. Similarly, higher prices for quality milk motivated farmers to participate in dairy contract farming (Saenger *et al.*, 2013).

Most of the key production decision-makers were males (60) percent while (40) percent were females. Out of this sub-population, (58%) of males and (42%) of females were under contract option (Table 3.4). This could be possible because most males have land ownership rights relative to females. Studies have also shown that males play a key role in the adoption of new technology as compared to females (Abdallah, 2016; Aryal *et al.*, 2020; Zulqarnain *et al.*, 2020).

Most household key production decision-makers reported that farming was their main occupation (87%). The highest proportion of non-contracted farmers (90%) reported that farming was their primary occupation, while contracted farmers at (85%). Salaried employees and business people participated in contract option accounting for 13% and 2%, respectively. Five percent of non-contracted farmers participated in casual labor, while contracted farmers reported a zero percent. Civil servants, business and casual labor occupations had a low number of respondents accounting for 9%, 2% and 2% respectively (Table 3.4). These results show that majority of French beans producers are not involved in off-farm activities. The mean difference among occupation averages was statistically significant at 1% level.

Extension access facilitates the dissemination of information to farmers. Among the contracted farmers, (77%) had access to extension services. On the other hand, (37%) of the non-contracted producers had access to extension services (Table 3.4). The mean difference between the two means was statistically significant at 1% level. Agricultural extension service is essential in informing and influencing farmers' decisions, especially in the adoption of new technologies. Similarly, Altalb *et al.* (2015) reported that agricultural extension is responsible for transferring and adopting new technologies to farmers.

Training access was higher among contracted farmers (68%) as compared to non-contract farmers (42%) (Table 3.4). Similarly, contracted farmers had the highest number of training with a mean of 4.8, whereas non-contracted producers recorded a mean of 0.9 (Table 3.3). The association between training access and choice of vertical coordination was statistically significant at 1% level.

Table 3.4: Descriptive statistics of farm and farmer characteristics for categorical variables

Variables		All	Contract	Non-Contract	χ^2
		%	%	%	
Farmer characteristics					
Gender	Male	60.47	57.58	65.06	1.194
	Female	39.53	42.42	34.94	
Marital status	Married	75.81	71.21	83.13	5.515*
	Single	15.35	16.67	13.25	
	Widowed	8.84	12.12	3.61	
Occupation	Business	2.33	2.27	2.41	12.864****
	Casual	1.86	0.00	4.82	
	Farmer	86.98	84.85	90.36	
	Civil servant	8.84	12.88	2.41	
Off-farm income	Yes	27.44	32.58	19.28	4.526**
	No	72.56	67.42	80.72	
Land ownership	Yes	79.53	81.06	77.11	0.4890
	No	20.47	18.94	22.89	
Rented-in land	Yes	68.37	68.18	68.67	0.005
	No	31.63	31.82	31.33	
Institutional factors					
Information access	Yes	76.74	83.33	66.27	8.318****
	No	23.26	16.67	33.73	
Extension access	Yes	61.40	76.52	37.35	32.980****
	No	38.60	23.48	62.65	
Training access	Yes	69.30	86.36	42.17	46.785****
	No	30.70	13.64	57.83	
Group membership	Yes	62.33	74.24	43.37	20.680****
	No	37.67	25.76	56.63	
Credit access	Yes	10.7	10.61	10.84	0.956****
	No	89.30	89.39	89.16	

***, **, * denotes statistical significance at 1%, 5% and 10% level.

Among the contracted and non-contracted farmers, (11%) had access to credit instead of (89%) who did not receive any credit (Table 3.4). The association between credit access and participation in vertical coordination options was statistically significant at 1% level. Agricultural credit enables farmers to overcome financial constraints in technology adoption (Abdallah, 2016).

Out of the sampled households, (62%) of the key production decision-makers were members of agricultural groups. Amongst this sub-population, (74%) used the contract option while (44%) participated in the non-contract channel. On the other hand, the majority of non-group household decision-makers participated in non-contract outlets accounting for 57% and those selling through contract channels at 26% (Table 3.4). The mean difference between group membership averages was statistically significant at 1% probability level. Group membership enhances sharing of information on the benefits of contract farming, thereby, convincing more farmers to join. This result conforms to that of Aku *et al.* (2018) who found that a group act as a means to access price information, secure market opportunities, obtain credit and enforce contracts

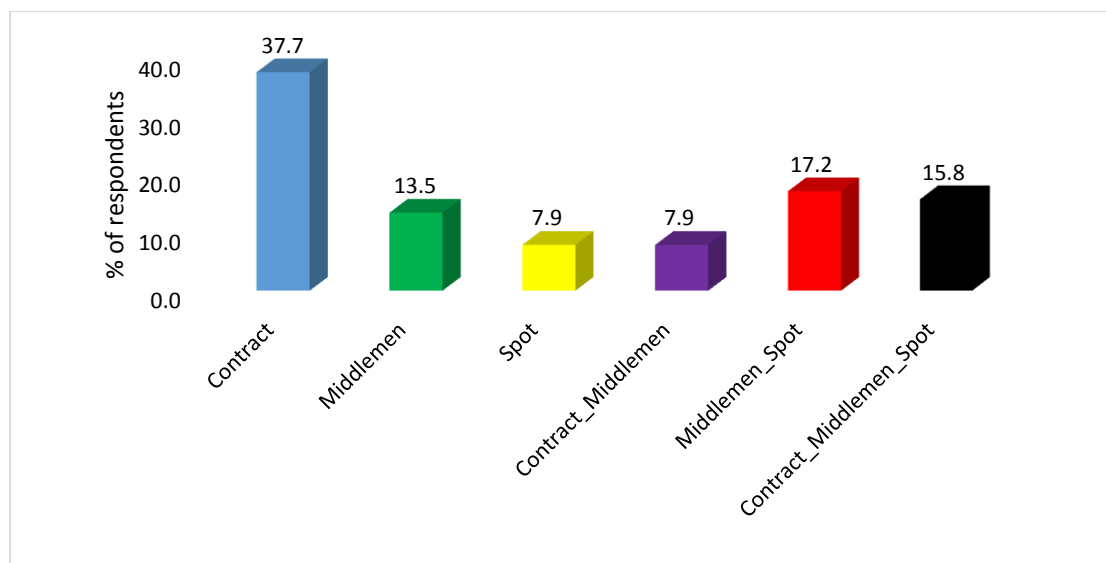


Figure 3.2: Vertical coordination options used by smallholder farmers

Farmers participated in either a single choice or a combination of outlets. The six identified options include contract (38%) middlemen (13%), spot (8%), contract and middlemen (8%), middlemen and spot (17%) while contract, middlemen and spot market combination at 16%. Contracting was the dominant marketing outlet among farmers, as shown in figure 3.2.

3.3.2 Empirical results

Table 3.5 shows the results of a multivariate probit model analysis of the factors influencing smallholder farmers' marketing decisions.

Table 3.5: MVP estimates for factors influencing VCO selection decisions

Variable	Contract		Middlemen		Spot	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
Age	-0.014	0.015	0.010	0.010	0.014	0.010
Gender	-0.948***	0.352	0.407***	0.207	0.105	0.206
Household size	-0.457**	0.184	0.044	0.093	-0.112	0.095
Education stock	0.031*	0.017	0.002	0.009	0.013	0.009
Farm size	-0.104	0.173	0.001	0.124	-0.017	0.116
Off-farm						
income	0.308	0.363	0.628***	0.237	0.625***	0.237
Group						
membership	0.554*	0.322	-0.326	0.225	0.009	0.215
Extension						
access	0.674**	0.330	-0.694***	0.222	-0.156	0.221
Number of						
training	0.181**	0.089	-0.021	0.045	0.038	0.051
Reliability	0.621**	0.190	-0.549***	0.148	-0.366***	0.141
Distance	0.039*	0.023	-0.020	0.015	-0.015	0.014
Farming						
experience	0.223***	0.052	-0.005	0.021	-0.092***	0.028
Information						
access	-0.151	0.378	0.061	0.248	0.311	0.238
Credit access	0.000*	0.000	0.000	0.000	0.000	0.000
_cons	-3.113	1.065	1.724	0.692	0.809	0.670

Number of observations =215

L.R test of $\rho_{30}=\rho_{31}=\rho_{32}=0$ $\chi^2(3)=33.359$ Prob > $\chi^2=0.0000$

Wald $\chi^2(42) = 131.69$ Prob > $\chi^2 = 0.0000$

***, **, * denotes statistical significance at 1%, 5% and 10% level respectively.

The Wald χ^2 test that all the regression beta coefficients are jointly equal to zero is rejected. (Wald $\chi^2(42) = 131.69$; Prob > $\chi^2 = 0.0000$). These imply that the explanatory

power of the variables included in the model is satisfactory. The likelihood ratio test (LR test: $\chi^2(3) = 33.359$; Prob > $\chi^2 = 0$) is highly significant at 1% level suggesting that multivariate probit model fits the data reasonably well.

Gender of the household head had a highly significant influence on the probability of choosing contract and middlemen options at 1% significance level each. Male-headed households had a higher likelihood of selling through middlemen by 4% and a lower probability of selling through contract by 9%. This implies that households headed by males were more likely to participate in middlemen options while less likely to select contract outlet. A possible explanation for the shift of males from contract to middlemen is that access to middlemen could reduce transport cost and market risks associated with the produce's perishability. Further, quick payment plays a crucial role while farmers decide which marketing channel to use, as reported by the respondents during the interviews. This finding is in line with that of Adugna *et al.* (2019), where farmers chose farm gate outlets to reduce transaction costs and cash constraints. However, Shammah *et al.* (2017) pointed out that male-headed households had a higher probability of selling pineapple in the export market than farm-gate. According to Shammah *et al.* 2017, males can engage in negotiations, possess more marketing networks and interact with more buyers, unlike women who are restricted by family roles.

Household size had a negative and significant effect on the choice of contract option at 5% probability level. Any additional adult to a household reduced the chances of participation in the contract by 47.7%. An additional member could imply more responsibilities to care for the aged thus increasing the family expenditure on food and other basic needs. An increased dependency ratio in a household would mean that less money is left to pay for contract requirements such as registration fees. This result conforms to that of Muricho *et al.* (2015), who noted that a higher dependency ratio puts more pressure on market participants to meet home consumption needs. However, Abu *et al.* (2016) found that household size had positive and negative effects on market participation. The authors argued that an increase in the number of family members could enhance market participation through labor provision and reduce the probability of participating in multiple market outlets due to the limited surplus available for sale.

Education stock was positive and statistically significant at 10% level for the choice of contract option. Households with higher education stock were more likely to participate in

contract than non-contract options. A one-year increase in household members' number of formal schooling resulted in 3% likelihood that that household would choose contract. This implies that better-educated household members are more likely to have improved access to market information that is likely to affect their decision-making. Access to this information places farmers in a better position to negotiate for better output prices, seek better market opportunities, and meet the required market quality standards. This result corroborates with studies showing that education positively impacts the producers' choice of market channel (Chala & Fana, 2017; Mariyono *et al.*, 2019; Zhang *et al.*, 2017).

Off-farm income had a positive effect on the choice of middlemen and spot market options at 1% significance level each. Involvement in off-farm activities increased the probability of participating in middlemen and spot market options by 62.8% and 62.5% respectively. A probable explanation for this is that farmers prefer to sell to channels that reduce the transaction cost involved in searching for the buyer. This result tallies with that of Emanu *et al.* (2015) who noted that farmers with off-farm income would prefer to sell their produce to the nearby market channel with lower prices than searching for other channels. However, Muthini *et al.* (2017) reported that farmers with off-farm income were less likely to sell to brokers. The contradicting authors argued that these farmers probably were not cash-constrained and therefore could delay their sales as they seek better prices from other channels.

Access to extension service was found to be significant for the selection of contract and middlemen options at 5% and 1% significance levels respectively. Producers who received extension services were more likely to select contract by 67.4% while less likely to choose the middlemen option by 69.4%. Extension agents provide advisory services to farmers which in turn, increases their ability to choose the best market channels such as contracts. Similarly, Muthini *et al.* (2017) reported that lack of extension services positively influenced the quantity of output sold to brokers. Moreover, Hirpesa *et al.* (2020) argued that access to extension services significantly increased the likelihood that a smallholder dairy farmer would participate in the contract market relative to the non-contract supply chain. However, access to extension services had a negative effect on the choice of rural collectors in coffee outlet choice (Gebre *et al.*, 2020).

Number of training was positive and statistically significant at 5% probability level for the contract option. A unit increase in training increased the probability of choosing the

contract option by 18.1%. This result suggests that training exposes farmers to a wide range of ideas and gives farmers opportunities to have better access to appropriate market information. Similarly, training in latex enabled farmers to access high-value channels that required quality produce (Zaw & Myint, 2016).

Group membership was positive and statistically significant at 10% level for the contract channel. Farmers belonging to an agricultural group had a higher probability of selling through a contract outlet by 55.4%. This can be attributed to the fact that producers who collectively market their produce to distant areas tend to incur reduced transaction costs. It may further be explained by the role of collective action in attaining bargaining power and reducing transaction cost which corroborates with findings by Mulbah *et al.* (2021). This finding is also consistent with those of Kiprop *et al.* (2020) who stated that, the probability of accessing processor market outlets increased with group membership compared to accessing the market as an individual producer. However, group membership can negatively impact market participation in case disagreement emerges among members, distorting marketing decisions (Olwande & Mathenge, 2011).

Access to credit was positive and statically significant at 10% level for the contract channel. A unit increase in credit received increased the chances of participating in the contract option. A possible explanation for this is that obtaining a contract market for French beans is both labor and capital-intensive and therefore credit access eases the liquidity constraint of households. This result conforms to that of Dessie *et al.* (2018) that showed that lack of credit reduced the probability of participating in the wholesaler marketing channel. Additionally, Melese *et al.* (2018) found that the availability of credit services had a positive significant effect on the choice of assemblers as a viable marketing channel for selling onions as opposed to direct consumers.

Farming experience was highly significant at 1% significance level for contract and spot market. An additional year of farming experience increased the probability of selling through contract option by 22.3% while less experience was associated with selling a larger proportion of output to the spot market by 9%. Farmers who had more farming experience were assumed to have better bargaining power and marketing linkage, and therefore, were able to understand opportunities and threats in the market. These producers, thereby, tended to sell their produce to the contract option because it offered farm inputs. However, Maina *et al.* (2015) noted that farming experience increased the probability of selling mango to a non-

contract channel. According to the contradicting authors, farmers preferred selling to brokers because of the long-term relationship between the farmer and the broker over the years.

Perception of the reliability of the outlet was statistically significant at 5%, 1% and 1% significance level for contract, middlemen and spot market respectively. High perception of reliability of the channel increased the probability of choosing a contract option by 62.1% while reducing the likelihood of selling through middlemen and spot market by 54.9% and 36.6% respectively. With the perishable nature of French beans, producers tend to choose market channels that have a ready market to supply their produce. This implies that contract attributes such as stable market prices, availability of market information, timely payments and guaranteed market motivated farmers to sell their produce through this channel. This result is in line with Dlamini *et al.* (2019) who found that market incentives such as bulk purchasing, quick process and lump sum payments encouraged farmers to sell through supermarkets compared to traditional markets.

