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DEVELOPMENT OF A FRAMEWORK FOR ECONOMIC, SOCIAL AND ENVIRONMENTAL SUSTAINABILITY OF COTTON PRODUCTION IN ZIMBABWE: A CASE OF GOKWE

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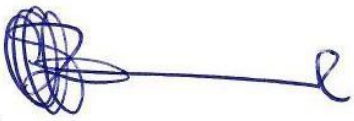
DISSERTATION APPROVAL

I certify that Tony Gwatsvaira was under my supervision. I have sufficiently supervised him and he has fulfilled all requirements that I set before him as the supervisor. In my judgement, the dissertation entitled "**DEVELOPMENT OF A FRAMEWORK FOR ECONOMIC, SOCIAL AND ENVIRONMENTAL SUSTAINABILITY OF COTTON PRODUCTION IN ZIMBABWE: A CASE OF GOKWE"** is of sufficient standard to meet the requirements for the Master of Philosophy degree at Chinhoyi University of Technology.

Approved by



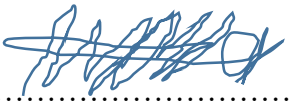
Dr. N. Mashavakure (Main Supervisor) 10 June 2025

DEDICATION

I dedicate this to my family members whose unwavering support, encouragement and love have been my guiding light throughout this journey. Your presence in my life has made all the difference and I am forever grateful for your influence.

DECLARATION BY CANDIDATE

I, Tony Gwatsvaira, declare that I am the sole author of this thesis, that during the period of registered study I have not been registered for other academic award or continue any other academic programs. The work presented in this thesis is original and my own, except where explicitly stated otherwise through citations and references.

Signature  ……..

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ABSTRACT

Until the year 2000, cotton was among Zimbabwe's largest foreign exchange earners, accounting for approximately 30% of the country's total foreign exchange earnings and a source of livelihood for most rural households. However, its production has progressively declined, and this suggests a need to investigate the potential for reviving the crop's production and viability. The present study assessed the economic, social, and environmental sustainability of cotton production in Zimbabwe using Gokwe as a case. A self-administered questionnaire was used to collect data from 300 farmers. The farmers were selected using stratified random sampling from three villages in Gokwe South namely Ganye, Machakata, and Zambezi, and three villages in Gokwe North namely Chigoronga, Mlambi, and Maringa. In each village, selected cotton farmers were grouped into three strata, namely high-producing, medium-producing, and low-producing, with each stratum containing an average of 100 farmers. The first objective investigated the economic sustainability of cotton production in Zimbabwe particularly in Gokwe. To address this objective, gross margin analysis was conducted to determine the viability of cotton farming. The results revealed that smallholder farmers in the low-producing stratum in Gokwe obtained negative profits with average of -US$51.63 per hectare per season. Medium producing farmers attained slightly higher profits with an average of US$23.16 per hectare, and high producing farmers attained highest profits averaging US$283.97. Furthermore, quantile regression analysis showed that age has a positive relationship with gross margin, with coefficients of 29.8 ($P < 0.017$) and 157 ($P < 0.000$) at the 25th and 75th quantiles, respectively. Seed type also has a significant positive impact, with coefficients of 103.84 ($p < 0.000$) and 247.75 ($P < 0.000$) at the 25th and 75th quantiles. Gender has a positive impact on gross margin, with coefficients of 25.4 ($P < 0.057$) and 23.25 ($P < 0.469$) at the 25th and 75th quantiles, respectively. Education has a negative coefficient at both quantiles, although the relationship is not significant ($P < 0.759$ and $P < 0.658$). Household size has a mixed impact on gross margin, with coefficients of 3.8 ($P < 0.466$) at the 25th quantile and -20.48 ($P < 0.124$) at the 75th quantile. Marital status has a positive impact at the 25th quantile (coefficient = 24.76, $P < 0.066$) and a negative impact at the 75th quantile (coefficient = -19.91, $P < 0.508$). Pest management has a positive coefficient at the 25th quantile (coefficient = 23.76, $P < 0.103$) but is not significant at the 75th quantile. Farmers should adopt sustainable farming practices, diversify their income sources, and strengthen their marketing and bargaining power. Further studies should focus on comparative analysis with other crops to compare

the profitability and sustainability of cotton production with crops, such as maize, soybeans, and tobacco.

Key words: economic viability, cotton production, sustainability, Gross margin.

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CHAPTER 1: INTRODUCTION

Agriculture is referred to as the mainstay of the Zimbabwean economy as it contributes 18.5% of the country's gross domestic product and 22.8% foreign currency generation (ZIMSTAT, 2022). As such, Zimbabwe is grouped into low income countries, with most of the population reliant on agricultural production as their means of livelihood. The performance of the agricultural sector has a ripple effect on the entire economy, influencing food security, employment, and overall economic growth (World Bank, 2022). When farmers are performing well, it does not only boost the agro-processing industry but also increases demand for goods and services from other sectors, such as manufacturing and services (FAO, 2017). This, in turn can result in economic diversification and growth, ultimately contributing to poverty reduction and improved standards of living for the population (Machingura, 2019).

Following Zimbabwe's independence in 1980, communal farmers played a crucial role in the country's agricultural sector. The new government then inserted policies that aimed to support smallholder farmers, including those in communal areas, through input support programs and market access (Machingura, 2019). However, communal farmers tackled constraints which include reduced access to resources, limited infrastructure, and vulnerability to climate change (Mapfumo et al., 2016). Despite these obstacles, communal farmers remained crucial to Zimbabwe's food security and agricultural production, especially in the production of crops like maize and cotton (Jayne et al., 2006).

In Zimbabwe cotton is considered to be a strategic crop that can be used in poverty alleviation especially to smallholder farmers. Cotton is characterized as the main stay crop for almost 1,000,000 people, which include farmers, farm workers and their families and secondary industrial workers (FAO, 2019). In Zimbabwe it is considered to be second largest earner of foreign currency after tobacco and it is also responsible for the contribution of 19% to the agricultural export earnings. Cotton is a crucial source of raw materials for the oil expressing industry, with more than 50% of local oil production coming from cotton seed (AMA, 2011).

Several policies put in place in Zimbabwe have had negative and far reaching impacts on the cotton sector as evidenced by reduced production and productivity of the crop over the years (Mujeyi, 2017).

For example, the land reform program targeted to allocate land to black farmers. However, this resulted in tenure insecurity, production decline and disruption of financial system. Cotton farmers have not been spared by these adverse impacts of the policies. Krueger et al. (1995) observed that the major cause of indirect effects in many countries was exchange rate misalignment. This occurs due to macroeconomic approaches which resulted in the reduction of the purchasing power of returns obtained from the sales of export and import competing products.

Exchange rate fluctuations and price controls in Zimbabwe have crucially affected the socio economic and environmental sustainability of cotton production in Zimbabwe (Manyeruke, 2020). The volatility of the exchange rate has influenced farmer's access to imported inputs, inflating costs and lowering the profits (Masiyandima et al., 2019). Price controls, meanwhile, have distorted market incentives, resulting in reduced production efficiency and reduced investment in sustainable farming practises (Chikanda, 2017). These factors have had far reaching socioeconomic impacts, including reduced incomes for farmers and farm workers, increased poverty, and decreased food security (Jayne et al., 2006). Environmentally the reduced investment in sustainable farming practices has resulted in soil degradation, water pollution, and loss of biodiversity (Mapfumo et al., 2016).

Zimbabwe produces almost 123,000 tonnes of cotton lint yearly, and exports 70% of it while 30% is used locally (Mukuruba, 2023). Cotton contributed an estimated 12% of total agricultural production in 2004 (RBZ, 2005). Smallholder farmers contributing almost 99% of the total cotton production (Mlambo and Poulton, 2003). The high cotton production is attributed to the semi-arid conditions prevalent in Zimbabwe that are conducive for cotton production.

Concerning engendering sustainability in the cotton production value chain, several efforts have been made in Zimbabwe including environmental awareness and implementation of policies which aim to ensure socio-economic and environmental conservation (Bowyer-Bower, 1996; Keely & Scoones, 2003; Munro, 2003). According to Johnson, (1994) Zimbabwe has applied a national conservation strategy in line with the Rio Earth Summit of the year 1992. In meeting the sustainability of cotton production in Zimbabwe, the major concerns have been mainly placed on socio-economic vulnerability, poverty reduction, justice in society, and financial sustainability, encompassing economic viability, fair labour practices, safe working conditions, equitable distribution of benefits, fair trade practices, gender equality, and social justice, as well as ensuring the industry's financial viability through efficient production, value addition, and market access.

Zimbabwe's economic activities, including agricultural production, have faced significant challenges in recent years. According to Hove and Gwaindepi (2021), the country's economy has experienced a decline in economic performance since the year 1998. As a result, government support to cotton farming declined as incentives fell short. The decline in economic activity in the country resulted in the reduced government expenditure on subsidies to farmers which usually supported their growth and development (Rukuni et al., 2006). In effort to boost the profitability and sustainability of cotton production in Zimbabwe, contract farming was introduced which involved both government and private sector players. According to Rukuni et al (2006) contract farming in cotton production can increase yields. Contract farming mainly targeted smallholder farmers who were postulated to contribute about 70% of national cotton output. The Contract farming program provided inputs such as seed, pesticides, and fertilizers and in some instances cash (Esterhuizen, 2004; Rukuni et al., 2006). Despite observations by some authors such as Mugwagwa (2005) that contract farming was not profitable, there is evidence of the programe being viable in many circumstance. The study seeks to analyse the sustainability of cotton production in Zimbabwe.

1.1 Problem statement

Cotton production in Zimbabwe has experienced a dramatic decline over the past decade, falling from 143,849 metric tonnes in 2012 to just 28,598 metric tonnes in 2022 (AMA, 2022). This downturn has raised serious concerns about the sustainability of the industry, particularly in regions like Gokwe District where cotton farming is a cornerstone of rural livelihoods. According to Machingura (2022), the viability of cotton production is increasingly questioned across environmental, economic, and social dimensions. If these sustainability challenges are not addressed, the collapse of cotton farming could exacerbate poverty, food insecurity, and rural underdevelopment. Despite its importance, there is limited empirical research assessing the multidimensional sustainability of cotton production in Zimbabwe. This study responds to that gap by employing a mixed-methods approach to evaluate the environmental, economic, and social sustainability of cotton farming in Gokwe District. By adopting a holistic definition of sustainability one that considers long-term viability, community resilience, and ecological stewardship the research aims to generate actionable insights for policymakers and stakeholders. Ultimately, the study seeks to inform strategies that can revitalize cotton production, safeguard farmer livelihoods, and promote sustainable agricultural development in Zimbabwe.

1.3 Research objectives

1.3.1 Main Objective

To develop a framework for sustainable cotton production in Zimbabwe's Gokwe District.

1.3.2 Specific objectives for

1. To determine economic sustainability of cotton production in Zimbabwe Gokwe district.
2. To determine social sustainability of cotton production in Zimbabwe Gokwe district.
3. To determine environmental sustainability of cotton production in Zimbabwe Gokwe district.
4. To determine factors that affect cotton production in Zimbabwe Gokwe district.
5. To determine strategies that can be used to sustainably produce cotton in Zimbabwe

1.4 Research Questions

1.4.1 Main Question

1) What are key factors influencing sustainability of cotton production in Zimbabwe?
2) Is cotton production sustainable in Zimbabwe?
3) Is the production of cotton in Zimbabwe economically sustainable?
4) Is the production of cotton in Zimbabwe socially sustainable?
5) Is the production of cotton in Zimbabwe environmentally sustainable?

1.4.2 Sub-questions

1) What are challenges facing cotton farmers in Zimbabwe
2) What are strategies for sustainable cotton production in Zimbabwe

1.5 Justification of the study

Assessment of the cotton profitability and sustainability in Zimbabwe is of great importance in the formulation and implementation of the economic policies in the country. The assessment also informs sustainable and profitable production of cotton. The analysis of the sustainability of cotton production in Zimbabwe is also useful in the assessment of the current frameworks and policies put in place to improve the cotton production in the country. Through undertaking the research current polices put in place to assess the profitability of cotton production in Zimbabwe will be analysed and various measures to improve both profitability and sustainability of cotton production will be recommended. Hence the study is justified. Empirical studies are very rare as the study aims to assess

both profitability and sustainability at the same time. Hence there is need to carry out the study in order to facilitate the improvement and recommendation of policies that aim to improve the viability and sustainability of cotton production in Zimbabwe.

