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Above all else I thank the Almighty God, Jehovah, for making this possible.
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<table>
<thead>
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<th>Description</th>
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<tbody>
<tr>
<td>CFC</td>
<td>Conservation Farming</td>
</tr>
<tr>
<td>CSO</td>
<td>Central Statistical Office</td>
</tr>
<tr>
<td>CCC</td>
<td>Cotton Association of Zambia</td>
</tr>
<tr>
<td>ESA</td>
<td>East and Southern Africa</td>
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<tr>
<td>GLS</td>
<td>Generalised Least Squares</td>
</tr>
<tr>
<td>IMCS</td>
<td>Independent Management Consultancy Service</td>
</tr>
<tr>
<td>LINTCO</td>
<td>Lint Company of Zambia</td>
</tr>
<tr>
<td>OLS</td>
<td>Ordinary Least Squares</td>
</tr>
<tr>
<td>WCA</td>
<td>West-Central Africa</td>
</tr>
<tr>
<td>ZMK</td>
<td>Zambian Kwacha (old currency)</td>
</tr>
<tr>
<td>ZNFU</td>
<td>Zambia National Farmers’ Union</td>
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ABSTRACT

Analysis of Supply Response of Cotton Farmers to Changes in Cotton Prices in Zambia

ChemboMpiya
The University Of Zambia, 2013

Cotton is one of the major cash crops produced in Zambia. It is mostly produced by small scale farmers on contract basis with the ginners. There are over 180,000 small scale cotton farmers. However, there is no local market for the cotton that is ginned. Therefore, ginners export almost all the cotton that is produced in the country. The resulting effect is that the cotton sector is highly affected by exogenous factors such as world market price, prices of substitutes for cotton which are not produced in Zambia as well as policies in cotton sectors of larger countries. Thus prices usually fluctuate and these fluctuations result in fluctuations of national cotton production levels. This study's aim is to analyze the responsiveness of cotton farmers to prices in cotton and the significance of other non-price factors that affect cotton production. This analysis is essential to ensure that the sector does not collapse as it is a source of income for many. This information is important in setting prices to ensure that farmers continue producing cotton. The study is based on two basic economic concepts which are supply elasticity and the basic theory of the production function of the firm. Supply response analysis is based on the Nerlovian model. It uses secondary data collected from CSO and IMCS collected in the years 2008, 2009 and 2010. The study revealed that the most influential non-price factor is how much cotton is sold in the current year which increases land allocation to cotton by about 40%. Other factors that affect allocation of land to cotton negatively include unavailability of farming implements to farmers, amount of land allocated to other farm products, significance of farming income in total household income. A unit increase in any of these factors reduces land allocated to cotton by 2%, 2.2% and 6% respectively. The strength of the effect of price was revealed to inconsistent as it was observed through calculation of supply elasticity that cotton supply elasticity was in some years elastic and in others not. It is strongly recommended that farmer input loans include farming implements such as tractors and installation of irrigation systems to increase productivity thus reducing responsiveness to changes in price.
CHAPTER ONE
INTRODUCTION

1.1 Introduction

Cotton is an important cash crop to many African countries. In Zambia, the market is concentrated as it has few buyers relative to sellers. Sellers being poor small holder farmers are unable to withhold their products from the market for a very long time when market prices are low. This is because the producers sell their product in its raw form, being very bulky, prone to fire accidents and degradation. The above factors put market power in the hands of the buyers who are mainly ginners. With less power in the market, the producers' only choice is to vary their farm allocation decisions at time of planting to avoid profitless ventures in the next farming season.

The Cotton Sector in Zambia was a monopsony regards purchase of seed cotton and a monopoly regards distribution of seed, pesticide, sprayers as well as provision of bags. Government accomplished this through LINTCO which was a state owned cotton company. LINTCO purchased seed cotton at fixed prices. However, LINTCO was sold to Lonrho Cotton and Clark Cotton in 1994. This was done as part of the liberalization process. Factors that led to this have been attributed to low and fluctuating production levels which eventually fell below 20,000 MT of seed cotton in the 1995 harvest year as. Another major factor was the financial crisis that LINTCO was experiencing resulting from substantial unpaid debt.