Distance to the market center was positive and statistically significant at 10% level for the contract option. A unit increase in distance to market increased the likelihood of choosing a contract by 3%. This implies that the probability of choosing a contract option increases with additional distance to the market center. A plausible explanation for this behavior could be, farmers incurred extra transaction cost while moving their produce to the market and thus they preferred to sell through contract since it provides transport for their produce. Similarly, Shammah *et al.* (2017) noted that additional distance to the market increased the probability of choosing an export market for pineapple fruits as opposed to the farm gate. According to the authors, gross margin from a high-value channel outweighs the opportunity cost of selling the produce at the farm gate due to transaction cost incurred. Additionally, farmers who are farther from the market are more likely to have large farms which exporters prefer because of economies of scale (Muthini *et al.*, 2017).

3.4 Conclusion and recommendations

Kenya operates under imperfect input and output market resulting in high transaction cost, price risks and thin markets. The study focuses on determinants of vertical coordination option choices based on data collected from smallholder French beans producers in Murang'a South Sub-County. The findings show that gender, household size, education, group membership, extension access, number of training, market reliability, farming experience, credit access, off-farm income, and distance to market singularly or simultaneously matter in

smallholder French beans choice on marketing option. Among the marketing options for French beans, contracting dominates spot market and marketing through middlemen.

The following are policy recommendations drawn from the study. First, there is a need to strengthen rural farmer organizations to increase their bargaining power and borrowing ability. Distance from the farm to the market significantly influenced vertical coordination choice decisions. This study recommends investing in infrastructure, especially roads, to reduce transaction costs and improve supply reliability. Household size was negative and statistically significant for the choice of contract option. This result brings forward the importance of demographic policy, which takes into account of the households' composition. Therefore, this study recommends the need for policy geared towards helping farmers with a high dependency ratio to improve their household income. Farming experience was highly significant for the choice of contract market option. Therefore, the government needs to organize more training on the new GGAPs, especially for older farmers. This move would enable farmers to meet high-value market requirements. Access to credit was found critical in driving the formal French beans marketing channel uptake. Financial institutions stakeholders should develop policies that favor the acquisition of credit at affordable rates.

CHAPTER FOUR
INFLUENCE OF VERTICAL COORDINATION OPTIONS ON ADOPTION OF
GLOBALG.A.Ps

Abstract

GLOBALG.A.Ps have appeared to increasingly control the exchange of horticultural products in the international market. To make horticulture exports viable and lucrative, smallholder farmers need to invest in GLOBAL Good Agricultural Practices (GGAPs). While research has focused on the impact of adoption on the welfare of farmers, the role of vertical coordination options (VCO) in stimulating the adoption of these standards has been ignored. This study examines the influence of VCO on the adoption of GGAPs among smallholder French bean producers in Murang'a South Sub-County. The cross-sectional data analysis results show that farmers on contract had higher adoption levels (66%) relative to non-contracted farmers (34%). Based on the logit findings, the determinants of farmer's compliance levels were age, gender, education, household size, training, extension service, group membership, farming experience, vertical coordination options and market availability and reliability. Therefore, this study recommends an incentive that will promote the improvement of agricultural extension to facilitate contract farming for the adoption of GGAPs. Additionally, the government should put in place measures to safeguard farmers from market exploitation.

4.1 Introduction

Globally, horticulture is the fastest growing sector in agriculture. It contributes to nutrition security, poverty alleviation, employment creation and improved income along the value chain (Krause, 2020). China has been ranked as the world's largest exporter of horticultural products (FAO, 2018). In Kenya, Horticultural production for export has been accredited for employment and rural community growth (Gichuku *et al.*, 2020). The sector remains among four foreign exchange-earners accounting for 19 % of Kenya's total exports in 2019. This consisted of floriculture at 11% while fruits and vegetables at 4% each. The key destinations for Kenya's horticultural exports include the Netherlands, United Kingdom, United Arab Emirates, United States of America and Germany (Kenya Export Promotion and Branding, 2020). With the outbreak of the Covid 19 crisis, Kenya experienced an increment in the export of horticultural products in the first quarter of 2020 surpassing levels of the previous years (Mold & Mveyange, 2020).

The call for fresh horticultural products is continually increasing in local and global markets. Consumers from developed countries such as European Union desire a year-round availability of fruits, vegetables and flowers. Customers in these countries are willing to pay higher prices for high-quality horticultural products. In response to these tendencies, the interest in accessing the international markets has significantly risen among traders and producers of horticultural products in developing countries (Krause *et al.*, 2016).

However, the rise in consumer demand for better food quality and safety and the difficult nature of food safety threats, put more pressure on compliance with agricultural practices at the farm level. Policies that highlight quality and safety standards along the chain have been developed to increase the productivity and marketability of agricultural produce. The GLOBALG.A.P. has been recognized as the main reference for good agricultural practices in the global market. It covers a wide range of concerns, including food quality, safety, traceability requirements, pesticide use risks, and the environmental sustainability of agriculture. Further, it has social effects as it takes care of workers' safety, health and welfare (Pandit *et al.*, 2017). Therefore, smallholders' ability to strengthen and remain competitive in the global export market will depend on their capacity to fully comply with these standards.

Nevertheless, the uptake level of GLOBALG.A.Ps at the farm level and post-harvest handling remain a global constraint among producers. This has been attributed to inadequate

awareness, high investment cost and lack of market opportunities (Krause *et al.*, 2020). Also, the insufficient capacities and specialized knowledge among public extension service providers to prepare farmers for advancement and compliance with GLOBALG.A.Ps have resulted in a shift in the standard-setting authority from public to private. Therefore, smallholder farmers rely on buyers or NGOs, or international organizations to provide support services to adapt to international standards. In such a scenario, smallholder farmers find themselves on a truncated plane in adopting GGAPs or the adoption could be said to be non-linear, meaning that they are not always on the same level of adoption. As a response, vertical coordination strategic options have evolved to provide producers with the necessary support structure to fill this gap (Gichuki *et al.*, 2020).

However, there is little information on the influence of various vertical coordination options on the performance of the horticultural supply chain. It is thus vital to understand the potential of Vertical coordination options in promoting the adoption of good agricultural practices among smallholder farmers. Therefore, this study seeks to evaluate the effect of vertical coordination options and other factors on the adoption of GLOBALG.A.Ps.

4.2 Methodology

4.2.1 Modeling strategy

To measure the status of adoption of GLOBALG.A.Ps, the adoption index was used as developed by Kumar *et al.* (2018) in the assessment of impacts of contract farming on the adoption of food safety standards in tomatoes. The study did an objective response from producers to determine whether they comply with each of the 49 practices at the farm level. The farm practices followed largely related to infrastructure at the farm premise such as grading shade, charcoal coolers, tap, toilet, bathroom and chemical store; hygiene of produce, personnel and farm premise; traceability measures such as production record track, plot labeling, pesticide use, record keeping; worker safety measures such as having full protective gear; worker health check, observing pre-harvest intervals, chemical sprayer equipment maintenance, pest and disease scouting, chemical use, disposal of chemical containers, environmental safety, adherence to pesticide residue limits, integrated pest management, water quality assessment, soil management, plant propagation material, plant nutrition management, packaging and transport of produce from the farm to the collection point. An aggregate score of good agricultural practices was then created by summing up all the responses given by a household. This served as a proxy for compliance with standards by a household.

The aggregate score for compliance with good agricultural practices for the m^{th} household is given as follows:

$$S = \sum_{j=1}^{49} F_{jm} \quad (4.1)$$

where F_{jm} represents the j^{th} G.A.P. followed by the m^{th} household. The scores were standardized to calculate the probability of a score occurring.

$GGAI$ was calculated as follows:

$$GGAI = \left(\frac{SA - SL}{SM - SL} \right) * 100 \quad (4.2)$$

where $GGAI$ is the GLOBALG.A.P. adoption index, SA is the household's actual score, SL is the minimum score for the households surveyed and SM is the maximum score among households surveyed. Farmers were divided into three groups based on the adoption levels. Producers with scores 0-30 were termed as low adopters, 31-60 medium adopters and 61-100 as high adopters (Kumar *et al.*, 2018). These groups were used to capture the status of compliance to good agricultural practices for all the vertical coordination options. The study also compared the mean $GGAI$ of contracted and non-contracted farmers as well as looked at their distribution by the level of adoption.

After calculating $GGAI$, the study employed a generalized ordered logit to determine factors influencing the degree of adoption of GLOBALG.A.P.s. This model is appropriate for this study since the dependent variable is categorical and ordered that is, the degree of adoption and a set of independent variables that influence the final probability. One major limiting assumption for ordered logistic regression is that the relationship between each pair of outcome groups is the same. Invariably, the ordered logistic regression model operates on the assumption that the corresponding coefficients (except the intercept) ought to be identical across the different logistic regression (as defined by the level of compliance), other than differences resulting from the sampling variability (Williams, 2006). This assumption is called the proportional odds assumption or the parallel regression assumption. However, this assumption is often violated and therefore, a generalized ordered model stands to be the most appropriate as it relaxes the assumption. This study adopted this model because it allows the

coefficients of the variable to vary among categories of variables. If this is not the case for all the variables, the model is called partially constrained (Eluru, 2013).

In the partially constrained generalized ordered logit model, only a sub-set of variables has a varying coefficient. Econometrically, the generalized logit model can be specified as follows:

$$P(Y_i > j) = g(X\beta_j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1 + [\exp(\alpha_j + X_i\beta_j)]}, j = 1, \dots, J - 1 \quad (4.3)$$

where J is the number of categories of the ordinal dependent variable, that is 3, Y_i is the categorical variable for compliance degree. α_j is the intercept, β_j parameter to be estimated and X_i is a vector of explanatory variables. The probabilities that Y_i will take on each of the values 1, 2 or 3 is shown as follows:

$$P(Y_i = 1) = 1 - g(X_i\beta_1) \quad (4.4)$$

$$P(Y_i = 2) = 1 - g(X_i\beta_1) - g(X_i\beta_2) \quad (4.5)$$

$$P(Y_i = 3) = g(X_i\beta_2) \quad (4.6)$$

$$Y_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon_i \quad (4.7)$$

where Y_i is the level of compliance to good agricultural practices by a farmer (3=high adopter; 2=medium adopter; 1=low adopter). X_1, \dots, X_n represent the explanatory variables; β_1, \dots, β_n is a vector of parameters to be estimated; β_o represents the intercept while ε_i is the error term.

The partially constrained model can be written as follows:

$$P(Y_i > j) = \frac{\exp(\alpha_j + X_{1i}\beta_{1j} + X_{2i}\beta_2)}{1 + [\exp(\alpha_j + X_{1i}\beta_{1j} + X_{2i}\beta_2)]}, j = 1, \dots, J - 1 \quad (4.8)$$

where the first subset of variables has non-constrained coefficients across the values, and the second subset has the same coefficient across the values of j . The generalized ordered logit model is equivalent to a series of binary logistic regression where categories of the dependent

variable are combined (Williams, 2006): for instance, since $J = 3$, then for $j=1$ the category is contrasted with categories 2 and 3 for $j = 2$ the contrast is between 1 and 2 versus 3.

The variables in Table 4.1 are chosen based on related literature (Gao *et al.*, 2017; Jitmun *et al.*, 2019; Karidjo *et al.*, 2018; Kassie *et al.*, 2015; Krause *et al.*, 2016; Kumar *et al.*, 2020; Ngwira *et al.*, 2014; Rodthong *et al.*, 2020; Zhao *et al.*, 2018) and particular variables of interest hypothesized to influence adoption status of GLOBALG.A.Ps.

Table 4.1: Model variables hypothesized to influence the degree of Adoption of GLOBALG.A.Ps

Variable	Description	Measurement	Expected sign
Dependent			
Y_i (GGAI)	Adoption degree 1=low, 2=medium 3=high	Categorical	
Independent variable			
VCO	1=contract 2=non-contract	Categorical	+/-
Age	Age of HH head (years)	Continuous	+
HhSize	Household size(adult equivalent)	Continuous	+/-
Gender	Sex of the household, 1=male, 0=female	Dummy	+
Edu	Education level (years of formal schooling)	Continuous	+
Crdtacc	Amount of credit (KES)	Continuous	+
Fsize	Farm size (in acres)	Continuous	+
Offincome	Off-farm income (KES)	Continuous	+
Grpm	Group membership	Dummy 1=yes, 0=no	+
Excont	Frequency of contacts	Categorical	+
Dist	Distant to the market	Continuous	+/-
Fexp	Farming experience(years)	Continuous	+
Infoacc	Information access	Dummy 1=yes, 0=no	+
AccTra	Access to trainings	Dummy 1=yes, 0=no	+
Avail	Availability of the outlet	5 Likert (SD to SA)	+
Rel	Reliability of the outlet	5 Likert (SD to SA)	+

SD=Strongly Disagree, D=Disagree, N=Neutral, A=Agree, SA=Strongly Agree

4.2.2 Description of variables for factors influencing the adoption of GLOBALG.A.Ps

Vertical coordination options (*VCO*) were postulated to have a positive association with the adoption of GLOBALG.A.Ps. Farmers on the contract were expected to have a higher probability of adopting GLOBALG.A.Ps as compared to non-contracted farmers. Vertically coordinated markets for instance contracts have a positive influence on the adoption of food safety measures (Kumar *et al.*, 2016).

The variable age of the production decision-maker in years (*Age*) was hypothesized to positively influence the adoption of GLOBALG.A.Ps among farmers. This is based on the fact that older farmers are more experienced in farming and have secured land rights. Contrary to this hypothesis, age was found to negatively affect the adoption of good agricultural practices. This could be possibly explained by the fact that young farmers are more innovative and fast decision-makers. In addition, they have the capacity to adopt new farm practices and technologies as opposed to the older farmers (Moturi *et al.*, 2015; Saadun *et al.*, 2018). However, Krause *et al.* (2016) argued that the older the farmers, the more likely they are to adopt, but with increasing age, this likelihood decreases again.

Gender of the production decision-maker (*Gender*) was postulated to positively influence the adoption of good agricultural practices. Households with the male as the key production decision-makers were expected to be more likely to adopt GGAPs. Similarly, Ernah *et al.* (2016) found that male-headed households were more likely to adopt sustainable agricultural technologies. The study argued that the adoption of agricultural technologies requires labor, land and other resources and in most cases, males have access to these resources. Contrary, Tshangase *et al.* (2018) postulated that adoption of conservation agriculture was expected to be higher among females than males since women are most involved in household farming activities in the rural areas. However, their results indicated higher adoption levels among males than females.

Education stock (*Edu*) was postulated to positively influence the adoption of GGAPs. The higher the number of formal schooling among the household members, the more likely farmers would adopt good farming practices. More education within a household was expected to facilitate the adoption of good farm management practices. New agricultural techniques such as integrated pest management practices, green control techniques and sustainable palm oil practices were more likely to be employed by educated producers (Anaglo *et al.*, 2014; Gao *et al.*, 2017; Ma & Abdulai, 2019).