1.6 Delimitations of the study

The study focuses on the profitability and sustainability of cotton production in Zimbabwe, specifically examining the challenges and opportunities faced by smallholder farmers. The geographical scope is limited to Zimbabwe's major cotton-producing region, Gokwe district, which is a leading cotton-producing area due to its favourable climate and soil conditions. This study will concentrate on economic, social and environmental sustainability, exploring factors such as profitability, market access, and policy frameworks.

1.7 Dissertation Outline

This thesis is organised into five chapters. The first chapter covers the introduction of the issues to be studied. This chapter covers the research problem, questions and also the justification for conducting the study. The second chapter will provide a literature review on issues about cotton production. The chapter provides an insight of conceptualization of key terms, overview of factors affecting cotton production, sustainability of cotton production in Zimbabwe, economic viability of cotton production, theoretical framework, research gap and empirical studies. The third chapter will provide an outline of the methodology used in the study. A conceptual framework was first developed in order to identify possible variables for the study. Tools of analysis are also discussed in the chapter. Chapter four is the results and discussion chapter. A summary of results is presented first before policy recommendations.

1.8 Chapter Summary

Chapter 1 of this study indicated the foundation for the research on sustainability of cotton production in Zimbabwe. This chapter sets the stage by presenting the background of the study, highlighting the significance of cotton production in Zimbabwe’s economy and challenges it faces. The problem statement articulates the specific issues affecting the sustainability of cotton production, while the research objectives outline the study’s aims. The research questions guide the investigation, and the justification of the study underscores its relevance and contribution to the field. By introducing these key elements, Chapter 1 establishes the context and framework for the entire study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

The main objective of this study is to assess the sustainability of cotton production in Zimbabwe's Gokwe district. Sustainable cotton production is a product of many variables thus proper understanding of the variables and how they affect and influence each other is critical for policy formulation and continued meaningful production of cotton in Zimbabwe. This chapter will focus on literature review guided by the different elements that makes literature a good basis for making informed decisions. These include but not limited to the six characteristics according to Copper's (1988) taxonomy of literature review. The characteristics are focus, goal, perspective, coverage, organisation, and audience. The literature review will start with conceptualisation of key terms, a focused review as guided by the study specific objectives, then a theoretical framework before signing off with a gap in knowledge that the study seeks to fill.

2.1 Conceptualization of key terms

Two key terms are shaping the study. These are sustainable development and cotton production.

2.1.2 Sustainable development

Sustainable development is defined as the development that aims to meet the need of the present without affecting or compromising the ability of the future generations to attain their own needs (WCED, 1987). This definition is comparable to that by Robert (2002) which defines sustainable development on the bases of laws of Thermodynamics. In Thermodynamics sustainable development is divided into four principles which are characterized by a society that tries to deplete the concentration of resources that belongs to the earth's crust, concentration of substances produced by the society, degradation of the natural processes and scenarios that hinders people from meeting their basic needs.

The International Union for Conservation of nature and natural resources (IUCN, 1991) highlighted the need to include ecological systems when defining sustainable development. They defined sustainable development as developing the quality of human life while living with the carrying capacity of the ecosystems. In a blend of the definitions of sustainability from WCED (1987) and the

IUCN (1991) they defined sustainable development as the way of ensuring dignified living conditions with regards to human rights through the development and maintenance of the wildest possible range of options for freely defining life plans. The definition emphasized the need to maintain a principle of equity amongst the present and the future generations in the use of environmental, economic and social resources (Altwegg et al., 2004). If societies are to put these into practice, it entails defence of the bio-diversity in terms of ecosystems, species and genetics, of which all these principles are vital to the foundations of life.

In sustainability, weak sustainability and strong sustainability are incorporated in understanding sustainability. Weak sustainability assumes that natural capital, can be substituted with manufactured or human capital, allowing for economic growth and development as long the total stock of capital is maintained (Solow, 1993). In contrast strong sustainability emphasizes the preservation of natural capital and recognizes its limited substitutability, prioritizing ecological integrity and environmental thresholds (Daly, 1996). Weak sustainability, on the other hand, is reflected in initiatives like conservation efforts, sustainable forest management, and climate change mitigation strategies that prioritize environmental protection and ecological resilience.

2.1.3 Cotton Production

Cotton production is a significant contributor to economies of many countries, particularly in regions with suitable climates (FAO, 2020). According ICAC, cotton is one of the most widely produced natural fibres globally, with major producers including China, India, and the United States (ICAC, 2022). Sustainable cotton production practices, such as integrated pest management and organic farming, can help mitigate environmental and social challenges associated with cotton production (WWF, 2002).

2.2 Factors that affect cotton production

According to Mahofa (2007) improving cotton production has remained a big challenge for the Zimbabwean government for a long time. This is despite it being associated with several benefits to the rural people and the nation at large. Since the year 1980, the government of Zimbabwe has come up with several measures to improve cotton production in the country. However, a number of factors have hindered the attainment of the desired results.

Evidence from the study by Thirtle et al., (1990) has indicated that the common agricultural production in Zimbabwe is affected by technology. The adoption of new technology is seen as crucial in the improvement of cotton production in the country. The new technology was seen to have a positive return on the cotton production as it introduced easier ways of producing cotton (Mahofa, 2007). The technology to be adopted in order to improve the cotton production in the country was generated through research and development, thus research and development is a crucial factor for the improvement of cotton production in the country. Also, the research and development which is crucial for the development of the cotton production in Zimbabwe can be imported from other countries and spread to small holder farmers through extension services (Thirtle et al., 1990). Thus, the research and development from the study by Thirtle et al. (1990) should work hand in hand with extension services in ensuring that there is improved cotton production in the country. In Zimbabwe, young energetic people are increasing unwilling to engage in cotton production as they deem it as labour intensive and have preferred white collar jobs Musara, Zivenge, Chagwiza, Chimvuramahwe, and Dube (2011). This has resulted in the cotton being produced by elderly and less energetic individuals who are less willing to adopt new technologies which have been observed by Thirtle et al.1990) to have been a contributing factor to improved cotton production in the Zimbabwe.

In Zimbabwe cotton production is affected by the current operation of cotton industry below capacity, (Buka, 2016) observed that most of the cotton producing firms in Zimbabwe are currently operating below capacity as they are operating at 30 %. The major factor causing these companies to operate below capacity was observed to be presence of obsolete machinery and equipment and also lack of appropriate capital. Thus, in order to ensure that the cotton production in the country is not affected, there is need to increase industry capacity to maximum potential (Buka, 2016).

Agricultural extension services support the adoption of technology to boost cotton production in Zimbabwe (Mahofa, 2007).

The production of cotton in Zimbabwe is also observed to be affected by the price and non-price policies by the government. The pricing policies in Zimbabwe and the macroeconomic policies were found to have a negative effect on the aggregate production of cotton in the country (Dercon, 1993). The negative effects of pricing policies from history have resulted in the reduction in the total production from the year 1970s and early 1980s (Dercon, 1993).

The cotton production in Zimbabwe also has environmental implications which in turn affect sustainability. Thus, cotton as a crop requires severe use of chemicals and fertilizers, and this has resulted in increased pollution of the environment (Bessarabova, 2013). Due to these effects imposed by the cotton production in Zimbabwe it is observed that it is less economically and environmentally sustainable (C & A, 2015).

Natural disasters also pose a great risk to the total cotton production in Zimbabwe (Roh, Pettit, & Beresford, 2008). The occurrences of natural disasters which are associated with climate change have been observed to have caused reduced cotton production in Zimbabwe (United Nations, 1992). The increased climate change which has fuelled the occurrence of droughts, storms, floods and other disasters has resulted in damage to the cotton sector particularly in Zimbabwe (FAO, 2015).

The input costs in Zimbabwe is a contributing factor on the negative effects on cotton production in Zimbabwe (Poulton & Hanyani-Mlambo, 2008). The costs of inputs which includes seed and fertilizer are relatively high as compared to the gain from the production of the cotton seed, thus the costs of inputs have lowered the quality and quantity of cotton produced in the country. In addition, contracting companies in Zimbabwe have weak bargaining power to the supplier of cotton inputs. This has resulted in increased prices of cotton inputs as they have less strong relations with the suppliers of cotton inputs (Poulton & Hanyanu-Mlambo, 2008).

The presence of subsidies is also a crucial factor in the cotton production in Zimbabwe (Buka, 2016). In Zimbabwe there are no subsidies as compared to other countries which produces cotton. This has negatively affected the cotton production in Zimbabwe as it has distorted the international market trade prices. Thus, the absence of subsidies on cotton production has resulted in higher costs of producing cotton in Zimbabwe as inputs are high, this has resulted in cotton produced in Zimbabwe being expensive as it is produced at a relative higher cost of production (Poulton & Hanyani-Mlambo, 2008).

Competition is also an additional factor that affects the cotton production in Zimbabwe, the presence of cheap clothing imports in Zimbabwe has acted as a negative factor to the production of cotton as it has provided direct competition to the cotton companies in the country (Buka, 2016). The presence of competition from cotton imports prompted the government of Zimbabwe to enact statutory instrument (SI) 142/2009 under the Agricultural Marketing Authority act 26/2004. Hence this effort by the government to enact a statutory instrument that aims to hinder the importation of cotton

products shows that imports of cotton products from other countries poses a threat to the cotton production in Zimbabwe (Buka, 2016)

If cotton farmers are given support services this can be a positive factor for improving cotton production in Zimbabwe (Mariga, 2004). Thus, services that aim to promote the cotton production in Zimbabwe are crucial in the facilitation of improved production as they improve efficiency in the production of cotton particularly in small holder farmers. Mariga (2004) noted that marketing services in terms of extension, seed production and input access was crucial in the improvement of cotton production process in Zimbabwe.

The production of cotton in Zimbabwe has been observed to be associated with several benefits which include foreign currency generation through export revenue, as it is the second most important export crop after tobacco (USAID, 2012). However, global competition has negatively affected the cotton production in Zimbabwe. The global competition which is responsible for causing fluctuations in the world lint prices on the international market, was observed to have caused instability in cotton producer prices (Svotwa et al., 2015). The producer price instability has been evident to have caused negative impacts in the cotton production in small holder farmers in Zimbabwe, as 65% of the cotton growers downscaled their production during the 2006/2, 2007/8 and 2008/9 seasons (Svotwa et al., 2015). The impact of cotton producer price instability, further affected the cotton production negatively as it resulted in (18%) of farmers from the study carried out by (Svotwa et al., 2015) neglecting cotton production and (5%) altering to produce other crops. Thus, the producer price instability has negative effects on cotton production in Zimbabwe. However, if adequate policies were present which aim at ensuring price stability, then cotton production would be affected less by the producer price instability (Svotwa et al., 2015).

The educational background of the cotton farmers is also a factor that can positively and negatively influence the aggregate cotton production in Zimbabwe (Svotwa et al., 2015). As farmers are equipped with a certain level of educational qualification this enables the interpretation of several factors that influence the cotton production, for example, weather and previous production patterns. The educational qualification enables the farmers to conduct a cost benefit analysis and to be able to produce cotton using viable mechanisms (Svotwa et al., 2015). This view of education being an important factor in cotton production in Zimbabwe is further supported by the study conducted by

Weir (1999) which indicated that education can improve farm level of production through the improvement of the quality of labour. Also, if small holder farmers are educated this enables farmers to quickly grasp and adopt the new innovations which may ease the production process of cotton in Zimbabwe (Svotwa et al., 2015)

Cotton production is also influenced by the satisfaction of cotton farmers from the prices they sell their cotton. As observed by Eaton and Shepherd (2001) (98%) of cotton farmers are dissatisfied with the prices they sell their cotton. The prices of cotton are often determined by the prevailing market prices which are often less attractive to cotton growers. The inability by cotton farmers to negotiate the prices of cotton with buyers, has resulted in low prices being paid for cotton. This in turn reduced the production of cotton in Zimbabwe as farmers are dissatisfied with the prices offered to the cotton, they produce Eaton and Shepherd (2001).