After privatization, government did not interfere in the cotton market whether in form price dictation or provision of marketing guidance. Competition between the two companies, Lonrho and Clark was minimal as they operated in different areas. Clark dominated the Eastern Province while Lonrho dominated the southern and central regions of the country. Privatization resulted in promotion and increase of cotton production such that by 1997 there were new entrants on both the production and buyers' sides. This caused ginners to increase their capacity thus causing a scramble for cotton in an attempt to minimize unit ginning costs. Some of the new entrants in the market did not distribute inputs hence they encouraged farmers to default their loan repayments in an effort to gain more by selling their produce to them.
World prices had a continual decline from their peak prices in 1995. By 1999, the effects of the lower prices trickled down to the farmers who were used to the earlier higher prices. The lack of transparency in price setting led to misunderstandings between farmers and out grower firms. This caused exit of some farmers as well as credit default. Lonrho was sold to Dunavant citing unpaid loans of up to USD $ 2 million per year. Production went down to less than 50,000 MT in 1999/2000 season. (Tschirley and Kabwe, 2009)

The cotton sector received some structural changes to recover it. Dunavant launched a distributor system with improved credit repayment. Clark also improved credit system and expanded production in Eastern Province with high repayment rates. As a result production rose between 2000 and 2005. Areas of cultivation were expanded and the country began to receive a premium on world markets and despite operating in a concentrated sector companies in Zambia paid prices nearly as high as a much less concentrated marketed in Tanzania.

The year 2006 had price at the center of a conflict in the cotton market. Due to the steady appreciation of the kwacha against the US Dollar, the cotton exporters realized less profit and thus reduced their buying price. This made most farmers reduce their level of production by 2007.

Evidently, cotton demand is inelastic while supply is elastic. The farmers are price takers and prices have had a lagged effect on cotton production levels due to the fluctuations in prices.

1.2 Problem Statement

Price fluctuations have resulted in mistrust from farmers in the mechanisms employed for setting prices in Zambia in the recent past and this threatens the sustainability of the sector which has employed farmers as well as formal employment for those working in ginning companies. This is a threat because the ginning companies’ average fixed costs of running ginneries per year increase with decreased production by farmers. The vice also threatens innovation and progress in improving productivity. Therefore, it is important that the level of production is stabilized and
farmers stop relying heavily on previous season’s prices to avoid losing out in seasons with good prices.

This paper sets out to evaluate the significance of key factors in changes in production levels of cotton at farm level and their effects on the responsiveness of farmers to cotton price variability when making farm allocation decisions. With increased productivity, profitability of the crop is increased thus reducing the risk of loss for farmers. With reduced risk, farmers are less likely to depend solely on previous year’s prices in their decision making at the beginning of the season.

1.3 Objectives of the Study

The general objective of this study is to measure the responsiveness of cotton farmers to price variation.

The following are the specific objectives:

➢ To measure the price elasticity of cotton.
  ➢ To establish the significance of non-price factors in cotton production.
  ➢ To establish a relationship between the areas of cotton cultivated and the factors (price and non-prices factors) that affect cotton production.

1.4 Rationale

According to Tschirley and Kabwe (2009), most farmers’ next best alternative when they don’t grow cotton is production of more maize. The disadvantage is that maize is far less tolerant to drought relative to cotton thus this alternative increases the farmers’ risk in drought years. Also, increased production in maize would further push the price of the crop downwards. Other cash crop alternatives such as Tobacco and Coffee are not grown in the same agro-ecological zones as cotton thus substitution cannot take place whereas crops such as paprika and groundnuts do not have a well-established support system for input access and marketing.

Prices in Zambia largely adjust from year to year. This causes changes in levels of production from year to year as farmers react to these fluctuations in price. By comparison of nominal price paid to farmers per kg of seed cotton from 2000 to 2005, Zambia was tied with Tanzania for the
highest price in ESA though its prices were well below those in WCA.’ (Tscharley and Kabwe, 2007) This shows us that the cotton sector has a lot of potential in being a sustainable source of income for small holder farmers.

Results of a research carried out by FSRP on the impact of conservation farming on small holder cotton farmers in Zambia suggests that ‘conservation farming can increase crop income by roughly 140% among the poorest small holder farmers with no access to cash inputs. A second category of farm households using purchase input packages costing $60 per season can increase crop income by a further 40% under hand hoe conservation farming. A third high-input package including herbicides and costing $130 per season enables farm households to quadruple crop income compared to low-input conventional tillage.’ (Haggblade, Kabwe and Plerhoples, 2011)

Below is a bar chart showing the trends in production level in Zambia from 2001 to 2010 as reported by the largest two firms in the industry courtesy of CSO.

