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DETERMINANTS OF MODIFIED ORGANIC FERTILISERS ADOPTION BY SMALL SCALE COTTON FARMERS IN MUTOKO DISTRICT, ZIMBABWE

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRIBUSINESS IN THE COLLEGE OF HEALTH, AGRICULTURE AND NATURAL SCIENCES

2020

Abstract

With the growing concern with regards to alleviating poverty in Africa, improving access to multiple and reliable production innovations for small scale farmers along the cotton value chain is one of the key elements to ensuring efficiency in agribusiness. This study sought to identify determinants of modified organic fertilisers' adoption by small scale cotton producers in Mutoko district of Zimbabwe. A sample of 290 farmers was selected using a stratified random sampling strategy from dominant cotton producing wards. Cross sectional data was collected using a self-administered questionnaire as the main data collection tool. It was supported by Key Informant Interviews during the study 2018/19 season. Mainly, primary data were used and augmented with secondary data from different stakeholders such as buyers, agro-dealers, extension agents and cotton contractors. The researcher used a combination of descriptive and quantitative techniques to analyse the data. Descriptive analyses involved the use of means, tables and percentage representations. Stakeholder perceptions were also captured using thematic analysis. The quantitative analyses involved the use of binary logit regression, gross margins, ratios and counterfactual analysis. The use of modified organic fertilisers was low, accounting for 22 % of the sampled farmers in the study area. Farmers mainly used no fertilisers at all or inorganic fertilisers supplied by contractors and the government through subsidies. The data shows that the age of household head, association to membership groups, number of sellers available in the markets and the prices of commodities such as organic fertilisers and cotton significantly affects the modified organic fertilisers' adoption decision. Farmers who adopted modified organic fertilisers had significantly higher food diversity and significantly lower food insecurity. Results from the study also show that small scale cotton farmers' access to input and output markets was constrained by lack of effective information dissemination mechanisms. This shows the weak coordination among stakeholders along the cotton value chain. Stakeholders perceived modified organic fertilisers as a gateway out of low productivity in small scale cotton producing areas. Farmers suggested the need to strengthen their access to modified organic fertiliser markets through decentralising selling points. The stakeholders also suggested establishment of information centres in their localities so as to harness from beneficial market information, which will in turn have a significant impact in cotton productivity and overall household welfare. The study postulates that benefits to farmers can be enhanced if stakeholder coordination and networking is encouraged through establishing a platform for continuous interaction. This could enhance the decision to use modified organic fertilisers in cotton production and increase the net value to be generated from the commodity in each marketing channel.

Key Words: smallholder, modified organic fertilisers, cotton

Declaration Page

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree.

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Acknowledgements

The following organizations and people are sincerely thanked for their unconditional support throughout the project. I am greatly indebted to my supervisor, Dr. K. Mukumbi who tirelessly informed and provided crucial guidance during the life of the project. Without her, this piece of work would have never been possible. Another big thank you to my husband for his patience, financial support and the constant encouragement during the trying times of the project. The list is endless but I say to all those who made this a dream come true, I will always treasure your great help and Thank you.

Dedication

To my family!

List of Acronyms and Abbreviations

AUREC	Africa University Research Ethics Committee
CSF	Critical Success Factor
EPZ	Export Processing Zone
FDI	Foreign Direct Investment
FISP	Fertiliser and Inputs Support Programme
GDP	Gross Domestic Product
GOZ	Government of Zimbabwe
IAR4D	Integrated Agricultural Research for Development
ITKS	Indigenous Technical Knowledge Systems
NARS	National Agricultural Research Systems
NGO	Non-Governmental Organisation
SADC	Southern African Development Community
SDG	Sustainable Development Goals (SDGs)
VC	Value Chain

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CHAPTER 1 INTRODUCTION

1.1 Introduction

Agriculture is one of the strategic sectors in most economies of Southern Africa and has vast potential for sustaining food security, strengthening income generating prospects, and alleviating extreme poverty (Baudron, 2001). It is the backbone of Zimbabwe's economy and underpins the economic, social and political lives of the majority of the people in the country (Rukuni *et al.,* 2006). Agriculture contributes approximately 17 % to Zimbabwe's Gross Domestic Product (GDP) (GOZ, 2013). In the 1990s, Zimbabwe used to be not only food self-sufficient but also produced surplus crops for multiple export markets. The country was referred to as the bread basket of Southern Africa and as such agriculture and food security remains its main role in the Southern African Development Community (SADC). However, the situation has changed in the recent years to the extent that the country can no longer sufficiently feed itself and has to depend on imports and foreign aid programmes from international organisations (Mango, *et al*., 2014). This has been worsened by rapidly growing populations and changes in tastes and preferences which have increased the need for a variety of food types at affordable prices.

The food producing capacity in Zimbabwe, as is with many African countries is increasingly constrained both by diminishing opportunities to bring new land into production and by the declining productivity of over-cultivated areas caused by soil degradation (Maiyaki, 2010). Maize continues to dominate the crop production systems in small scale farming areas of Zimbabwe. However, cotton remains a major strategic source of income among small scale farmers in the arid and semi-arid areas of Zimbabwe and a foreign currency earner for the country. The major costs drivers

with cotton production in the small-scale sub sector are labour, fertilisers and pesticides.

Depletion of soil fertility is a major problem when decisions about sustaining agricultural production and productivity in Zimbabwe are made at all spatial and temporal spaces. This is also true for cotton enterprises among small scale farmers in marginalised areas. Ajewole (2010) noted that agriculture, since the inception of the green revolution, has relied on the excessive use of inorganic fertilisers to improve soil fertility and improve yields. Ketema & Bauer (2011) noted that although intensive farming involving the use of these inorganic fertilisers in large amounts has resulted in increased productivity of farm commodities, there are negative effects on soils, quality of water and food. According to Catur (2011), Nitrogen, Phosphate and Potassium based synthetic fertilisers leach into groundwater and increase their toxicity, causing water pollution thus disrupting aquatic ecosystems. In Zimbabwe serious consequences of eutrophication have been reported in water bodies like Kariba, Chivero and Mutirikwi. A similar pattern was reported by Martey *et al*. (2013) in Ghana where this reality has greatly increased the competition for limited usable water resources for household consumption, industry and agriculture.

For sustainable crop cultivation, there is need for appropriate application of nutrient resources and conservation of soil fertility. There is therefore a need for agribusiness stakeholders along the cotton value chain in Zimbabwe to shift the agricultural transformation drive towards adopting and using organic agriculture practices that are environmentally safe, affordable and renewable (McCann & Dongwonshin, 2018; Roba, 2018). Organic fertilisers are natural materials of either plant or animal source. These mainly include livestock manure, green manures and crop residues which work directly as a source of plant nutrients and indirectly influences the soil

properties. The application of organic fertilisers in agriculture can contribute to converting the poor fragile land into stable productive zones. Many parts of Zimbabwe are arid and semi-arid, experience recurrent droughts, have poor soils and are zones of crop failures. The use of locally adapted organic fertilisers is compatible with these smallholder cotton farmers in these areas who generally lack finances to buy inorganic fertilisers (Eicher, 1995). In response, farmers usually use livestock manure, cover crops and composts for small gardens and plots, which in most cases average two hectares.

Organic fertilisers are a Critical Success Factor (CSF) in that they improve soil fertility and soil structure thus improving soil drainage and infiltration (Sultana, Kashem, & Mullah, 2015). Overall, the reduction in the use of inorganic fertilisers will reduce contamination of the soil and water environments while at the same time reducing production costs, increasing marketing margins for farmers and enhancing the functioning of multiple small-scale farmer driven value chains (Svotwa *et al.,* 2007). In response to the realities mentioned above, most fertiliser companies in the country have embraced the production of modified organic fertilisers in their business lines. Communities have also devised strategies to locally modify the existing organic fertilisers with the aim of improving the productivity gains and reduce production costs. However, there has been low and at times no production of these fertilisers due to the prevailing hard economic conditions which have stalled innovations. The small-scale farmers are left with no option except to continue depending on subsidised inorganic fertilisers which are mainly brought in by Non-Governmental Organisations (NGOs) (Makokha *et al*., 2001). This is happening at the expense of more potentially beneficial modified organic fertilisers which have not been adequately supported especially by the government.

1.2 Background to the study

Poor soil fertility is a major constraint to crop production in Zimbabwe (Mugandani *et al*., 2012). Various types of fertilisers are widely used in agriculture to improve and maintain soil fertility while increasing crop yields and viability of enterprises. A fertilizer is any organic or inorganic material of natural or synthetic origin that is applied to the plants to supply nutrients essential to plant growth and ensure sustainable productivity. According to Terefe, Ahmed & Gebremariam (2013), the use of fertilisers is directly responsible for 40-60 % of the world's food production. Inorganic fertilisers increase the nitrate levels of soil and kill beneficial microorganisms in the soil that convert dead animal and plant remains into nutrient-rich organic matter. Although inorganic fertilisers usually containing all necessary nutrients that are directly accessible for plants, their continuous use alone causes soil organic matter degradation, soil acidity, and environmental pollution. According to Rukuni *et al*. (2006) inorganic fertilisers leach into ground water sources and surface water bodies bringing conditions like water hardiness and eutrophication.

Zimbabwe has a growing need for fertilisers in order to increase land and labour productivity and intensify crop production, especially in the smallholder farming subsector. Fertiliser and Inputs Support Programmes have been used in the country to encourage fertiliser use especially among resource constrained small scale farmers. Inorganic fertiliser use among cotton farming households is on the decline owing to unavailability, increased prices and financial constraints. On the other hand, inadequate investment in research for sustaining soil fertility is leading to degradation of land that is currently in agricultural use especially in the drier parts of the country (Baudron, 2001). This is regardless that Zimbabwe has a well-developed

fertiliser industry which until 1990 ensured that the country was self-sufficient in most of its fertiliser requirements. However, unfavourable macroeconomic factors have undermined the performance of the industry. Consequently, the fertiliser manufactures have been operating below capacity since the late 1990s and the country has become a net importer of inorganic fertilisers (Mutami, 2015).

Of major concern is that inorganic fertilisers have been in short supply in Zimbabwe for some time now. Furthermore, when the commodity becomes available on the markets, the price is beyond the reach of many small-scale cotton farmers (Rukuni *et al.,* 2006). It therefore becomes imperative for the country to migrate towards the use of modified organic fertilisers to bridge the supply gap and maintain the sustainable crop cultivation practices for food, income and nutritional security. However, there is still low uptake and use of modified organic fertilisers by farmers and other agribusiness enterprises in Zimbabwe hence the need to conduct this study with a specific focus on the cotton enterprise.

1.3 Statement of the Problem

In Zimbabwe, there is low uptake of modified organic fertilisers by cotton farmers despite their comparative economic, health and environmental benefits relative to the conventional inorganic fertilisers. This has significantly compromised productivity levels across multiple enterprises including cotton especially in the semi-arid areas of Zimbabwe where the crops have relative comparative advantage (Rukuni *et al.,* 2006). Stakeholders have also not concretely pushed and supported the uptake and utilisation of these fertilisers across multiple geo-spatial spaces and this has also affected the production, distribution and utilisation by farmers (Terefe *et al.,* 2013). The study therefore seeks to understand these intricate issues and find possible

solutions to the low uptake challenge with modified organic fertilizers among small scale cotton farmers in Zimbabwe.

1.4 Research Objectives

The main aim of the study was to explore and understand why there is low uptake of modified organic fertilisers by cotton farmers in Mutoko District of Zimbabwe.

Specifically, the study sought to:

1. Examine the factors causing the low uptake of modified organic fertilisers by small scale cotton farmers.
2. Determine the impact of modified organic fertilisers on farm household welfare of food and income security.
3. Explore the cotton value chain stakeholders' perspectives about modified organic fertilisers.

1.5 Research Questions

1. What are the factors causing the low uptake of modified organic fertilisers by selected agribusiness stakeholders?
2. What is the impact of modified organic fertilisers on farm household welfare in terms of food and income security?
3. How do cotton value chain stakeholders perceive modified organic fertilisers?

1.6 Hypotheses

- Social, economic and institutional factors have an impact on the uptake of modified organic fertilisers by selected agribusiness stakeholders.

- Farm households who use modified organic fertilisers are relatively worse off on welfare in terms of food and income security.
- Cotton value chain stakeholders do not perceive modified organic fertilisers as a viable alternative to conventional inorganic fertilisers.

1.7 Significance of the Study

This study is very crucial in providing information to stakeholders in the agribusiness sector, i.e., to the farmers, policy makers, and the companies (private and government, NGOs and civic society organisations). Farmers need to know the benefits and disadvantages associated with the use of modified organic fertilisers as well as the harm caused by use of inorganic fertilisers. This will lead to sustainable agriculture as well as well as promoting good agricultural practices especially with cotton production which dominates the drier parts of Zimbabwe. Policy makers need to act on an informed point of view so it is important for them to know about the prevailing conditions in the fertiliser industry. This study will provide these insights to be used for strategy development. Findings from the study can also then be used to promote use of modified organic fertilisers in Zimbabwe as a sustainable way of improving performance of the cotton enterprise.

1.8 Delimitation of the Study

- The study focused on modified organic fertilisers as an innovation whose current state of adoption has not been extensively explored with the hope of promoting its production and use.
- The study was limited to cotton farmers, fertiliser companies, contracting firms, farmer unions, NGOs, soil analysts and exporting standards

associations as they form part of the stakeholders in the modified organic fertilisers industry.

- The study used questionnaires and key informant interviews for data collection during the 2018/19 season.

1.9 Limitation of the Study

Stakeholders, especially inorganic fertiliser producing companies had misconceptions about the intentions of the study from a business perspective. In some cases, they were not willing to give their full opinion. This challenge was addressed by providing them with the consent forms and declaration for privacy and confidentiality which both parties signed. This guaranteed that the information they provided was safe with the researcher.