The ownership of assets which can be used for the production of cotton is also an influencing factor in the cotton production in Zimbabwe (Svotwa et al., 2015). Since the costs of producing cotton in Zimbabwe are high, farmers with assets which can be used in the cotton production process such as ploughs and cattle are able to maximize on improved draught power and manure. Also, ownership of assets enables the cotton farmers to attain income from activities such as hiring of inputs used in the cotton production which includes plough and Cattle (Svotwa et al., 2015).

In Zimbabwe cotton production is additionally affected by the unstable macro-economic conditions which are characterized by high inflation rates. In the period 2006 to 2009 the Zimbabwean dollar was depreciating with high levels of inflation being experienced (Coltart, 2008). This in turn has reduced the level of cotton produced in the country as this made investment in the agricultural production particularly cotton difficult.

Credit availability is also an influencing factor in the cotton production in Zimbabwe. If credit is effectively allocated to small holder famers in Zimbabwe, the level of production of cotton will likely improve Jayne et al (1993). As supported by the study conducted by Jayne et al (1993) the increased availability of credit to cotton farmers is responsible for the improved cotton production in Zimbabwe. However, in Zimbabwe lending institutions particularly banks are reluctant to give credit to cotton farmers as they consider the agricultural sector risky. This is supported by the study conducted by

Chigunha et al (2019) in which he observed that (85%) of the credit institutions he used to analyse factors affecting credit allocation to the agricultural sector, ascertained that the agricultural sector in Zimbabwe was considered risky. Hence this has resulted in reduced allocation of loans to cotton producing farmers in Zimbabwe. Also the land tenure system in Zimbabwe was derived to be another factor that caused low allocation of credit to the agricultural sector in Zimbabwe. The credit allocation systems in Zimbabwe argued that the government policy on land tenure, exposed them to risk as few farmers had 99-year leases and the property rights were unclear (Richardson, 2005). Hence the reduced allocation of credit to agricultural sector in Zimbabwe contradicts the results by Jayne et al (1993) which stipulated that credit availability positively affects the production of cotton in Zimbabwe.

Also, the lack of effective pest control mechanism in the cotton production can negatively affects the cotton production in Zimbabwe (Mujeyi, 2021). Due to absence of effective ways to control pests, the general trend of average yield has been evident to have been declining since the year 1990. Thus, lack of effective ways to manage pests in cotton production affect the production negatively (AMA, 2011).

2.3 Sustainability of cotton production

In Zimbabwe, past analysis has indicated that there has been heavy awareness on the environmental sustainability of cotton production and also awareness with regards to the conservation policy on the environment (Bowyer-Bower, 1996; Munro, 2003; Keeley & Scoones, 2003). In order to effectively implement measures to ensure the sustainability of cotton production in Zimbabwe, the national strategy with the aim of conserving the environment for cotton production. The conservation strategy in Zimbabwe has been introduced since the Rio Earth Summit in the year 1992 (Chenje & Johnson, 1994). In Zimbabwe as stipulated by Chenje & Johnson (1994) there has been multiple policies to ensure the sustainability of cotton in Zimbabwe. These policies have focused mainly on wildlife, forest resources, indigenous woodlands and resettlement. In the sustainability of cotton production in Zimbabwe history has indicated that soil conservation was associated with policies that aimed to create contours ridges on all sloping cultivated land in order to avoid the loss of soil through erosion (Hagmann & Murwira, 1996). However, during the period beginning 1980s specifically in the areas in the North-West of Zimbabwe (Gokwe) the focus switched from the use of contour ridges to the application of chemicals, fertilizers and manure. The use of these resulted in reduced use of traditional

methods to conserve soil which included contour ridges, this resulted in the sustainability of the soil for cotton production in Zimbabwe being neglected (Campbell et al., 1998).

Equity in Zimbabwe has been a major constraint to the sustainability of cotton since the year 1930 when the Land Apportionment Act was introduced. The land apportionment act segregated the allocation of land based on race, with fertile and productive land being allocated to white farmers whilst less productive land was allocated to black people (Keeley & Scoones, 2003). As we analyse the unfair allocation of land resulting from the land apportionment act, this likely influenced the sustainability of cotton production negatively. As the black farmers who were allocated less fertile land produced reduced quantity and quality of cotton (Keeley & Scoones, 2003).

As described in the definition of sustainability by WCED (1987) sustainability refers to the ability of the present generation to meet the present need, without compromising the needs of the future generation. Thus through this definition the sustainability of cotton in Zimbabwe has been negatively been influenced by high cost of import duty imposed on cotton inputs which has significantly contributed to higher cost of production for cotton (Mahofa, 2007). The high import duties that are taxed on imported cotton inputs have significantly increased the costs of production thus contributing to low production of cotton in Zimbabwe.

Also the sustainability of cotton in Zimbabwe is significantly affected by gender and equity in the society. It is observed that in small scale farming systems women contribute more labour for the aggregate cotton production (FAO, 2015). For the social sustainability of cotton production, evidence has indicated that women are underrepresented in the decision making process, which includes farmers associations, cooperatives and groups. In addition, it is noted that women have reduced associations with cotton companies, reduced participation at cotton production trainings and also have less access to inputs for cotton production (FAO, 2015). Severe costs have been imposed on the agricultural sector as the gender gap has resulted in unfair allocation of many assets, inputs, livestock, technological knowledge, financial services and education. Thus an observation by (FAO, 2011) concluded that if women were to be given equal opportunity in the allocation of these resources, they would contribute about 20-30% to the total output of the cotton produced in farms. This contribution would significantly improve the food security in the societies as there will be improved food security in Zimbabwe (FAO, 2011).

In order to improve the yield of cotton, several measures have been implemented and these includes the application of chemicals on cotton in order to tackle pests and diseases (Banuri, 1998). The use of chemicals in the cotton production process has been observed to have contributed to improved yield in the short run. However, in the long run the use of crop chemicals has been postulated to result in negative impacts which include environmental degradation with more effect being felt by human, solid, water quality, local biodiversity and ecological balance (Doward, 2005). In southern African countries including Zimbabwe, the full extent of the effects of pesticides is difficulty to measure, but it is observable that the chemicals particularly pesticides are toxic and affect human health (Greene, 2005). As we stress the importance of the sustainability of cotton production in Zimbabwe, the World Health Organization (WHO) has concluded that human exposure to pesticides is carcinogenic and toxic. In addition, some chemicals were observed to have contributed to increasing residues in the soil, ground water and food production chain. This is observed to be exposing the human population to slow and increasing poisoning (Greene, 2005)

Also the use of pesticides to control pests is observed to have contributed to the increased cost of pesticides. Thus the repeated use of pesticides is observed to have contributed to a problem called Pesticide Treadmill (Banuri, 1998). This is a situation were higher levels of pesticides are needed to control pest population, as the continued use of these pesticides creates resistance within the pests. It is observed that the use of chemicals such as Dichlorodiphenyltrichloroethane in the years and 1940s to 1950s resulted in the improved yield drastically for an observed period. However, the improved yield declined drastically as there was pest resistance. The pest resistance caused farmers to use more chemicals in order to attain the desired results; this resulted in increased cost to farmers on crop chemicals. Hence it affected the sustainability of cotton production negatively (Greene, 2005)

In order to cure the problem of non-viable cotton production systems, conservation agriculture has been promoted widely in order to boost both the profitability of cotton production in Zimbabwe and also to solve the problem of land degradation resulting from less sustainable agricultural practices (Mavunganidze et al., 2013). ZCATF (2009) research indicates that conservation agriculture offers a solution to the problems faced by smallholder farmers in Zimbabwe, where unsustainable production practices have led to decreased livelihoods. In addition to problems resulted from non-viable

agricultural production, there has been reduced total production in terms of yields, degradation of land which is a result from soil erosion. Unsustainable agricultural practices have resulted in soil nutrient depletion, exacerbating the challenges faced by farmers, particularly in the cotton sector, amid global price fluctuations (Marongwe et al., 2011).

Also the decline in cotton production output has resulted in small holder farmers engaging in environmentally unsustainable soil and crop management practices (Kassam, 2011). In Zimbabwe it is observed that the average cotton productivity per unit area has declined from 503 kg/ Ha in 1980 to 243 kg / Ha in 2012 (USDA, 2012). The decline in the output of cotton as indicated is mainly attributed to poor soil management practices which does not aim to conserve the soil. Also a combination of poor soil management practices and repeated occurrence of droughts have been major factors which have resulted in low cotton production thereby threatening the sustainability of cotton production in Zimbabwe (Hassan & Nemachena, 2008).

To ensure economic sustainability of cotton production for smallholder farmers in Zimbabwe, it's crucial to consider not only financial profitability but also the long-term environmental and social implications of cotton farming practices. Government of Zimbabwe has set minimum prices of seed cotton with the aim of lowering the production costs of small holder farmers (Mutambara and Mujeyi, 2020). The major aim of setting the maximum price of seed cotton was to lower the production costs incurred by cotton farmers. However, despite this effort by the government there has been reduced adoption by the stakeholders which includes cotton merchants who refuse to lower the prices of seed cotton. This has resulted in cotton farmers facing continued high cost of production in growing cotton which has threatened the financial sustainability of cotton production in Zimbabwe (Cotton Indaba Task Force Team 2012).

Also the government of Zimbabwe in order to ensure the sustainability of cotton production in Zimbabwe it has used various statutory instruments which include SI 142 of 2009 and SI 63 of 2011 (Mutamabara & Mujeyi, 2020). The Agricultural Marketing Authority (AMA) was given the mandate to ensure that there has been compliance with regards to the terms and conditions agreed between cotton farmers and ginners. As stipulated in the terms and conditions of the contracts between cotton farmers and ginners, ginners were obliged to provide inputs to farmers in terms of seed, fertilizers,

chemicals and agricultural extension services to farmers. In return the farmer was supposed to sell the cotton to the ginner as stipulated in the contract (Mutambara and Mujeyi, 2020). These benefits offered to cotton farmers in Zimbabwe through contract farming have been observed to be crucial, since before the introduction of contract farming these farmers were facing the problem of high inflation rates and inconsistent supply of inputs from the government. Thus contract farming has proved to be crucial to the cotton farmers in Zimbabwe (Singh, 2002), 2009).

The government of Zimbabwe has been vigilant in attempts to ensure the sustainability of cotton production in Zimbabwe. Thus in the year 2016 it introduced another statutory instrument (SI 64 of 2016, which aimed to regulate against importation of cotton products that can be manufactured locally in the country. In order to import cotton products in Zimbabwe the statutory instrument required permits (Government of Zimbabwe, 2017). The statutory instrument was mainly focused on ensuring the sustainability of cotton production in Zimbabwe as it aimed to reduce the competition and also to ensure that the local industries compete with the foreign cotton companies. Also the statutory instrument ensured that the supply chain between small holder farmers and ginners is not affected by entrance of foreign companies, hence it aimed at ensuring the sustainability of cotton production in Zimbabwe (Dumbu & Karonga, 2013).

The sustainability of cotton production in Zimbabwe is essential since lack of sustainability will likely result in welfare challenges in the country (GOZ, 2004). Due to the economic conditions which have negatively affected the cotton farmers in Zimbabwe, the government is implemented measures to support the sector. Evidence has indicated that child malnutrition has since increased from 13 percent in 1999 to 20 percent in 2002 (Dekker, 2009). Also the adverse effects of bad macro-economic conditions on cotton farmers in Zimbabwe has been increased HIV / AIDS as a result of poverty accumulated from low cotton production levels which have affected the cotton farmers in Zimbabwe (World Bank, 2007).

2.4 Economic viability of cotton production in Zimbabwe

In order to improve the economic viability of cotton production in Zimbabwe, several actions have been introduced which include the Pfumvudza system (climate-smart proof agriculture). According to Mavesere & Dzawanda (2023) *pfumvudza* is a Zimbabwean vernacular word which refers to the accumulation of new leaves during the spring season which is an indicator of new farming season

evolving. In addition, Mavesere & Dzakwanda (2023) described Pfumvudza as a conservation agriculture technique which involves crop production intensification approach which involves farmers utilizing resources on small scale range so as to maximize on management. Since climate change has been evident to have induced droughts and negatively affecting the viability of cotton production, particularly in small holder farmers, the industry is exploring new adaptation strategies (Frischen et al., 2020); Mait et al., 2015; Tadesse, 2016). The government of Zimbabwe has responded by introducing the concept of Conservation agriculture which is based on three principles which includes rotation of crops planted, mulching and minimum tillage, with major aim on maximization on yield (FAO et al., 2020). As cotton farmers adhere to the principles of Pfumvudza, this has been observed to have resulted in improved yields as compared to farmers who did not adopt the principles of Pfumvudza. Matsa (2021) ascertained that those farmers who adopted the Pfumvudza concept attained 800 percent more yields as compared to those that did not adopt Pfumvudza. Thus through the Pfumvudza concept farmers have a higher chance of getting increased yield which enables them to attain more revenue and improve the viability of cotton production (Mujere, 2021).