Household size (*Hhsize*) was defined by adult equivalent. Larger household size and a higher dependency ratio could imply that there is pressure on the household to provide food and other basic needs thus reducing the chances of adopting new technologies. On the other hand, larger household size could also mean availability of labor to implement labor-intensive GLOBALG.A.Ps such as labels, grading shades and charcoal coolers. Likewise, Ma and Abdulai (2019) noted that family size had a positive and significant effect on the adoption of labor-intensive integrated pest management technology on Chinese apple.

Farm size (*Fsize*) was hypothesized to influence the adoption of GLOBALG.A.Ps. There is a strong positive correlation between the amount of cultivated land and the adoption of agricultural technologies (Aguilar-Gallegos *et al.*, 2015; Anaglo *et al.*, 2014; Ngwira *et al.*, 2014; Rodthong *et al.*, 2020). However, Ali (2012) found that farm size had a negative coefficient indicating that vegetable producers with large land sizes were less likely to adopt good post-harvest handling practices as compared to smallholder farmers. Consequently, Ntshangase *et al.* (2018) found that larger pieces of land were associated with farmers being less likely to adopt conservation agriculture. According to the authors, farming is regarded as a low desired profession and those with non-farm jobs tend to lease their land to others. In this study, land size was not statistically significant. This can be explained by the fact that French beans production is done under irrigation in schemes and most farmers rent land for production.

Off-farm income (*Offincome*) was hypothesized to positively influence the adoption of GLOBALG.A.Ps. Additional income from other sources could increase the likelihood of producers investing in new technologies. Off-farm income had a significant influence on the adoption of sustainable agricultural technologies (Aguilar-Gallegos *et al.*, 2015; Cafer & Rikoon, 2018). In addition, off-farm income is correlated with the adoption of improved agricultural techniques, as it solves credit constraints or acts as a substitute for borrowed credit (Diirro, 2013; Hailu *et al.*, 2014; Mariano *et al.*, 2012).

The number of years involved in farming (*Fexp*) was postulated to influence the adoption of GLOBALG.A.Ps. The number of farming experience indicates the level of skills acquired during the entire farming period. Over the years of production, older farmers may have seen the impact of food safety standards on the productivity and profitability of a farm (Paraffin *et al.*, 2018). However, Kumar *et al.* (2020) found that experienced dairy producers were less likely to adopt food safety standards than inexperienced producers.

Access to training (*TraAcc*) was postulated to positively influence the adoption of GLOBALG.A.Ps. Effective training provides knowledge and skills necessary to facilitate the adoption of new practices. Cafer and Rikoon (2018) revealed that lack of training adversely influenced the performance of producers. In addition, specific theory and practical classes have proven to be efficient in the delivery of integrated pest management (Kabir & Rainis, 2015).

Access to information (*InfoAcc*) was hypothesized to positively influence the adoption of GLOBALG.A.Ps by smallholder French beans farmers. Information networks enhance the exchange of information among actors such as producers, extension officers, and input and output service providers (Aguilar-Gallegos *et al.*, 2015). Access to information serves to encourage farmers to adopt sustainable agricultural practices (Kassie *et al.*, 2015). Information on threats and opportunities helps farmers to better understand new agricultural technologies (Gao *et al.*, 2017).

Group membership (*Grpm*) was postulated to positively influence the adoption of GLOBALG.A.Ps among farmers. Social capital such as farmer groups plays a vital role in helping farmers to adopt good agricultural practices (Kassie *et al.*, 2015). In addition, social networks provide a suitable environment for sharing essential information on new farm management practices among like-minded groups (Ngwira *et al.*, 2014). Moreover, Kumar *et al.* (2020) noted that group participation has a significant positive effect on the adoption of food safety measures.

Access to extension service (*ExtAcc*) was postulated to positively influence the adoption of Global good agricultural practices. Extension services are considered a great source of information and play an integral role in promoting improved farming practices among farmers, as they create associations between motivation and attainment systems (Huang & Karimanzira, 2018). Extension services are delivered by professionals in the relevant areas. The theory and practical skills provided by extension officers in Africa have proven to facilitate the adoption of sustainable agricultural practices (Kassie *et al.*, 2015). For instance adoption of integrated pest management was due to frequent contacts with extension officers (Kabir & Rainis, 2015).

Credit access (*CrdtAcc*) was hypothesized to enhance the adoption of GLOBALG.A.Ps. Farm infrastructure such as grading shade, charcoal coolers and chemical equipment involve some cost which majority of smallholder farmers are unable to meet.

Support services that provide services such as credit access, input and output market access are important for farm management (Jitmun *et al.*, 2019; Promme *et al.*, 2017). Mottaleb *et al.* (2016) pointed out that access to credit can ease farmers' liquidity challenges, alleviate household risk-bearing ability, and thus increase chances of adopting new agricultural technologies. Contrarily, Karidjo *et al.* (2018) reported that farmers receiving credit for the adoption of agricultural technology can easily misuse it for other purposes such as family expenditure and school fees.

Distance from the farm to the market (*Dist*) was hypothesized to negatively influence the adoption of GLOBALG.A.Ps. This implies that farmers who were located in areas with poor road connectivity were disadvantaged from accessing input market and essential production information. Zeweld *et al.* (2014) argued that distance from the suppliers to the vicinity of the farmers compromised the adoption of chemical fertilizer.

Reliability of the output market (*Rel*) was postulated to positively influence the adoption of GLOBALG.A.Ps. Access to a consistent market motivates farmers to adopt good agricultural practices. Market access during the peak of supply and constant input supply at affordable prices stimulated farmers to employ roundtable sustainable palm oil practices (Rodthong *et al.*, 2020). In addition, Zhao *et al.* (2018) pointed out that farmers would decide on the adoption of raw milk food safety measures depending on the market incentive factors.

4.3 Results and discussion

4.3.1 Descriptive statistics

The results and relevant discussions on adoption levels are presented in Tables 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7. Contract farming appears to have a positive impact on compliance with GLOBALG.A.Ps at the farm level. The results in the Table 4.2 indicates that 61% of the farmers were contracted while 39% were non-contracted. The adoption level of good agricultural practices in French beans was significantly higher for contract farmers (66%) than non-contracted farmers (34%) (Table 4.3). Generally, 18% of the farmers were low adopters, 39% medium adopters while 43% were high adopters. The study equally revealed that 65% of the contracted farmers were high adopters, 35% medium adopters and zero percent for low adopters. On the other hand, it was found that 8% of non-contracted farmers were high adopters, 45% medium adopters whereas 47% were low adopters (Table 4.4). The overall adoption of GGAPs was at 53%. The results also indicated that farmers used either one or a combination of options in selling their produce. The adoption level for different

options was; contract farmers (66%), middlemen (38%), spot market (32%), contract and middlemen (70%), middlemen and spot market (32%) while those using contract, middlemen and spot market combination had an adoption level of 63% (Table 4.5).

Table 4.2: Proportion of farmers on contract and non-contract options

Variable	% of farmers
Contract	61
Non-contract	39

Table 4.3: Adoption index for contract and non-contracted farmers

Variable	GGAI %
Contract	66
Non-contract	34
All	53

Table 4.4: Category of users of GLOBALG.A.Ps

Levels	All (N=215)	Contract (N=132)	Non-contract (N=83)
	%	%	%
Low	18	0	47
Medium	39	35	45
High	43	65	8

Table 4.5: Adoption levels for different vertical coordination options

Channels	Mean	Std. Dev.	f-value
C	65.76	13.34	9.681*
CM	69.55	10.75	
CMS	63.32	14.27	
M	37.53	15.56	
MS	31.72	15.33	
S	31.83	21.14	

* denotes statistical significance at 10% level.

Table 4.6 shows that the mean adoption of farm audit, irrigation water assessment, soil test analysis and charcoal coolers were zero percent which is very detrimental. The non-adoption of these practices was as a result of the high cost incurred in acquiring these essential services. This result is in line with Panahzadeh *et al.* (2015), who found that economic constraint was one of the major barriers to implementing GAPs technologies in livestock units. Labeling of plots, preventing animal activities on the farms, use of safer and less toxic chemicals and use of hat or scarf personal protective gear were fairly adopted at 59%, 53%, 55% and 54%, respectively. On the high end, the period between last pesticide use and resumption of harvesting, hygiene when handling chemicals, crop rotation and tidiness as site management were adopted at 93%, 95%, 93 and 90% respectively. Farmers were also good in compliance with chemical use prescriptions which contradicts results by Talukder *et al.* (2017) where farmers relied on their own experience when determining chemical usage. Grading and proper handling of produce were good, and the adoption level was 86%. The mean adoption of record-keeping of farm practices was 54%. Farmers were rational in choosing certified seeds, and the adoption level was 79%.

Table 4.6: Adoption of GLOBALG.A.Ps in French beans

Parameters of GGAPs	Mean Adoption (%)
Presence of a first aid kit	23.72
Records on chemical use	47.44
Regular checking of farm equipment	77.67
Following chemical prescription labels	81.86
Observing wind direction while spraying	75.35
Annual health checks	8.37
Practice crop rotation	93.02
Observe period between last pesticide use and resumption of harvesting	92.56
Separating non-conforming produce from the good one	86.51
Do soil analysis	0.00
Plant certified seeds	78.66
Keep farm records	53.95
Keep records on pest control and necessary actions taken	46.05
Use crates to carry produce to collection centers	16.28
Apply for farm audit	0.00
Do irrigation water assessment	0.00
Farm hygiene instructions visibly displayed	3.26
Proper disposal of empty chemical containers	6.98
Presence of a grading shade	47.91
Presence of a charcoal cooler	0.00
Presence of soil erosion control practices	80.00
Presence of a label on French beans plot	59.07
Presence of a water storage facility	66.98
Presence of a handwashing area near the chemical store	60.00
Measures to prevent chemical drift	76.28
Measures to collect water	75.81

According to Table 4.7 results, proper disposal of empty chemical containers was very low (7%), thus posing a threat to the environment. This result is in line with Pandit *et al.*

(2017) where the adoption of proper waste and pollution management was almost zero. Therefore, there is a need to create more awareness among farmers on the importance of environmental conservation. Record keeping and plot labeling as traceability parameters were fairly adopted at 57% percent. These practices were higher among contracted farmers (80%) than non-contracted farmers (17%). This could be attributed to the fact that export contractors provided labels and ledgers to the majority of the contracted farmers. The results also indicated that farmers had low compliance with health safety with only 8% of the farmers going for annual health checks. This finding is in line with Kaseem *et al.* (2021). However, Annor *et al.* (2016) noted that farmers fully complied with health safety and welfare requirements. In the case of integrated pest management, fair adoption levels were reported especially in cultural and use of less toxic chemicals, and the overall uptake was 52%. Similarly, Kaseem *et al.* (2021) reported that farmers were partially compliant with IPM due to limited knowledge of environmentally friendly technology.

Table 4.7: Adoption levels as per GLOBALG.A.Ps

Variable	All (N=215) %	Contract (N=132) %	Non-contract (N=83) %
Integrated pest management	52	58	41
Environmental safety	7	12	0
Personal protective gear	54	55	34
Health checks	8	11	5
Traceability requirements	57	80	17

4.3.2 Empirical results

Adoption of the GLOBALG.A.P. standard is critical in improving smallholder farmers' access to the international markets. Table 4.8 presents results on the factors influencing smallholder farmers' adoption of GLOBALG.A.Ps.

Table 4.8: Generalized Ordered Logit Estimates

GGAI	Coef.	Std. Err.	P> z
Low			
Group membership	1.703	0.730	0.020**
VCO	1.516	0.782	0.053**
Age	-0.085	0.026	0.001***
Gender	0.886	0.505	0.079*
Household size	-1.200	0.315	0.000***
Education	0.090	0.029	0.002***
Farm size	-0.318	0.334	0.342
Off-farm income	0.681	0.613	0.266
Extension access	1.277	0.577	0.027**
Training access	2.267	0.716	0.002***
Availability	-1.228	0.468	0.009***
Reliability	1.135	0.504	0.024**
Distance	0.142	0.134	0.287
Farming experience	0.907	0.148	0.000***
Information access	-1.005	0.608	0.098*
Credit access	0.770	0.876	0.379
_cons	0.349	1.958	0.859
Medium			
Group membership	-0.065	0.704	0.927
VCO	1.516	0.782	0.053**
Age	-0.085	0.026	0.001***
Gender	0.886	0.505	0.079*
Household size	-1.200	0.315	0.000***
Education	0.090	0.029	0.002***
Farm size	-0.318	0.334	0.342
Off-farm income	0.681	0.613	0.266
Extension access	1.277	0.577	0.027**
Training access	2.267	0.716	0.002***
Availability	-1.228	0.468	0.009***
Reliability	1.135	0.504	0.024**
Distance	0.142	0.134	0.287
Farming experience	0.907	0.148	0.000***
Information access	-1.005	0.608	0.098*
Credit access	0.770	0.876	0.379

_cons	-8.028	2.302	0.000***
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Number of observations = 215

$L\chi^2(17) = 320.86$

Prob > $\chi^2 = 0.0000$

Log likelihood = -63.084942; Pseudo $R^2 = 7178$

***, **, * denotes statistical significance at 1%, 5% and 10% level. High user category was used as the base category.

Age was negative and statistically significant at 1% level for the adoption of good agricultural practices among producers in the low and medium user categories. Although higher age was postulated to have a positive effect on the adoption of GLOBALG.A.Ps, this finding indicated that older farmers are less likely to employ good agricultural practices at the farm level. The significant relationship with the intention suggests that younger farmers have a higher probability to adopt GLOBALG.A.Ps. The mean age of farmers was 46 years indicating that the majority of the French beans farmers are still in their productive years. This finding is consistent with that of Terano *et al.* (2015) who noted that younger farmers had a higher intention to adopt sustainable farming practices in rice. Contrary, Corallo *et al.* (2020) found that young respondents showed a negative correlation with the adoption of a traceability system for handling consumer pressures.

Gender had a positive influence on the adoption of good agricultural practices. Gender was significant at 10% level. Households with males as the key production decision-makers had a higher probability of adopting the GLOBALG.A.Ps. A possible explanation for this is that majority of males have property rights thus have the discretion to adopt the new practices. Consequently, female-headed households are mostly widowed or divorced. In such situations, alongside the cultural factors, their likelihood of adopting good agricultural practices becomes negligible. Previous studies have found similar results (Keelan *et al.*, 2014; Sennuga *et al.*, 2020). However, Gao *et al.* (2017) noted that female farmers had a higher adoption level of green control techniques relative to male farmers. According to the authors, female farmers pay more attention to agricultural production quality and safety than males.