CHAPTER 2 REVIEW OF RELATED LITERATURE

2.0. Introduction

The previous chapter provided an introduction to this research by placing the research topic into the context of cotton value chain stakeholders under consideration. This section provides information and insights into potential determinants of choices in terms of using modified organic fertilisers. It also highlights the role of interactions in facilitating cotton market linkages in the small-scale farming sector of Zimbabwe and beyond. The starting point was to look into different definitions of innovations, innovation systems, marketing dynamics in the small holder agricultural sector and placing these in a framework where they could potentially be utilised in the cotton production decision making processes.

2.1. Importance of agricultural innovations

There is consensus among development practitioners that agricultural innovation is one of the most critical and limiting resources in most small-scale agricultural production systems of Africa (Masuka, 2012). Innovative practices are critical for Integrated Agricultural Research for Development (IAR4D) initiatives that are emerging across the globe. This has led to stagnation in the subsistence-oriented production dimension which rarely focuses on the marketing of produce and interaction among the complex and multiple stakeholders in value chains. The implication is that in most cases, especially with small scale producers in the drier parts of Zimbabwe where crops such as cotton and small grains can do well, farmers have not been willing to take up emerging innovations (Baudron, 2001). According to Neil & Lee (2001), agricultural innovation is a specific instrument designed to

facilitate low cost and efficient production in agricultural activities. It can also be viewed as a set of actions designed and implemented by a platform of stakeholders to facilitate and/or improve pre-existing means of agricultural production and foster sustainability.

Ngeno (2017) states that there are two major drivers of successful agricultural innovations in developing countries. Firstly, is the availability and affordability of innovations and secondly it is whether the farmer's expectations that adoption will remain profitable after its uptake. These decision-making drivers will ultimately and jointly determine the extent to which farmers are risk averse with respect to the innovation. There are a number of factors which drive the above expectations, ranging from availability and size of land, family labour, prices and profitability of the selected agricultural enterprises. Zeller, Diagne & Mataya (1998) reported that in Malawi, adoption of innovations had a cascading effect on productivity and household incomes. As such there is a case for pushing the innovation adoption agenda across multiple enterprises including cotton in the marginalized areas of Zimbabwe so as to benefit from this positive co-relationship. The study therefore is motivated to understand the prime determinants of the adoption of modified organic fertilisers in Mutoko district as a potential gateway out of low productivity and incomes from the enterprise.

2.2 Overview of organic farming practices

Organic farming has emerged strongly as an internationally regulated, legally enforced and standardized alternative agricultural paradigm in the advent of the sustainability discussions around the Sustainable Development Goals (SDGs) agenda (Sultana *et al.,* 2015). The organic farming practices rely on ecological processes, biodiversity and cycles adapted to local conditions with the aim of sustaining the

health of soils, ecosystems and improving the welfare of people. Organic farming originated in Germany in the early 19th century from the pseudo-scientific roots of bio-dynamic farming and spread slowly to the greater Africa especially in the 21st century. Organic farming has evolved into an ecologically friendly compliment of conventional farming systems which have been shown to have adverse environmental and health impacts due to intensive use of synthetic inputs such as pesticides, herbicides and fertilisers (McCann *et al.,* 2018). The substitution of synthetically manufactured agricultural inputs, such as inorganic fertilisers, by minimally processed naturally-occurring organic inputs, such as organic fertilisers, forms the core principle of organic farming (Govere, Madziwa, & Mahlatini, 2011).

In most small-scale farming communities, there is a mentality which has been motivated by the voices of the green revolution and views conventional inorganic fertilisers as the panacea to productivity challenges (Food and Agriculture Organisation of the United Nations [FAO], 2006). There are also reports that small scale farmers who decide to migrate to organic practices, only do so on small pieces of land and with traditional cereal crops such as maize and sorghum. The uptake decision has bypassed the 'cash crops' because fundamentally, the contractors who provide the input packages also do not believe in the potential of modified organic inputs such as fertilisers (Gelgo, Mshenga, & Zemedu, 2016). The Government of Zimbabwe in collaboration with various stakeholders such as private companies and financial institutions have made strides in facilitating industrialisation and modernisation across industries (Government of Zimbabwe [GOZ], 2013). Modification of existing organic fertilisers can also take centre stage in these developments and be enshrined in the policies governing production and marketing if there is stakeholder consensus. It therefore becomes inevitable to examine the

perceptions of various stakeholders in relation to production, distribution and uptake of modified organic fertilisers given their potential to improve yields, food and income status of households.

2.3 Organic fertilisers and their role in increasing agricultural productivity

All agricultural crops require adequate, timely and important nutrients in the soil for their optimum growth (Islam *et al*., 2017). In Africa, there are observations that low productivity among farmers has a co-relationship with low availability of nutrients for agricultural crops. This is particularly so even when fertiliser companies continue to explore opportunities for expanding production of inorganic fertilisers in their portfolios. In Zimbabwe, there are incidences of low productivity levels caused by low soil nutrients associated with low application of fertilisers, particularly organic fertilisers among small scale farmers (FAO, 2006). This has contributed to high food and income insecurity in most parts of Zimbabwe.

Cotton remains one of the largest consumers of inorganic fertilisers. A report by Mujeyi (2013) shows that the contract farming option adopted to reduce the risks of high production costs has remained expensive and out of reach for small scale farmers. In more recent times where the economy of Zimbabwe has been aggregately underperforming, import bills for inorganic fertiliser companies have also increased significantly. The burden has been passed on to the consuming farmers who ultimately get very low profit margins. Organic fertilisers can be a strategic way to reduce the costly component of fertilisers especially so when they are modified to suit the local environments where they will be used. The focus of the study is therefore to explore modifications to the existing organic fertilisers such as livestock dung, organic manure and compost manure and how they can enhance cotton productivity in small scale communities of Zimbabwe. The main modifications done

by farmers in Mutoko district were to blend cow and goat manure in well defined proportions of 1 unit goat dung to 3 units cow dung as guided by advice from extension officers and blending compost watery extracts and liquid manures before application to the field. These practices were not commonly done with cotton production since farmers were of the opinion that the nutrients required by cotton could not be provided by organic fertilisers.

Organic fertiliser is a plant fertiliser that is derived from locally available organic sources (Bandara & Thiruchelvam, 2008). They can range from organic compost to cow manure, but they must be derived from all organic sources. Govere *et al*. (2011), defines organic fertilisers as soil amendments containing the minimum contents of nitrogen, phosphate and potash (NPK) that is derived solely from the residues of an organism. They include solid organic fertilisers such as farm yard manure, green manure and compost as well as modified liquid organic fertilisers such as plant extracts, compost watery extracts and liquid manures. The latter may outperform inorganic fertilisers if adopted and used at appropriate scales. The use of Indigenous Technical Knowledge Systems (ITKS) in the design and production of the modified versions of organic fertilisers become important in determining their potential acceptability by targeted end users.

According to Ajewole (2010), organic fertilisers are more environmentally friendly than inorganic fertilisers and economically add value to soil and crop production practices. This is an important dimension which stakeholders need to appreciate and tap into so that they produce and scale up the use of modified organic fertilisers. Additionally, these organic fertilisers sustain and restore soil inherent properties, enhance soil biological activities and potentially increase crop yields. In the advent of '*safe foods*' and traceability concerns by niche markets, stakeholders are also

appreciative of the reality that agricultural produce from organic systems are also safe for human consumption since they are free from chemicals. This is also supported by Catur (2011) who states that organic fertilisers increase organic matter in soil, which improves the soil structure to create more air space and water retention capacity.

Organic fertilisers also enhance soil nutrient availability by releasing nutrients at a slower and more consistent rate. Ukoje (2013) reports that in most contexts, aggregately the use of organic fertilisers improves nutrient mobilisation and protects the soil against rain and wind erosion. If all these positives are embraced by stakeholders on a common decision making and interactive platform, then modified organic fertilisers can be adopted for crop production including cotton thereby reducing multiple production, financial, marketing and institutional risks.

2.4 Empirical literature on impacts of adopting organic fertilisers

The application of organic fertilisers has been shown to have positive impact on soil fertility, soil physical properties and consequently crop yield in most parts of the world. Cross cutting research has focused on growth performance, productivity and income gains of using organic fertilisers by farmers. Cheng-Wei *et al*., (2014) observed the patterns in a study carried out on the effects of organic manure and inorganic fertilisers on the growth and development of *Stevia rebaudiana* Bertoni, a natural sweetener plant in America through experimental plots. The study revealed that organic manure cultivation promoted root activity in 40 days after transplanting compared with the inorganic fertiliser cultivation, and the dry weight of the above ground has exceeded inorganic fertiliser cultivation in 60 days after transplanting. This relatively better performance can be taken advantage of to increase yield by farmers who are usually resource constrained.

In another study to find out the effects of organic fertilisers on the growth and yield of beans (bush bean, winged bean and yard long bean) by Islam *et al.,* (2016), it was revealed that all the legumes grown with organic fertiliser produced the highest yield and yield attributes relative to those in inorganic conditions. Shumba *et al.,* (2014) also carried out a study on the mineralisation of organic fertilisers used by urban farmers in Harare and their effects on maize (*Zea mays* L.) biomass production and uptake of nutrients and heavy metals. Study findings showed that organic fertilisers produced significantly higher biomass than inorganic fertilisers due to their greater residual fertility. Another study by Catur (2011) on the benefits of organic fertiliser application revealed that organic fertilisers have the potential to increase productivity and farmer income.

Given these previous positive outcomes, the researcher aims to add to the knowledge base by looking at the *in-situ* effects of modified organic fertiliser application on cotton in an arid region of Zimbabwe. The study further explores the food security implications of the adoption decision, an act which has not yet been widely explored in literature, especially in Zimbabwe with cotton.

2.5 Theoretical framework

The theoretical approach adopted in this research project was structured around the adoption and impact of innovations philosophy. The researcher used a blend of the innovation approach theory and utility maximisation theory as theoretical frameworks to explain the factors behind the uptake of modified organic fertilisers in this study. A transaction cost dimension was also factored into the framework to explore the different costs which accrue to stakeholders when they make the decision to be a part of the modified organic fertiliser platform.

2.5.1 The innovation approach theory

According to Neil & Lee (2001), an innovation system can be defined as:

"…a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into social and economic use, together with the institutions and policies that affect their behaviour and performance…".

In this definition, an innovation is conceptualised in a more systemic, interactive, evolutionary and responsive way. It is a new understanding of innovation as a change process in communities such as farms. The definition acknowledges that innovation design, distribution and adoption can be triggered by multiple determinants in many different ways. It can emanate from for example be an environmental issue (decline of soil fertility), a competitive condition (changes in market constitution), a new policy direction (land tenure reform), or an international organization intervention (Neil and Lee, 2001). These complexities, in as much as they seem to occur in isolation, can in practice occur simultaneously thereby presenting challenges for the decision maker. In the current research the innovation was defined as any form of modified organic fertilisers used in the study area. Figure 1 shows an innovation as a multi-actor process.

Figure 1: Elements of an agricultural innovation system
Source: Neil & Lee (2001)

An innovation system is also shown as a dynamic process of interacting embedded in specific institutional and policies contexts by many stakeholders. The study blended the system with the innovation process as shown in Figure 2 so as to explore the determinants of modified organic fertiliser adoption by cotton farmers. These facets also show the existence of many stakeholders who should provide goods and services for the final adoption decision to be made.

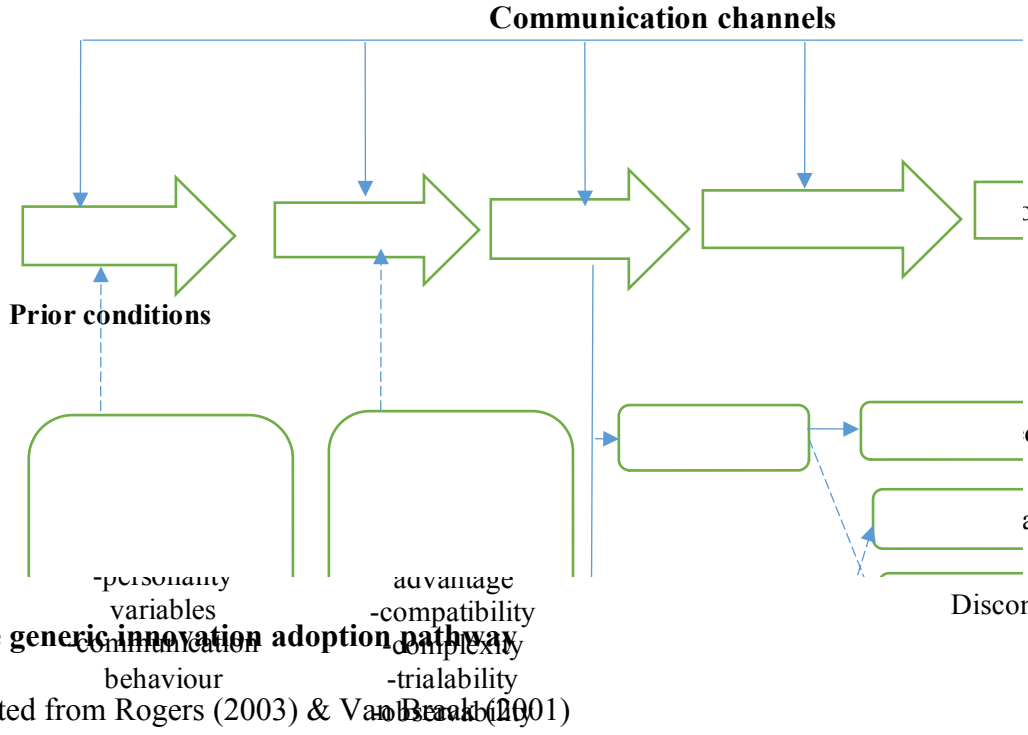


Figure 2: The generic innovation adoption pathway

Source: Adapted from Rogers (2003) & Van Braak (2001)

Multiple adoption categories have been reported in literature depending on context and nature of the innovation in terms of investment cost and usability. In his ground breaking work on adoption of innovations, Rogers (2003) defined the adopter categories as the classifications of members of a social system on the basis of innovativeness. This classification includes innovators, early adopters, early majority, late majority, and laggards. In each adopter category, individuals are

similar in terms of their innovativeness which was defined by Van Braak (2001) as a relatively-stable, socially-constructed, innovation-dependent characteristic that indicates an individual's willingness to change their familiar practices. Understanding innovativeness can therefore be viewed as a toolkit in exploring and unpacking the desired and main behaviour in the innovation-decision processes by individuals and organisations as influenced by their environments within a stakeholder platform.