Also the occurrence of droughts in Zimbabwe has lowered the cotton production and intercepted the country from attaining the sustainable development goals, which includes depletion of poverty, eradication of hunger and promotion of good health within the societies in Zimbabwe (Frischen et al., 2020). Therefore, the Pfumvudza concept was adopted in order to improve production and counter challenges resulting from climate change. If the yields of cotton are improved through Pfumvudza concept farmers are assured of more revenue as production increases and in turn increases the viability of cotton production in Zimbabwe (Mujere, 2021).

In order to improve the viability of cotton production in Zimbabwe, the government of Zimbabwe often uses policies that aim to improve the viability of cotton production. For example, in the year 2009 the government introduced legislation that aimed to curb side marketing during the production process of cotton (Mujeyi, 2013). There was introduction of the statutory instrument SI 142 as a legislation that aimed to hinder side marketing and also ensure that there was long term viability of cotton production in Zimbabwe through the entire production process of cotton (Mujeyi, 2013). As legislations are introduced to curb side marketing this ensure accountability in the use of inputs as farmers are obliged by legislation to make use of the inputs they are given by the contractor in the

production of cotton. Thus viability of cotton production is attained through these legislations that are introduced by the government.

Also the introduction of contract farming has been observed as a contributing factor in the attainment of the viability of cotton production in Zimbabwe (Mujeyi, 2013). As cotton farmers are allocated inputs for use in the production process of cotton, this could increase the size of cotton under production, improvement of the quality of cotton and also ensure a guaranteed market for the cotton produced. Allocating quality inputs to farmers ensures that there is improved cotton production and quality which enable farmers to sell the cotton produced at a higher price thus attaining the viability of cotton production in Zimbabwe (Svotwa & Mapfumo, 2015). As postulated by Poulton & Hanyani-Mlambi (2008) the high input costs which are incurred by the farmers reduced the viability of cotton production in Zimbabwe as the profit gains obtained are lower as compared to the cost improved quality seed. Thus through legislation imposed by the government to ensure that cotton farmers are allocated inputs through contract farmer could lower the cost of production and ensure the improved viability of cotton production in Zimbabwe (Poulton & Hanyani-Mlambo, 2008).

The introduction of subsidies on cotton can be a promising strategy to improve the viability of cotton production in Zimbabwe (Buka, 2016). In Zimbabwe it has been observed that there has been absence of subsidies on the cotton production so as to cushion cotton farmers. Due to absence of subsides that aims to cushion cotton farmers, there has been distortion in the international trade as cotton farmer in Zimbabwe are producing cotton at a relative higher cost. This has resulted in the cotton produced in Zimbabwe becoming more expensive thereby reducing the Zimbabwe produced cotton demand on the international market. This contributes to reduced viability of cotton produced in Zimbabwe, thus subsidies can be used as a tool that can improve the viability of the cotton produced in Zimbabwe (Buka, 2016).

The problem of unfair and unstable pricing in Zimbabwe has been evident since 2008 when has left many cotton farmers were short changed and their viability affected negatively (Dekker, 2009. In order to improve the viability of cotton production in Zimbabwe, consultative meetings on producer price of cotton was observed to have helped in the improvement of cotton viability in Zimbabwe (Mujeyi, 2021). As published on the Cotlook an index the consultative meetings to negotiate the producer price of seed cotton involved the analysis of the farmers and ginners cost of production and also the existing international market price of cotton lint. The main aim was to assess a level of

equilibrium in which both the farmers and ginners are able to maximize the profits so that both the farmer and ginners attain viability in their production (Mujeyi, 2021). Hence these consultative meetings are crucial in improving the viability of cotton production in Zimbabwe.

In order to improve the viability of cotton production in Zimbabwe, good policies that promotes agricultural production have been observed to be an effective mechanism (Chigumira, 2017). In the year 2013 in Zimbabwe, the Zimbabwe Agriculture Investment Plan (ZAIP) 2013- 2017 evolved. It was focused on principles which included increasing the production and productivity through improved management and sustainable use of land, water, forestry and wildlife resources, increased participation of farmers in domestic and export markets through the development of efficient agricultural marketing systems (Chigumira, 2017). Also these principles involved in the (ZAIP) are crucial in the attainment of viability particularly in the cotton production in Zimbabwe, as it is supported by Olujenyo (ND) who postulates that profit maximization can be attained through maximizing output from a given resource. Thus through the policies introduced such as (ZAIP) viability can be attained as the policy focused on increasing production which as stated by Olujenyo (ND) results in the viability being observed.

In Zimbabwe, research and development is crucial in the attainment of viability of cotton production (Chigumira, 2017). Research and development has been observed to have resulted in high yielding cotton varieties which contributes to increased production. Thus viability is attained as cotton farmers are able to increase production as a result of improved technology from research and development (Chigumira, 2017). Chigumira (2017) has indicated that the agriculture research act (Chapter 18:05) was provided for the establishment of research and development in order to improve the viability of cotton production in Zimbabwe.

Mahofa (2013) postulated that the production of cotton is mainly constrained by high duty that is taxed on the imported agricultural inputs which result in increased cost and reduced viability. Thus the fiscal incentives by the government of Zimbabwe can act as a measure to improve the viability of cotton production in Zimbabwe (Chigumira, 2017). The Farmers Special deductions which involved farmers being allowed to receive special deductions which included over and above normal deductions is a useful tool ensuring viability in the cotton production in Zimbabwe. The special deduction which may include reduction in the expenditure on fencing, stumping land, sinking boreholes and wells can help cotton farmers attain viability. As the reduction of these costs enables

farmers to maximize on production which results into the viability of cotton production in Zimbabwe. The fiscal incentives to boost agricultural production in Zimbabwe, inputs for agricultural production which includes fertilizers, seeds and pesticides for cotton are zero rated in terms of tax percentages. This results in reduction in the costs of producing cotton as the costs of improving this inputs decline, in return in promotes improves production which results in improved viability of cotton production in Zimbabwe (Zimbabwe Revenue Authority, 2016).

In Zimbabwe the government attempted to improve the viability of the cotton production through the Presidential Input Scheme (Chigumira, 2017). The presidential input scheme established in 2013 ensured the supply of inputs to the farmers through the provision of seed and fertilizers. The presidential input scheme aimed to assist constrained farmers so that they can be able to boost their agricultural production in particular cotton so that viability can be attained.

If the problem of transport is solved in the cotton sector particularly to cotton farmers in transporting the cotton produced to the market, the viability of cotton in Zimbabwe can be attained (Mahofa, 2013). As indicated by Mariga (1994), communal farmers in Zimbabwe face a problem of transport bottlenecks which results in the late marketing of the cotton produced which results in reduced viability of cotton production in Zimbabwe. The problem of late marketing of cotton in Zimbabwe caused by transport problem results in a cycle of problem which includes late purchase of inputs for the next season, late planting and reduced yield for the coming seasons. Thus if the transport problem is solved this acts as a strategic tool in improving the viability of cotton production in Zimbabwe as there will be quick further allocation of resources towards the cotton production (Mahofa, 2013).

Sound and effective macro-economic policies can be used as a strategy to boost the viability of cotton production in Zimbabwe (Mahofa, 2013). In Zimbabwe several economic challenges have been faced which includes shortage of foreign currency to support the provision of agricultural inputs. Evolving from the year 2000 the cotton sector in Zimbabwe has faced the economic challenges which includes high levels of inflation, unstable official exchange rates and shortage of key commodities which are vital in the cotton production which include fuel (Mlambo & Poulton, 2003). This has in turn affected the cotton viability in the country negatively as it has resulted in reduced gains from the production. Hence if the government enhances sound macro-economic policies which aim at ensuring stability in the inflation, official exchange rate and availability of fuel in the country this can improve the viability of cotton production in Zimbabwe (Mahofa, 2013).

Improved institutional environment can also be used as useful tool in improving cotton viability in Zimbabwe. As indicated by Poulton et al (2023) existence of weak institutional environment acts as a constraint to improved production and viability of cotton in Zimbabwe. As evident most of the production of cotton in Zimbabwe is contributed by contract farming with 70 percent of the production coming from cotton production (Chizarura, 2007). Thus there is need to establish good institutional laws that aim to enforce contracts engaged between the farmers and the ginners so that viability is attained in the production process of cotton (Mahofa, 2007).

2.5 Theoretical framework

The study is set to be guided by several theories that aim to support the concepts involved in the study. This section illustrates various theories that support this study.

2.5.1 Profit maximization theory

The profit maximization theory, which is elaborated by the work of various scholars postulate that smallholder farmers aim to maximize profits for their production activities (Machingura, 2019). In this theory smallholder farmers are treated as farm businesses whose main target of production is to allocate resources in order to maximize profit (Umar, 2013). Thus, cotton farmers in Zimbabwe particularly in Gokwe are viewed as agents who aim to maximize profits from the production of cotton through the allocation of adequate resources towards the production of cotton. In this theory of profit maximization, the assumption is that resources and production conditions which these farmers encounter are the same and that the markets for the inputs such as labour, capital, and out are competitive. In the profit maximisation theory Schultz made an assumption that small holder farmer's correlate positively to the price incentives offered on the products they produce and ascertains that low output in the production was a result of low output per given area of the available factors of production. In cotton production in Zimbabwe there is a characteristics of low production, since there is usually low availability of resources to be used in the production process.

In the profit maximization theory Schultz further argued that in case of harsh conditions characterized by risky activities farmers learn quickly to adapt to the conditions and allocate their resources efficiently in a manner that results in the profit maximization. In Zimbabwe cotton farmers have been seen to have adapted effectively to the harsh economic conditions which are usually characterized by high inflation rates, un-stable exchange rates and high unemployment (Umar, 2013).

2.5.2 Risk bearing theory of profit

The theory of risk bearing is derived from Hawley (1921), who suggested that someone who undertakes a risk in order to engage in a particular business activity attains profit based on the risk he/she undertakes to start the particular business. In this theory of profit which correlates with the study, the level of output attained by the entrepreneur is positively correlated with the amount of risk the entrepreneur engages in. Thus the risky theory of profit correlates with my study which aims to determine the profitability of cotton production in Zimbabwe, particularly by cotton farmers in Gokwe. Thus cotton farmers in Zimbabwe are viewed in relation to this theory as risk takers who produce cotton in spite of harsh economic environment, harsh political environment, harsh climatic environment and harsh institutional environment. As cotton farmers engage in all these risks, as stipulated by the theory they are guaranteed to attain more profit as they engage in risky activities during their cotton production process. The risk cotton farmers may engage in may include producing cotton under an environment characterized by high levels of competition which may results in reduced prices for the cotton produced. Kwa (2001) postulated that as the costs of producing cotton increases, the international prices of cotton declines. Thus this negative correlation between high cost of production and reduced prices of cotton results in farmers facing the risk of producing cotton and selling it at a lower price which is usually not viable. The risk theory of profit relates to the study as farmers of cotton are characterized as risk takers who faces several risks during their cotton production process.

2.5.3 Innovation theory of profit

This theory of profit interacts with the study as it postulates that the creation, development of new products of ways of producing products results in the attainment of profit. Thirtle et al (1990) indicated that agricultural production which includes cotton production in Zimbabwe is positively affected by the adoption of new technologies. Developed by Schumpter, the innovation theory of profit ascertains that through the creation of new products or production process profit can be attained. Thus in relation to the study cotton farmers in Zimbabwe are estimated to attain profits if they engage in innovation which results in the new ways of producing cotton at a limited cost. If farmers find ways through research to produce cotton at a limited cost profit is attained as stipulated in this theory the allocation of adequate resources towards research and development and extension services results in improved profits and development in the cotton sector in Zimbabwe (Mahofa, 2013).