Education indicates the human capital factor influencing the adoption of GLOBALG.A.Ps. Education stock was positive and statically significant at 1% level. This study suggests that households with a high number of formal schooling are more equipped with skills to understand the importance of GGAPs and can influence adoption. This result

corroborates with previous findings in the adoption studies. For instance, Srisopaporn *et al.* (2015) noted that education improves producers' ability to adjust to changes. Additionally, years of schooling among orchid producers positively influenced the adoption of Q-G.A.P. in Thai (Krause *et al.*, 2016).

The coefficient for household size was negative and statistically significant at 1% level. This implies that any additional adult person to a household reduces the probability of the adoption of GGAPs by 11%. This can be explained by the fact that big families have higher expenditure thus more money is spent on family needs than the farm. Similarly, Nthambi *et al.* (2013) found that an increase in the number of people leads to a decrease in individual compliance with good agricultural practices in export vegetables. However, Belachew *et al.* (2020) observed that family size positively influenced the adoption of water conservation measures in Ethiopian highlands.

Contact with extension officers was related to an increase in the adoption rate. Extension contact was positive and significant at 5% level. A possible explanation is that farmers with frequent extension contact are more likely to trust the information received and consider following the idea. Similarly, Dung *et al.* (2018) found that low uptake levels of good agricultural technologies were linked to inadequate extension contacts.

Farming experience in French beans production was positive and significant at 1% level. The number of years involved in farming was positively and significantly associated with the implementation of the GLOBALG.A.Ps. This result implies that farming experience plays a very influential role in the adoption of good agricultural practices. This finding corroborates with that of Suwanmaneepong *et al.* (2016), who noted that implementation of the GLOBALG.A.Ps at the farm level was based on farming experience. However, Huang and Kamarinzira (2018) found that farmers with more years of experience were more likely to stick with the original methods that are familiar to them than to employ newer farming techniques.

The study equally revealed that participation in GLOBALG.A.P. training was positive and significant at 1% level. This implies that households that undertake training through either the government or private organizations are correlated with higher adoption levels. This finding suggests the importance of creating awareness among smallholder French beans producers. Similarly, Pongvinyoo *et al.* (2014) found that conducting a group training program or a workshop effectively influences the adoption of good farm practices. However,

Suwanmaneepong *et al.* (2016) argued that access to training had a negative correlation with the adoption of G.A.P. According to Suwanmaneepong, training attendance disappointed once farmers realized the cost and benefits associated with the adoption of the G.A.P. program.

The results also showed that membership to a group-based organization had a positive effect on the adoption of GLOBAL G.A.Ps. Membership to a group was significant at 5% level. A possible explanation is that farmers who participated in agricultural groups had more access to information about the effectiveness and benefits of the new practices. Moreover, members in a group become socialized and develop similar norms and preferences on practices concerning farm management over time. This result is consistent with that of Tu *et al.* (2018), where participation in agricultural cooperatives or clubs had the largest positive effect on the adoption of eco-friendly rice. However, Connor *et al.* (2020) found that membership to a group reduced farmer's acceptance of rice straw management practices.

Information access was negative and statistically significant at 10% level. Information sources such as social media, barazas, neighbors, friends and relatives negatively influenced the adoption of GGAPs. This could be attributed to the fact that information provides farmers with cost and benefits and thus producers are likely not to adopt if the threats are higher than the opportunities. Likewise, Gao *et al.* (2017) noted that frequent communication with neighbors had a negative effect on the adoption of green control techniques among farmers. Contrary, Sharma and Peshin (2016) found that information access positively influenced the adoption of integrated pest management in Indian vegetables. The authors argued that information access through media publicity made farmers understand the features and advantages of integrated pest management.

Vertical coordination options was positive and statistically significant at 5% level. This implies that participation in contract farming increased the likelihood of adopting the GGAPs. Contract farming is the dominant vertical coordination option conducive for promoting farmer's safe production behavior. Similarly, Hou *et al.* (2020) found that contract arrangement significantly increased the adoption of food safety governance in the agri-food supply chain.

Availability of the outlet was negative and statistically significant at 1% level. Producers' perception of the readily available markets reduced their likelihood of adopting good farm practices. This implies that readily available markets made farmers reluctant in

employing global good agricultural practices. This could be possible because with or without adoption they could still sell their produce.

The reliability of the outlet was positive and statistically significant at 5% level. Perception of the reliability of the market increased the probability of adoption of GLOBALG.A.Ps. This implies that the reliability of the market in terms of fair prices and timely payment motivated farmers to adopt good agricultural practices. This result is consistent with that of Zhao *et al.* (2018) who found that, adoption of food safety measures in raw milk depended on market incentives.

4.3.3 Post estimation test results

Parallel lines assumption

One major strength of the gologit2 model is that it can estimate two special cases of a generalized model: parallel lines/proportional odds assumption and partial proportional lines assumption. Since the parallel lines assumption is usually violated, the gologit2 command relaxes it for some variables while maintaining for others. In the generalized ordered logit estimates presented in table 4.8, the gologit2 command has relaxed the parallel lines/proportional odds assumption for one variable while maintaining it for the rest of the variables. Therefore, the gologit model stands to be the most appropriate for this study.

Multicollinearity test

Variance inflation factor was used to test the presence of multicollinearity. The VIF mean value was 1.75, ranging from 1.06 to 3.75 (Appendix 5). Based on the threshold of 10 the study found the absence of multicollinearity. The presence of multicollinearity causes the estimated regression coefficients to have incorrect signs that could have led to wrong conclusions (Mijena, 2011).

Breusch-Pagan test for heteroscedasticity

Breusch-Pagan test was used to test the presence of heteroscedasticity. The probability chi-square was 0.2828 which is greater than 0.05 suggesting that heteroscedasticity was not a problem. We fail to reject that the null hypothesis that the variance is homoscedastic.

Table 4.9: Pairwise correlation test for categorical variables

	Extension access	Training access	Off-farm income	Group membership	Information access
Gender	1				
Extension access	-0.1136	1			
Training access	-0.0225	0.2593	1		
Off-farm income	0.0496	0.1023	0.2059	1	
Group membership	-0.0594	0.1327	0.2317	0.0694	1
Information access	-0.1524	0.1741	0.2542	0.1412	0.1855

The pairwise correlation values for categorical variables ranged from 0.0225 to 0.2593 which is below the acceptable cut-off point of 0.5. This implies that there was no strong association among the categorical variables used in the model.

4.4 Conclusion and recommendations

In assessing the influence of vertical coordination on the adoption of GGAPs among smallholder French beans producers in Murang'a South Sub-County, the study found that the overall adoption rate of good agricultural practices was 53%. Contracted farmers had a higher compliance rate of 66% while non-contracted farmers adopted 34%. The adoption rate for some GGAPs was below 10% including annual health checks, proper disposal of chemical containers, soil test analysis, irrigation water analysis, and establishment of charcoal coolers. Given the adoption rates across the various parameters, the study results show that there is room for enhancing adoption across the vertical coordination channels to improve French beans marketing. Moreover, age, gender, household size, education, vertical coordination options, group membership, training, extension access, farming experience and reliability of the market, are critical in the uptake of GLOBAL G.A.Ps.

Based on the empirical results, the study suggests the following recommendations: First, The government should organize more training on the latest GLOBAL G.A.Ps trends

especially for smallholder farmers. Training should target the youth since the aging farmers are not likely to comply with standards. Second, the government needs to look at how compliance will be made easier and affordable for farmers by setting minimum prices for horticultural produce to cater for compliance cost. Third, extension service providers should sensitize farmers on the need to adopt good agricultural practices, essential to assist farmers in remaining competitive in the global market. Fourth, the government should focus on tapping the production potential of smallholder farmers by encouraging group formation, subscription and active participation. Finally, the private sector and the government should invest in the provision of farm credits to farmers. This could be enhanced by developing rural financial institutions which could facilitate rural savings while providing loans to farmers at lower interest rates.

CHAPTER FIVE
EFFECTS OF PARTICIPATION IN CONTRACT AND NON-CONTRACT
VERTICAL COORDINATION OPTIONS ON GROSS MARGIN OF
SMALLHOLDER FRENCH BEANS FARMERS

Abstract

Procurement of fresh produce requires consistent and high-quality supply. With the growing demand for safe and quality agricultural products in the global market, the Kenyan government has made substantial efforts to promote contract farming in linking farmers to high-value markets. Although the French beans markets are relatively well developed they operate side by side with the middlemen and spot market. Using a multinomial endogenous switching regression model and data from random sample of 215 farmers this study examined the effects of contract and non-contract vertical coordination options on the gross margin. The results show that participation in multiple market outlets significantly increased gross margin per season. For instance, smallholder farmers reported KES 22 565 (ATT) per season for selling in all three vertical coordination options. Consequently, the adoption of the three market outlets was positively influenced by education and off-farm income suggesting that farmers should be encouraged to participate in off-farm activities to generate extra cash that can facilitate marketing. Additionally, extension agents should encourage farmers to diversify their marketing as a way of reducing risks associated with selling to one market outlet.

5.1 Introduction

Food systems in many developing countries are changing rapidly with a growing role of vertically coordinated chains (Ogutu *et al.*, 2020). The change in food demand towards safe and diversified products is mainly due to the rise in levels of income, urbanization, trade and liberalization (Khan *et al.*, 2019). These changes represent both opportunities as well as challenges to smallholder farmers. Whether smallholder producers are successful depends to large extent on the way production and distribution are coordinated along the value chain (Abebe *et al.*, 2016). In response to this change, vertically coordinated chains have received considerable attention since they enhance the implementation of new standards and address market access challenges (Moustier *et al.*, 2010). Vertical coordination options such as contracts are usually seen as beneficial to farmers as they tend to reduce market risks and can offer credit to farmers (Bellamere, 2018). In addition, contract is considered to be an affirmative development for improving agricultural innovation in developing countries (Otsuka *et al.*, 2016; Ton *et al.*, 2018).

However, there is serious concern about whether smallholder producers really benefit from contract arrangements. One major issue is the threat that smallholder farmers may be excluded from contract arrangements due to the high transaction cost involved in the adoption of food safety measures and marketing (Anjani *et al.*, 2018). Further, inequality from contract arises when contract agents selectively buy produce from farmers in regions with better roads, easier access to water and large-sized farms (Vabi Vamuloh *et al.*, 2019). Smallholders who cannot afford high production and marketing cost buy inputs of inferior quality. Using poor harvesting and post-harvest handling methods, they generate little added value and thus record a declining gross margin.

Linking smallholder producers to high-value markets is crucial for Kenya's economic development plans. This is because the majority of Kenya's population depends on agriculture for their living. According to Kenyan Agriculture Census 2019, total agricultural households were 6.4 million and out of this, 88% were engaged in small scale-farming activities (Kenya National Bureau of Statistics, 2019). Additionally, approximately 70% of smallholder farmers in Sub-Saharan Africa including Kenya live in rural areas with associated challenges such as limited access to farm inputs, markets, infrastructure and institutional support (Mwambi *et al.*, 2016). With the increased consumption of fruits and vegetables in the global markets, smallholder producers can be empowered to take advantage of the prevailing market opportunities through participation in vertical coordination options.

This will enhance increased incomes as well as reducing poverty levels which is prevalent among smallholder farmers.

Although there is evidence that vertically coordinated chains have a positive effect on the welfare of smallholder farmers (Bernard *et al.*, 2017; Dubbert *et al.*, 2019; Mwambi *et al.*, 2016; Wainaina *et al.*, 2012), there is a scarcity of empirical evidence on the effects of vertical coordination options on gross margin especially when producers are using more than one marketing channels. This study contributes to the literature by examining the effect of participation in single or combined vertical coordination options on gross margin. Therefore, the objective of this study is twofold. First, to examine the determinants of smallholder producers' choice of French beans marketing channels. Second, to estimate the effects of farmers' choice of French beans marketing outlets on gross margin.

5.2 Analytical framework

A two-step multinomial endogenous switching regression (MESR) model was employed to model the determinants of choice and effects of contract and non-contract farming on gross margin. Gross margin was estimated for farmers on contract, non-contract and on both options. Self-selection occurs in contract participation and this may lead to non-zero covariance between the error term of the treated selection and the outcome equations. This model helps to account for both self-selection bias and endogeneity. Specifically, the MESR treatment effect approach was used following Durbin and Mc Fadden (1984) and Bourguignon *et al.* (2007) was used to correct for selection bias. MESR framework has the advantage of estimating individual choices as well as alternative combinations of options. In the first step, farmers' decision choices about individual vertical coordination options and combined strategy were modeled using a multinomial logit selection model, while recognizing the interrelationships among the outlet choices. The study identified six marketing strategies utilized by smallholder farmers. In the second stage, the effects of each option and combined vertical coordination options on gross margin were estimated using ordinary least squares regressions (OLS) with selectivity corrections terms from the first stage. Gross margin was calculated by subtracting total variable cost from the total revenue per acre as follows:

$$GM = TR - TVC \quad (5.1)$$

Total revenue was calculated by taking the total quantity of marketable surplus multiplied by the unit price. Variable costs include seeds, fertilizer, pesticides, fungicides,

soil analysis, irrigation water assessment, irrigation water, family labor, hired labor and farm audit. It is assumed that farmers choose a form of vertical coordination option that can provide a maximum utility, Y_i by comparing the gross margin given by M alternative VCOs. The requirement for farmer i to choose j over other alternatives M is that $Y_{ij} \succ Y_{iM} \quad M \neq j$, that is, j provides a higher gross margin than any other option. The expected gross margin associated with each vertical coordination option cannot be directly be seen but can be expressed as a function of observable factors in a latent variable as follows:

$$Y_{ij}^* = X_i \beta_j + \varepsilon_{ij} \quad (5.2)$$

where Y_{ij}^* is a latent variable, X_i is a vector of explanatory variables, while ε_{ij} is the error term. The X_i covariate is assumed to be uncorrelated with the idiosyncratic unobserved disturbance term ε_{ij} that is $E(\varepsilon_{ij} | X_i) = 0$ under the assumption that ε_{ij} are independent and identically Gumbel distributed. The probability that farmer i chose French beans marketing outlet j can be specified by a multinomial logit model (Mc Fadden, 1993).

$$P_{ij} = P(\varepsilon_{ij} < 0 | X_i) = \frac{\exp(X_i \beta_j)}{\sum_{M=1}^j \exp(X_i \beta_M)} \quad (5.3)$$

In the second stage, ESR was used to estimate the effect of choice on gross margin. All producers on contracts were the treated observations whereas non-contracted farmers were the control observations. Farmers face a total of M regimes with $j = 1$ being the base category (contract option). Among the remaining alternatives ($j = 2, 3, 4, 5, 6$), at least one form of VCO is adopted. In this step, the determinants of gross margin whether a farmer is contracted or non-contracted are determined. The estimated equation can take the following specification:

$$\left\{ \begin{array}{l} Q_{ic} = \beta_{ic} Z_{ic} + \varepsilon_{ic} \text{ if } c \\ Q_{inc} = \beta_{inc} Z_{inc} + \varepsilon_{inc} \text{ if } nc \end{array} \right. \quad (5.4)$$

where Q_{ic} and Q_{inc} are the expected gross margin for producers on contract and non-contracted respectively, Z_{ic} and Z_{inc} are the explanatory variables, β_c and β_{inc} are the parameters to be estimated while the error terms ε_{ic} and ε_{inc} are distributed with $E(\varepsilon_{ij} | X, Z) = 0$ and variance $(\varepsilon_{ij} | X, Z) = \sigma_j^2$. Q_{ij} is observed if, and only if, VCO j is

used. This occurs when $Y_{ij}^* \succ_{M \neq 1}^{\max} (Y_{im})$. If the error terms in the selection and regime equations are not independent, OLS estimates will be biased. A consistent estimation of β_j requires the inclusion of the selection correction terms of the alternative options in equation (5.4)