There are critical issues which have been reported with adoption studies and these include awareness about an innovation, processing of the information about the costs and benefits, testing or seeing in situ and then possible uptake of the innovation (Ali & Abdulai, 2010). The current study, though guided by the frameworks in Figure 1 and 2, acknowledges that the process of adoption is not necessarily linear and can be more complex especially in cases where multiple related innovations are introduced at the same time. These complexities also manifest when multiple stakeholders such as cotton farmers, contractors, transporters and agro-dealers are involved. To cater for these temporal dynamics, the study focused on the modified organic fertilisers used during the 2018/19 farming season with cotton.

2.5.2 The utility maximisation theory

It is an economics concept that, when making a purchase decision, a consumer attempts to get the greatest value possible from expenditure of least amount of money. In the study, an adopter is defined as a farmer who used modified organic fertiliser in the 2018/19 season. Since the adoption variable is binary nature, the logit regression model was selected for modelling the choice making processes. Informed by Ngeno (2017) and based on the logit regression model, for any cotton farmer in

the study area, the demand for adopting the modified organic fertiliser is modelled as:

$$D_i^* = \beta' X_i + \mu_i \quad (1)$$

Where, X_i = the determinants of adopting the modified organic fertilisers; β = the parameter estimate; and μ = the error term. Following the model above, the actual demand for the modified organic fertiliser by the farmer is given as:

$$D_i = \begin{cases} 1 & if\ D_i^* > 0 \\ 0 & if\ D_i^* \leq 0 \end{cases} \quad (2)$$

The probability that a household will effectively adopt and use modified organic fertiliser is given based on the utility maximisation motivation. This implies that the farmer will make the adoption decision if there are net benefits from the choice made. Otherwise the farmers will continue using their traditional inorganic fertilisers.

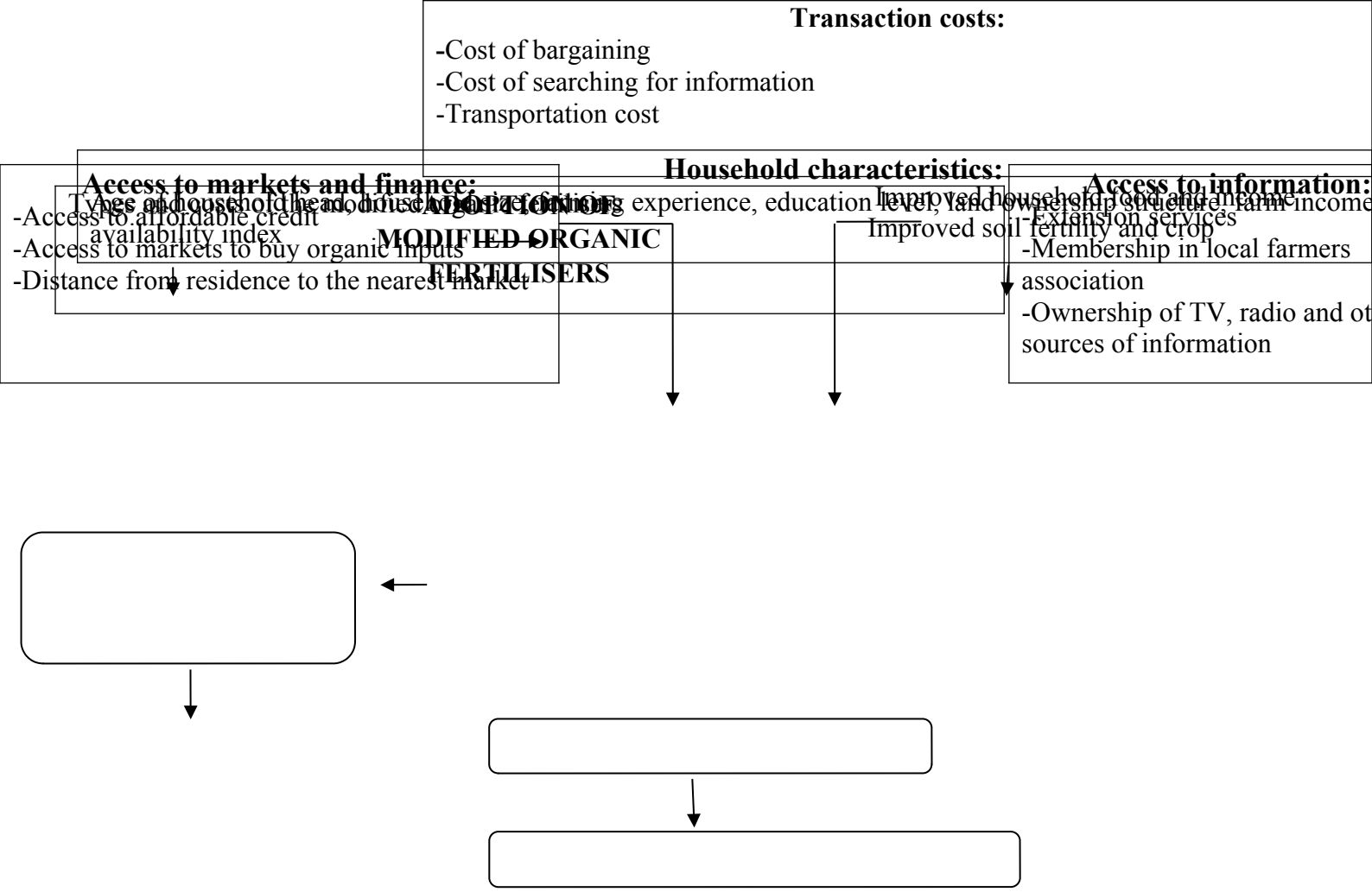
2.5.3 The transaction cost theory

Transaction costs account for a significant proportion of total costs in transactions among stakeholders (Zeller, Diagne, & Mataya, 1998). Exchanging goods and services in markets implies absorbing multiple costs such as search costs, negotiating costs and transport costs. One fundamental cause of unbalanced sharing of these costs is the asymmetry in information among trading partners (Ukoje & Yusuf, 2013). This can also trigger a sequence of events where transacting parties do not really know the true value of the commodity they are faced with. Contracts have also been widely used to reduce the effect of transaction costs on businesses along agricultural value chains.

2.6 Conceptual framework of factors influencing adoption of organic fertilisers

Although portfolios of agricultural technologies such as modified organic fertiliser adoption, are available to farmers, their adoption has been constrained by several and

intertwined factors overtime. In a study done by Gelgo, Mshenga & Zemedu (2016) in Ethiopia, in an effort to improve productivity, fertilizers were highly promoted. This promotion included both organic and inorganic fertilisers. However, adoption of organic fertilisers was lower than that of inorganic fertilisers. The identified factors impeding adoption included household characteristics, resource ownership, transaction costs, access to the market, information and credit. These factors were also identified in a sorghum seed adoption study by Musara *et al*. (2019), and were classified into socio-economic factors and institutional factors. From the multiple literature sources used by the researcher, the adoption determinants are summarised in Figure 3.



e 3: Factors influencing modified organic fertilisers adoption
e: Adapted from Musara *et al.* (2019)

The current study hypothesised that several factors influence modified organic fertilizer adoption. For example, younger and educated household heads with higher number of working family members are more likely to adopt modified organic fertilizer. This is mainly because of a better understanding and processing of innovation about new ideas associated with one's level of education (McCann & Dongwonshin, 2018). Larger family sizes have higher chances of having more readily available labour which is required for the labour intensive processing and use of modified organic fertilisers. The study also shows that, in the study area, female headed households are more likely to adopt modified organic fertilisers compared to male headed households. Females are early adopters of most agricultural innovations since they source information about emerging practices with the aim of increasing productivity. Females are more likely to be more involved in agricultural activities while males are more inclined towards more formal jobs especially in urban areas. The size of land owned by the farmer and the number of livestock has a positive effect on adoption of modified organic fertilizer. If a household owns more and diverse livestock, they tend to have more reliable sources of raw materials that are needed for producing modified organic fertilisers from for example animal manure.

Having reliable access to timely information positively affects the farmers' decision of adoption of modified organic fertilisers. Discussions during the study show that farmers can get information from multiple sources including extension officers and farmers associations. Access to appropriate information has the likelihood of increasing farmers' inclination towards modified organic fertilizer adoption (Islam *et al*., 2017). Availability of modified organic fertilisers at a lower cost relative to conventional inorganic fertilisers for farmers increases likelihood of adopting modified organic fertilizer. Lower transaction costs related to modified organic

fertilizer adoption can lead to higher likelihood of adoption. Farmers will argue that adoption of modified organic fertilizer improves soil fertility therefore potentially increasing farm income through enhanced productivity levels (Gelgo *et al*., 2016).

Estimation of transaction costs related to innovation adoption is very important in sustaining innovation use among farmers. The common transaction costs are search and information costs along value chains. Search and information costs are the most immediate determinants of the adoption decision. These are the costs incurred in the process of determining and assuring availability of the required modified organic fertiliser in strategic markets. These decision-making units may be buyers and sellers and sometimes third bodies called mediators who are interested in knowing the quantified implications of the transaction costs on their business decisions (Musara *et al*., 2019; Martey *et al*., 2013).

2.7 The farmer first approach in production-marketing mixes

Small scale farmers tend to face problems related to production and marketing management. In most cases they cannot, on their own, adequately design solutions to overcome these obstacles. In such situations, The Farmer First approach has emerged as an opportunity for the input suppliers, researchers, extension professionals and farmers to work together and find appropriate ways through assessing different solutions. Roba (2018) observed that during the changing production processes, farmers often evolve new ideas to improve their cultivation such as mixing organic and inorganic fertilisers to reduce the cost and access burden. This creates a space for stakeholders to inclusively design and organize new mechanisms on a common platform, with the farmers having power and influence in decision making. The approach has been applied not only at household level but also at village and community level as community experimentation.

In addition, there are some cases where strategies have successfully focused to solve problems of the whole village through the use of marketing channel choice advisory services in adopting local organic fertilisers (McCann & Dongwonshin, 2018). The aim will be to find out new ways of doing and bringing in synergy of the stakeholders. The strategies need to be adapted to specific conditions of a farming system and to have the participation of farmers as well as scientists. Especially they must acknowledge local wisdom as a vital element for the development of useful marketing innovations. The role of extension officers is to ensure proper implementation and manage feedback loops. Studies in Nigeria have shown that the approach has benefited the various stakeholders especially farmers to effectively respond to the use of organic fertilisers. The farmers utilised ICT modes to help coordinate activities with other stakeholders in an efficient manner (Ajewole, 2010).

2.8 Summary

The review of literature aimed at identifying studies related to the adoption of organic fertilisers and other related agricultural innovations by small-scale farmers in agricultural value chains. From the empirical evidence, there are chances that appropriate and informed choice of modified organic fertilisers has the ability to increase small holder farmer's market activities by raising the quantity and quality of available information, reducing uncertainty, lowering transaction costs and enhancing market efficiency. The overall reduction of production costs and the increase in market efficiency can have huge impact on the development of sustainable cotton markets and on food security in the semi-arid areas of Zimbabwe. Chapter three presents the methodology that was adopted for the research.

CHAPTER 3 METHODOLOGY

3.0 Introduction

The chapter describes the methods which were used for the research process. Statistical procedures employed in data analyses are also outlined. Description of the study area, research design, population, sample size, sample unit description, formulation, pre-testing of the instruments, administration of research questionnaires, and data analysis are also covered in this chapter.

3.1 Description of Study Area

The case site for the study was Mutoko District in the Mashonaland East Province of Zimbabwe. The researcher focused on cotton farmers. The crop was chosen because of its economic importance in the study area and the country at large. According to Rukuni *et al*. (2006), the cotton industry plays a very important role in the country's economy. The industry generates employment across its numerous sub-sectors thus being a tool for poverty alleviation. The cotton crop supports thousands of livelihoods in the smallholder farming communities around the country. There have been low and declining yields in small holder farming communities because soil nutrients are being depleted without being replenished. Mutoko has both dry land farming and horticulture crops produced in green house. The district mainly relies on farming as a source of livelihood since it is in natural farming region III (Mugandani *et al*., 2012). However, the soils in Mutoko are generally poor and shallow which renders the need to promote modified organic fertiliser use to improve the soils and enhance productivity gains.

3.2 The Research Design

This research used a pragmatic paradigm since, given the nature of the study, this allowed for qualitative and quantitative approaches to be used. For example quantitative statistical measurements established causality amongst selected variables of interest (Greene, 2000). This research used the statistical package STATA 13 to analyse the data. The core methodology of this research was quantitative. Quantitative methodology was chosen to explain the cause-effect relationship (Roberta & Twycross, 2015) between the modified organic fertilisers adoption decision and various independent variables as alluded to in Figure 3 and Table 1. Quantitative researchers use different tools to gather quantitative numeric data that can be tabulated and analysed statistically (Maddala, 1983). Data were gathered on farm physical and financial performance, attitudes and behaviour of stakeholders on an interactive platform. The main data collection was based on questionnaires administered to sampled respondents.