2.5.4 The economic theory of market operations

Also in this study the economic theory of market operations is relevant in effectively addressing the concepts involved in the study which include sustainability. In this theory the assumption is that the forces of demand and supply are responsible for the determination of the amount of output produced of a particular product (Zhao and Tisdell, 2010). The theory further postulates that an increase in demand for a particular product will to a greater extent increase the market supply of the product. The increase in supply of the product attracts more producers to produce the product in order to meet the demand, in the case of cotton production in Zimbabwe the demand for cotton has increased globally which has resulted in increased need by the cotton farmers to produce cotton. Hence the theory of economic theory of market operations is effective in explaining the principles involved in the study which includes profitability and sustainability of cotton production (Zhao & Tisdell, 2010).

In addition, the theory of market operations interacts with the study, since it indicates that the price of a particular product is determined by the forces of demand and supply (Zhao & Tisdell, 2010). Thus the price of cotton in Zimbabwe relates effectively to the principle of market theory as the absence of subsidies on cotton production in Zimbabwe has resulted in distorted internal prices of cotton. Thus absence of subsidies on cotton production results in reduced supply of cotton in the country. This results in increased prices of cotton as the supply of cotton was reduced. The sustainability of cotton production in Zimbabwe is influenced by market forces, specifically the balance between demand and supply. According to economic theory, a decrease in cotton supply can lead to an increase in demand, potentially driving up prices. However, this can have a negative impact on the sustainability of cotton production. Vice-versa an increase in the supply of cotton in Zimbabwe will results in the prices of cotton sold to merchants being low which affects the sustainability of cotton production negatively.

2.5.5 Absolute advantage trade theory

The theory was developed by Adam Smith (1776) who was seen as the father of economics. In the theory Adam Smith postulated that absolute advantage as the process by which a particular individual or a nation attains production of a particular product at a relative lower cost as compared to others. The theory suggests that an individual or nation that trade across borders should specialize in producing goods that they have an absolute advantage over another. This theory of absolute advantage relates to the study as Gokwe is characterized as a drought prone area which receives low rainfall and

less suitable for the production of crops which requires adequate rainfall. Thus if farmers are to produce other crops which require large amounts of rainfall they will have to engage irrigation which results in increased cost of production. Cotton requiring low rainfall and often sustain in drought conditions is suitable for production in Gokwe as farmers produce cotton at a relative lower cost. Thus farmers in Gokwe produce cotton as they produce it at a lower cost of production in addition with them being supplied inputs by the government. This enables cotton farmers to attain an absolute advantage as postulated in the Absolute advantage theory by Adam Smith. Also the production of cotton in Gokwe is characterized by cheap labour which results in reduced costs of production. Most of the farmers in Gokwe make use of family labour and also engage in cotton production themselves which results in cotton farmers producing cotton at a relatively lower cost of labour (Larsen, 2002). This creates an absolute advantage to the farmers as through the use of family labour they are able to produce cotton at a relatively lower cost of production. Thus this study correlates positively with the absolute advantage theory postulated by Adam Smith.

2.5.6 Dependency Theory

The dependency theory can be incorporated in the study, as it states that resources flow from the periphery (the poor) to the rich and wealth, in the equation the wealth benefits from the manipulation of the poor (Ferraro, 1996). The poor produces resources and sell the resources to the wealth at a lower price which results in the wealth gaining profit as they obtain the resources at lower costs from the poor and sell the resources at a higher cost, thus attaining wealth in the process. The dependency theory can also be applied at internal level, with the poor nations attaining low revenue from the products they produce as they sell the products to the rich nations at a relative lower prices (Rodney, 1973).

This theory of dependency interacts effectively with the study as cotton farmers in Zimbabwe particularly Gokwe., The farmers produce cotton and sell it to the government and other cotton companies at relatively lower prices. However, the government and cotton companies' benefits a lot as they sell the cotton produced to international companies and charge higher prices thereby attaining huge profits (Musara & Dziwa, 2015). This situation where farmers sell at a lower price to the government and cotton companies, results in imbalance between the farmers and the buyers. Weak

bargaining power by the cotton farmers is the end result with farmers being unable to negotiate for improved prices and conditions of trade (Musara & Dziwa, 2015).

2.5.7 World Systems Theory

In addition, the world systems theory relates to the study, the theory correlates with the dependency theory as it aims to indicate the differences that occur in the cotton production system. The world systems theory postulates that global economy is a single, integrated system characterized by a hierarchical structure of core, semi-periphery, and periphery countries. The theory indicates that there are three groups in the production process which involves the core, semi-periphery and periphery. In this system the semi-periphery acts as an agent who manipulates the core and sell the produce to the periphery. This acts as a reason why most of the cotton farmers in Zimbabwe are less developed and also poor. Cotton farmers are viewed as the periphery and are exploited by the semi-periphery which is the government as it offers lower prices to the cotton farmers. In return the government and the cotton companies who takes advantage of the cotton farmers are further exploited by the international participants who take advantage of the gazette exploitative prices. The theory further postulate that inequalities exists in the production systems with one benefiting at the expense of the other (Musara & Dziwa, 2015).

2.6 Conceptual framework

The conceptual framework for analysing the economic sustainability of cotton production in Zimbabwe provides a comprehensive structure for understanding the complex interactions between economic, environmental, and social factors. By examining the relationships between these components, this framework acknowledges that economic viability is essential for cotton production, but also recognizes the significance of environmental stewardship, social responsibility, and economic responsibility. The framework highlights the need to balance economic goals with environmental concerns, such as water conservation and soil health, as well as social considerations, including labour rights and community well-being. By applying this framework, researchers can identify key drivers of sustainability and develop targeted interventions to improve sustainable cotton production in Zimbabwe. This framework can also inform policy decisions and industry initiatives aimed at improving the economic, environmental, and social performance of cotton sector in Zimbabwe, thus ultimately contributing to a more sustainable and resilient agricultural industry.

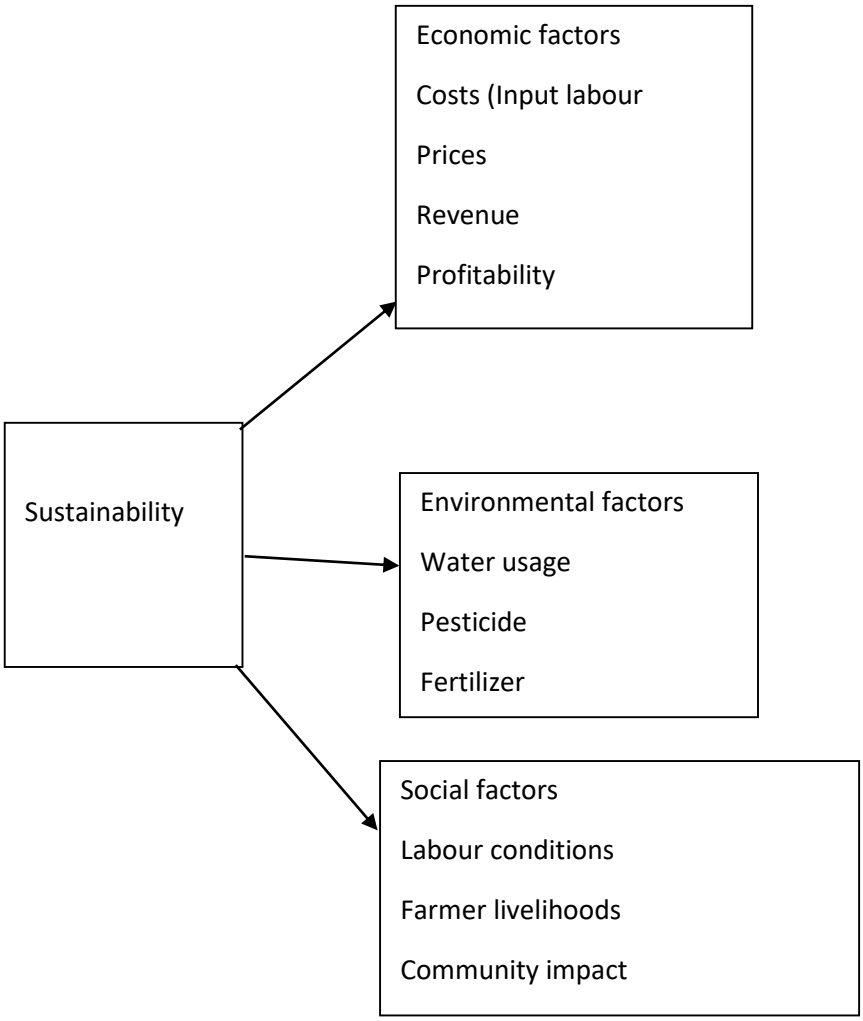


Figure 3:1 Conceptual framework-social economic and environmental sustainability of cotton Production Gross margin analysis

The study used the gross margin analysis and its association to production costs and gross incomes. In literature, gross margin refers to the revenue that remains in a particular enterprise after the variable costs of production are subtracted (Ghambi, 2015). In addition, a gross margin budget refers to the full approximation of the output, cost of production and viability of an individual crop. The gross margin budget will combine all costs incurred during the production process for a particular enterprise, for example, it shows the profitability of and particularly enterprise.

Gross margin analysis aims to measure the viability of a particular section of a production process on which the farmers aims to specialize the production on, given the availability of the resources. Gross margin analysis in addition can be used to perform the cost benefit analysis of engaging in a particular crop given the farmer wishes to diversify the crops grown (Ghambi, 2015).

The formula for measuring gross margin

$$Gross\ margin = Gross\ income - Cost\ of\ production$$

(Ghambi, 2015)

Where gross margin is the difference between gross income (price of the product multiplied by output) and the cost of production thus the sum of all variable costs incurred in the production process. Due to the fact that total fixed cost are not negligible (Olukosi and Erhabor, 1988 and Samboko, 2011), the gross margin analysis was used in the study.

Hazel (1971) revealed that gross margin is gross output (price multiplied by yield) deduct variable cost or direct costs which are incurred. In order to come up with the gross revenue (total gains), output in kilograms per hectare will be multiplied by the upper price at which the farmer sold the cotton. A blend of all variable cost per yield in relation to costs per area planted will be identified through a standard and structured questionnaire. The cost will include the cost of labour, implementation of the production process and also the cost of inputs. The variables cost that was use in the research will include labour, planting, seeds, chemicals and also transportation of cotton. The value inserted on the particular cost of production will be deducted from the total gross revenue in order to come up with the gross margin analysis. In conclusion the gross margin will then be concluded as the discrepancy between the total revenue and the total cost of production.

2.7 Importance of cotton production in Zimbabwe

Cotton production is a major contributor to Zimbabwe's economy, with smallholder farmers producing around 99% of the country's cotton, according to Mlambo and Poulton (2003). The cotton industry of late is now being considered as the mainstay of the Zimbabwean economy and cotton production is now being assumed to have exceeded tobacco as the nation's greatest foreign exchange earner. The cotton sector is responsible for bringing in an annual export revenue of above US$150 million (GOZ, 2004). Despite the land reform program having adverse effects on the agricultural industries, particularly the tobacco industry, cotton production remains a vital sector for many smallholder farmers in Zimbabwe. However, it did not manage to influence the cotton industry negatively as the industry relied more frequently on the participation of small holder farmers. In the year 2000 and 2001 the opening of new cotton producing areas was a very strong indication that cotton production was not affected negatively by the land reform program in the country (Mahofa, 2007).

Also cotton production in Zimbabwe is considered to have a positive effect on the poverty reduction and improving the livelihoods of cotton farmers. A study by Mlambo et al., (2004) elaborated the impacts on poverty of alternative seed cotton prices. Through the use of a microeconomic model of seven smallholder cotton household types calibrated on 2001 and 2002 research data from Muzarabani and Guruve districts, the study aims to evaluate the economic viability of cotton production among smallholder farmers. They observed that increasing seed cotton prices to ZW$80 resulted in reduction of the proportion of households below nationally defined total poverty line from 56 percent to 38 percent. They also observed that smallholder farmers who had limited access to credit tend to be more responsive to price changes than those who had access to credit (Mahofa, 2007).

In line with the improvement of food security in Zimbabwe, Govereh and Jayne (2002) studied the synergies/ trade-offs between crops grown for cash and food crop production in Gokwe North District. They analysed data with a sample of 430 rural households in the year 1996, the results indicated that after controlling for household assets, education and locational differences, households engaging intensively in cotton production attained greater output, as compared to non-cotton and marginal producers. They managed to assert that potential spill-over benefits for food crops through the involvement in cash crop programs were significant to consider the improvement of ways to intensify food crop (Govereh and Jayne, 2002).