Figure 1: Production Trends in Zambian Cotton Production
The most influential factor in the production level of cotton by the cotton farmers is previous year price. In most cases, the alternative crop for resource allocation is growing more maize as its production cost is relative lower due to the subsidies provided by government. However with erratic rainfall caused by climate change growing more maize entails assuming greater risk as maize is not drought tolerant. Therefore cultivation of a crop such as cotton which is relatively drought tolerant reduces the risk of loss for each season. Other factors influencing the level of production for cotton farmers include productivity, cost of production and returns on the crops grown and sold.

**Figure 2: Trends in average Cotton prices for past ten years**

![Graph showing trends in average Cotton prices for past ten years.](image)

In an effort to increase land productivity, Conservation farming is an encouraged practice amongst farmers as studies have revealed it increases productivity. According to a study undertaken by Haggblade, Kabwe and Plerhoples, on the impact of conservation farming on smallholder cotton farmers in Zambia. Conservation farming (CF) has a set of practices aimed at raising agricultural productivity on farms at various resource levels. Hand hoe and animal traction Conservation Farming packages have been developed by Zambia’s Conservation Farming Unit (CFU) to raise crop yields. With dry season minimum tillage, farmers are able to
plant early, thus improving plant establishment, growing period, and access to early season microbial nitrate production. “Crop residue retention builds up soil organic matter, soil structure and water retention capacity, thus improving plant responsiveness to small but targeted doses of mineral fertilizer. Leguminous crop rotations raise soil fertility through biological nitrogen fixation. Conservation farming, thus, increases land productivity through a variety of improved agronomic practices.” (Haggblade, Kabwe and Plerhoples, 2011)

Ideally, with increased productivity a farmer’s profit margin is increased thus reducing his risk. In turn, reduced risk to incur loss should reduce the sensitivity to price fluctuations. With guaranteed supply of raw material in the sector, there is chance for the sector to grow.

Given different levels of input under Conservation Farming, there is difference in cost as well as change in productivity. Therefore, change in productivity does not directly translate to less sensitivity to market prices when planning for the following season. To achieve a sustainable cotton sector that can grow to accommodate innovation and improvement in technology as well as a higher and constant source of income to farmers from this cash crop, there is need to cushion the effects of unstable prices on farmers.

The measure of sensitivity of farmers’ cotton production helps to predict the level of production per kwacha change in price. Significance of other factors affecting production levels suggests which measures are more effective in stabilization of production levels. Estimating farmers’ supply response will enable better planning due to the ability to estimate changes in production levels thus being able to maintain particular levels of production.

1.5 Structure of the Report

This research report is divided into five (5) chapters. The first chapter introduces the study in terms of the background, problem statement, study objectives and rationale. Chapter two is a discussion on the literature review; chapter three presents the research methodology. Study findings are presented and discussed in chapter four and the paper concludes with chapter five which contains the conclusions and recommendations.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

Studying the responsiveness of both consumers and suppliers of product is essential to be able to forecast future production. In this study, we focus on the producers’ responsiveness to price. Therefore, to develop the study we first look at the underlying economic concepts of the study in this chapter. There are two basic concepts on which this study is based. These concepts are supply elasticity and the basic theory of the production function of the firm.

2.2 Conceptual Framework

According to McConnell, Brue and Barbiero (2007), the firm is defined as a business organization that owns and operates one or more plants. Firms employ resources to produce a good or service for profit. Plants may be defined as a physical establishment that performs one or more functions in producing, fabricating and distributing goods and services. Examples include factories, mines, farms as well as stores. Thus each farm is treated as a separate firm.

The major objective of the firm is to gain profit from their activities. Therefore, the less profitable cotton farming is the less likely he is to allocate his plot to cotton farming. The demand for cotton is assumed to be inelastic as ginners are the price setters while farmers are the price takers. Quantity of Cotton produced is assumed to be equal to the quantity of cotton bought by ginners due to the lack of storage capacity for farmers.

\[
\text{Profit} = \text{Revenue} - \text{Cost of Production}
\]

\[
\text{Revenue} = \text{Price} \times \text{Quantity Produced}
\]

Supply elasticity is defined as the responsiveness of producers to changes in prices of their goods or services. The responsiveness of farmers’ to changes in cotton prices is measured by the formula for supply elasticity:

\[
\text{Supply Elasticity} = \frac{\text{Percentage Change in Quantity Supplied of Product}}{\text{Percentage Change in Price of Product}}
\]
The production function defines the relationship between the inputs and outputs thus describing the rate at which inputs are transformed into outputs. Its basic form is:

\[ Q = f(X_i) \]

Where \( i = 1, 2, \ldots, n \) representing different physical inputs.