The expected outcome is presented in four cases as follows:

$$E(Q_{ic} / C = 1) = \beta_c Z_{ic} + \sigma_{\varepsilon_c} \lambda_c \text{ Observed} \quad (5.5)$$

$$E(Q_{inc} / C = 1) = \beta_{nc} Z_{ic} + \sigma_{\varepsilon_{nc}} \lambda_c \text{ Counterfactual} \quad (5.6)$$

$$E(Q_{inc} / C = 0) = \beta_{nc} Z_{inc} + \sigma_{\varepsilon_{nc}} \lambda_{nc} \text{ Observed} \quad (5.7)$$

$$E(Q_{ic} / C = 0) = \beta_c Z_{inc} + \sigma_{\varepsilon_c} \lambda_{nc} \text{ Counterfactual} \quad (5.8)$$

where σ_j is the covariance between the error of selection and regime equation, λ_j is the inverse mills ratios computed from the estimated probabilities in the regime equations. The standard errors in the regime equations were bootstrapped to account for heteroscedasticity arising from the generated regressor (λ_j). The conditional and unconditional gross margin expected from producers on contract and non-contracted were calculated based on the parameters to be estimated β_c and β_{nc} . To calculate the average treatment (ATT) on the treated (contracted) the actual gross margin and its counterfactual were differentiated according to Carter and Milon (2005). Similarly, average treatment on untreated (non-contracted) ATU was calculated as the difference between the observed and the counterfactual gross margin.

$$ATT = E(Q_{ic} / C = 1) - E(Y_{inc} / C = 1) \quad (5.9)$$

$$ATU = E(Q_{inc} / C = 0) - E(Y_{ic} / C = 0) \quad (5.10)$$

The variables were chosen based on related literature (Abebe *et al.*, 2016; Anjani *et al.*, 2018; Bellamere & Lim, 2018; Khan *et al.*, 2019; Kumar *et al.*, 2019; Mwambi *et al.*, 2016; Ogutu *et al.*, 2020; Ola & Menapace, 2020; Park *et al.*, 2014; Sahara *et al.*, 2015) and particular variable of interest for this study. Explanatory variables hypothesized to influence gross margin are presented in Table 5.1.

Table 5.1: Variables hypothesized to influence gross margin

Variable	Description	Measurement	
Dependent			
Y_i	Gross margin	Continuous	
Independent variable			
Age	Age of HH head(years)	Continuous	+
Hhsize	Household size(adult equivalent)	Continuous	+
Gender	Sex of the household, 1=male, 0=female	Dummy	+
Edu	Education stock (years of formal schooling)	Continuous	+
AccCrdt	Amount of credit (KES)	Continuous	+
Fsize	Farm size (in acres)	Continuous	+
Offincome	Off-farm income (KES)	Continuous	+
Grpmember	Group membership	Dummy 1=yes, 0=no	+
Extnservice	Extension access	Dummy 1=yes, 0=no	+
Dist	Distant to market (kilometers)	Continuous	+/-
Fexp	Farming experience (years)	Continuous	+
Infosource	Information sources	Categorical	+
AccTra	Number of training	Continuous	+
Avail	Availability of the outlet	5 Likert=(SD to SA)	+
Rel	Reliability of the outlet	5 Likert=(SD to SA)	+

SD=Strongly Disagree, D= Disagree, N= Neutral, A=Agree, SA=Strongly Agree

5.3 Results and discussion

Table 5.2 presents a summary statistics and choice of French beans market outlets, while Table 5.3 shows results of smallholder farmers' gross margin.

5.3.1 Descriptive statistics

Table 5.2: Summary statistics and choice of French beans outlets by smallholder producers

Variables	C	CM	CMS	M	MS	S	All	f-value
Age	45.70 (12.94)	52.17 (11.06)	46.94 (12.38)	43.38 (11.57)	46.65 (13.82)	47.41 (10.19)	46.40 (12.53)	2.87
Male headed households	56.79 (49.85)	58.82 (50.73)	58.82 (49.96)	62.07 (49.38)	81.08 (39.71)	35.29 (49.26)	60.47 (49.01)	11.63**
Household size	3.51 (1.58)	3.71 (1.62)	4.23 (1.99)	4.50 (1.98)	3.90 (1.78)	4.24 (1.79)	3.90 (1.78)	3.86
Education stock	33.53 (17.11)	36.29 (18.75)	47.24 (23.46)	41.10 (20.81)	38.11 (20.09)	40.18 (19.64)	38.25 (19.92)	5.35
Farm size	1.23 (0.96)	1.33 (1.22)	1.61 (0.76)	1.10 (0.99)	1.18 (0.90)	1.14 (0.84)	1.26 (0.94)	5.76
Farmers with Off-farm income (%)	20.99 (40.98)	23.53 (43.72)	64.71 (48.51)	20.69 (41.23)	16.22 (37.37)	23.53 (43.72)	27.44 (44.73)	28.67***
Farmers in group (%)	69.14 (46.48)	88.24 (33.21)	79.41 (41.04)	48.28 (50.85)	24.32 (43.50)	76.47 (43.72)	62.33 (48.57)	37.32***
Extension access (%)	83.95 (36.94)	47.06 (51.45)	73.53 (44.78)	37.93 (49.38)	35.14 (48.40)	41.18 (50.73)	61.40 (48.80)	41.41***
Farming experience	13.73 (6.53)	17.18 (6.23)	12.11 (5.05)	5.10 (3.60)	4.65 (2.68)	5.12 (4.28)	10.34 (6.86)	38.62***
Distance	3.59 (1.76)	4.22 (2.41)	3.87 (2.10)	3.84 (1.35)	4.34 (2.05)	3.55 (1.41)	3.85 (1.86)	11.42**
Training	4.74 (2.92)	4.94 (3.38)	4.70 (2.98)	0.96 (1.40)	0.78 (1.18)	1.23 (2.17)	3.29 (3.04)	45.61***
Availability	3.98 (0.63)	3.50 (0.73)	3.68 (0.61)	3.36 (0.85)	2.93 (0.83)	3.56 (0.39)	3.60 (0.78)	44.91**
Reliability	3.74 (0.55)	3.17 (0.81)	3.14 (0.76)	2.88 (0.65)	2.59 (0.61)	2.97 (0.64)	3.27 (0.77)	7.83

***, **, * denotes statistical significance at 1%, 5% and 10% level.

Note: Standard deviations are given in parenthesis; C denotes contract, CM contract middlemen, CMS contract middlemen spot, M middlemen, MS middlemen spot and S spot

Table 5.3: Gross margin for different market outlets

Variables	C	CM	CMS	M	MS	S	All	f-value
Yield per Acre	1411 (846)	1212 (710)	1993 (801)	940 (790)	809 (485)	851 (516)	1276 (838)	16.79***
Total revenue	55558 (35836)	52296 (28543)	93333 (39026)	409060 (31597)	36523 (20536)	31941 (20655)	54154 (37026)	20.77***
Total variable cost	36832 (21966)	32363 (17640)	54999 (23400)	29819 (23206)	27925 (15953)	25979 (17353)	36014 (22515)	8.08
Gross margin	18726 (16587)	19933 (13905)	38335 (19479)	11088 (9801)	8598 (8067)	5961 (4668)	187140 (17332)	55.46***

*** denotes statistical significance at 1% level.

Note: Standard deviations are given in parenthesis; C denotes contract, CM contract middlemen, CMS contract middlemen spot, M middlemen, MS middlemen spot, S spot.

The mean gross margin from French beans production per season was KES 18, 140. The average gross margin for contracted farmers was KES 23, 932 as compared to KES 8, 928 for non-contracted farmers (Table 5.4). This implies that participating in contract farming or contract with any other channel increased returns as compared to non-contract options. The mean difference between gross margin averages was statistically significant at 1% level. The average variable cost for the non-contract option was lower than that of the contract option. A possible explanation for this is that contracted farmers used certified seeds which had a higher cost. Total yield was also higher for contracted farmers than non-contracted farmers. This can be attributed to the fact that contracted farmers used improved seed varieties and had larger farm size compared to non-contracted farmers. This result is consistent with that of Mabuza *et al.* (2014) who reported that farmers with high production were more likely to sell through high-value market outlets compared to middlemen and farm gate channels. This also contributed to higher total revenue reported by contracted farmers.

Table 5.4: Gross margin for contract and non-contracted farmers

Variables	All (215) Mean	Contract Mean	Non-Contract Mean	t-value
Yield (per acre)	1276(838)	1535(859)	864(610)	-6.20***
Total revenue	54154(37026)	64868(39393)	37116(29902)	-5.73***
Total variable cost	36015(22515)	40936(23278)	28188(18877)	-4.20***
Gross margin	18139(17332)	23932(18971)	8928(8313)	-6.802***

*** denotes statistical significance at 1% level. Standard deviations are given in parenthesis.

5.3.2 Empirical results

The determinants of the choice of VCO options are presented in Table 5.5. The results show that the age variable had a positive and significant effect on the choice of middlemen and spot market combination (MS) at 10% significance level. An increase in the age of the production decision-maker by one year increased the likelihood of choosing middlemen and spot market option by 5%. This finding implies that older French beans farmers were more likely to sell their produce through non-contract options. A possible explanation is that older producers are less likely to be influenced to sell through modern outlets such as contracts. Additionally, selling through non-contract options provide instant payments. This finding is consistent with that of Kumar *et al.* (2019).

Gender was positive and statistically significant at 10% and 1% level for the choice of middlemen (M) and middlemen and spot market combination (MS) respectively. Male-headed households increased the probability of selecting the two options by 11.9% and 20.6% respectively. These imply that male-headed households were more likely to choose non-contract options for selling their produce relative to women. This shift can be attributed to the fact that non-contract options pay farmers immediately they deliver produce, unlike the contract option which makes payment at specified dates after delivery of output. The timing of payments with non-contract options is likely to attract households that are financially constrained. This result is in line with Ola and Menapace (2020). Similarly, Kumar *et al.* (2019) reported that male-headed households were likely to sell their milk through local traders or other households compared to women.

Household size was positive and statistically significant at 10% level for the choice of middlemen option. An increase in household size by one member increased the probability of selecting the middlemen option by 55.7%. This implies that larger households were more

likely to choose the middlemen option for selling their output. A possible interpretation for this is that a bigger household size means that much of the household income is spent on food consumption and less is left for searching the high-value market. However, Kumar *et al.* (2019) reported larger households had higher bargaining power thus participated in cooperatives.

Education stock was positive and statistically significant at 10% level for the choice of contract, middlemen and spot market combination (CMS). An increase in the number of education stock by a year increased the likelihood of participation in all the three outlets by 4.3%. More educated households were more likely to choose multiple market outlets in selling their produce. A possible interpretation is that knowledge influences households to diversify their risks by participating in multiple channels to increase their income. This finding is consistent with that of Park *et al.* (2014) who found that educated and more trained households sold their output through multiple market channels.

Off-farm income was positive and statically significant at 1% level for the choice of contract middlemen and spot market combination (CMS). A unit increase in the amount of income from off-farm activities increased the probability of selecting all three market outlets. Farmers with off-farm income were more likely to participate in multiple market outlets. This can be attributed to the fact that market diversification involves some transaction cost such as searching cost which only wealthier farmers can be able to invest. Although diversification act as a risk-spreading tool, it involves cost such as labor, packaging, storage and transport which only resource-rich farmers can achieve (Hardesty & Leff, 2010). Additionally, the Contract channel pays farmers on monthly basis, and therefore, the extra cash generated from off-fam activities increased farmers' willingness to accept delayed payment. This is in line with the finding by Thamthanakoon (2019).

Membership in the agricultural group was negative and statistically significant at a 1% level for the choice of middlemen and spot combination (MS). Group membership decreased the likelihood of choosing middlemen and the spot market option by 16.9%. Through the group, members can share information on threats of using non-contract options, which include price fluctuation and failure to show up by some middlemen during harvesting, as reported by farmers during the interviews. This information could discourage the adoption of these marketing outlets. Similarly, vegetable farmers who belonged to a group in Thailand were more likely to sell through cooperatives than informal channels (Mukiama *et al.*, 2014).

Table 5.5: Parameter estimates of alternative VCO using multinomial logit (first stage)

Variable	CM	CMS	M	MS	S
Age	0.040 (0.037)	0.000 (0.027)	0.011 (0.033)	0.056* (0.034)	0.052 (0.036)
Gender	-0.016 (0.759)	-0.096 (0.524)	1.195* (0.702)	2.063*** (0.782)	-0.370 (0.775)
Household size	0.171 (0.385)	-0.189 (0.257)	0.557* (0.334)	0.313 (0.377)	0.224 (0.387)
Education	-0.014 (0.035)	0.043* (0.025)	-0.016 (0.034)	-0.023 (0.037)	-0.008 (0.038)
Farm size	0.085 (0.367)	-0.064 (0.294)	0.059 (0.400)	0.182 (0.424)	-0.065 (0.473)
Off-farm income	0.469 (0.905)	2.014*** (0.573)	0.825 (0.808)	0.643 (0.922)	0.945 (0.914)
Group membership	1.358 (1.033)	0.611 (0.609)	-0.318 (0.678)	-1.691** (0.789)	1.092 (0.799)
Extension access	-2.850*** (0.932)	-0.451 (0.667)	-1.155* (0.700)	-0.766 (0.758)	-0.953 (0.800)
Number of training	0.040 (0.165)	0.050 (0.120)	-0.290 (0.187)	-0.199 (0.205)	0.024 (0.219)
Reliability	-1.497** (0.620)	-0.509 (0.497)	-1.018* (0.558)	-1.016* (0.580)	-1.172* (0.630)
Availability	0.104 (0.633)	-0.582 (0.511)	-0.638 (0.576)	-1.613** (0.626)	-0.065 (0.717)
Distance	0.036 (0.186)	0.051 (0.142)	0.046 (0.191)	0.404* (0.216)	0.004 (0.210)
Farming experience	0.099 (0.066)	-0.105 (0.068)	-0.322** (0.112)	-0.471* (0.130)	-0.438*** (0.141)
Credit access	0.000** (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
_cons	-0.359 (3.054)	2.233 (2.222)	5.768 (2.606)	7.095 (2.222)	3.214 (3.237)

***, **, * denotes statistical significance at 1%, 5% and 10% level. Contract (C) was used as the base category. Standard errors are given in parenthesis.