2.8 Review of empirical studies

Larpar et al (2011) observed that the international market is responsible for the big role in the determination of profitability of cotton in Mali. The research revealed that prices during the production season 2005-2006 were not reliable as they did not manage to offset the average costs of production. They observed that the rising inputs costs and reduction in yields were increasingly reducing the profitability of cotton production. In a related study Oxfam (2012) also confirmed that through a survey carried out with cotton farmers in Mali, where results indicated declining household incomes as a result of declining world market prices.

A research study by Minot and Daniels (2002) found that a 40% reduction in farm-gate prices of cotton led to a decline in the number of cotton growers, and would also result in a 7% reduction in farmers' income. According to Manyani et al., (2014), a 40% decline in cotton prices results in a significant increase in poverty among cotton farmers, from 37% to 59%. The results of their study also concluded that there was a strong relationship between the prices of cotton and the rural welfare in Benin. A reduction of farm level prices of cotton by 40% was likely estimated to result in a reduction in rural per capita income of 7% in the short run and 5-6 % in the long run period.

A research by Jayne et al. (1993) made use of the profit function in order to econometrically approximate factors affecting agricultural production in the country. In the research the state marketing infrastructure and increased credit availability was found to be responsible in the stimulation of the crop production. It was also discovered that research and design had negative effect on crop production, however, these results contradict the findings of Thirtle et al (1990).

A study by Ghambi, (2015) analysed the market participation and profitability of cotton production. The study used a two-step analysis in order to calculate the profitability of cotton production. In the study the first step involved gross margin analysis in order to determine total revenue value of cotton production. In the second stage, the research conducted a multiple regression model in order to identify factors influencing profitability of cotton. The study managed to identify the factors that influenced the profitability of cotton production. These factors were farm gate price, land tenure, level of education of the household head, age of household head, gender of household head, household size, off farm income received, extension services, experience in production of crop and distance to the market (Rearden, et al., 1997; Samboko, 2011). In addition, crop prices, level of returns and costs involved in the production process were also found to influence cotton profitability (Samboko, 2011;

Odhiambo, Kristanson & Kashangaki, 1996). Liszbinski et al. (2020) analysed sustainability in Soyabeans production from the perspective of the producers. The research used descriptive and quantitative statistics in order to achieve its main objectives. The study made use of a sample of 179 participants and data was collected inform of questionnaires and online platforms, according to Malhotra (2012) online platforms have been used more frequently as they are more reliable, easy to access the target population and also lower cost in carrying out the study.

In order to analyse factors affecting maize production, productivity and profitability in Zimbabwe. A study by Gwara (2011) extensively evaluated the responsiveness of maize supply to price and none price determinants. The study made of use time series maize data which dated from 1980 to 2007. The results of the assessment showed that prices did not play a crucial role in the explanation of maize productivity variability. The research came to the conclusion that price only cannot be the only factor that influence cotton production, rather a combination of other factors influenced the cotton production. These factors included non-price factors which included credit allocation and access, rainfall, level of consumption and area put under maize were found to significantly affect maize supply response. The research recommended solutions that to greater extent targets none price factors as means of doing away which price factors in accessing the production of maize.

Research based on a sample of 400 farmers concluded that marketing costs were a major factor affecting maize supply, playing a crucial role in agricultural household decision-making. The research established policies that aim to reduce the cost of marketing in order to ensure that farmers adequately obtain their return in investment, which results in food security in Nigeria.

In addition, a study by Naima (2021) which aimed to analyse the profitability and resource use efficiency of wheat production in some selected areas of Naogan district in Bangladesh, made use of a sample of 80 respondents picked from four villages as a representation of the study. This study made use of a simple random sampling technique in order to collect data from the samples. In addition, the study made use of both primary and secondary data. The Cobb Douglas production function was used in the analysis in order to match the requirements of the study. The study observed that there was overuse of labour, land preparation, manure and irrigation for wheat farming and also seed, fertilizers and pesticides were underused. The study also observed that wheat farmers had challenges which included lack of operating capital, shortages of fertilizers, lack of good quality seeds, disease, pest

infestation, and shortage of facilities, lack of transport, low market price of wheat product and higher prices of wheat inputs.

Zhao & Tisdell (2010) used the economic theory of market operations in order to provide a background of factors influencing the sustainability of cotton production. The theory of market operations claims that market demand and supply conditions are responsible for the determination of the volume of production of a commodity and the direction of change. When things are held constant the theory of market operations ascertains that when the demand for a product rise the average price of the product will also rise. In the case of cotton, they observed that the average demand has increase and there is been observed tendency of the willing of farmers to supply cotton (Zhao &Tisdell, 2010).

Zhao & Tisdell (2009) through the use of linear regression model observed a close relationship between cotton output per hectare as a function of time in the world, China and Australia on the basis of data for the period 1980-2007. As stipulated in the regression analysis Zhao and Tisdell (2009) observed that world cotton yields per hectare showed to increase by 9.77 kg per year while China's and Australia cotton output increased by 22.27 and 29.93 kg per year, respectively.

2.9 Research Gap

The review of empirical studies related to the research topic and objectives highlights that cotton production plays a significant role in improving food security and alleviating poverty, particularly among smallholder farmers in Zimbabwe. Although several studies have addressed similar topics, few have analyzed sustainability of cotton production in Zimbabwe incorporating environmental, social and economic factors. This study aims to assess the factors affecting cotton production in Zimbabwe and provide crucial information on strategies to improve cotton sustainability. Additionally, it seeks to analyse the sustainability of cotton production at the household level, an area that has received limited attention in previous research. The literature on the sustainability of cotton production in Zimbabwe is also scarce, and this study aims to fill these gaps.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides the methodologies that was used in this study including the analytical framework. This chapter elaborated the research design, the relationship between hypothesis, objectives and method of analysis,

3.2 The formula for measuring gross margin

Gross margin = Gross income – Total variable costs (Ghambi, 2015) where Gross income refers to the total amount of income earned from a particular source, before deducting expenses, taxes, or other deductions (FAO, n.d), and Total variable costs refer to the sum of all costs that vary directly with the level of production or output (Debertin, 2012).

A research which was undertaken by (Hazel, 1971) concluded that gross margin is gross output (price multiplied by yield) deduct variable cost or direct costs which are incurred. In order to come up with the gross revenue (total gains), output in kilograms per hectare was multiplied by the upper price at which the farmer sold the cotton. A blend of all variable cost per yield in relation to costs per area planted was identified through a standard and structured questionnaire. The cost included the cost of labour, implementation of the production process and also the cost of inputs. The variables cost that was used in the research included labour, planting, seeds, chemicals and also transportation of cotton. The value inserted on the particular cost of production was deducted from the total gross revenue in order to come up with the gross margin analysis. In conclusion the gross margin was then be concluded as the discrepancy between the total revenue and the total cost of production.

3.3 Research design

This research adopted quantitative research design because of the characteristics of the study objectives. A quantitative research design refers to a system that aims to obtain data through a formal, objective, systematic process that collects numerical data. The study objectives mainly targeted quantifiable information which relates to production costs, revenue attained and several quantifiable variables, hence the research design made use of the quantitative research design.

3.4 Relationship between objectives, hypothesis and method of analysis

Table 3.1 Relationship between objectives, hypothesis and method of analysis

Objective	Hypothesis	Data required	Method of analysis
1) To analyse the sustainability of cotton production in Zimbabwe	Cotton production in Zimbabwe is profitable.	Primary data on seed cotton yield ha^{-1}, seed cotton variable costs ha^{-1}, seed cotton producer price kg^{-1}	Gross margin Analysis Chi-Square tests
2) To analyse the social , economic and environmental sustainability of cotton production in Zimbabwe	Cotton production in Zimbabwe is sustainable	Primary data on social sustainability, economic sustainability and environmental sustainability	Chi-square test and Likert scale
3) To determine factors affecting cotton production in Zimbabwe	The following factors affect cotton production	Level of education House hold size Farming experience Number of cattle owned Distance to the market	Quantile regression analysis
4) To suggest strategies of sustainable cotton production in Zimbabwe	The following factors are strategies for sustainable cotton production	Reducing gender discrimination Training of farmers Increased family size Increasing extension frequency Improved number of cattle owned Bringing markets closer to farmers Promoting farmer membership to organisations Improved mechanisation Improved access to credit Improved pest and disease control Early land preparation Timely arrival of inputs	Chi-Square tests

3.5 Analytical frame work

The techniques and strategies used in this research included descriptive statistics, Chi-square test, and quantile regression analysis. Descriptive statistics were used to summarize and describe the characteristics of the data, while the Chi-square test was employed to examine the relationships between categorical variables. Quantile regression analysis was utilized to model the relationships

between the predictor variables and the outcome variable, gross margin, at different points in its distribution. These techniques are discussed in more detail below, along with their limitations and potential drawbacks.

3.5.1 Descriptive Statistics in the Study

Descriptive statistics were employed in this study to summarize and describe the characteristics of the data collected on cotton production in Gokwe, Zimbabwe. Specifically, measures of central tendency (mean, median, and mode) and variability (standard deviation, range) were used to describe the distribution of key variables such as cotton yields, input costs, and farmer demographics. Frequency distributions and cross-tabulations was utilized to identify patterns and relationships between variables. By applying descriptive statistics, this study aimed to provide a clear and concise overview of the state of cotton production in the study area, facilitating a better understanding of the factors influencing its sustainability and profitability.

3.5.2 Chi-Square Test in the Study

The chi-square test of independence was utilized in this study to examine the relationships between categorical variables related to cotton production in Gokwe, Zimbabwe. Specifically, the test was applied to investigate associations between variables such as farmer demographics (e.g., age, education level) and adoption of sustainable cotton production practices, as well as between farm characteristics (e.g., farm size, irrigation status) and cotton yield outcomes. By using the chi-square test, this study aims to identify significant relationships between these variables, providing insights into the factors that influence the sustainability and profitability of cotton production in the study area. The results informed recommendations for policymakers, farmers, and other stakeholders seeking to improve the cotton sector in Zimbabwe. Quantile Regression Analysis in the Study

Quantile regression analysis was employed to examine the relationships between predictor variables and the outcome variable, gross margin, across different points in its distribution. Specifically, the analysis investigated how variables such as farmer demographics, farm characteristics, and production practices influenced gross margin at the 25th, 50th, and 75th quaintiles. By analysing the relationships at different quantiles, this study provides insights into the heterogeneous effects of these variables on cotton production profitability, shedding light on the factors that impact the most profitable and least profitable farmers. The results offer valuable information for policymakers and farmers seeking to enhance the productivity and profitability of cotton production in the study area.

3.6 Method of analysis in relation to objectives

Objective 1: To assess the sustainability of cotton production

To attain this economic sustainability, gross margin analysis was conducted to assess the viability of cotton production. Thus the revenue was calculated by multiplying the number of kilograms produced by the farmer market value of kilogram of cotton in the market. Costs involved in the cotton production were collected which involves fertilizers, pesticides, herbicides, labour, plating, weeding, grading, packing, transport, land preparation, seed. Thus the formula for gross margin revenue less cost was used to assess the viability of cotton production. Chi-square tests were conducted in order to assess the social sustainability of cotton production. Thus factors which includes access to market, community engagement, fairness of labour practises and access to resources were tested using Chi square test. In addition, Chi-Square tests were also conducted to assess the environmental sustainability of cotton production. Factors which includes soil management practises, water conservation, and frequency of using chemicals were used in the study

Objective 2: Factors affecting cotton production

To attain the objective of determining factors affecting cotton production, this study examined the correlation between various socio-economic and institutional factors and cotton production outcomes. Specifically, the study investigated the impact of gender, level of education, farming experience, extension frequency, number of household assets (proxied by cattle ownership), distance to the market, and membership in farming organization on cotton production. By examining these factors using statistical tests, such as Chi-square test, this study aimed to identify the significant determinants of cotton production and provide insights for improving cotton production.

3.6.3 Objective 3: To suggest strategies for sustainable cotton production in Zimbabwe

To identify strategies for sustainable cotton production in Zimbabwe, this study examined various factors that can contribute to improved productivity and sustainability. The factors investigated included reducing gender discrimination, training farmers, increasing family size, enhancing extension frequency, improving household assets, bringing markets closer to farmers, promoting farmers membership in organisations, improving mechanization, access to credit, pest and disease control, early land preparation and timely input delivery. The study used Chis-square statistical tests to analyze the impact of these factors on sustainability cotton production.