However, most of these inputs are scarce. This means that the rational farmer will seek to allocate resources to more profitable enterprises. Therefore, the profitability of each enterprise determines the pattern of resource allocation to that enterprise.

The formula adapted to the study:

\[
\text{Responsiveness of Small Holder Cotton Farmers to Changes in Cotton Price} = \frac{\text{Percentage Change in Amount of cotton produced}}{\text{Percentage Change in Average Price set by main buyers per year}}
\]

If supply elasticity lies between 0 and 1, then it is inelastic. This means that producers are not significantly sensitive to changes in price. A supply elasticity value that is equal to or above 1, shows that supply is elastic thus producers are significantly responsive to changes in product prices. The negative sign for all negative elasticities is ignored. Only take absolute values for analysis.

The main determinant of supply elasticity is the amount of time producers have to respond to product price change. Other factors include productivity, cost of production as well as possibility of producing other products with the same major inputs.

The market supply curve is an upward sloping curve with price and quantity on the y and x axis respectively. The supply curve shows how much the producer is willing to supply at a given product price. The fact that it is upward sloping shows that the producer is willing to supply more of a product at a higher price. The market supply curve can be shifted by factors such as price of competing products, weather, technology and behavior of institutions in the sector.
2.3 Known Findings

The supply elasticity of cotton has been found to be less than 1, showing that it is inelastic. In many regions cotton supply does not significantly respond to prices. In the United States the short run and long run price elasticities were found to be 0.36 and 0.64 respectively (Duffy, 1987).

This finding is also supported by Smith (1999), who reported that production of cotton was on the increase in years of low prices as well as years with high prices. He attributes the high responsiveness to prices in general in Africa to poor infrastructure, market failure and risk aversion.

In Greece, elasticity of cotton supply was found to decrease with as the size of the farm reduced. Therefore, small holder farmers were found to be more responsive to price changes than the larger farmers (Katakou 2011).

There is not much available information on the actual level of sensitivity of cotton farmers to price changes in Zambia. Nevertheless, work has been done to ascertain the impact of changes in tillage practices as well as the overall performance of the cotton sector in general.

Challenges in the sustainability of the cotton sector have been attributed to low productivity, lack of value addition, inadequate provision of extension services and mistrust in the current price setting mechanism from players in the cotton market.

Results of a study conducted on the Productivity Impact of Conservation Farming on Smallholder Cotton Farmers in Zambia by Steven Haggblade, Steven Kabwe and Christina Plerhoples suggest that “conservation farming can increase crop income by roughly 140% among the poorest smallholder farmers, with no access to cash inputs. A second category of farm households, using purchased input packages costing $60 per season, can increase crop income a further 40% under hand hoe conservation farming. A third, high-input package including herbicides and costing $130 per season enables farm households to quadruple crop income compared to low-input conventional tillage.”
The 2003 Cotton-Textile-Apparel Value chain Report on Zambia mentions that Zambia does have the capacity to double its cotton production if a partnership between Government, farming community, ginning industry and even spinning industry is employed in so that extension services / out-grower schemes (i.e. training, education, financing, etc) are expanded, yields per hectare are improved, access to affordable farming inputs such as cottonseed is provided to farmers, the farming community is educated about their obligations in terms of these input cost provisions.

Other measures that could improve sustainability of the sector’s production include identification of areas suitable for irrigation cotton farming and develop infrastructure accordingly (water distribution, electrification etc) and ensuring that cultivars are limited in line with the needs of the spinning industry regionally and overseas. A profound increase (doubling) of cotton growing was reported to have the ability to reduce the incidence of side-selling.

With so much potential in the sector, there is need to improve its sustainability so as to allow all such possible developments to take place. Development cannot take place with fluctuations in production levels. Production levels need to stabilize to pave way for technological advancement research and capacity building. All such efforts would be in vain if employed while farmers still mistrust the price setting system as response will vary from year to year.

2.3.1 Features of Cotton Production in developing countries

There are three major features characterize of agricultural production. These include producers and consumer; risk and uncertainty and expectations (Thirtle and Townsend, 2010). Producers are mainly small scale farmers who prioritize production for home consumption. This entails that cash crops such as cotton are only attended to after plans for family food production is ensured. Therefore, cash crops such as cotton always have food crops as a major source of competition for input allocation. The “consumers” are mainly ginning companies who mainly export the product after buying it and processing it. They set the price while the producers are price takers.
Risk and uncertainty is responsible for the variations in production levels. When the prices are perceived to be too uncertain, it is difficult to budget for the farm thus risk averse farmers grow less risky crops.