Two research designs were applied to this research, that is, a descriptive design which was meant to explain the characteristics of the subjects under investigation and the explanatory design that was important in explaining facts based on the outcome of the research. The former laid a foundation from which all the other findings were then referred to. The latter explanatory design then dealt with an in-depth understanding of the cause-effect relationship among the variables of interest and how they affected the modified organic fertiliser adoption decision by the farmers. In addition, recommendations for policy makers and other relevant stakeholders were drawn based on the explanations from the two designs. In other words, this was the strategy used to identify possible interventions and solutions to the stated research problem.

3.3 Population and Sampling

A two-stage sampling technique was used for the study. Purposive sampling was used to select 5 Wards with the most cotton growers amongst 29 wards in the district. The selection was motivated by the observation that the wards were leading in cotton farming activities. These wards also had significant proportions of farmers who had land under the enterprise. Proportionate sampling was then used in the second stage to select representative numbers of modified organic fertilisers adopters and non-adopters. Proportionate sampling was applied because the given sampling units were observed to be logically heterogeneous and random. Since the population to be used was known in the study area, the sample size for this study was calculated as:

$$n = \frac{N}{\left[1 + N\left(e^2\right)\right]} \quad (1)$$

Where; n is the outcome sample size, N is the population size (total number of the cotton households in the selected 5 wards of Mutoko district (from the cotton companies registers for 2018/19 season which is 2500 of which 22 % use modified organic fertilisers), e is allowable margin of error (level of precision) ranging from 0.05 to 0.1.

The margin of error captures how the sample behaviour deviates from that of the total population. To reduce this error, the researcher opted for the smallest possible margin of error at e=0.05. This meant that the sample size was:

$$n = \frac{2500}{\left[1 + 2500\left(0.05^2\right)\right]}$$

=344 cotton farmers

Of these farmers, 40 % were sampled as modified organic fertilisers adopters thereby translating to 76 cotton farmers and the other 268 were non-adopters. There was an 85 % response rate for the questionnaire and as such 290 farmers had data captured during the study. The representation was 63 were adopters and 227 were non-adopters.

In the study area, six agro-dealers who supply modified organic fertilisers, 15 independent cotton buyers, 3 agro-wholesalers and two cotton contracting companies were also randomly sampled.

3.4 Data Collection Instruments

This research focused on using primary data. A structured questionnaire and key informant interviews were used as data collection instruments for this study. The questionnaires were developed with some open-ended questions that allowed for thorough probing of the respondents to give as much information as possible to answer the research questions and help in drawing meaningful conclusions about the subject matter. The key sections that were captured in the questionnaire included, but were not limited to detailed demand level of modified organic and inorganic fertilisers, farmers', NGOs', as well as soil analysts' perspective towards modified organic fertilisers, strengths and weaknesses of modified organic fertiliser producers and shortcomings of these fertilisers.

Questionnaires have several advantages especially that they have fixed response questions. This tends to guide the respondent to think within a narrowed framework and thus making data analysis easy and reliable. They can also be standardised for specific researches especially the recurring ones like national censuses among others. Therefore, in these cases, there will be no need to reproduce questionnaires each time the same research has to be done. Lastly the study used the questionnaire because it

was more efficient in data collection since data were collected directly from the unit of analysis, for example a household decision maker.

Some of the disadvantages are that, questionnaires can be responded to by a wrong person who might have limited information on the subject matter. To avoid this, preplanning with potential respondents was done before administering the questionnaires so that the intended respondent was interviewed. If poorly administered, they may be less interactive, a trait which affects the quality of data collected. The question and answer approach does not give room to both the researcher and respondent to think outside the questionnaires framework. Questionnaires have limited opportunity for probing additional data. To go beyond these issues, the questionnaire was pilot tested and some open-ended questions included. In some cases, responses were limited to the questions asked and this closed out other crucial information that the respondent may have had concerning the subject matter. A free environment was established before the questioning commenced so that the respondent felt free to share as much information as they could.

Secondary data were also collected from various stakeholders' reports and used to validate and augment primary data. However, minimum reference was given to secondary data in cases where primary data were not readily available or were likely to be unreliable. In limited cases secondary data were used to triangulate data provided by farmers such as the prices in markets and volumes sold to various cotton buyers. Secondary data were also by the researcher. This was extracted from open sources such as the internet and records of selected stakeholders including fertilizer companies, government departments and ministries, NGOs as well as development

partners. Table 1 shows the summaries of the data collection tools used and the respondents targeted by each.

Table 1: Summary of Data Collection Instruments

Data collection instrument	Respondents to interview
Questionnaire	Smallholder cotton farmers
Key informant interview guide	Farmer unions, inorganic fertiliser companies, modified organic fertiliser companies, soil analysts, exporting companies, contracting companies, NGOs and relevant stakeholders and ministries

Validity and reliability issues were also accounted for in the study. Validity is defined as the extent to which a concept is accurately measured in a quantitative study while reliability relates to the consistency of a measure (Roberta & Twycross, 2015). The study used cross sectional data collected during the 2018/19 season. The researcher acknowledges that using cross sectional data limits observations to a particular point in time and becomes more of a snapshot analysis. The effect of time is not captured with this type of data.

3.5 Analysis and Organisation of Data

The researcher used a combination of descriptive and quantitative techniques to analyse the data. Descriptive analyses involved the use of means, tables and percentage representations. Stakeholder perceptions were also captured using thematic analysis. The quantitative analyses involved the use of binary logit regression, gross margins, ratios and counterfactual analysis.

3.5.1 Logit regression model for analyzing the adoption decision

Generally, the term adoption refers to various processes and stages as one gets to know about an innovation and finally decides to use the innovation at some point (Neil & Lee, 2001). In this study, adoption was defined to mean using any form of modified organic fertiliser during the 2018/19 farming season. This definition implies that a binary dependent variable was established since any farmer would either be an adopter or non-adopter. Borrowing from Greene (2000), the specification of the logit model allowed for the interactive examination of the modified organic fertiliser adoption determinants. In the study, the likelihood of observing the dependant variable (P_i) was tested as a function of selected social, economic and institutional variables which included age of household head, extension services received on modified organic fertilisers, labour availability in the household, access to modified organic fertilisers markets and experience in cotton farming. Therefore:

$$P_i = \Pr(Y_i = 1) = \frac{\exp(Z)}{1 + \exp(Z)} \tag{2}$$

A natural log transformation of (2) results in (3) which can further be modified to (4):

$$\ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \sum_i^n \beta_i X_i + \mu_i \tag{3}$$

$$Z_i = \beta_0 + \sum_i^n \beta_i X_{i\cdot} + \mu_i \tag{4}$$

Where; P_i is the probability that the i^{th} farmer is an adopter of modified organic fertiliser (Yi = 1); β_0 is the intercept; β_i's are the slope parameters; and X_i's are the independent variables.

The marginal effect for the logit model is given as:

$$\frac{\delta P_i}{\delta X_j} = \frac{\exp(z)}{1 + \exp(z)}\left(\frac{1}{1 + \exp(z)}\right)\beta_{j.} \tag{5}$$

As implied by Ramanathan (2002), the dependant variable in this model, Z_i in (4) is to be interpreted as the natural logarithm of the probability that the choice to adopt the modified organic fertilisers would be made. The coefficients in the model will give the signs of the partial effects of each of the independent variables on the probability (Woodridge, 2003) of a cotton farmer adopting modified organic fertilisers. The expected effects of selected determinants on the modified organic fertiliser adoption decision presented are presented in Table 2.

Table 2: Description of modified organic fertiliser adoption variables

Variable	Description	Units	Expected effect
Age	Age of principal decision maker	Year	-
Household size	Number of active family members	Number	+
Land size	Size of arable land holding	Hectare	+
Membership	Number of social groups by members	Number	+
Nonfarm	Proportion of off farm income	Percent	-
Experience	Period farmer has been producing cotton	Years	+
Extension	Number of extension visits per week	Number	+
Gender	Whether a farmer is female (0) or male	Dummy	+/-
Price_C	Average weighted price of cotton	Currency	+
Price_O	Average weighted price of organic	Currency	-
Price_I	Average weighted price of inorganic	Currency	+
Suppliers	Number of organic fertiliser suppliers	Number	+
Market	Distance to modified organic fertilizer	km	-

3.5.2 Gross margin and ratio analyses

Gross margin is the difference between output revenue and the total variable costs. It is used to evaluate the performance of different enterprises or the same enterprise across different clusters of players. Comparative gross margin analysis was done for

the cotton enterprise to determine the profit margins associated with the practices for adopters and non-adopters of modified organic fertilisers. The formula that was adopted to calculate the gross margins is:

$$GM = TR - TVC \quad (6)$$

Where GM is the gross margin; TR is the total revenue and TVC is the total variable costs of cotton production.

However though gross margin is an important analytical tool to access the profit margins of farming enterprises, it has some disadvantages. Of note is that there is no inclusion of fixed costs in the analysis. This incomplete analysis may lead to wrong conclusions which either understand or overstate the margins (Zeller *et al*., 1998). It also does not take into account possible environmental and social effects that may arise due to different types of technologies. Results of a gross margin analysis are valid for the season under consideration therefore they may be not useful for other recommendations outside the current state. To augment the gross margin analysis, an exploration of the financial position of adopters and non-adopters was done using various ratios including net margin and return per dollar invested.

3.5.3 Food security and associated impacts of the adoption decision

Food security is an important component of welfare and can be analysed at various sclaes such as national and household (Musemwa, Muchenje, Mushunje, Aghdasi, & Zhou, 2015). The household dietary diversity score (HDDS) and the household food insecurity access score (HFIAS) have widely been used as proxies for food security (Mango *et al*., 2014). There is evidence that these two indicators can adequately capture multiple dimensions of food insecurity (Maxwell, Vaitla, & Coates, 2014).

Household dietary diversity score (HDDS)

The HDDS is defined as a measure based on a recall of all food or drink items consumed by the household members during the last 24 hours and is a useful proxy for food security (Mango *et al*., 2014). Its main strength is that it has a very strong co-relationship with key food security indicators such as the adequacy of a household's intake of proteins, calories and other nutrients. The study used a six-point scale so that respondents recalled food and drink stuffs consumed in the past 24 hours.

$$HDDS = \sum_{i=1}^{6} X_i \tag{7}$$

where $HDDS$ is the score and X_i is the food group consumed by household member.

Household food insecurity access score (HFIAS)

According to Maxwell *et al*. (2014), the HFIAS is a continuous access measure of the degree of household food insecurity over the past 30 days. The measure is an indicator of household food insecurity in terms of insufficient food supplies and assumed quality thereof. It also factors in anxiety about household food insecurity which is an important indicator. Musemwa *et al*. (2015) noted that HFIAS is a more subjective measure since it captures the household members' perception about the consumed diets and this may completely miss the nutritional composition of these diets and their sources. Eight distinct categories of occurrences were isolated in the study as:

"1= Anxiety about food (in)adequacy; 2= Eating foods of a limited variety; 3= Eating less-preferred foods; 4= Inability to eat even the less-preferred foods; 5= Eating smaller meals than needed; 6= Eating fewer meals in a day; 7= Going to bed hungry; 8= Failing to obtain food of any kind during the whole day or night".

The progression from 1 to 8 shows increasing insecurity. A binary response was then used as *yes (1) and no (0)* depending on whether any of the 8 occurrences were encountered in the household over the past 30 days. A severity question based on frequency of occurrence was assigned as a follow up to the occurrence observation over the same period. A scale was developed as, *"1 = rarely, 2 = sometimes, and 3=often"*. This implied that the range for the HFIAS was 0-24.

$$HFIAS = \sum_{i=1}^{8} X_i F_i \tag{8}$$

Where $HFIAS$ is the score; X_i is the food insecurity occurrence observation and F_i is the frequency of occurrence.

Effects of adopting modified organic fertilisers

A number of studies have used a combination of matching techniques with Average Treatment Effect on the Treated (for the observable outcome) and endogenous switching regression (for the unobservable outcome). This study used the counterfactual analysis approach to determine the food security impact of adopting. This approach has also been successfully used in agricultural innovation impact evaluations (Ngeno, 2017; Amare, Asfaw & Shiferaw, 2012).

3.6 Ethical Consideration

The research proposal was submitted to the Africa University Research Ethics Committee (AUREC) for approval before data collection commenced. Enumerators were trained on how to conduct data collection with all the procedures involved being adequately covered. Effort to assure the non-violation of the following ethical considerations was done at all stages of this study:

1. Right to free and informed consent: The enumerators explained the research aims, risks and possible benefits to the selected participants. Participation was also not compulsory.
2. Right to confidentiality: Questionnaires were administered individually to respondents to ensure that whatever information the respondent said was between him/her and the enumerator. Furthermore, all the research material particularly questionnaires were kept secure in a locked room and on a password protected computer. The data which was captured in STATA 13 used codes to represent respondents instead of their names.
3. Right to privacy: Respondents were interviewed in their individual capacities as household heads.
4. Right to anonymity: The questionnaires did not bear respondents name but the code only for anonymity purposes. However, a separate sheet that identified the respondent was kept to allow the researcher to make verifications of the data collection process.
5. Use of appropriate methodologies: Objectivity in this research is key and bias related errors were avoided by adhering to the scientific processes of research.
6. Truthful: During the presentation of findings, information is presented as per the outcome of the study. The researcher is indifferent in terms of the outcome of the research and therefore information is presented objectively as guided by the outcome of the analyses process.
7. The researcher and enumerators avoided being involved in ideological issues for the purposes of maintaining integrate of the whole process.