3.7 Data collection

The study made use of mainly primary data collected using a standard questionnaire. The standard questionnaire used in the collection of data contained various questions which aimed to address the objectives stated in the study. The questionnaire contained questions relating to the profitability of cotton production, sustainability of cotton production and factors that affect cotton production in Zimbabwe (Appendix1). Also a key informant interview questionnaire involving questions that targeted key stakeholders in the cotton production was used (Appendix 1).

3.8 Study site description

The research collected data from Gokwe which is the largest district in Zimbabwe and is located in the north-western parts of the country. Gokwe is located in the Agro-ecological Region III according to the agro-ecological classification agro-ecological classification, which is characterized by receiving 600-650 mm of rainfall annually, temperature's ranges from 20 to 31 degrees. The altitude ranges from approximately 900 to 1200 metres. In Gokwe, production of cotton is the major source of agricultural income, with every household being involved the production of the crop (Nyambara, 1999). The district is dominated by communal followed by resettlement land tenure system. The inhabitants of Gokwe are a combination of mixed tribal origins, because of people who migrated to the region in order to take advantages growing cotton in the area (Dzingirayi, 1999). The occurrence of people of mixed tribal origins makes Gokwe suitable for conducting the research as it represents a diverse socio-cultural landscape of the country.

3.9 Research process

The initial approach to participants involved familiarizing with the research area through a preliminary visit. This mini survey was conducted by interacting with key informants in the field of cotton, including Agritex officers, village heads, lands officers, representatives from the Zimbabwe Farmers Union, and Cottco representatives. Sampling was carried out following this preliminary survey.

3.10 Sampling method

A multi-stage random sampling technique was employed to select a sample of 300 farmers from six villages in the study area. The sampling frame was stratified into three production structures: high-producing, low-producing, and medium-producing farmers. This stratification allowed for a representative sample of farmers across different productivity levels with three villages from Gokwe

North and three villages in Gokwe South. Within each village, a list of farmers was compiled and categorized into one of the three production strata, and then farmers were randomly selected from each production stratum, ensuring a diverse and representative sample. The total sample size of 300 farmers was allocated proportionally across the three strata. This approach enabled the study to capture the variability in cotton production practices and outcomes among farmers in the region, providing a robust foundation for analysis and inference.

CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents the findings of the study, sustainability of cotton production in Gokwe district, Zimbabwe: an economic, environmental and social analysis. The chapter starts by presenting the response rate, followed by demographic data before presenting the study findings according to the specific objectives of the study.

4.2 Demographic data

The respondent's demographic data including age, education level, farming experience, marital status and household size are shown on Tables 4.1-4.6. The majority (70.3%) of participants were women while men only constituted 29.7%. The age distribution was categorized into young (18-27 years, 8.4%), middle-aged (28 to 37 years, 3.7%), 48 to 57 years, 31.9% and old aged (above 57 years, 56%). In terms of education, 61.7% of farmers had not gone to school, 31.7% had primary education, 5.0% had a national certificate, and 1.7% were Master Farmers. The majority of participants (57.7%) had a household size of 7-8 members, while 31% had 1-2 members. Farming experience was categorized as follows: 5 years or less (27%%), 6-10 years (6.3%), 11-15 years (38%), 16-20 years (6.2%) and 21-25 years (3.3%) and ≥ 25 years. Marital status-wise, 49.3% were married, 24% were widowed, 15.3% were single, and 11.3% were divorced. 15% of the farmers had national certificate in agriculture and only 1.7% had master farmer training in cotton production.

Table 4.1 Gender distribution of cotton farmers who participated in the survey in Gokwe district, Zimbabwe

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	89	29.1	29.7	29.7
Female	211	69.0	70.3	100.0
Total	300	98.0	100.0	

Table 4.2 Age distribution of cotton farmers who participated in the survey in Gokwe district, Zimbabwe

Age	Frequency	Percent	Valid percent	Cumulative
18-27	25	8.2	8.4	8.4
28-37	11	3.6	3.7	12.10
38-47	59	19.3	19.8	31.9
48-57	36	11.8	12.1	44.0
>58	167	54.6	56.0	64.4

Table 4.3 Level of education of cotton farmers who participated in the survey in Gokwe district, Zimbabwe

	Frequency	Percent	Valid Percent	Cumulative Percent
Master Farmer	5	1.7	1.7	1.7
National Certificate	15	5.0	5.0	6.7
Primary	95	31.7	31.7	23.3
Not gone to school	185	61.7	61.7	68.3
Total	300	100.0	100.0	

Table 4.4 Number of years in farming of cotton farmers who participated in the survey in Gokwe district, Zimbabwe

	Frequency	Percent	Valid Percent	Cumulative Percent
≤5 Years	81	26.5	27.0	27.0
6-10 YEARS	19	6.2	6.3	33.3
11-15 YEARS	114	37.3	38.0	71.3
16-20 YEARS	19	6.2	6.3	77.7
21-25 YEARS	10	3.3	3.3	81.0
>25 Years	57	18.6	19.0	100.0
Total	300	98.0	100.0	

Table 4.5 Household size of cotton farmers who participated in the survey in Gokwe district, Zimbabwe

		Frequency	Percent	Valid Percent	Cumulative Percent
	1-2	93	30.4	31.0	31.0
	3-4	11	3.6	3.7	34.7
	5-6	8	2.6	2.7	37.3
	7-8	173	56.5	57.7	95.0
	9+	15	4.9	5.0	100.0
	Total	300	98.0	100.0	
Total		306	100.0		

Table 4.6 Marital status of cotton farmers who participated in the survey in Gokwe district, Zimbabwe

	Frequency	Percent	Valid Percent	Cumulative Percent
Single	46	15.3	15.3	15.3
Married	148	49.3	49.3	64.7
Widow / Widower	72	24.0	24.0	88.7
Divorced/ Separated	34	11.3	11.3	100.0
Total	300	99.9	99.9.	

4.3 Sustainability of cotton production in Zimbabwe

4.3.1 Economic sustainability

The objective of analysing the sustainability of cotton production in Zimbabwe Gokwe district, was addressed by the findings that are presented below under three broad categories that is economic sustainability, social sustainability and environmental sustainability. As shown in Table 4.7, the

results of the study revealed an increase in profitability from low producing through medium to high producing farmers. The mean values for low producing farmers is –US$51.63, this reveals a loss or negative economic sustainability. The mean value for medium producing farmers was US$23.16 indicating a slight positive return in cotton production. High producing farmers indicated a mean value of US$283.98, this reviews a huge rise in profit or positive economic sustainability.

Table 4.7. Economic sustainability of cotton production among low, medium and high producing cotton farmers in Gokwe district, Zimbabwe

	Minimum (USD)	Maximum (USD)	Mean (USD)	Std. Deviation
Low producing	-177.00	54.00	-51.63	46.52046
Medium	-130.00	108.40	23.16	29.53840
High producing	.00	902.00	283.98	183.23101

4.3.2 Social sustainability

The Chi-Square test results revealed a significant relationship between social sustainability and four key factors: access to market for selling cotton, community engagement, fairness of labour practices, and access to resources. With a significance level of 0.05, the null hypothesis was rejected for all four factors, indicating that they are all important contributors to social sustainability. These findings suggest that improving access to markets, fostering community engagement, promoting fair labour practises, and ensuring access to resources can have a positive impact on social sustainability. The results highlight the importance of addressing these factors to enhance social sustainability in the context of cotton production.

Table 4.8: Effect of access to markets, community engagement, fairness of labour practises and access to resources on the social sustainability of cotton production in Gokwe district, Zimbabwe

Null Hypothesis	Test	P- Value	Decision
Access to market for selling cotton on improving social sustainability	One-sample One-Sample	0.00 0.048	Reject Null hypothesis
Community engagement in improving social sustainability	One-Sample Chi-Square Test	0.00	Reject Null hypothesis
Fairness of labour practises in improving social sustainability	One-Sample Chi-Square Test	0.00	Reject Null hypothesis
Access to resources for social sustainability	One-Sample Chi-Square Test	0.00	Reject Null hypothesis
Level of significance 0.05			

4.3.3 **Environmental sustainability**

The Chi-Square test results revealed a significant relationship between environmental sustainability and key factors: soil management, water conservation and frequency of using chemicals. With a significance level of 0.05, the null hypothesis was rejected for all factors, indicating that they are all important contributors to environmental sustainability. These findings suggest that improving soil management, water conservation and frequency of using chemicals are critical in promoting environmental sustainability. The results highlight the importance of addressing these factors to enhance environmental sustainability in the context of cotton production.

Table 4.9 Effects of soil management practices, water conservation and frequency of using chemicals on the environmental sustainability of cotton production in Gokwe district, Zimbabwe

Null Hypothesis	Test	P-Value	Decision
Soil management practices on improving environmental sustainability	One-Sample Chi-Square Test	0.00	Reject Null hypothesis
Water conservation methods potential to improve environmental sustainability	One-Sample Chi-Square Test	0.00	Reject Null hypothesis
Frequency of using chemicals on improving environmental sustainability	One-Sample Chi-Square Test	0.00	Reject Null hypothesis

Level of significance 0.05

4.4 Factors affecting cotton production in Zimbabwe, Gokwe district

Table 4.10 presents the quantile regression analysis results, examining the impact of various factors on gross margin in cotton production in Zimbabwe's Gokwe district. The analysis indicated that factors such as gender, age, education, household size, marital status, seed type, and pest management have a significant impact on gross margin. The quantile regression results indicate that these factors influence gross margin differently across various quantiles (25th, 50th, and 75th), showing the heterogeneous relationships between these factors and gross margin.

The quantile regression analysis results for cotton production in Zimbabwe's Gokwe district revealed that various factors significantly impact gross margin. Age has a positive relationship with gross margin, with older farmers tend to have higher gross margins (coefficients of 29.8, p = 0.017 at the 25th quantile and 157, P = 0.000 at the 75th quantile). Seed type also has a significant positive impact, with coefficients of 103.84 (P = 0.000) and 247.75 (P = 0.000) at the 25th and 75th quantiles, respectively. Gender has a positive impact on gross margin, with coefficients of 25.4 (P = 0.057) at

the 25th quantile and 23.25 (P = 0.469) at the 75th quantile. Education has a negative coefficient at both quantiles, although the relationship is not significant at the 25th quantile (coefficient = -3.8, P = 0.759) and 75th quantile (coefficient = -13.48, P = 0.658). Household size has a mixed impact on gross margin, with coefficients of 3.8 (p = 0.466) at the 25th quantile and -20.48 (P = 0.124) at the 75th quantile. Marital status has a positive impact at the 25th quantile (coefficient = 24.76, P = 0.066) and a negative impact at the 75th quantile (coefficient = -19.91, P = 0.508). Pest management has a positive coefficient at the 25th quantile (coefficient = 23.76, P = 0.103) but is not significant at the 75th quantile (coefficient = 10.2, P = 0.836). These findings highlight the different relationships between these factors and gross margin, giving important insights for policymakers and farmers to develop targeted strategies to improve cotton production in Zimbabwe.

Table 4.10 Effects of age, gender, level of education, household size, marital status, seed type, pest management on cotton production in Zimbabwe, Gokwe district.

Table 4.10 Quantile regression analysis results, examining the impact of various factors on gross margin in cotton production in Zimbabwe's Gokwe district.