Expectations in terms of prices are usually based on the prevailing price at the time of planning. Therefore, if prices are low little or no resources are allocated to production of cotton. Farmers do not have a scientific and reliable way of estimating the following year's prices, hence some important factors are left out when coming up with price expectations such as competing products on the world market and large countries' policy towards cotton production.

2.4 Conclusion

Some studies suggested that cotton supply is inelastic which is contrary to popular belief that farmers are highly responsive to market prices. However, most markets in which these studies were conducted were not identical to the local cotton market. Therefore, this study will help analyze local cotton supply response in the local market using the underlying economic concepts mainly used to measure supply responsiveness which are supply elasticity and least squares regression technique using the Nerlovian model.
CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter looks at the methods and procedures that were used to conduct the study. To carry out the research, data collected over different years of production was required. However, there were limited resources in terms of funds and time which acted as constraints for the research in general. Since it was not possible to collect all the data required, secondary data was used in this study for the analysis.

3.2 Data Sources

Data used in this study is secondary household survey data courtesy of the IMCS and CSO. This data was collected in Central, Southern, Western and Eastern provinces of Zambia using questionnaires and interviews.

3.3 Model and Assumptions

The study uses the Nerlovian model to analyze supply response. The simple Nerlovian model consists of three equations:

1. \( A_t^D = a_0 + a_1 P_t + a_2 Z_t + \mu_t \)
2. \( P_t^e = P_{t-1} + \beta (P_{t-1} - P_{t-1}) \)
3. \( A_t = A_{t-1} + \gamma (A_t^D - A_{t-1}) \)

where \( A_t \) = actual area under cultivation at time \( t \).

\( A_t^D \) = area desired to be under cultivation at time \( t \).

\( P_t \) = actual price at time \( t \).

\( P_t^e \) = expected price at time \( t \).
$Z_t = \text{other exogenous factor(s) affecting supply at time } t.$

$\beta$ and $\gamma$ are termed the expectation and adjustment coefficients respectively.

In this study, the non-price factor that is taken into consideration is the type of farming that a farmer uses and substitutability of the crop. Therefore the model is specified as follows:

1. $A_t = a_0 + a_1 P_t^{\epsilon} + \mu_t$

2. $P_t^{\epsilon} = P_{t-1}$

3. $A_t - A_{t-1} = \gamma (A_t^0 - A_{t-1}) + a_2 T + a_3 S + Z_t$

The reduced form of the above equation obtained is:

$$A_t = a_0 g + (1-g) A_{t-1} + a_1 g P_{t-1} + a_2 T + a_3 S + \gamma \mu_t + Z_t$$

$T$ and $S$ are the type of farming practice used and substitutability of cotton in terms of alternative number of different crops available.

The equation is further reduced based on the following assumptions:

- The study assumes that the market period, which is the period in which producers of a product are unable to change the quantity in response to price change, is assumed to be one year. This is due to the fact that, cotton is mainly grown by small holder farmers who are entirely dependent on rain-fed production hence cotton is a seasonal crop. During the market period, supply is fixed. Therefore, the effects of price changes on production levels are lagged. The effects of the current year’s prices are observed in the following year. The study only considers the long run supply changes.

- The other major assumption is that the expected price for the following year equals the currently prevailing price.

The final reduced form of the equation is:

$$A_t = a_0 + a_1 P_{t-1} + a_2 T + a_3 S + \gamma \mu_t + Z_t$$
Estimation of parameters of the reduced form of the equation is done using Ordinary Least Squares (OLS) technique. The elasticity of supply (production) is obtained by deriving the price elasticity of hectarage and elasticity of yield per hectare then adding the two.

3.4 Analytical Framework

The elasticity of supply (production) is obtained by deriving the price elasticity of Area and elasticity of yield per Lima then adding the two. This was to account for differences in productivity among farmers. Elasticities are calculated between years of production using lagged prices. The expected price in the next year is assumed to be equal to the prevailing price. A graph is produced to show elasticities between production years in Microsoft excel. Charts that show the descriptions of the sample population were produced in Microsoft excel to simplify the description of the sample population. The supply response relation is estimated using ordinary least squares technique using Stata. Factors affecting production of cotton considered include lagged prices, total area of other crops produced, contribution of farming income to total income, technology (this is represented by ownership of cultivators, rippers and ploughs) and education level of the farmer.
CHAPTER FOUR
STUDY FINDINGS AND DISCUSSION

4.1 Introduction

This chapter presents the findings of the study. It shows the calculated elasticities as well as descriptions of the sample population and the results that were obtained after estimating the model. The chapter then goes on to discuss the findings of the study and their implications.