3.7 Summary

The Chapter highlighted the research plan that was adopted for the study. The study site where the modified organic fertiliser utilisation patterns were analysed was identified as Mutoko District. The research philosophy was also explained in relation to it suitability in attaining the objectives of the study. A presentation of the data collection strategies and analytical approaches was also done. This paved way for the results and discussion chapter which follow in this dissertation report.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

The previous chapter looked at the research methodology applied in this study in order to assess the choices of fertilisers by small-scale cotton farmers and the associated decision of using modified organic fertilisers. This chapter proceeds to look at presentations and analysis of the data obtained from the field, where a survey was done and the research managed to administer questionnaires and key informant interviews. Reference was also made to statistical tests in order to further spell out the statistical links between the variables drawn for data analyses. The data collected from the various cotton value chain stakeholders are analysed, presented, and discussed according to set objectives of the study.

4.2 Data Presentation and Analysis

Data were collected on various household specific, production and market related variables. These included the age of farmers, the household size and other factors that contribute to the adoption decision such as experience of the farmer in cotton production, access to market in terms of time to reach market points as well as source of pricing and marketing information as captured by the number of extension contacts. Data were presented using statistics such as frequencies, mean comparisons, and regression analyses.

4.2.1 Demographic summaries of selected variables

A demographic summary is presented in Table 3.

Table 3: Summary of selected demographic characteristics

Variables	Percentage (%)	
	Adopters	*Non-adopters*
Age of household head		
18-25	36	4
26-33	21	16
34-41	19	26
42-49	9	22
50 and above	15	32
Extension contacts		
1-5	26	68
6 and above	74	32
Labour availability score		
1-3	56	87
4-6	38	12
7 and above	6	1
Highest level of education of household head		
Primary school	37	68
Secondary school	34	14
Tertiary	29	18
Distance to the market		
1-10	45	26
11-20	26	48
21-30	24	16
31 and above	5	10

The adopting sampled households comprised of 76% of the respondents below 41 years as compared to 46% for the non-adopting households. With both adopters and non-adopters of modified organic fertilisers, significant proportion of the respondents had access to extension services accounting for about a quarter of the adopting households which were sampled having more the 5 contacts per season. From the study area, large number of interviewed farmers who adopted the organic fertilisers

had formal education accounting for 63%. Farmers are relatively closer to their modified organic fertiliser choice walking on average 20 minutes to get to the markets.

4.2.2 Market prices and volumes of cotton sold

The market prices and the volumes of the cotton sold in the study area are as shown in Figure 4.

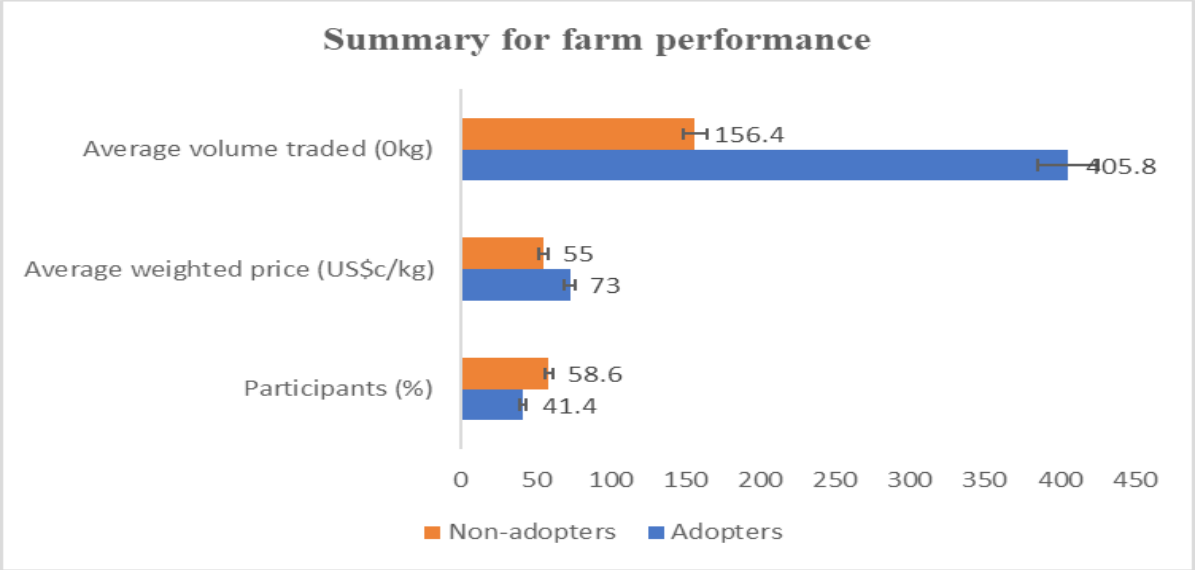


Figure 4: Comparative summary for selected farm performance indicators

Relatively, the farmers who adopted modified organic fertilisers fetched higher prices around US$0.73/kg as compared to their non-adopting counterparts who fetched US$0.55/kg. During discussions with farmers and cotton contracting firms, these farmers had cotton which was highly graded in the markets and hence was bought at higher prices by merchants. Adopters also sold about 4058 kg of cotton per farmer in their markets of choice and non-adopting farmers sold less at 1564 kg. The adopters had higher productivity levels due to the modified organic fertilisers which they used and hence sold more.

4.2.3 Services provided by farmer associations

The research also looked at the services provided by farmer associations. Figure 5 shows the services provided by farmer associations in Mutoko District.

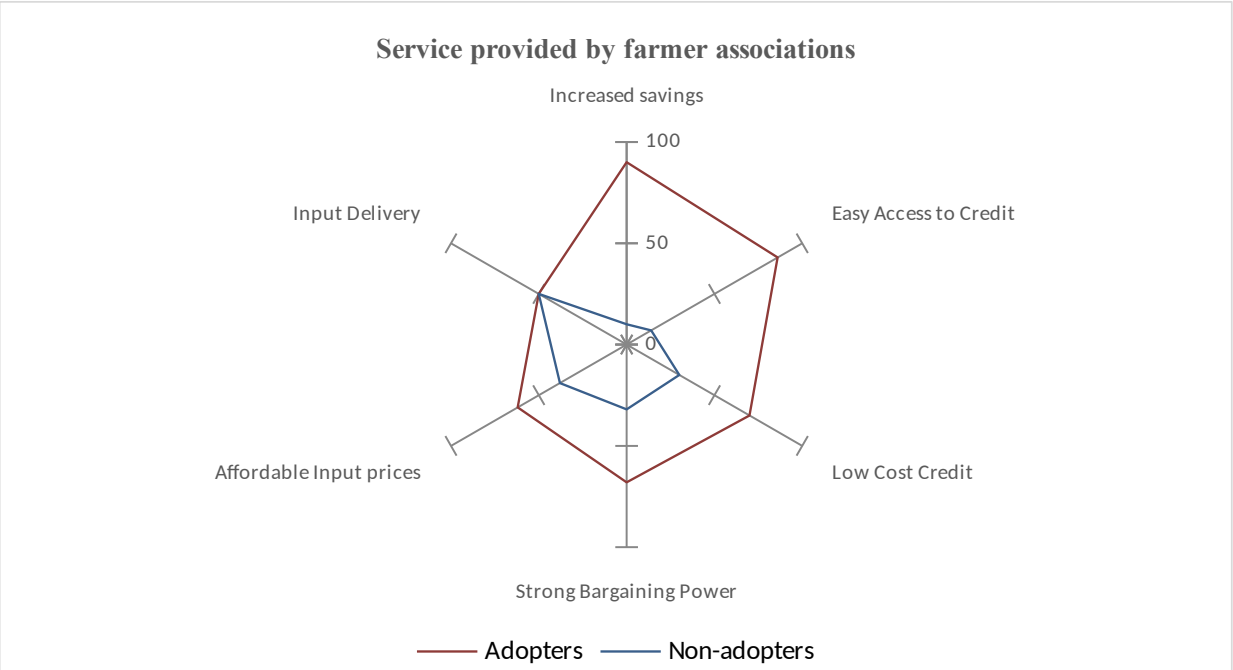


Figure 5: Summary of services offered by associations

Figure 5 highlighted that cotton farmers are benefiting directly from being associated in farmer groups. Of the respondents, 90% are benefiting from increased savings through the group Village Savings and Lending (VSL) approach. The 86% were accessing credit through use of the group model to enhance financial inclusion. As a result, they are also accessing low cost credit through use of group collateral with microfinance institutions and banks. Of the respondents, 68% have gained strong bargaining power when approached by various buyers, 62% accessing inputs at affordable prices through discounts and 50% input delivery due to large quantities procured by group members.

4.2.4 Challenges faced by cotton farmers

The challenges faced by the small-scale cotton farmers in Mutoko District are shown in Figure 6.

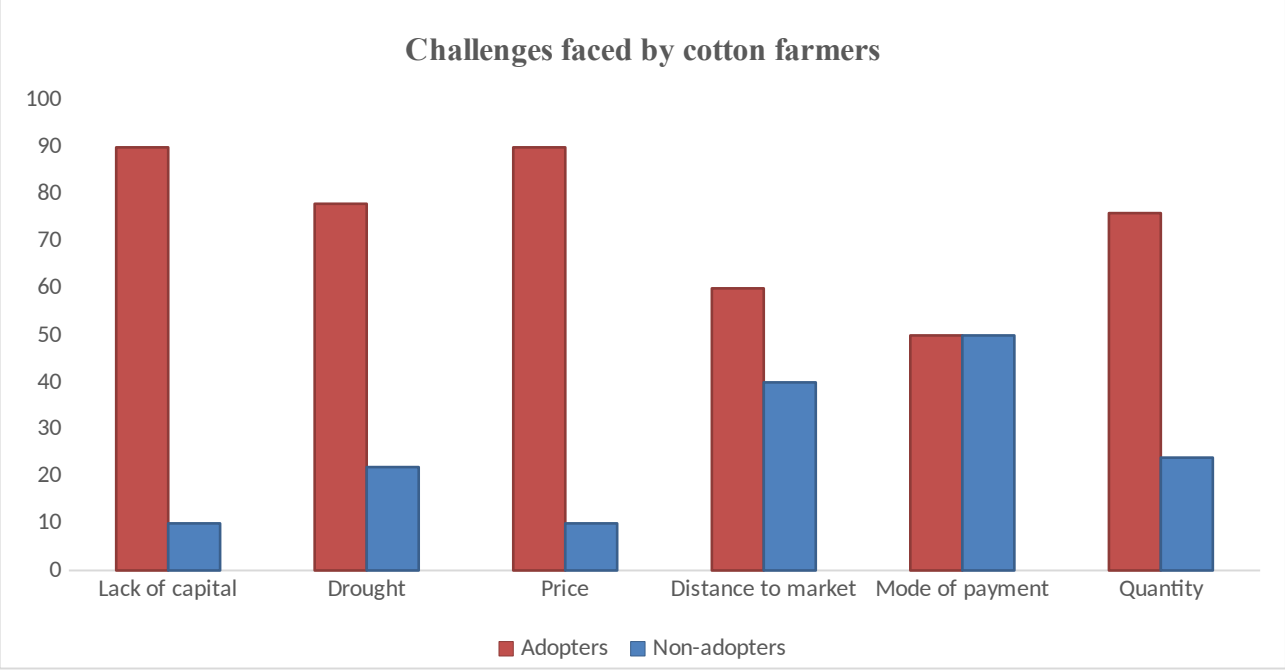


Figure 6: Summary of challenges experienced by cotton farmers

About 90 % farmers indicated that they are facing challenges in cotton production due to lack of working capital to invest in emerging innovations which can make sure the project remains viable. The prices of inputs in the markets are also reported to be high and discouraging farmers from participating in these markets. These two factors are influenced by a number of other aspects like the current economic conditions among other dynamics.

4.2.5 Participating stakeholders along cotton value chain

Figure 7 shows the stakeholders that were participating in the modified organic fertiliser platform in the study area.

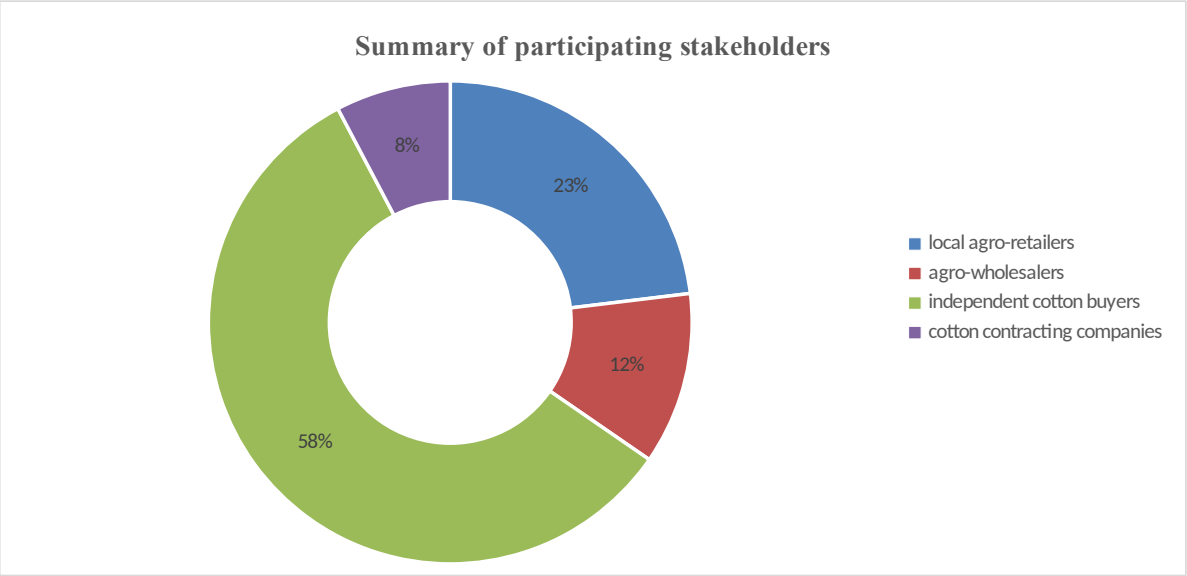


Figure 7: Participating stakeholders

The main stakeholders were the independent cotton buyers (58 %) who have taken advantage of the proclivity of contracted farmers to side market their produce if better prices are offered. Local agro-dealers (11 %) have also come on board to bridge the gap left by contracting companies who, according to findings from key informant interviews and farmers, do not always provide all the required inputs in the right quantities and at the right time.