Note: C means contract, CM contract middlemen, CMS contract middlemen spot, M middlemen, MS middlemen spot, S spot a

Access to agricultural extension service was negative and statistically significant for the selection of contract and middlemen combination (CM) and middlemen option (M) at 1% and 10% significance levels, respectively. Contact with extension agents decreased the likelihood of selecting either option by 28.5% and 11.5%, respectively. A possible explanation for this is that government extension agents may not be effective in providing contract-specific technical support, which corroborates the findings by Abebe *et al.* (2013). Extension service may also expose farmers to the benefits and cost of using the contract option, and thus, farmers are less likely to select this option if the cost is high. Likewise, farmers can also learn about the dangers of selling through the middlemen option such as price fluctuation, which may discourage them from adopting the option.

Reliability of the outlet was negative and statistically significant for the selection of contract and middlemen combination (CM), middlemen option (M), middlemen and spot market combination (MS) and spot market option (S) at 5%, 10%, 10% and 10% significance level respectively. Perception of the reliability of the channel decreased the likelihood of selecting any of the three combinations by 15.0%, 10.2% and 10.1%, respectively. While contracts provide inputs to farmers and organize weekly collection center pick-ups, producers complained that these buyers offset input and transportation costs by offering lower prices for their produce. Similarly, middlemen organize weekly farm gate pick-ups but according to the interviews, farmers received a lower price by avoiding transport cost. This finding is consistent with that of Abebe *et al.* (2013) who reported that, while farmers have an assured market, it can be disadvantageous if the agreed price is lower than the expected utility thus, farmers consider the fixed price option unattractive.

Availability of the channel was negative and statistically significant for the choice of middlemen and spot market combination (MS) at 5% significance level. Perception of the availability of the outlet decreased the probability of selecting middlemen and the spot market option by 16.1%. Although farmers perceived middlemen and spot markets as easy to access, they were discouraged from choosing these outlets, possibly because these channels

offered lower prices. Similarly, Abebe *et al.* (2016) reported that the price offered by the high-value market was 15% higher than that offered by middlemen and the spot market.

Distance to the market center positively affected the choice of middlemen and spot market option (MS) at a 10% significance level. This implies that choosing this market outlet combination increases with additional distance to the market. This can be attributed to the fact that a long distance to the market is associated with high transport cost and the risk of spoilage which may encourage farmers to sell their produce to the middlemen and other farm gate buyers, which corroborates with findings by Bardhan *et al.* (2012).

Farming experience had a negative effect on the selection of middlemen option (M), middlemen and spot market combination (MS) and spot market option (S) at 5%, 10% and 5% significance level respectively. The probability of choosing the three non-contract options decreased by 32.2%, 47.1% and 43.8% with an increase in the number of farming experience. A possible explanation is that farmers with more farming experience are less likely to participate in a single marketing outlet like middlemen and the spot market to increase their income. Similarly, Thamthanakoon (2019) noted that producers with more farming experience tended to diversify and were more likely to sell through different marketing channels. Additionally, producers with more farming experience are expected to have more knowledge of production and marketing and thus are less likely to choose informal markets. This result is consistent with Sahara *et al.* (2015) who reported that farming experience positively influenced the selection of high-value channels among smallholder chilli farmers.

The amount of credit received was positive and significant for the selection of contract and middlemen option (CM) at 10% significance level. The amount of credit received in the last production season increased the likelihood of choosing contract and middlemen option. This can be attributed to the fact that contract enforcement is both capital and labor-intensive and therefore credit access could alleviate cash constraints among smallholder farmers. This result is consistent with that of Mwambi *et al.* (2016) where farmers who had access to credit were likely to invest in the production of fruits that met buyers' requirements, thus earning them premium prices. Likewise, farmers who sold through middlemen option are likely to be resource-poor and credit received could only be invested in production and therefore, they chose middlemen to avoid transport cost which tallies with finding by Ahmed *et al.* (2016).

The estimated average gross margin from the adoption of french beans marketing channels was calculated from the multinomial endogenous switching regression model for both ATT and ATU effects (Table 5.6). According to Table 5.6, farmers should be viewed from two scenarios: one, where producers are using a single market channel that is a contract, middlemen or spot market; secondly, where farmers are using more than one outlet two or three channels simultaneously. The ATT and ATU were positive and negative, suggesting that some farmers realized higher gross margins while others experienced losses depending on the marketing channel adopted. Farmers significantly increased their gross margin by participating in more than one market channel. For instance, producers received (ATT) KES 22,566 per season when they sold French beans through contract, middlemen and spot market combination (CMS), which is consistent with the results by Kumar *et al.* (2019) that dairy producers realized higher returns by participating in more than one market outlet. However, Producers reduced their gross margin by KES 14,443 for selecting middlemen and spot market option combinations.

Among farmers participating in a single market outlet, maximum gross margin (ATT) was reported among farmers who sold through the spot market (S; KES 4,850). However, farmers were worse off by participating in contract option (C), reducing their gross margin by KES 5,152. For counterfactual cases, households that adopted the marketing channels would have had both losses and higher gross margin (ATU) had they not adopted them. For instance, the ATU estimates for non-selling farmers (CO) would have increased by about KES 22,932 had they adopted all the three market outlets (CMS). On the other hand, their gross margin would have decreased by KES 34,084 had they chosen middlemen and spot market option (MS). Additionally, they would have been worse off had they selected middlemen option combination (M) and contract option (C) alternatives. Producers who sold to spot market outlet (S) increased their gross margin by about KES 8,556 over not selling to this channel. The findings from two scenarios (ATT and ATU) indicated that farmers obtained a high gross margin while others lost by participating in their choice's channel combination. The ATT and ATU of farmers who participated in contract and middlemen option combination (CM) was not statistically significant. Similarly, producers who chose middlemen option (M) reported a negative and insignificant ATT effect, suggesting that they realized losses.

Table 5.6: Average expected Gross margin from French beans (per season)

French beans marketing Channels		Associated with a channel	Not associated with a channel	Treatment effects ATT/ATU
C	Associated	18,725.86	23,777.56	ATT= -5,051.70***
	Not associated	15,299.26	17,785.51	ATU= -2,486.25*
CM	Associated	19,932.94	25,198.59	ATT= -5,265.65
	Not associated	22,710.99	17,985.82	ATU= 4,725.17
CMS	Associated	38,334.88	15,769.42	ATT= 22,565.47***
	Not associated	37,278.27	14,346.23	ATU= 22,932.04***
M	Associated	11,087.00	13,870.70	ATT= -2,743.12
	Not associated	9,636.06	19,239.32	ATU= -9,603.26***
MS	Associated	1,027.45	15,450.10	ATT= -14,442.64***
	Not associated	-15,148.67	18,935.26	ATU= -34,083.92***
S	Associated	19,577.93	14,727.62	ATT= 4,850.31***
	Not associated	25,705.47	17,143.27	ATU= 8,556.21***

***, **, * denotes statistical significance at 1%, 5% and 10% level.

Note: C means contract, CM contract middlemen, CMS contract middlemen spot, M middlemen, MS middlemen spot, S spot and CO not associated with a channel.

5.4 Conclusion and recommendations

Contract farming is becoming increasingly crucial for high-value commodities in developing countries, partly because local and foreign markets require a coordinated supply chain for food production quality and safety. Still, informal markets play a significant role in linking smallholder French beans farmers to the market. Therefore, this study investigates the effects of contract and non-contract options on smallholders' gross margins using data collected from Murang'a South Sub-County. The findings indicate that the likelihood of selling to any of the marketing channels was influenced by age, gender, household size, education, off-farm income, group membership, extension access, reliability of outlet, availability of outlet, distance, farming experience and credit access. The study also reveals that participation in a contract or contract with any other combination significantly increased smallholders' gross margin.

The study suggests that farmers should be encouraged to engage in off-farm activities in order to generate additional funds that can be used to facilitate marketing. Additionally, extension agents should encourage farmers to diversify their marketing strategies as a way to mitigate the risks associated with selling to a single market outlet.

CHAPTER SIX

GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

6.1 General discussion

The choice of vertical coordination option can increase the adoption level of GGAPs and gross margin among smallholder farmers. The overall objective of this study was to determine the effects of vertical coordination on supply chain performance among smallholder French beans producers in Murang'a South Sub-County. The specific objectives included determining factors influencing the choice of vertical coordination options, evaluating the effects of vertical coordination options on the adoption of GGAPs and estimating the effects of vertical coordination option choices on Gross margin. The study employed a multivariate probit model, gologit model, and multinomial endogenous switching regression model to achieve the three objectives. Primary data were collected using a semi-structured questionnaire.

The findings indicated that farming was the main occupation, with only 13% of the farmers embracing off-farm activities. Education level was high among contracted farmers suggesting that they are more receptive to new ideas and innovations. Contracted farmers also reported the longest farming experience relative to those selling to non-contract markets. The study found that socioeconomic factors matter in smallholder marketing decisions. Further, contract farming had a positive effect on the adoption of GLOBALG.A.Ps with farmers on contract reporting an adoption rate of 66% compared to their counterparts (34%). Similarly, participation in contract or contract with other outlet combinations significantly increased smallholders' gross margin.

6.2 Conclusions

- i. In determining factors that influence the choice of vertical coordination options, the findings indicated that gender of the household production decision-maker, household size, education stock, group membership, extension access, number of training, market reliability, farming experience, credit access, off-farm income and distance to market significantly influenced the marketing strategies of smallholder farmers. The survey further revealed that the contract option was the dominant marketing channel among farmers.
- ii. The findings also indicated that the adoption level of GLOBALG.A.Ps was still low among farmers, with some practices recording a zero percent. This observation

suggests measures to improve the adoption of Global good agricultural practices. The result further revealed that Participation in contract farming had a positive influence on the adoption of GGAPs. Contract farmers reported a higher adoption level, with none being in the low category of users. The other factors influencing the adoption of GLOBALG.A.Ps included age, education stock, household size, training and farming experience.

- iii. A key finding is that farmers who participated in all three marketing channels realized the highest gross margin. This implies that participation in multiple marketing outlets can improve the welfare of farmers and thus reduce the poverty levels among rural households.

6.3 Recommendations

- i. To improve participation in high-value markets, smallholder farmers should be encouraged to subscribe and participate in agricultural farmer groups to share information. Besides, this collective action will enhance their bargaining power, thus increasing their borrowing abilities. Additionally, off-farm activities generate cash that provides an alternative means of financing production, adopting good farm practices and marketing. Therefore, the government and relevant partners should invest in rural infrastructure, especially roads and electricity, which could enhance the development of rural-based economic activities while making it easier for smallholder farmers to engage in off-farm activities.
- ii. The government, through extension agents, should sensitize farmers on the importance of adopting GLOBALG.A.Ps in order to compete in the global market. Secondly, farmers should be encouraged to form groups to share information about the new GLOBALG.A.Ps. Finally, the government should consider how to make compliance easier and more affordable for farmers by establishing minimum prices for horticultural produce to cover compliance costs.
- iii. Smallholder farmers should be encouraged to participate in multiple marketing channels to spread market risks. Participation in informal markets should be discouraged as farmers do not realize higher returns.

6.4 Areas of further research

Further research should be done on the analysis of disincentives for the adoption of capital-intensive GLOBALG.A.Ps such as irrigation water assessment, soil nutrient test; establishment of farm infrastructures like grading shade and charcoal coolers; annual health

checks and personal protective gear, which could inform policymakers on the appropriate measures to increase adoption of GLOBALG.A.P.s. Additional research on the dis-adoption of contract farming among farmers should also be done.

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APPENDICES

Appendix 1: Household Questionnaire

A. QUESTIONNAIRE IDENTIFICATION

Questionnaire Number.....

Name of Enumerator.....

Dear respondent,

I am Naomi Chelang'a, Pursuing MSc. Agribusiness management at Egerton University. I am conducting a research on **Vertical coordination and horticultural produce supply chain performance among smallholder French beans producers in Murang'a South Sub-County, Kenya**. You have been selected to participate in this interview however your participation is voluntary. The information you provide will be confidential and your name will not appear at any level of this report writing. Thank you.

Name of interviewer.....

Household number.....

Ward.....

Village.....

Date of interview.....

B. HOUSEHOLD CHARACTERISTICS (tick where appropriate)

1.1a Gender of the household head 1=male [] 0=female []

1.1b Gender of the production decision-maker 1=male [] 0=female []

1.2a Age of the household head years

1.2b Age of the production decision-maker.....years

1.3 Marital status of the production decision maker

1=married [],

2=single [],

3=widowed []

1.4 Household size and composition

Household members	Age(years)	Male	Female

1.5a What is the education level of the production decision maker?number of years of formal schooling

1.5b Education level of the household members

Household members	Years of formal schooling

1.6 What is main occupation of the production decision maker?

1.7a Do you have any off-Farm income 1=Yes [] 2=No [] if **yes** continue If **no** go to question **2.1**

1.7b What is the source of your off-farm income?

Business [] Civil servant [] Casual labor [] others (specify)

C. PROPERTY RIGHTS

2.1 Do you own land? 1=Yes[] 2= No[] if **yes** continue, if **no** go to question **2.6**

2.2 What is the total land owned?

2.3 Do you rent out land? 1=Yes[] 2=No[] if **yes** continue, if **no** go to question **2.6**

2.4 What is the total land size rented out?

2.5 What is the price per acre of the rented out land?

2.6 Do you rent in land? 1=Yes[] 2=No[]

2.7 If **yes** what is the total land size rented in.....

2.8 What is the price per acre of the rented-in land.....

2.9 Please specify if there is any other form of land ownership.....

D. FRENCH BEANS PRODUCTION

3.1 What is the total land size in acres?

a) Under French beans production..... b) Under other crops.....

3.2 Apart from French beans, do you have other crops on your farm? 1=Yes[] 2=No[]

3.3 What is the total acreage of land for each alternative crop?

Crop grown	Size of land(acres)

3.4 How long have you been in French beans production? years

E. FRENCH BEANS PRODUCTION VARIABLE COST

4.1 Please provide information on the main variable cost incurred in the last French beans production season?

No	Type of variable cost	Unit of measurement	Quantity used	Price per unit used	Transport cost per unit of inputs (KES)	Total cost per unit of inputs
	Soil analysis	KES/acre				
	Irrigation water assessment	KES/lt				
	Farm audit	KES/acre				
	Machinery expenditure	KES/acre				
	Seeds	Kg/acre				
	Planting fertilizer(DAP)	Kg/acre				
	Manure	Kg/acre				
	Top dressing fertilizer(CAN)	Kg/acre				
	Fungicides	Lt/acre				
	Pesticides	Lt/acre				
	Irrigation water	Lt/acre				
	Others(specify)					

4.2 Please provide the labor cost incurred in the last French beans production season

Labor cost/acre	Hired cost per (man days)			Family labor per (man days) wage earned if worked on other farms other than your own		
	No	Price/day	Days	No	Price/day	Days
Land preparation						
Planting						
Weeding						
Top dressing						
Harvesting and grading						
Others(specify)						

F. MARKETING OF FRENCH BEANS

5.1 What is the distance from homestead to?

Distance in Kilometer	Cost of Kilometers covered in KES
Homestead to market center.....	
Homestead to administrative office.....	
Homestead to tarmac road.....	