4.2 Elasticity of Cotton Supply

After calculating the supply elasticities, the data presented in graph below was obtained. The supply elasticity calculations vary greatly as shown in the graph below. Between some years, the elasticity was inelastic while some years showed elastic supply. In the calculations, the prices were lagged to reflect the assumption that expected price equaled current average price.

Figure 3: Graph of Supply elasticities over the years
Since supply elasticity that lies between 0 and 1, shows that supply is inelastic. This means that producers are not significantly sensitive to changes in price. A supply elasticity value that is equal to or above 1, shows that supply is elastic thus producers are significantly responsive to changes in product prices. The negative sign for all negative elasticities is ignored. Only take absolute values for analysis. From the above results we see that the supply of cotton is neither consistently elastic nor inelastic. This shows that cotton farmers are not always responsive to cotton prices.

The inelasticity of cotton supply may be due to specialization of some farmers. Therefore, they produce cotton even when the price is bad. Also, it could be due to the expectation of low supply in the following year which yields an expectation of higher prices to follow a year of low prices. Another reason for this result is that non-price factors have a significant effect on the levels of production that overrides the effects of prices.

4.3 Estimation of the Model

Before the model estimation is presented, here are the descriptives of the sample population. Note that this sample population was selected by IMCS which is the source of the data used. In total, there were 866 observations made on 290 cotton farmers over a period of 3 years.

4.3.1 Description of Sample Population

The sample population was made up of cotton farmers from Central Province, Eastern Province, Southern Province and Western Province which are major producers of cotton in the country. The pie chart on the next page shows the distribution of the location of the farmers.
In this study, most of the farmers were female. This may be attributed to the fact that there has been a campaign for women farmers to sign contracts under their own names rather than their husbands. It also shows high participation of women in farming and this helps women access inputs as well as extension services. The figure below illustrates the percentage distribution of sex among the farmers in the sample population.

**Figure 4: Distribution of Sex in the Sample Population**
Most of the farmers in the sample population were found to be married. However, the type of marriage as to whether these marriages were polygamous or monogamous was not indicated. This fact limits the ability of the study to analyze how much decision making power each farmer has or how much spousal support they get. It also makes it difficult to properly describe household headship. The figure on the next page shows the distribution of marital status among the farmers in the sample population.

Figure 5: Distribution of Marital Status among the Sample Population

Another factor taken into consideration in the study is the level of education attained by the farmers. The data collected indicated which level of education that the farmers has attained and not merely attended. The group of farmers is dominated by those who have attained only primary education followed by those whose highest level of education is secondary education then those who have not attended formal school at all. The least number was of those who had attended tertiary education. This information is illustrated on the next page in the bar chart.
The final descriptive of the sample population in the study is the significance of farming income in total household income. This is shown by the level of contribution to total household income. It was expected that the higher the significance of farming income to total household income the more cautious a farmer is when making farming decisions. This entails that a farmer would be risk and averse and more responsive to price changes in his potential products. The bar chart below shows the level of contribution of farming income to total household income among the farmers in the sample population.

Figure 6: Level of Education attained

Figure 7: Level of Contribution of Farming Income to Total Household Income
4.3.2 Estimation of the model

The model is shown below:

\[ A_t = a_0 + a_1 P_{t-1} + a_2 T + a_3 S \]

Where:

- \( A_t \) is the area allocated to cotton production year \( t \)
- \( a_0 \) is the intercept
- \( P_{t-1} \) is the lagged price
- \( T \) is the technology which is represented by ploughs, cultivators, harrows and rippers.
- \( S \) is the substitutability of crop which is represented by the area of other crops cultivated.

There were 866 observations and the \( R^2 \) value was 0.1570. Prob>F = 0.0000 thus the model was significant overall. This shows that model explained 15.70% of the findings. The OLS regression output is shown in the appendix. Below is table showing GLS results obtained.