4.2.6 Determinants of modified organic fertiliser adoption

Guided by the frameworks in Chapter two, the study used a binary logit regression analysis framework to determine factors that influenced the farmer's decision to adopt any form of modified organic fertilisers. The results for various variables which were tested are as presented in Table 4.

Table 4: Logit regression estimates for the modified organic fertilisers adoption

Variable	Coefficient	z-value	p-value
LOG_AGE	-1.964** (0.539)	-3.644	0.043
LANDSIZE	0.039 (0.127)	0.307	0.278
AHHLDSIZE	1.850 (2.396)	0.772	0.129
PRICE_C	0.971 (1.036)	0.937	0.437
PRICE_O	-0.164* (0.018)	-9.111	0.001
MEMBERSHIP	2.446***(1.162)	2.105	0.067
MARKETDST	-1.619** (0.718)	-2.255	0.011
EXTENSION	1.603** (1.222)	1.312	0.030
LOG_OFINC	-0.941*** (1.143)	-0.823	0.051
EXPERIENCE	0.331 (0.489)	0.677	0.396
SLNUMBER	0.248* (0.075)	3.307	0.005
CONSTANT	0.327 (1.236)	0.265	0.143

The dependent variable is probability of modified organic fertiliser adoption. Standard errors are in parenthesis. *; ** and *** shows p-values significant at 1 %, 5 % and 10 % levels respectively.

Of the 11 variables captured in the analyses, 5 significantly ($p<0.05$) influenced the farmer's decision to adopt modified organic fertilisers. Results from the data show that household specific variables, market conditions and institutional factors affect the decision to use any form of modified organic fertilisers by the cotton farmers.

4.2.7 Food and income security impact of modified organic fertilisers

Food and income security impact of modified organic fertiliser adoption was also analysed and the data indicated significant variations within the isolated categories for both HDDS and HFIAS as shown in Table 5.

Table 5: Summary of categorised HFIAS and HDDS values

Food security indicator category	Proportion (%)		Difference-test
	Non-adopters	Adopters	
Household dietary diversity score (HDDS)			
1 to 3	79.65	20.35	8.187***
4 to 6	25.21	74.79	-2.073**
Household food insecurity access score (HFIAS)			
0 to 10	41.0	59.0	1.621**
11 to 20	80.9	19.1	7.032***
21 to 30	93.1	6.9	12.994***

***; ** and * indicate p-values significant at 1 %, 5 % and 10 % levels respectively (for adopters versus non-adopters).

About 70 % of households who did not adopt modified organic fertilisers in the sampled communities of Mutoko District had relatively lower HDDS values. The reverse patterns are reported for the HFIAS values where the non-adopters of the innovation had high food insecurity as indicated by higher values compared to their adopting counterparts. It was also important to analyse the economic impacts of adopting modified organic fertilisers. Table 6 shows the comparative real mean costs of production and the associated returns for adopters and non-adopters.

Table 6: Absolute economic benefits of adopting modified organic fertilisers

Economic indicator	Adopters	Non-adopters	Average treatment effect
	(1)	(2)	(3) = (1) – (2)
1. Productivity (kg/ha)	1352.13 (42.56)	755.856 (21.365)	596.274**(18.271)
2. Price ($/kg)	73.002 (0.724)	62.113 (0.938)	17.889*** (1.117)
2. Gross value ($/ha)	987.055 (13.58)	496.484 (21.308)	517.57*** (21.995)
3.Variable costs ($/ha)	84.237 (1.562)	63.007 (2.186)	21.23** (1.907)
4. Net returns ($/ha)	902.818 (14.09)	433.477 (20.384)	469.34*** (35.638)
5. Average area (ha)	5.62 (1.003)	5.23 (0.998)	1.39 * (0.827)
6. Total returns ($)	5073.84 (42.01)	2267.084 (21.594)	2806.76 *** (28.3)

***; ** and * indicate p-values significant at 1 %, 5 % and 10 % levels respectively.

There is evidence from the data that adopters of modified organic fertilisers had significantly higher productivity per hectare ($p<0.05$), market prices, gross margins and net returns per hectare ($p<0.01$) but they however had significantly lower variable costs per hectare of the cotton produced ($p<0.05$) (Table 6). Similar results were also reported by Baquedano, Sanders & Vitale (2010) in a subsidy study conducted in Mali. Results of the counterfactual analyses with food and income security indicators are shown in Table 7.

Table 7: Counterfactual impact analysis of modified organic fertiliser adoption

Food security indicator	Actual (household adopted)	Counterfactual (if household did not adopt)	Average treatment effect
	(1)	(2)	(3) = (1) – (2)
1. Total returns	5073.84 (42.005)	3928.65 (31.892)	1145*** (12.4)
2. HFIAS	5.537 (1.134)	10.183 (0.891)	4.65*** (0.86)
3. HDDS	5.23 (0.48)	3.19 (0.17)	2.04*** (0.09)

***; ** and * indicate p-values significant at 1 %, 5 % and 10 % levels respectively.

There is statistical evidence that households who adopted the modified organic fertilisers have significantly higher total returns from cotton production and higher HDDS. However, they have lower HFIAS ($p<0.01$).

4.2.8 Stakeholder perspectives on organic fertilisers

As summary of the thematic responses generated from the stakeholders in the study are in Figure 5. This was complemented with a stakeholder thematic analysis to understand more about how they relate to each other. A number of distinct themes were isolated to explain the behavioural patterns of farmers and other stakeholders with respect to the modified organic fertiliser options at their disposal and knowledge. These thematic issues revolved around cost effectiveness, the need for

information access and potential to enhance cotton productivity performance as in Figure 8.

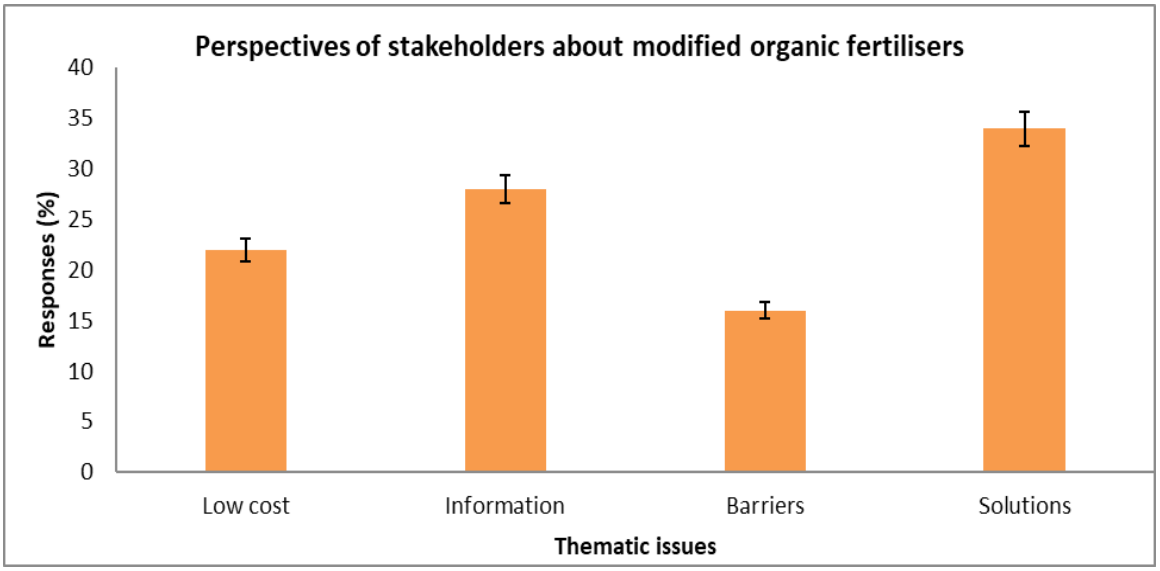


Figure 8: Thematic perspectives from stakeholders

The major stakeholders identified to be directly linked to the modified organic fertilisers' platform were the cotton farmers, NGOs, private contractors, traders (agro-dealers and individual buyers) and extension officers. The missing stakeholders who may improve the functioning of the modified organic fertiliser adoption platform are the researchers and financiers.

4.3 Discussion and Interpretation

The findings of the research presented above are discussed in this section. The first section focuses on the drivers of organic fertiliser adoption by small scale cotton farmers.

4.3.1 Age of household head

From the analysis in Table 4, the results showed that age of the household head had a negative and significant ($p<0.05$) influence on the probability of uptake of the

modified organic fertilisers. The reason maybe that the younger farmers are more innovative and interested in trying new methods of producing the cotton so as to boost the production levels. They feel that due to the crop's lower market prices, they will increase their aggregate incomes from producing more by adopting yield enhancing fertilisers and marketing in rewarding markets thus changing the emerging mentality that cotton is no longer the '*white gold'* but yet another '*poor man's crop*'. Discussions with key informants showed that the younger farmers would traditionally opt for horticulture related crops which are offered by the NGOs driven development projects since these are considered high value crops. However due to the reduced investment by multiple stakeholders towards the cash crops and the support offered by the government and contracting farmers with cotton, younger farmers are emerging as the most active in the cotton enterprise. Mazvimavi and Twomlow (2009) also reported similar findings in the drier parts of Zimbabwe by noting that older farmers are more inclined towards accepting innovation packages for enhancing performance of cereal crops since they are more concerned with household food security as their immediate priority. This also explains the observed variation by age of the decision-making household head.

4.3.2 Market prices for the fertilisers and household incomes

Production costs are a critical consideration when farmers decide on crop choices (Rukuni *et al*., 2006). The result of this study confirms the hypothesis that the prices of inputs negatively influence farmers to buy more of a commodity in any given market *ceteris paribus*. As the prices of the modified organic fertilisers in the markets increase, the likelihood of farmers adopting decreases. This can be directly attributed to the fact that the small-scale cotton farmers will decrease their chances of getting meaningful returns from the enterprise if input market prices, such as those

for fertilisers are unfavourable. Farmers reported that currently, the prices of the available modified organic fertilisers are very comparable with those of the conventional inorganic fertilisers and as such there is no motivation to migrate to the former. They argue that they would rather adhere to the inorganic fertilisers, whose performance they already know.

Household incomes are also an important determinant of the innovation adoption decision. Data from the study show that as the proportion of household income from non-farm activities increases, the chances of the household adopting the modified organic fertilisers decrease. In this case cotton farmers with higher levels of household income are less likely to use the modified organic fertilisers for cotton production. These farmers argued that they would rather invest in the quality requirements of buyers, stick to the inorganic fertilisers and anticipate generating more income and investing further into diversified agricultural activities through the multiplier effects of the benefits. Ndiritu, Kassie and Shiferaw (2014) support this view point arguing that since agricultural activities are seasonal and risky, farmers are more likely to take up production systems which increase their economic sustainability.

4.3.3 Distance to markets and number of buyers

Distance was measured by the duration it takes to reach the nearest and most preferred market outlet for modified organic fertilisers. From the results in Table 2, distance to market has a negative and significant ($p<0.05$) influence on the adoption of modified organic fertilisers decision. The longer the distance to the market the less the likelihood of demanding the modified organic fertilisers option since farmers feel they will not have chances of reaching the markets at low transaction costs (Musara *et al*., 2009) and profitably produce the cotton and offset these costs. Because of

longer average distances to most lucrative markets in the study area, farmers are forced to remain locked in their traditional inorganic fertilisers which are relatively easily accessed from contractors and the government subsidy programmes. In this regard, distance to the market increases the transaction costs of accessing sellers thereby discouraging use of certain market options (Musara *et al*., 2019).

The number of organic fertilisers sellers has a positive and significant ($p<0.01$) influence on the chances of farmers adopting the modified organic fertilisers. The immediate benefit of having many sellers in markets is observed when there is healthy competition which increases pricing efficiency. Farmers reported that as more suppliers came into the area, the prices of the modified organic fertilisers started to decline. This incentivised farmers to buy large volumes and variety of these fertilisers. Additionally, more sellers of modified organic fertilisers mean that more of the product is supplied and is available for the farmers in multiple market outlets including roadside vendors, small local agro-dealers and larger wholesalers. This greatly improves availability and access to the modified organic fertilisers by the farmers.

4.3.4 Assistance from extension officers and membership

Extension services are an important ingredient in catalysing generation and dissemination of production and marketing information within farming communities. This is especially so in the small holder set ups where extension officers remain the most reliable source of the information. There is a widely held consensus that increased frequency of contact with extension agents should increase the chances of accessing high amounts of reliable information about emerging and more rewarding production innovations such as modified organic fertilisers that are at the farmer's disposal. As such, the likelihood of adopting the modified organic fertilisers

increases as the frequency of extension contacts increase. This finding is consistent with a study by Amare *et al*. (2012) in maize-cowpeas farming in Tanzania where extension services had a positive implication on the adoption of the integrated cropping system.