5.2 Please indicate the mode of transport, distance and cost incurred when accessing the nearest French beans market outlet

Mode of transport	Distance in kilometer	Duration in hours	Cost in KES
Head loading			
Boda boda			
Matatu			
Buyer transport			
Others (specify)			

5.3 What is the state of the road to the market?

1=Murram [] 2=Tarmac [] 3=Others (Specify)

5.4 Do you have any access to information on French beans market outlet? If **yes** continue, if **no** go to question **5.6**

5.5 Please indicate the source and frequency of access to French beans market information

Source of market information	Frequency (daily, weekly, monthly, annually)
Family	
Farmer group	
Extension officers	
Radio	
Television	
Barraza	
Others (specify)	

- 5.6** Who is the main buyer of your produce? 1= Export contractor [] 2=Middlemen [] 3=Spot market [] 4=others (specify).....
- 5.7** How do you decide where to sell your produce? 1= access [] 2=price [] 3= quick payments [] 4= reliable market []
- 5.8** How is the price set during sales? 1= through negotiation [] 2= market-driven [] 3= the seller sets the price [] 4= the buyer sets the price [] 5= others (specify).....
- 5.9** Please indicate your perception on the main vertical coordination option of your choice.

1=Strongly Disagree 2=Disagree 3= Neutral 4=Agree 5=Strongly Agree

(SD= Strongly Disagree, D=Disagree, N=Neutral, A=Agree, SA= Strongly Agree)

Likert items on attributes of vertical coordination options	SD	D	N	A	SA
a) Availability of the choice					
i) The choice is readily available					
ii)The choice is easily accessible					
b) Reliability of the choice					
i) Payment is on time					
ii) Price fluctuation is low					
iii) Agreement is always honored					
iv) Market information always available					

G. FRENCH BEANS YIELD AND REVENUE

6.1 Please provide information on the last production season.

Total Quantity produced in kg/acre	Quantity sold to each market outlet in kg	Price per kg for each market outlet	Revenue ($P \times Q$)
	Contract.....		
	Middlemen.....		
	Spot.....		
Total kg.....			Total revenue.....

6.2 How long does it take to receive your payments?

Outlets	Duration
Contracts	
Middlemen	
Spot market	

H. ACCESS TO EXTENSION SERVICE

7.1 Have you received any form of extension service on French beans? If **yes** continue, if no go to question **7.10**

7.2 How frequent is the extension service? 1=weekly [] 2=twice a week [] 3=once a month [] 4=once a year []

7.3 What is the mode of extension delivery? 1=Farm visits [] 2=Field days [] 3=Office visits [] 5=others (specify).....

7.4 Are the extension services always available when you need help? 1=Yes [] 2=No []

7.5 Which extension service providers did you engage with?
 1=Government extension officers [] 2=Private extension experts [] 3=NGOs []
 4=Farmer groups [] 5=Specify others if any.....

7.6 What services were you provided with by the extension officers? 1 =marketing information [] 2=production and post-harvest management [] 3= others (specify)

7.7 Did you incur any cost in getting extension service? 1=Yes [] 2=No [] if **yes** continue, if **no** go to question **7.10**

7.8 What type of cost did you incur?
 1=transport cost to an extension office [] 2=time spent [] 3=payment for the extension service 4=others (specify).....

7.9 Please provide any of the costs incurred for obtaining any of the extension services in **KES**.

Type of extension service cost	Cost in KES
Transport cost to an office	
Time spent (amount earned if worked)	
Payment for the extension service	
Others (specify)	

- 7.10** Have you ever received any training on French beans production? 1=Yes [] 2=No []
- 7.11** If **yes** what type of training did you receive? 1= good production practices [] 2= post-harvest handling [] 3= environmental safety [] 4= first aid and worker safety [] 5= others specify.....
- 7.12** How many times have you received training on French beans?

I. CREDIT ACCESS

- 8.1** Did you ever need credit during the last production season? If **yes** continue, if **no** go to question **9.1**
- 8.2** Did you apply for any credit in the last production season? If **yes** continue, if **no** go to question **8.10**
- 8.3** Did you get the credit? If **yes** continue, if **no** go to question **8.9**
- 8.4** Did you get the whole amount applied? If **yes** go to question **8.6**, if **no** continue
- 8.5** Why were you not given the whole amount?
1=had an outstanding loan [] 2=had no security [] 3=others (specify).....
- 8.6** What was the source of your credit? 1=Society [], 2=Bank [], 3=Micro finance
4=others (specify)
- 8.7** Please indicate the amount of credit received and the interest rates.

Source of credit	Amount received	Interest rates in KES
Society		
Bank		
Microfinance		
Others (specify)		

- 8.8** How did you repay the credit? 1=by selling French beans [] 2=from other sources []
- 8.9** What was the reason for not being given? 1=had an outstanding loan [] 2=had no security [] 3=others (specify).....

8.10 Why did you not apply for credit?

1=fear [] 2=expensive [] 3=had no security [] 4=others (specify).....

J. SOCIAL CAPITAL

9.1 Do you belong to any group association? If **yes** continue, if **no** go to question **9.5**

9.2 Which type of group association do you belong to?

1=Farmer group [] 2=Welfare group [] 3=Marketing group [] 5=Merry-go round []
others (specify).....

9.3 How long have you been a member of a group association?

9.4 What benefits do you derive from group membership?

1=access to market information [] 2=advice on production techniques []
3=information on credit access [] 4=welfare [] 5=others (specify)

9.5 Why don't you belong to a group?

1=high membership fee [] 2=distance with group members [] 3=lack of trust []
4=others (specify).....

9.6 To what extent do you agree or disagree that the available market outlets offer reasonable prices for the French beans delivered?

1=Strongly Disagree 2=Disagree 3= Neutral 4=Agree 5=Strongly Agree

SD=Strongly Disagree **D**=Disagree **N**=Neutral **A**=Agree **SA**=Strongly Agree

Likert items on the extent of trust for the different market outlet	SD	D	N	A	SA
Contract					
Middlemen					
Spot					

K. GLOBALG.A.Ps ADOPTION STATUS

10.1 Do you always clean the store floor every time pesticide spill on it? 1=Yes [] 2=No

- 10.2** Do you drink or eat when handling or while inside the farm chemical store? 1=Yes [] 2=No []
- 10.3** Do you wash hands with soap every time you come from the store or handle farm chemicals? 1=Yes [] 2=No []
- 10.4** Do you have a first aid kit in your house? 1=Yes [] 2=No []
- 10.5** Did you keep records of chemicals used in the last production season? 1=Yes [] 2=No []
- 10.6** Do you check your sprayer for any fault every time before spraying? 1=Yes [] 2=No []
- 10.7** Do you use a prescription label to determine the amount of water used for mixing pesticides? 1=Yes [] 2=No []
- 10.8** Do you use special containers for mixing pesticides? 1=Yes [] 2=No []
- 10.9** Does the applicator observe the directions of the wind while spraying? 1=Yes [] 2=No []
- 10.10** Does the applicator always wear any of the following protective gear when applying or handling pesticide? (Tick where appropriate)

Item	Yes	No
Long-sleeved overall		
Rubber gloves		
Gumboots		
Goggles		
Nose mask		
Hat/head scarf		

- 10.11** If **no** to any of the above questions, do you change clothes and take shower immediately after the sprayer leak on your body? 1=Yes [] 2=No []
- 10.12** Do workers who have contacts with chemicals submit to annual health checks due to exposure to toxic products? 1=Yes [] 2=No []
- 10.13** Please indicate if you practice any of the following integrated pest and disease management

Pest management strategy	Yes	No
Crop rotation		
Use of a resistant variety		
Fallow the plot		
Uproot and burry infected plants		
Regular disease and Pest scouting		

Use of safer and less toxic pesticides		
Adjusting application rate, timing and frequency to protect beneficial organisms		
Use of insect traps		
Use of biological natural pesticides		

10.14 Do you adhere to the period between the last pesticide application and resumption of harvesting (PHI)? 1=Yes [] 2=No []

10.15 Are non-conforming produce stored in clearly designated and segregated areas to avoid contamination of products? 1=Yes [] 2=No []

10.16 Did you do soil analysis in the last production season? 1=Yes [] 2=No []

10.17 If **no**, why don't you do soil analysis?

1=expensive [] 2=service not available [] 3=others (specify).....

10.18 Do you plant certified seeds? 1=Yes [] 2=No []

10.19 If **no**, why don't you use certified seeds?

1=expensive [] 2=seeds not available [] 3=inaccessibility [] others (specify).....

10.20 Do you keep records on all production and post-harvest activities in your farm?

1=Yes [] 2=No []

10.21 Do you keep records of pest control inspection and necessary actions taken?

1=Yes [] 2=No []

10.22 Are the harvesting containers cleaned and used exclusively for produce? 1=Yes []

2=No

10.23 Do you carry your produce with a crate to the collection center? 1=Yes [] 2=No []

10.24 Do you apply for farm audit inspections in every production season? 1=Yes []

2=No []

10.25 If **no** why don't you apply? 1=expensive [] 2=it is provided by the buyer []

3=service not available [] 4=others (specify)

10.26 Do you do irrigation water assessment at least once a year? 1=Yes [] 2=No []

10.27 If **no**, why don't you do water assessment?

1=expensive [] 2=service not available 3=others (specify)

10.28 Does the farm has hygiene instructions visibly displayed to workers and visitors?
1=Yes [] 2=No

10.29 Is there evidence of proper disposal of empty chemical containers, for instance burying them underground and recycling? 1=Yes [] 2=No []

10.30 Go to question **11.1**

To be observed by the enumerator

10.30 Is there a storage and grading shade near the French beans plot? 1=Yes [] 2=No []

10.31 Is there evidence of a charcoal cooler near the farm plot? 1=Yes [] 2=No []

10.32 Is there evidence of soil erosion control practices at the farm? For instance mulching, cross line techniques on slopes, sowing grass on the borders of the site? 1=Yes []
2=No []

10.33 Is there evidence of a fence on the French beans plot to prevent excessive animal activity? 1=Yes [] 2=No []

10.34 is there evidence of labels on all the French beans plots on the farm? 1=Yes []
2=No []

10.35 Is the site kept in a tidy and orderly condition? 1=Yes [] 2=No []

10.36 Is there a water storage facility at the farm? 1=Yes [] 2=No []

10.37 Is there evidence of a clean toilet and handwashing facility near the farm plot 1=Yes
[] 2=No []

10.38 Is there a place to wash hands next to the chemical store? 1=Yes [] 2=No []

10.39 Is there active measure to prevent pesticide drift from or to neighboring plots? For instance vegetative buffers at the edges of cropped fields? 1=Yes [] 2=No []

10.40 Is there a measure implemented to collect water? For instance from building roofs?
1=Yes [] 2=No []

Off-farm income

11.1 What is the range of income received per month from off-farm activities in (KES)?
1=less than 5000 [] 2=5000-10000 [] 3=10000-20000 [] 4=20000-30000 []
4=30000-40000 [] above40000 []

Challenges facing French beans production

12.1 What major challenges are you facing in producing French beans?

1= high production cost [] 2= inaccessibility to market [] 3= poor produce prices [] 4= stringent GLOBALG.A.Ps [] 5= others (specify).....

Thank you

Appendix 2: Conversion Factors for Computing Adult Equivalents

Age	Adult Equivalence	
	Males	Females
Under 1 year	0.33	0.33
1-1.99	0.46	0.46
2-2.99	0.54	0.54
3-4.99	0.62	0.62
5-6.99	0.74	0.70
7-9.99	0.84	0.72
10-11.99	0.88	0.78
12-13.99	0.96	0.84
14-15.99	1.06	0.86
16-17.99	1.14	0.86
18-29.99	1.04	0.80
30-59.99	1.0	0.82
60 and over	0.84	0.74

Source: World Health Organization, (2007)

Appendix 3: Multivariate probit results

```
. mvprobit( contract =Age Gender Hhsize Edu Fsize Offincome Grpm ExtAcc NoTra Rel Disst Fexp
> ( middlemen =Age Gender Hhsize Edu Fsize Offincome Grpm ExtAcc NoTra Rel Disst Fexp InfoAc
> t =Age Gender Hhsize Edu Fsize Offincome Grpm ExtAcc NoTra Rel Disst Fexp InfoAcc CrdtAcc )
```

```
Multivariate probit (SML, # draws = 5)          Number of obs   =      215
Log likelihood = -264.06428                      Wald chi2(42)    =     131.69
                                                Prob > chi2      =      0.0000
```

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	

contract						
Age	-.0138274	.0153352	-0.90	0.367	-.0438837	.0162229
Gender	-.9480119	.3520396	-2.69	0.007	-1.637997	-.258027
Hhsize	-.4571253	.1844073	-2.48	0.013	-.8185569	-.0956936
Edu	.0308699	.0165492	1.87	0.062	-.0015659	.0633057
Fsize	-.1035158	.1732104	-0.60	0.550	-.443002	.2359703
Offincome	.307908	.3634573	0.85	0.397	-.4044552	1.020271
Grpmember	-.5544028	.3215732	-1.72	0.085	-.0758691	1.184675
ExtAcc	.6738459	.3302627	2.04	0.041	.0265429	1.321149
NoTra	.1808142	.0891042	2.03	0.042	.0061731	.3554553
Rel	.6213806	.1901032	3.27	0.001	.2487852	.993976
Disst	.0386891	.0225239	1.72	0.086	-.0054569	.0828352
Fexp	-.2227876	.0518398	-4.30	0.000	-.2211835	-.3243917
InfoAcc	-.1505847	.3779124	-0.40	0.690	-.8912795	.59011
CrdtAcc	.0000269	.0000163	1.65	0.099	-5.07e-06	.0000589
_cons	-3.113446	1.064686	-2.92	0.003	-5.200192	-1.026701

middlemen						
Age	.010012	.0099656	1.00	0.315	-.0095203	.0295443
Gender	.4067451	.2066855	1.97	0.049	.001649	.8118412
Hhsize	.0444469	.0927436	0.48	0.632	-.1373272	.2262209
Edu	.0018576	.0090983	0.20	0.838	-.0159747	.0196899
Fsize	.0013383	.1244369	0.01	0.991	-.2425535	.24523
Offincome	.62808	.2372385	2.65	0.008	.1631011	1.093059
Grpmember	-.3264793	.2247435	-1.45	0.146	-.7669685	.1140098
ExtAcc	-.6936418	.2224246	-3.12	0.002	-1.129586	-.2576976
NoTra	-.0214701	.0454485	-0.47	0.637	-.1105475	.0676074
Rel	-.5492119	.1481599	-3.71	0.000	-.8396	-.2588237
Disst	-.0200748	.0147047	-1.37	0.172	-.0488955	.0087459
Fexp	-.0050178	.0207747	-0.24	0.809	-.0457354	.0356998
InfoAcc	.0608237	.2478085	0.25	0.806	-.424872	.5465195
CrdtAcc	5.98e-06	.0000119	0.50	0.615	-.0000173	.0000293
_cons	1.724049	.6923623	2.49	0.013	.3670441	3.081055

spot						
Age	.0135443	.0095343	1.42	0.155	-.0051425	.0322311
Gender	.1054411	.2064096	0.51	0.609	-.2991142	.5099965
Hhsize	-.1115284	.094865	-1.18	0.240	-.2974604	.0744037
Edu	.0132406	.0090404	1.46	0.143	-.0044782	.0309593
Fsize	-.0166296	.1156357	-0.14	0.886	-.2432713	.2100122
Offincome	.6248202	.2372902	2.63	0.008	.15974	1.0899
Grpmember	-.0093564	.2154998	0.04	0.965	-.4130155	.4317283
ExtAcc	-.1555289	.2205957	-0.71	0.481	-.5878886	.2768307
NoTra	.0377166	.0512975	0.74	0.462	-.0628245	.1382578
Rel	-.3661312	.1409326	-2.60	0.009	-.642354	-.0899083
Disst	-.0151622	.0142651	-1.06	0.288	-.0431212	.0127968
Fexp	-.0923189	.0282107	-3.27	0.001	-.1476109	-.0370269
InfoAcc	.311037	.2384743	1.30	0.192	-.156364	.778438
CrdtAcc	4.30e-08	.0000103	0.00	0.997	-.0000202	.0000203
_cons	.8092459	.6703035	1.21	0.227	-.5045247	2.123017