**Table 1: Generalized Least Squares results**

<table>
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<th>t-value</th>
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<tr>
<td>othercropstotal</td>
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<tr>
<td>cotton</td>
<td>-0.040</td>
<td>(6.92)**</td>
</tr>
<tr>
<td>ploughs</td>
<td>0.021</td>
<td>(1.35)</td>
</tr>
<tr>
<td>cultivators</td>
<td>-0.019</td>
<td>(0.78)</td>
</tr>
<tr>
<td>magrippers</td>
<td>0.023</td>
<td>(0.93)</td>
</tr>
<tr>
<td>hhincome</td>
<td>-0.009</td>
<td>(0.52)</td>
</tr>
<tr>
<td>education</td>
<td>-0.025</td>
<td>(1.43)</td>
</tr>
<tr>
<td>maritalstatus</td>
<td>0.011</td>
<td>(0.60)</td>
</tr>
<tr>
<td>price</td>
<td>0.000</td>
<td>(2.57)*</td>
</tr>
<tr>
<td>_cons</td>
<td>0.137</td>
<td>(1.29)</td>
</tr>
<tr>
<td>R2</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>716</td>
<td></td>
</tr>
</tbody>
</table>

* p<0.05; ** p<0.01
Since the model explains a low percentage of the findings, we analyze the findings at 85% confidence level. The variables that were found to be insignificant are education level and the ownership of ploughs. This means that the level of education and the ownership of ploughs did not have an effect on the amount of area allocated to the production of cotton.

The amount of cotton sold in the current year had the largest effect on the amount of land allocated to cotton for the next production period. This may be because it is the most recent indicator of a farmer’s cotton productivity and potential. A unit increase in amount of cotton sold in the current year increases land allocated to cotton by 40%. The more cotton a farmer sales in the current year, the more likely he is to produce more cotton in the next production period. Another major factor in land allocation was Price. Price had a positive influence on the amount of land allocated to cotton production as expected. The study findings showed that a unit increase in price increases land allocated to cotton production by about 0.2%. The model shows that the current year’s price is major influence over the area of land allocated to cotton production. This may be because most small scale farmers are risk averse as mentioned by Smith (1999).

A unit’s increase in total area allocated to other crops other than cotton on the farm reduces the area allocated to cotton production by 2%. This is because other crops increase competition for factors of production such land. A unit’s increase in owning a ripper increases the land allocated to cotton production by about 2.2%. This is because owning a plough reduces the work load of the farmer and increases his productivity. This makes easier for the farmer to produce both for consumption as well as cash crops like cotton. Ownership of the other farming implements considered like ploughs and cultivators had a negative effect on how much land was allocated to cotton production but was not significant at 85% confidence level.

4.3.3 Hypothesis Testing

- Variance Inflation factor, VIF, revealed there is no multicollinearity as the mean VIF value was 1.26 which is less than 10.
- The OLS regression results were corrected for heteroskedasticity by producing robust results thus producing generalized least squares table.

- The OV test revealed there's missing variables which is the case because the data was not collected primarily for analysis of cotton thus study would be more effective using primary data.
CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the conclusion and recommendations of the study based on the findings and interpretations of the study findings.

5.2 Conclusion

Overall the study was successful as all specific objectives were achieved. The elasticity of supply was measured and it varies from zero to over three. We see that the supply of cotton is neither consistently elastic nor inelastic. This shows that cotton farmers are not always responsive to cotton prices. Some significant none price factors were revealed and these include ownership of farming implements, cotton sold in the current year, area of land allocated to other crops grown by the farmer. Education levels were found not to be significant.

5.2 Recommendations

Farmers need to insure their production because of the variations in price and unpredictability of profit. This is because cotton prices are determined by exogenous factor over which the players in the local market have no control over. Farmers should be assisted with farming implements in on loan terms to increase productivity of labor and thus increase farm capacity then supply will be less elastic. This will ensure production of cotton sector thus encouraging development of the sector in terms of research and innovation. Simple irrigation systems should be invested by farmers as a hedge against the unfavorable weather, drought. This is because the study has revealed that some non-price factors have a huge effect on the level of production.
Farmers should be encouraged to take advantage of extension services provided by some ginning companies to increase their productivity so that changes in price should not result in losses. Extension services must also be improved to be more effective.

The study could be improved by adding variables that were not considered in this study. Therefore use of primary data in future studies is recommended. Suggested extra variables include fertilizer usage in production, access to information as well as extension (commodity specific), weather patterns and ginning companies by whom farmers are contracted. This is because the study revealed that some variables were missing.
REFERENCES


Haggblade S, Kabwe S and Plerhoples C (2011) Productivity Impact of Conservation Farming on Smallholder Cotton Farmers in Zambia, working paper no. 47, food security research project


Thirtle C and Townsend R (2010) Supply Response within the Farming Context: Supply Response Estimation, University of Reading