Rukuni *et al*. (2006) also supports this and reports that in most African small-scale setups, farmers are more likely to have access to extension services and knowledge when they are part of social membership associations. The main social associations to which household members subscribed to in the study area included farmer groups, church groups and general social groups. The interactions on these various group platforms enabled farmers to educate each other about innovative production, marketing and negotiation practices. Farmers and key informants however reported that extension services are often directed towards farmers who are wealthier and more likely to have chances of taking up the emerging innovations. This inequality in the distribution of resources is linked with production inefficiency and limited control of important agricultural resources which manifests and is sustained in small scale farming zones (FAO, 2011).

4.3.5 Food and income security benefits of adopting organic fertilisers

The study also adopted a counterfactual condition which assumes that modified organic fertilisers adoption is determined exogenously but in practice it can be a potential endogenous variable. It acknowledges that the unobservable characteristics of the sampled households could be the cause for the observed differences in welfare indicators. For example, the observed differences in the indicators in Table 6 might be a case where a farmer with the 'right attitude' towards cotton could have generated higher net returns per hectare without necessarily adopting the modified organic fertilisers. Musara *et al*. (2019) also noted significant inefficiencies among

sorghum producing households across all scales of production and reported this as a driver for limited intensification prospects. A study conducted by Asfaw, Shiferaw, Simtowe and Lipper (2012) pointed towards the need to adopt more sustainable practices to grease the benefits from adoption of the innovation. In order to sustain the positives of modified organic fertilisers, smallholder cotton farmers would also need to adopt low cost technologies of production.

Given that the adopters of modified organic fertilisers have relatively higher total returns, this enhances their purchasing power in food commodity markets thereby enabling them to buy a variety of food for the family. The income from cotton production can also be used to support the production of for example other cereal crops such as maize, sorghum and improve the food security status of the households. Similar results were reported by Ngeno (2017) in a study of adopters of tea plucking innovations and strategies as opposed to the farmers who did not adopt the practices.

In a study conducted by (Diiro 2013), similar observations were made for adopters of conservation practices as opposed to their non-adopter counterparts. The former had higher returns in the magnitude of 26 % from their production. In a rice intensification study conducted by (Faltermeier & Abdulai, 2009), similar patterns were also reported where intensive rice farmers were better off in food security. Josephson, Ricker-Gilbert, & Florax (2014) however reported that it is population density in farming communities which directly determine the intensification prospects for an adopted innovation and associated productivity gains. This might also mean that in the current case of modified organic fertilisers, the community pull programs can allow benefits to cascade to all farmers.

A stakeholder analysis and interpretation of interactions on modified organic fertilizer platforms is discussed at this stage.

4.3.6 Lowered business production costs

About four fifths of the participating stakeholders expressed the benefits of lowered production costs as a result of using modified organic fertilisers. They also noted that for the benefits to be sustained, there is need to strengthen financial and soft skills (negotiating and bargaining) training support among say for example farmers and agro-dealers, and enhance their investments which they have established over time in the study area. This they said is possible for the innovation if membership and extension service systems are properly designed from the lowest level of individual stakeholders as agents of change in facilitating infusion of support structures such as targeted contracts with modified organic fertilisers for improved cotton productivity and food security. They argued that lowered production and transaction costs associated with adoption of modified organic fertilisers can be perceived to have the potential to generate higher net income margins and help improve their overall welfare gains in the marketing channels. Major operating costs identified are incurred on activities such as transportation of the fertilisers from the market to the farm and payment of labour used in the application of the fertiliser.

One farmer said:

> "*It [the modified organic fertilisers] reduces the costs of production since in most cases the fertilisers are relatively cheaper and more easily accessible than the conventional inorganic fertilisers"*

Another agro-dealer said:

> "*Information and communication sharing on the modified organic fertiliser issues has reduced the risks of production and the associated losses. However, sometime back, I went to Harare in search of the modified organic fertilisers, unfortunately, the suppliers had run out of stock, so I had to go back empty handed".*

The above sentiments show that the stakeholders perceive the challenge on high transaction costs associated with the modified organic fertilisers at all links of the value chain as a factor reducing the prospects of uptake by small scale farmers. To mitigate this, some farmers have improved links with modified organic fertiliser suppliers and NGOs thereby enhancing efficiency since they are benefiting from economies of scale. There was consensus among stakeholders that traditionally, small-scale cotton farmers had challenges in increasing productivity, but due to the stakeholder networks they have access to a greater number of stakeholders to interact with and considerable information about the goods and services they demand and provide along the cotton value chain. The findings are also confirmed in empirical work on multiple value chains by World Bank (2006) in Mozambique.

4.3.7 Limited scaling up (and out potential) for the fertilisers

There was widely held consensus that stakeholders perceive modified organic fertilisers as having scope for being scaled up by current users and new users. The use of initiatives such as farmer groups as a platform for exchange of information among the various modified organic fertilisers marketing channel chain actors was said to be of importance by the stakeholders. They reported that the limited options from which farmers may get the information on organic fertilisers acted as a

disincentive for its adoption and subsequent scaling out potential. Farmers noted that there is limited scope for exchange of information through voluntary interaction, sharing of ideas and peer learning among modified organic fertilisers adopters. There is no well-designed platform where for example farmers and traders get information on the latest market trends of cotton.

One trader said:

> *"Tapping into the scaling up potential of the modified organic fertilisers is useful to me because it helps me to get viable profit margins".*

Another extension agent said:

> *"Scaling out prospects for the modified organic fertilisers makes the administration of cotton farming easier and facilitates getting information about marketing and pricing of these fertilisers products from suppliers."*

One retailer indicated that:

> *"Taking advantage of the business potential from scaling up capacity of the modified organic fertilisers, one can be able to make appropriate decisions on how the demand and supply patterns of the modified organic fertiliser are moving. This determines when, how and of how much of the commodity to buy, pricing and promotion. This is of economic importance because it saves time and other resources'.*

From the above, the research observes that the stakeholders are primarily worried about the modified organic fertiliser industry growth prospects. They perceive that currently there is need to shorten the traditionally long marketing channels for the modified organic fertilisers. This is confirmed by a study in Mbire district of Zimbabwe by Musara *et al.* (2019) which found that farmers supported in marketing

channels increasingly dealt directly with wholesalers or large-scale intermediaries than smaller intermediaries. Although better market access can be a powerful means of alleviating poverty, Zeller, Diagne & Mataya (1998) found that participation still depended on the quality of what producers had to sell in multiple markets. According to the stakeholders, they perceive that this dimension still needs to be strengthened in the modified organic fertiliser projects. Financing institutions can help stakeholders to invest in more appropriate production and storage structures.

4.3.8 Barriers to adoption and overall farm performance

There is evidence from the discussions during the study that benefits of the adoption advocates' strategies in facilitating uptake of the modified organic fertilisers can be only recognised by the informed stakeholders. There are some barriers to effective integration of the cotton related activities in the overall farm performance matrix through socio-cultural dimensions. These are the restrictions that hinder flow of modified organic fertilisers' benefits along the value chain hence resulting in aggregate poor farm performance.

One extension officer pointed out that:

> *"Illiteracy is the biggest challenge that we are facing with small-scale cotton farmers, among them there are some who do not know what market oriented and diversified production is all about."*

From what was highlighted by the stakeholders, it clearly shows that there are asymmetries in accessing certain stakeholders for example farmers accessing wholesalers of modified organic fertiliser due to proximity challenges. The efforts of the available options usually miss potential targets and as such this discourages farmers and other small actors in the marketing channel chains from utilising

opportunities such as the modified organic fertilisers on the stakeholder platform. A study by Ortmann & King (2007) also made similar observations in South Africa. However, farmers and other stakeholders alike should be encouraged and motivated about the potential of cotton since there is a shift in technological orientations and should learn to adjust and suit the environment of technology and the broader marketing channels demands and expectations.

4.3.9 Challenges for small stakeholders on the platform in providing solutions

The platform roles are to provide long term solutions to the challenges faced by small scale farmers and other small stakeholders such as local agro-dealers' access to reliable raw materials.

One farmer said:

> *"Low cotton market prices still remain one of the critical challenges that we are facing when we are selling our products."*

A community leader indicated that:

> *"The most significant challenge is lack of capital to purchase high yielding seeds and chemicals to use with the modified organic fertilisers, hence resulting in low productivity."*

The reality of smallholder farming communities is that they are the low-income zones of most countries. As such they always lag behind the innovation advancement revolution. This, according to Rukuni *et al*. (2006) brings about the major problem of poverty and food insecurity. To mitigate such a challenge, they should be establishment for rural and micro operational finance to assist small scale stakeholders to access production factors including ICT platforms so that their income levels can increase. This was also the sentiments of stakeholders in terms of

how the use of modified organic fertilisers can aggregately benefit the whole farm and go beyond the use on cotton production only.

4.4 Summary

The findings of the research were presented and discussed so as to facilitate drawing conclusions and recommendations of the research. Three dimensions as guided by the research questions on adoption determinants, food and income security impacts of adoption and the perceptions of stakeholders with respect to modified organic fertilisers were looked at.

CHAPTER 5 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter represents the summary, conclusions and recommendations from the research with regard to the objectives of the study in a way to provide answers to the research questions. The study aimed at determining the factors which influence the adoption of modified organic fertilisers by small scale cotton farmers in Mutoko District. Perceptions of stakeholders and the welfare impacts of the adoption decision were also examined. The results obtained in the previous chapter are linked to related literature so as to find out the relationships and differences in order to make conclusions and recommendations.

5.2 Discussion

This study was an analysis of the small holder cotton farmers' decision making in terms of using modified organic fertilisers in Mutoko district of Zimbabwe. It was conducted with a sample of 290 small scale cotton farmers and other stakeholders whom they interact with such as agro-dealers and contractors. Quantitative and qualitative techniques were used to analyse data using a binary logit regression model, counterfactual analysis and thematic stakeholder analyses. The results from data indicated that the age of the household head negatively influenced the probability of taking up the modified organic fertilisers. Mazvimavi and Twomlow (2009) also reported similar findings in the drier parts of Zimbabwe with the adoption of conservation farming techniques. Access to extension services had a positive effect on the probability of adoption. The likelihood of adopting the modified organic fertilisers increases as the frequency of extension contacts increase.

This finding is consistent with a study by Amare *et al*. (2012) in maize-cowpeas farming in Tanzania. Distance to modified organic fertiliser market reduces the chances of adoption. In this regard, distance to the market increases the transaction costs of accessing sellers thereby discouraging use of certain market options (Musara *et al*., 2019).

Number of organic fertiliser sellers in the market has a positive and significant influence on the chances of farmers adopting the modified organic fertilisers. Rukuni *et al*. (2006) also noted that the convenience of having many options to buy from creates an incentive for buying fertilisers. As the level of household income increases, the chances of adopting modified organic fertiliser decreases. Ndiritu *et al*., (2014) supports this view point arguing that the seasonal and risky nature of agriculture increase the proclivity for farmers to take up production systems which increase their economic sustainability. Price of modified organic fertilisers negatively influenced the adoption decision by the farmer. High production costs limit the scope to make purchases of strategic inputs (Devereux, 2006). Membership to associations had a positive influence on the decision to adopt modified organic fertilisers. According to FAO (2011), the inequality in the distribution of information between socially networked farmers and those who are not, is important in sustaining comparative advantages in adopting innovations in small scale farming zones.

Farmers who adopted the modified organic fertilisers had relatively higher food security, productivity and returns from cotton production. A study conducted by Asfaw *et al*., (2012) pointed towards the need to adopt more sustainable practices to grease the benefits from adoption of innovations. In order to sustain the positives of modified organic fertilisers, smallholder cotton farmers would also need to adopt low cost technologies of production. Many stakeholders agreed that networking and trust

can be important for the exchange of information that enhances efficiency along the exchange platforms. Issues raised by the stakeholders within market linkages strategies include barriers to access to strategic resources and the limited mitigation of challenges for the effective participation in modified organic farming markets. This is confirmed by a study in Mbire district of Zimbabwe Musara *et al*. (2019) which found that farmers supported in marketing channels increasingly dealt directly with wholesalers or large-scale intermediaries than smaller intermediaries. Although better market access can be a powerful means of alleviating poverty, Zeller, Diagne & Mataya (1998) found that participation still depended on the quality of what producers had to sell in the many markets at their disposal. The main missing stakeholders identified by the study are the financiers and the researchers.

5.3 Conclusions

As hypothesised, social, economic and institutional factors are important in determining the cotton farmer's decision to take up the available modified organic fertiliser options. The important factors were the age of the principal decision maker, household income, distance to the market, market prices and the membership to social associations. Adopting modified organic fertilisers can increase food diversity and reduce food insecurity among households. The decision also leads to increased productivity and margins from cotton production practices. The fundamental thematic issues reported by stakeholders are reduction in production and transaction costs by using modified organic fertilisers, limited access to information and knowledge about the modified organic fertilisers and lack of support from potentially strategic partners such as contractors and the government. Additionally, breaking the barriers to effective stakeholder integration in networks remains a concern for stakeholders. There is therefore a case for enhancing networking among stakeholders

in facilitating market linkages along the modified organic fertilisers marketing channels in the study area.

5.4 Implications

The findings from the study are very crucial in providing information to stakeholders in the agribusiness sector, i.e. to the farmers, policy makers, and the companies (private and government, NGOs and civic society organisations). This should positively influence how they make decisions on how to support the production and utilisation of modified organic fertilisers. Farmers will be made more aware of the food security, productivity and income benefits associated with the use of modified organic fertilisers. This might help them reflect on the harm caused by use of inorganic fertilisers and switch to the more environmentally friendly option. This should lead to sustainable agriculture as well as well as promoting good agricultural practices especially with cotton production which dominates the drier parts of Zimbabwe. Policy makers are most likely going to make resources allocation decisions based on an informed point of view since they will now know more about the prevailing conditions in the modified organic fertiliser industry.

5.5 Recommendations

On the basis of the study findings and conclusions it can be recommended that stakeholders collaborate and help each other in developing the policies that make access to modified organic fertilisers for cotton production and marketing information more accessible and affordable for small scale farmers across age and income levels differentials.