/atrho21	-.6948691	.1829598	-3.80	0.000	-1.053464	-.3362744

/atrho31	-.2544985	.1389736	-1.83	0.067	-.5268818	.0178848

/atrho32	.4841234	.1354092	3.58	0.000	.2187263	.7495206

rho21	-.6011009	.1168524	-5.14	0.000	-.7831493	-.3241473

rho31	-.2491426	.1303472	-1.91	0.056	-.4829939	.0178829

rho32	.4495398	.1080449	4.16	0.000	.2153037	.6348628

```
Likelihood ratio test of rho21 = rho31 = rho32 = 0:
chi2(3) = 33.3589 Prob > chi2 = 0.0000
```

Appendix 4: Marginal effects on estimates from Multivariate probit model

Variable	Contract		Middlemen		Spot	
	Coef.	p-value	Coef.	p-value	Coef.	p-value
Age	-0.014	0.367	0.010	0.315	0.014	0.155
Gender	-0.948	0.007	0.407	0.049	0.105	0.609
Household size	-0.457	0.013	0.044	0.632	-0.112	0.240
Education	0.031	0.062	0.002	0.838	0.013	0.143
Farm size	-0.104	0.550	0.001	0.991	-0.017	0.886
Off-farm income	0.308	0.397	0.628	0.008	0.625	0.008
Group membership	0.554	0.085	-0.326	0.146	0.009	0.965
Extension access	0.674	0.041	-0.694	0.002	-0.156	0.481
Number of training	0.181	0.042	-0.021	0.637	0.038	0.462
Reliability of outlet	0.621	0.001	-0.549	0.000	-0.366	0.009
Distance	0.039	0.086	-0.020	0.172	-0.015	0.288
Farming experience	0.223	0.000	-0.005	0.809	-0.092	0.001
Information access	-0.151	0.690	0.061	0.806	0.311	0.192
Credit access	0.000	0.099	0.000	0.615	0.000	0.997

Appendix 5: Variance inflation factor (VIF) multicollinearity test results for the gologit model

Variable	VIF	1/VIF
Edu	3.75	0.266819
Hhsize	3.35	0.29854
Rel	2.2	0.453808
Avail	2.07	0.483509
Fexp	1.95	0.512733
TraAcc	1.6	0.624857
Age	1.56	0.63907
ExtAcc	1.44	0.696152
Fsize	1.4	0.713409
Offincome	1.32	0.7595
Grpmember	1.26	0.796579
InfoAcc	1.16	0.859206
Gender	1.11	0.901158
Crdtacc	1.06	0.939786
Dist	1.06	0.943836
Mean VIF	1.75	

Appendix 6: Gologit2 results estimates

```
. gologit2 GGAI Grpm VCO Age Gender Hhsize Edu Fsize Offincome ExtAcc TraAcc Avail Rel Dist Fexp InfoAcc crdta
> cc, npl (Grpm)
```

```
Generalized Ordered Logit Estimates          Number of obs   =       215
                                             LR chi2(17)      =       320.14
                                             Prob > chi2      =       0.0000
Log likelihood = -63.44284                  Pseudo R2       =       0.7162
```

- (1) [low]VCO - [medium]VCO = 0
- (2) [low]Age - [medium]Age = 0
- (3) [low]Gender - [medium]Gender = 0
- (4) [low]Hhsize - [medium]Hhsize = 0
- (5) [low]Edu - [medium]Edu = 0
- (6) [low]Fsize - [medium]Fsize = 0
- (7) [low]Offincome - [medium]Offincome = 0
- (8) [low]ExtAcc - [medium]ExtAcc = 0
- (9) [low]TraAcc - [medium]TraAcc = 0
- (10) [low]Avail - [medium]Avail = 0
- (11) [low]Rel - [medium]Rel = 0
- (12) [low]Dist - [medium]Dist = 0
- (13) [low]Fexp - [medium]Fexp = 0
- (14) [low]InfoAcc - [medium]InfoAcc = 0
- (15) [low]crdtacc - [medium]crdtacc = 0

	GGAI	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
low							
Grpmember		1.703255	.7298666	2.33	0.020	.2727424	3.133767
VCO		1.515948	.7824914	1.94	0.053	-.0177065	3.049603
Age		-.0845707	.0263373	-3.21	0.001	-.1361909	-.0329504
Gender		.8860156	.5051573	1.75	0.079	-.1040745	1.876106
Hhsize		-1.199952	.3149593	-3.81	0.000	-1.817261	-.5826429
Edu		.0901848	.0290778	3.10	0.002	.0331934	.1471762
Fsize		-.3176553	.3340631	-0.95	0.342	-.9724069	.3370963
Offincome		.6811756	.6129615	1.11	0.266	-.5202069	1.882558
ExtAcc		1.276678	.5767747	2.21	0.027	.1462206	2.407136
TraAcc		2.267381	.7162076	3.17	0.002	.86364	3.671122
Avail		-1.227826	.4678881	-2.62	0.009	-2.14487	-.3107824
Rel		1.135235	.5043044	2.25	0.024	.1468163	2.123653
Dist		.1421469	.1335925	1.06	0.287	-.1196897	.4039834
Fexp		.9070926	.1478133	6.14	0.000	.617384	1.196801
InfoAcc		-1.004699	.6077365	-1.65	0.098	-2.195841	.1864427
crdtacc		.7701497	.8760282	0.88	0.379	-.9468341	2.487134
_cons		.348828	1.958107	0.18	0.859	-3.488991	4.186647
medium							
Grpmember		-.0645587	.703824	-0.09	0.927	-1.444028	1.314911
VCO		1.515948	.7824914	1.94	0.053	-.0177065	3.049603
Age		-.0845707	.0263373	-3.21	0.001	-.1361909	-.0329504
Gender		.8860156	.5051573	1.75	0.079	-.1040745	1.876106
Hhsize		-1.199952	.3149593	-3.81	0.000	-1.817261	-.5826429
Edu		.0901848	.0290778	3.10	0.002	.0331934	.1471762
Fsize		-.3176553	.3340631	-0.95	0.342	-.9724069	.3370963
Offincome		.6811756	.6129615	1.11	0.266	-.5202069	1.882558
ExtAcc		1.276678	.5767747	2.21	0.027	.1462206	2.407136
TraAcc		2.267381	.7162076	3.17	0.002	.86364	3.671122
Avail		-1.227826	.4678881	-2.62	0.009	-2.14487	-.3107824
Rel		1.135235	.5043044	2.25	0.024	.1468163	2.123653
Dist		.1421469	.1335925	1.06	0.287	-.1196897	.4039834
Fexp		.9070926	.1478133	6.14	0.000	.617384	1.196801
InfoAcc		-1.004699	.6077365	-1.65	0.098	-2.195841	.1864427
crdtacc		.7701497	.8760282	0.88	0.379	-.9468341	2.487134
_cons		-8.028304	2.301819	-3.49	0.000	-12.53979	-3.516821

Appendix 7: Marginal effects estimates for determinants of market choice using multinomial logit model

Variables	C	CM	CMS	M	MS	S
Age	-0.003 (0.003)	0.002 (0.002)	- 0.002 (0.002)	-0.002 (0.002)	0.003 (0.002)	0.002 (0.002)
Gender	-0.038 (0.053)	-0.008 (0.036)	-0.037 (0.047)	0.039 (0.046)	0.111*** (0.041)	-0.067* (0.036)
Household size	-0.011 (0.027)	0.007 (0.018)	-0.033 (0.024)	0.036* (0.021)	0.000 (0.021)	0.000 (0.018)
Education	-0.001 0.003	-0.001 0.002	0.005** 0.002	-0.001 0.002	-0.001 0.002	0.000 0.002
Farm size	-0.001 (0.031)	0.005 (0.017)	-0.009 (0.026)	0.000 (0.029)	0.012 (0.025)	-0.007 (0.024)
Off-farm income	-0.158*** (0.057)	-0.012 (0.041)	0.168*** (0.045)	0.007 (0.057)	-0.013 (0.054)	0.008 (0.044)
Group membership	-0.055 (0.060)	0.061 (0.050)	0.049 (0.053)	0.002 (0.043)	-0.133*** (0.040)	0.077** (0.037)
Extension access	0.143** (0.061)	-0.127*** (0.043)	0.023 (0.056)	-0.042 (0.047)	0.010 (0.043)	-0.008 (0.036)
Number of training	0.004 (0.012)	0.003 (0.008)	0.009 (0.011)	-0.020 (0.016)	-0.004 (0.014)	0.009 (0.012)
Reliability	0.114 (0.045)	-0.057** (0.028)	0.002 (0.042)	-0.020 (0.040)	-0.014 (0.034)	-0.025 (0.030)
Availability	0.063 (0.048)	0.020 (0.030)	-0.037 (0.046)	0.011 (0.038)	-0.089*** (0.033)	0.033 (0.035)
Distance	-0.010 (0.015)	0.000 (0.009)	0.001 (0.013)	-0.012 (0.013)	0.027** (0.012)	-0.006 (0.010)
Farming experience	0.021*** (0.006)	0.011*** (0.003)	0.001 (0.006)	-0.002 (0.008)	-0.017** (0.008)	-0.013* (0.007)
Credit access	0.000 (0.000)	0.000** (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)

***, **, * denotes statistical significance at 1%, 5% and 10% level.

Note: Standard errors are given in parenthesis

Appendix 8: Parameter estimates of gross margin from MESR (second stage)


Variable	C	CM	CMS	M	MS	S
Age	-0.014 (0.011)	0.013 (0.016)	-0.010 (0.012)	-0.012 (0.013)	0.019 (0.015)	0.009 (0.010)
Gender	0.130 (0.227)	-0.096 (0.361)	-0.163 (0.251)	0.182 (0.269)	0.924*** (0.349)	0.045 (0.202)
Household size	0.080 (0.111)	0.016 (0.174)	-0.168 (0.123)	0.211* (0.128)	-0.004 (0.157)	-0.120 (0.099)
Education	0.001 (0.011)	-0.006 (0.016)	0.025** (0.012)	-0.006 (0.012)	-0.009 (0.015)	0.014 (0.010)
Farm size	0.044 (0.134)	0.059 (0.177)	-0.019 (0.141)	0.066 (0.154)	0.140 (0.190)	0.009 (0.120)
Off-farm income	0.855*** (0.280)	-0.317 (0.443)	0.851*** (0.267)	-0.043 (0.338)	-0.188 (0.400)	0.695*** (0.240)
Group member	0.004 (0.251)	0.519 (0.478)	0.356 (0.275)	-0.027 (0.272)	-1.034*** (0.338)	-0.030 (0.216)
Extension access	0.708*** (0.260)	-1.306*** (0.467)	0.209 (0.302)	-0.281 (0.291)	0.122 (0.326)	0.044 (0.232)
Training	0.047 (0.050)	0.079 (0.083)	0.071 (0.057)	-0.136 (0.085)	-0.091 (0.101)	0.023 (0.052)
Reliability	0.639*** (0.207)	-0.487* (0.291)	0.107 (0.231)	-0.143 (0.240)	-0.137 (0.259)	-0.213 (0.182)
Availability	0.271 (0.202)	0.266 (0.292)	-0.137 (0.239)	0.110 (0.224)	-0.631** (0.264)	-0.224 (0.178)
Distance	0.031 (0.058)	0.050 (0.085)	0.029 (0.063)	-0.036 (0.075)	0.221** (0.097)	0.059 (0.053)
Farming experience	0.042*** (0.024)	0.094*** (0.032)	-0.012 (0.029)	-0.052 (0.044)	-0.140** (0.057)	-0.087** (0.028)
Credit access	0.000 (0.000)	0.000** (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
_cons	3.201 (0.938)	-2.692 (1.328)	-1.616 (0.955)	-0.310 (1.026)	0.908 (1.189)	1.046 (0.775)

***, **, * denotes statistical significance at 1%, 5% and 10% level.

Note: Standard errors are given in parenthesis


Appendix 9: Research permit


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Appendix 10: Publication abstract



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DETERMINANTS OF VERTICAL COORDINATION OPTION CHOICES AMONG SMALLHOLDER FRENCH BEANS PRODUCERS IN KENYA

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ABSTRACT

Research background: With market liberalization and the introduction of the new Global GAP measures, several vertical coordination options have emerged, presenting smallholder farmers with multiple market outlets. The choice of any vertical coordination option (VCO) is likely to be entwined by farm, farmer and vertical coordination attributes, yet the selection of an appropriate market outlet for delivering farm produce is not clear-cut.

Purpose of the article: This study determines factors influencing the choice of vertical coordination options among smallholder French beans producers in Murang'a South Sub-County

Methods: Using data from a sample of 215 smallholder producers, the study employed a multivariate probit model (MVP) to explain the determinants of vertical coordination option choices among French beans farmers in four wards located in Murang'a South Sub-County.

Findings & Value added: The results indicate that the choice of vertical coordination option was significantly influenced by gender, household size, education stock, group membership, extension service, training access, farming experience, off-farm income, credit access, distance and market reliability. This implies that the promotion of collective action as an institutional tool for linking farmers to high-value markets, matters. These networks will aid in sharing knowledge, increasing borrowing power and thus, producers can improve French bean quality as required by the market. Additionally, financial institutions stakeholders should develop policies that favour the acquisition of credit at affordable rates. Further, the government with other relevant stakeholders should conduct more training on global gap standards.

Key words: vertical coordination; smallholder producers; multivariate probit model; french beans

JEL Codes: C01; D81; Q13