Appendix 1: OLS Regression Results

<table>
<thead>
<tr>
<th>Source</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
<th>Number of obs = 716</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>10.0400482</td>
<td>9</td>
<td>1.11556091</td>
<td></td>
</tr>
<tr>
<td>Residual</td>
<td>53.919449</td>
<td>706</td>
<td>0.076373157</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>63.9594972</td>
<td>715</td>
<td>0.089453842</td>
<td></td>
</tr>
</tbody>
</table>

- F( 9, 706) = 14.61
- Prob > F = 0.0000
- R-squared = 0.1570
- Adj R-squared = 0.1462
- Root MSE = 0.27636

| area       | Coef.    | Std. Err. | t    | P>|t| | [95% Conf. Interval] |
|------------|----------|-----------|------|------|----------------------|
| othercrops-l | -.0018986 | .0017073  | -1.11| 0.266| -.0052506 -.0014534 |
| cotton      | -.0401924 | .0040885  | -9.83| 0.000| -.0482194 -.0321653 |
| ploughs     | .0206994  | .0153804  | 1.35 | 0.179| -.0094974 .0508961 |
| cultivators | -.0186426 | .0263291  | -0.71| 0.479| -.0703553 .033053  |
| magrippers  | .0225053  | .0243255  | 0.93 | 0.355| -.0252356 .0702643 |
| hhincome    | -.0092966 | .0175468  | -0.53| 0.598| -.0439431 .0253499 |
| education   | -.0254326 | .0175705  | -1.45| 0.148| -.0599292 .0090641 |
| maritalsta-s| .0107896  | .0148051  | 0.73 | 0.466| -.0182777 .039857  |
| price       | .02001834 | .0000752  | 2.44 | 0.015| .0000357 .000331  |
| _cons       | .136955   | .1045466  | 1.31 | 0.191| -.0683044 .3422144 |
## Appendix 2: Variance Inflation Factor

<table>
<thead>
<tr>
<th>Variable</th>
<th>VIF</th>
<th>1/VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>ploughs</td>
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<td>0.637320</td>
</tr>
<tr>
<td>othercrops~l</td>
<td>1.53</td>
<td>0.653594</td>
</tr>
<tr>
<td>cultivators</td>
<td>1.48</td>
<td>0.675999</td>
</tr>
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<td>magrippers</td>
<td>1.24</td>
<td>0.805190</td>
</tr>
<tr>
<td>price</td>
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<td>0.860973</td>
</tr>
<tr>
<td>cotton</td>
<td>1.16</td>
<td>0.863036</td>
</tr>
<tr>
<td>education</td>
<td>1.09</td>
<td>0.917152</td>
</tr>
<tr>
<td>maritalsta~s</td>
<td>1.05</td>
<td>0.955703</td>
</tr>
<tr>
<td>hhincome</td>
<td>1.03</td>
<td>0.970674</td>
</tr>
<tr>
<td><strong>Mean VIF</strong></td>
<td><strong>1.26</strong></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3: Test for Omitted Variables

Ramsey RESET test using powers of the fitted values of area

$H_0$: model has no omitted variables

$F(3, 703) = 163.40$

$Prob > F = 0.0000$
Appendix 4: Test for Omitted Heteroskedasticity

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of area

$\chi^2(1) = 227.33$
Prob $> \chi^2 = 0.0000$
Appendix 5: Generalised Least Squares Results

Linear regression

| area         | Coef.    | Std. Err. | t     | P>|t|  | [95% Conf. Interval] |
|--------------|----------|-----------|-------|------|----------------------|
| othercrops-1 | -.0018986| .0012984  | -1.46 | 0.144| -.0044477 to .0006506|
| cotton       | -.0401924| .0058057  | -6.92 | 0.000| -.0515909 to -.0287938|
| ploughs      | .0206994 | .0152872  | 1.35  | 0.176| -.0093145 to .0507132|
| cultivators  | -.0186426| .0239522  | -0.78 | 0.437| -.0656687 to .0283834|
| magrippers   | .0225053 | .021961   | 0.93  | 0.353| -.0249995 to .0700102|
| hhincome     | -.0092966| .0178196  | -0.52 | 0.602| -.0442823 to .0256892|
| education    | -.0254326| .0177757  | -1.43 | 0.153| -.0603322 to .009467  |
| maritalsta-s | .0107896 | .0179788  | 0.60  | 0.549| -.0245086 to .0460879|
| price        | .0001834 | .0000714  | 2.57  | 0.010| .0000432 to .0003235 |
| _cons        | .136955  | .1063076  | 1.29  | 0.198| -.0717618 to .3456718|

Number of obs = 716
F( 9, 706) = 6.79
Prob > F = 0.000
R-squared = 0.1570
Root MSE = .27536