Small scale cotton farmers

The study findings point towards the importance of responsive extension systems to facilitate information generation and dissemination. The most immediate strategy

will be to consider establishing social groupings for farmers with mandates of discussing around cotton production using modified organic fertilisers. The study findings also show that there is need to further tap into the food access and food diversity benefits of using modified organic fertilisers in cotton production. To achieve this, farmers need to be educated about the benefits of using modified organic fertilisers for cotton with a commercial orientation of producing and marketing the crop. The main benefit is that the innovation reduces production costs while increasing productivity and thus boosts the net income.

Government and its policy making agents

Policy makers and the government agents should appreciate and embrace the reasonable approach of blending modern and traditional approaches of communicating along the available modified organic fertilisers marketing channels. These decisions need to be guided by the specific factors which affect the decision to adopt the modified organic fertilisers by small holder farmers. For example the government can influence inclusion of cotton as a supported crop in mainstream agribusiness development trajectories. This will encourage stakeholders to participate on the cotton value chain platform knowing that the policy framework is accommodative of their interests.

Non-governmental organisations

The potential of realigning extension systems with the demands of accessing and utilising modified organic fertilisers cannot be overlooked in strengthening the soft skills of farmers' ability to negotiate and bargain for better prices in markets. Non-governmental organisations, through their existing structures of extension delivery and advocacy for environmentally friendly practices may facilitate training programmes on negotiation skills so that other stakeholders can efficiently settle

transactions within a win-win framework. This has the potential of reducing exploitation of those with limited soft skills by for example agro-dealers and buyers or contractors. If this is done, then farmers may take up the modified organic fertilisers and increase productivity, income and aggregate food security.

Private companies and researchers

Empirical evidence from the stakeholder analyses shows that networking is important in improving access to goods and services along the cotton value chain. In this regard, the novelty of the interactions requires models that encompass attitudes of co-innovation and co-existence among all the actors involved in the cotton value chain. This calls for setting up of a cotton production-marketing innovations platform in the study area. Private companies such as contractors and researchers can play a critical role in facilitating this paradigm shift since they have the technical expertise. Researchers can also harness from the determinants affecting use of modified organic fertilisers such as income and design and scale out other low cost inorganic fertilisers which can be commercialised.

5.6 Suggestions for Further Research

The study used the cross-sectional data from a survey to ascertain the factors influencing the adoption of modified organic fertilisers and the associated welfare effects of the adoption decision. A more holistic analysis would have required the use of panel data which acknowledges and controls for the heterogeneity of households, a task which crosses sectional data cannot achieve without introducing biases. Studying the welfare phenomenon with panel data will also bring out the temporal dimension into the study i.e. answers the questions as to whether the currently observed positive of food access and food diversity gained from adopting modified organic fertilisers in the present study persist over periods of time.

The study also focused on Mutoko district, which is just one of the many dominant cotton producing zone of Zimbabwe. In as much as these results provide great insights into the cotton value chain practices and issues, expanding this to other production zones will benefit decision makers to get a more comprehensive state of the cotton value chain which embraces modified organic fertilisers in Zimbabwe. It can also be beneficial to try the modified organic fertilisers with other crops such as sorghum which also does well in the drier parts of Zimbabwe.

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APPENDICES

Appendix 1: Household questionnaire

My name is Melody Ngonyamo, an MSc Agribusiness Student at Africa University, Zimbabwe. I am conducting a research entitled "**An investigation of the determinants of modified organic fertilisers adoption by small-scale cotton farmers in Mutoko District, Zimbabwe**" as part of the requirements for the degree programme. Kindly bear in mind that any information gathered from this interview will not be used for any other purposes except for this study. The information will also be treated with confidentiality. The questions herein are intended for the household head or his/her proxy. Other household members may be requested to assist during the process of the discussion. Your cooperation will be greatly appreciated.

ID:

Identification details

Name of enumerator: _____

Date of interview: _____

Location (ward): _____

SECTION A: Demographic distribution

1. Gender: (tick where appropriate). • 0. Male. • 1. Female.

2. Marital status: (tick where appropriate). • 0. Married • 1. Otherwise

3. Highest level of education completed? (tick where appropriate) • 0. None • 1. Primary • 2. O level • 3. A level • 4. Certificate • 5. Diploma • 6. BSc • 7. MSc • 8. PhD

4. House hold age distribution (for members who were full time at the homestead during the 2018/19 season):

Household member	**Age (state years)**	**Contributes towards household labour (Yes/No)**
1: Farmer		
2:		
3:		
4:		
5:		

5. State average monthly household income. $_____

6. State number of years participating in agriculture: _____

7. Number of social groups to which household members belong: _____

SECTION B: Agronomic and financial performance

8. Household landholdings (state hectares): _____

9. Main crops grown on plots (state three): _____

10. For how long have you been producing cotton? (state years): _____

11. Did you produce cotton using modified organic fertilisers in the 2018/19 season? (tick where appropriate). • 0. No • 1. Yes

12. If yes, how many hectares of cotton did you crop using modified organic fertilisers in the 2018/19 season? _____

13. If no, how many hectares of cotton did you crop using inorganic fertilisers in the 2018/19 season? _____

14. How many kgs of cotton did you harvest during the 2018/19 season? _____

15. What was the average price per kg? $/kg_____

16. Which specific modified organic fertilisers did you use to produce cotton using in the 2018/19 season? (please list)

_____

_____

__

17. For how long have you been using modified organic fertilisers for crop production? (State years) _____

18. Why do you use modified organic fertilisers for cotton production?

(Explain)_____

19. What is the distance to the nearest source of modified organic fertiliser market? _____km

20. How did you finance the purchase of modified organic fertilisers during the 2018/19 season? (Specify in the table below). Rate the reliability of the source of finance on the scale: 1. Not reliable. 2. Slightly reliable. 3. Moderately reliable. 4. Very reliable. 5. Extremely reliable

Source of finance	**Duration**	**Average finance per year ($)**	**Challenges**	**Reliability**
1.				
2.				
3.				
4.				

SECTION C: Farm management practices

21. Have you received any training related to modified organic fertilisers? (tick where appropriate). • 0. No • 1. Yes

22. Who provided this training? _____

23. How frequently do you receive this training? (State average times per year). _____

24. In your opinion, did you benefit from this training? (tick where appropriate).

• 0. No • 1. Yes

25. In your opinion what aspects need to be captured in the training?

(Explain)

_____

26. How frequently do you receive extension services? (State average visits per week). _____

27. What constraints do you experience in accessing and using modified organic fertilisers? Please rate the problems on the basis of the given scale: 1. Not a serious problem 2. Slightly severe. 3. Moderately severe. 4. Very severe. 5. Extremely severe.

Constraint	**Rating**	**Suggested solution(s)**
Late delivery of fertilisers		
Unavailability of fertilisers		

Inefficient extension services		
High fertiliser prices		
Labour shortages		
Market unreliability for produce		
High transport costs		
Low output market prices		
Other _____		

28. What inputs did you use in cotton production during the 2018/19 season and what were the sources? Rate the reliability of source on the scale: 1. Not reliable. 2. Slightly reliable. 3. Moderately reliable. 4. Very reliable. 5. Extremely reliable

Input	**Units**	**Unit cost ($)**	**Total cost ($)**	**Source**	**Reliability**
Seed					
Fertilisers:					
Inorganic					
Modified organic					
Herbicides					
Pesticides					
Labour:					
Land preparation					
Sowing					
Weeding					
Fertilising					
Spraying chemicals					
Harvesting					
Thrashing					
Transporting:					

Inputs from market					
From field to home					
Produce to market					
Other (specify)					

29. Do you have any credit buying arrangements with modified organic fertiliser sources? (tick where appropriate). • 0. No • 1. Yes

30. Are your modified organic fertiliser sources reliable?

(Explain)_____

SECTION D: Household food consumption and security

31. Please recall all food or drink items consumed by the household members during the last 24 hours. (tick for Yes where appropriate)

Staple foods	**Response**
Maize	
Sorghum	
Rice	
Millet	
Potatoes	
Beans	
Groundnuts	
Soybean	
Sweet potatoes	
Other (please specify)	
Beverages and drinks	
Tea	
Soft drinks	

Beer	
Fruits	
Oranges	
Mangoes	
Pawpaws	
Bananas	
Apple	
Guava	
Other (please specify)	
Meat & other products	
Beef	
Goat meat	
Sheep meat	
Pig meat	
Chicken	
Bush meat	
Fish	
Eggs	
Other (please specify)	
Vegetables	
Tomatoes	
Onions	
Cabbage	
Spinach	
Okra	
Pumpkin	
Cucumber	

Fats, oils, sweeteners, snacks and	
Cooking fat	
Margarine	
Bread	
Biscuits	
Popcorn	

32. State whether you encountered any of the below during the past 7 days and rate them on a scale of *"1 = rarely, 2 = sometimes, and 3=more often"* (tick appropriate boxes)

QUESTIONS	**IF YES INDICATE HOW OFTEN**				
	Yes	*No*	*Rarely*	*Sometimes*	*More often*
Is the food adequate to the family members?					
Is there any day you have eaten smaller meals than needed					
Did they eat foods with a limited variety?					
Is there any day you ate less preferred foods?					
Did they consume fewer meals in a day?					
Is there any day they failed to obtain food of any kind?					
Did they ever go to bed hungry?					
Is there a day or night have gone the whole day or night without eating any food?					

SECTION E: Policy knowledge and recommendations

33. Are you aware of any policies that are currently impacting on modified organic fertiliser use in your communities? • 0. No • 1. Yes

(Elaborate)_____

34. Who do you think should be involved in supporting the use of modified organic fertilisers?

(Explain)_____

35. What specific policies need to be put in place to support the uptake of modified organic fertilisers?

(Explain)_____

Appendix 2: Key informant interview checklist

Date:

Name of the interviewer:

INTERVIEWEE DEMOGRAPHIC INFORMATION

Organisation: _____

Organisation's main business: _____

Position and title: _____

Experience in agriculture related activities: (please state years). _____

Age (please state years) _____

Gender (please tick where appropriate) • 0. Male. • 1. Female.

Marital status (please tick where appropriate) • 0. Married • 1. Otherwise

Highest level of education you have completed? (tick where appropriate) • 0. None

• 1. Primary • 2. O level • 3. A level • 4. Certificate • 5. Diploma • 6. BSc • 7. MSc

• 8. PhD

KEY INFORMANT INTERVIEW GUIDE

1. What challenges related to soil fertility have you experienced in the organisation's main line of business?
2. Please explain your involvement in the following agricultural activities:
   i) production.
   ii) processing.
   iii) marketing.
   iv) Other (please specify).

3. What is your understanding of modified organic fertilisers?

   Prompt: please give examples of modified organic fertilisers.

4. Please identify the main producers of modified organic fertilisers?

   Prompt: please also identify the main consumers.

5. What are the advantages of using modified organic fertilisers?

   Prompt: please highlight disadvantages as well.

6. What challenges do stakeholders face in the following aspects of modified organic fertilisers?

   i) production.

   ii) marketing.

   iii) utilisation.

7. Please elaborate on the existing policies that are related to the following aspects of modified organic fertilisers:

   i) producing,

   ii) marketing.

   iii) utilisation.

8. Please explore any hazards associated with crop production which uses modified organic fertiliser?

   Prompt: If yes, are you concerned about them?

9. What strategies can be implemented by stakeholders to improve the current components of modified organic fertilisers:

   i) production.

   ii) marketing and promotion.

iii) utilisation.

10. How are the prices for modified organic fertilisers determined in markets?

    Prompt: in your view, are these prices fair for trading partners?

11. Do you have any other comments regarding this topic? Is there anything else you would like to add?

I will be analysing the information collected and preparing a summary report of the findings. I'll be happy to send you a copy if you are interested. Thank you very much for your time.

Appendix 3: Logit regression model output

logit log_age landsize ahhldsize price_c price_o membership marketdst extension log_ofinc experience slnumber

```
Iteration 0:   log likelihood = -115.64441
Iteration 1:   log likelihood = -84.558481
Iteration 2:   log likelihood = -80.491449
Iteration 3:   log likelihood = -80.123052
Iteration 4:   log likelihood = -80.118181
Iteration 5:   log likelihood = -80.11818

Logit estimates                                   Number of obs   =
290
                                                  LR chi2(11)     =
71.05
                                                  Prob > chi2     =
0.0000
Log likelihood = -80.11818                        Pseudo R2       =
0.4372

------------------------------------------------------------------------------
--
      adopt |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------+-----------------------------------------------------------------
     log_age |  -1.964038   .5392157    -3.64** 0.043    -2.605611    2.359384
    landsize |   .0395361   .2731662     0.31   0.278     .0153054    .5410369
   ahhldsize |   1.850029   2.396037     0.77   0.129     .3510298    2.544706
     price_c |   .9714055   1.036158    -0.94   0.473     .6056111    1.359314
     price_o |  -.1643614   .0181662    -9.11*  0.001    -.0530354    .1540369
  membership |   2.446029   1.162037     2.11***0.067     1.035102    3.150233
   marketdst |  -1.619377   .7182586    -2.26** 0.011    -2.048837    2.307501
   extension |   1.603401   1.222157     1.31** 0.030     .7642813    2.359476
   log_ofinc |  -.9410363   1.143162    -0.82***0.051    -1.533381    1.780083
  experience |   .3310829   .4893925     0.68   0.396     .0557390    .9508271
    slnumber |   .2482008   .0751860     3.31*  0.005    -1.063259    8.144650
       _cons |   .3271284   1.236196     0.27   0.143    -1.103975    .9106492
------------------------------------------------------------------------------
```

Appendix 4: AUREC approval letter