Simultaneous Quantile regression	Number of Obs = 300
Boot st r ap(100) Ses	.25 Pseudo R2 = 0.0382
	.50 Pseudo R2 = 0.0304
	75 Pseudo R2 = 0.0304

Gross margin	Coefficient	Boot strap St d err	t	P> (t)	(95% conf	interval
Q25						
Gender	25.4	13.30199	1.91	0. 057	-7799376	51. 57994
Age	29.8	12.37763	2.41	0.017	5.439322	54.16068
Education	3.8 -	12.35194	-0.31	0.759	28.11012	20.51012
Household size	3.8 -	5.209781	0.73	0.466	6.453482	14.05348
Marital status	24.76	13.43444	1.84	0.066	-1.680602	51.2006
Seed type	103.4	27.0459	3.84	0.000	50.61039	157.0696
Pest management	23.76	14.53477	1.63	0.103	-4.846199	52. 3662
Cons	-180	32.36396	-5.56	0.000	-243.6962	-116.3038
Q50						
Gender	24	17.45122	1.38	0.170	-10.34612	58.34612
Age	46.1	11.97798	3.89	0.000	23.02589	70.17411
Education	4	11.79124	0.34	0.735	-19.20659	27.20659
Household size	-9.6	7.170395	-1.34	0.182	-23.71221	4.512207
Marital status	3	12.02275	0.25	0.803	-20.66223	26.25947
Seed type	108.6	27.05674	4.01	0.000	55.34904	161.851
Pest management	1.2	14.25698	0.08	0.933	-26.85947	29.25947
Cons	-98.8	30.67541	-3.22	0.001	-159.1729	-38.42706
Q75						
Gender	23.25	32.05377	0.73	0.469	-39.83572	86.33572
Education	-1348333	30.43183	-0.44	0.658	-73.37687	46.4102
Household size	-20.48333	13.2618	-1.54	0.124	-46.58417	5.6175
Marital status	-19.9667	36.012	-0.55	0.580	-90.84265	50.90932
Seed type	247.75	46.01189	5.38	0.000	157.193	338.307

Pest management	10.2	49.27614	0.21	0.836	-8678143	107.1814
Cons	-140.81	81.05577	-1.74	0.083	-300.3443	18.71092

4.5 Strategies for sustainable cotton production in Zimbabwe Gokwe district

The results on Table 4.11 rejected the null hypothesis at ($P < 0.05$) significance level. The results on table 4.11 indicates that the following factors are strategies for sustainable cotton production in Zimbabwe, Gokwe district: reducing gender discrimination, training of farmers, increased family size, increasing extension frequency, improved number of cattle owned by farmers, bringing markets closer to farmers, promoting farmers membership to farmers organisation, improved mechanization amongst farmers, improved access to credit, improved pests and diseases control, early land preparation and timely arrival of inputs.

Table 4.11 Strategies for sustainable cotton production

Null Hypothesis	Test	P-Values	Decision
Reducing gender discrimination on cotton	One-Sample Chi-Square Test	0.00	Reject Null
Training of farmers	One-Sample Chi-Square Test	0.00	Reject Null
Increased family size	One-Sample Chi-Square Test	0.00	Reject Null
Increasing extension frequency	One-Sample Chi-Square Test	0.00	Reject Null
Improved number of cattle owned by	One-Sample Chi-Square Test	0.00	Reject Null
Bringing markets closer to farmers	One-Sample Chi-Square Test	0.00	Reject Null
Promoting farmers membership to farmers	One-Sample Chi-Square Test	0.00	Reject Null
Improved mechanization among small	One-Sample Chi-Square Test	0.00	Reject Null
Improved access to credit	One-Sample Chi-Square Test	0.00	Reject Null
Improved pests and disease control	One-Sample Chi-Square Test	0.00	Reject Null
Early land preparation	One-Sample Chi-Square Test	0.00	Reject Null
Timely arrival of inputs	One-Sample Chi-Square Test	0.00	Reject Null

Level of significance 0.05

CHAPTER 5: DISCUSSION

5.1 Demographics data

5.1.1 Gender

As shown in Table 4.1, the results showed that 70.3% of the participants were female, whilst 29.7% were male. This is could be because most of the hand to hand work in the fields is done by women (Mugwe et al., 2008). The dominance of women in the study, supports the notion that women tend to perform better in labour intensive task. To further support the dominance of women in the study, ZWRCN/SARDC (2008) identified women as de facto heads of household in communal areas. This is because majority of men work in urban areas, leaving cotton production to their wives and children. This has a significant implication for social, economic and environmental sustainability, including increased workload and responsibilities for women, and a potential decline in agricultural production (Kristjanson et al., 2017).

5.1.2 Age

The majority of cotton farmers were over 58 years old. This trend suggests that experience and maturity are valued in cotton production, but it may also imply potential labour constraints due to the physical demands of the work. These findings align with Usher (2006), who noted that cotton growing requires experienced farmers. The dominance of elderly farmers may compromise the sustainability of cotton production due to their limited adoption of new technologies and potential labour shortages.

5.1.3 Level of education

As shown in Table 4.3, there is dominance of low literacy levels amongst cotton farmers. As postulated by Adolwa, (2012), the low literacy level often associated with low level of education pose a challenge to farmers in adopting technologies. Also low literacy level among farmers suggest that most of them would not be able or find it difficult to read agricultural extension and other agricultural literature associated with cotton production. The presence of low literacy levels also affects cotton farmers' ability to keep agribusiness records and tackle business activities due to lack of basic education and mathematical skills, resulting in the farmers incurring losses as they would not be able to manage their operational expenses and revenue (Ghambi, 2015).

5.1.4 Farming experience

The study revealed that the majority (39.3%) of farmers had 11-15 years of experience in cotton production, followed by those with 5 years or less (34.0%) while those with 6-10 years had the least proportion of 7.3%. As suggested by Macharia et al. (2014), Geta et al. (2013) and Akinola et al. (2010), farmers with experience tend to adopt new technologies more easily as compared to those with less experience. In respect to socio-economic and environmental sustainability a low proportion of experienced farmers may negatively affect the dissemination and adoption of sustainable agricultural practises (Davis et al 2010).

5.1.5 Household size

As indicated in the Table 4.5, the majority of the participants had a household size of 7-8 with a percentage of 56.6%. The United Nations Department of Economic & Social Affairs Population Division (2019) defines a household with more than five members as large. Large families are more prone to economic strains because they have many mouths to feed (Ghambi, 2015), and this threatens the economic and social sustainability of cotton production. However, evidence also indicates that families with many members tend to benefit from labour availability in agricultural activities (Abdulai & Huffman, 2014).

5.1.6 Marital status

Results of marital status in Table 4.6 indicated that the marital status of the participants varied, with the majority being married (49.3%), and the least being separated (11.3%). While married couples dominate cotton production in the study area, this may not necessarily translate to a household-based workforce, given that some female farmers' husbands may be engaged in urban employment (FAO, 2018). A relatively high percentage of divorced individuals may indicate changes in household structure, potentially influencing farm labour dynamics (ICAC, 2020).

5.2 Sustainability of cotton production

5.2.1 Economic sustainability of cotton production

The results in Table 4.7 highlight the important relationship between revenue levels and cotton production. High income farmers are characterized as having more production as they have, access to machinery, and are quick to adopt new technologies (Wu, 2022). This enables them to produce more

cotton and attain higher revenue (Makombe, 2017; Chikwati, 2018). For example, Kelly et al. (2015) observed that high-performing farms tended to present better financial performance due to efficient use of resources. In contrast, medium producing farmers showed a moderate level of profits, with profits averaging US$23.16 ha^{-1} $year^{-1}$, indicating a slight positive return in cotton production. This implies that medium producing farmers are able to cater for their production costs and generate some revenue. These results explain the significance of implementation of better farming practices which results in improved production and effective management of resources (Ricker-Gilbert et al., 2011). These farmers produce medium range output as they have medium-sized land, limited access to machinery and are moderate in adopting technology (Moyo et al., 2015). However, the relatively low mean profits suggest that these farmers face several challenges in cotton production. These challenges include lack of access to credit, lack of markets, and lack of access to extension services and limitation of inputs (Poulton et al., 2004). It is likely that, low producing farmers face significant challenges, which includes reduced access to land and markets.

The low producing farmers attained negative mean profit value with an average of US$-51.63, suggesting that these farmers are facing economic losses or negative economic sustainability. Farmers in this category are also characterized as reluctant to adopt new technologies, resulting in low production (Moyo et al., 2015; Nyakudya, 2015). Similarly, Ali and Abedulla (2002) revealed that farmers who made use of improved technologies and better management practices attain higher profits and improved economic sustainability. Poulton et al. (2004) observed that the economic losses among low producing farmers may be due to their challenges in accessing high-quality seeds and fertilizers due to constrained financial resources (Jayne et al., 2010). Also the low producing farmers have limited access to irrigation, leaving them to rely solely on rainfall leading to crop failures and low yields (2015). Also low producing farmers attains low profits due to limited access to resources, including finances, modern farming technologies, and infrastructure (FAO, 2014). The results of the present study are consistent with previous research that indicated a strong relationship between production and profit.

5.2.2 Social sustainability

The results of Chi-Square test show that access to market and fairness of labour practices had significant relationships ($P < 0.05$) with social sustainability among farmers in Gokwe district. This suggest that farmers with better access to markets and those who prioritize fair labour practices are

more likely to attain social sustainability. These findings agree with the notion that access to markets can improve farmers' chances of selling their products, improve their revenue, and improve their standards of living (IFAD, 2018; World Bank, 2020). As a result, when formulating policies emphasis should be on prioritizing programs that improve access to markets. This includes investing in rural development and advocating for market-oriented agricultural practises (FAO, 2019). Also fair labour practises in cotton production involve allocation of fair wages, safe working conditions and social protection of workers (ILO, 2019). These practises are essential in maintaining the well-being of workers and attaining social justice (Sen, 2000). Labour certification programs which are initiatives for fair labour practises should be prioritized to attain social sustainability (Fairtrade International, 2020). Therefore, policymakers and practitioners should focus on supporting initiatives that encourage community engagement among farmers, such as community-driven development projects and social programs (World Bank, 2019).

As shown in Table 4.8, the results revealed a significant correlation between community engagement and social sustainability, indicating that farmers who actively participate in their communities tend to achieve better social sustainability results. Community engagement can manifest in various ways, including involvement in local organizations, volunteering, and participating in social events (Putnam, 2000). By connecting with their communities, farmers can foster social capital, gain access to support networks, and enhance the overall well-being of their communities (Pretty, 2003). Therefore, policymakers and practitioners should focus on supporting initiatives that encourage community engagement among farmers, such as community-driven development projects and social programs (World Bank, 2019).

A significant correlation between resource accessibility and social sustainability as observed in this study suggests that farmers with enhanced access to resources, including credit, technology, and training, are more likely to achieve better social sustainability results. Gaining access to these resources can support farmers in boosting their productivity, raising their income, and lessening their vulnerability to external shocks (IFAD, 2018). Consequently, it is important for policymakers and practitioners to prioritize programs that enhance resource access for farmers, such as agricultural extension services, credit initiatives, and technology transfer programs (FAO, 2019).

5.2.3 Environmental sustainability

The results of this study revealed that both soil management practices and water conservation methods had a significant relationship ($P < 0.05$) with environmental sustainability. This suggests that farmers who implement soil conservation and sustainable soil management practices are more likely to attain improved environmental sustainability outcomes. Soil management practices, such as crop rotation, organic amendments, and conservation tillage, can help to lower soil erosion, improve soil fertility, and facilitate biodiversity (FAO, 2019; USDA, 2020). By implementing good soil management practises, farmers can enhance long-term health and productivity of their soils, while also lowering the environmental impact of farming practices (Lal, 2004). Moreover, these results suggest that farmers who practise water conservation and efficient irrigation practices are more likely to experience improved environmental sustainability outcomes. Water conservation methods, such as drip irrigation and mulching, can help to lower water waste, improve crop yields, and facilitate water security (IWMI, 2019; Postel, 2000). By implementing water conservation, farmers can lower their environmental impact, while also developing their resilience to droughts and other climate-related shocks (Gleick, 2003).

The results of the study also indicate a significant association between the frequency of using chemicals and environmental sustainability. This suggest that farmers who lower their use of chemical pesticides and fertilizers are more likely to attain improved environmental sustainability. The overuse of chemicals has been observed to have negative effects as it results in damage to beneficial insects, pollinators, and other non-target species, while also contaminating the soil, water and air (WHO, 2019; EPA, 2020). As farmers lower their use of chemicals, they can attain biodiversity, improved soil health and reduced environmental impact (Altieri, 2002).

The environmental sustainability of farming practices is essential for implementing ecosystem health and resilience. As farmers implement environmental sustainability, the objective of attaining long-term health and productivity is achieved, whilst lowering their environmental impact. The results attained from environmental sustainability are critical for developing ecosystem health and resilience. As farmers attain environmental sustainability, they get associated benefits such as which includes long-term health and productivity of their lands is attained, while also lowering their environmental impacts. Environmental sustainability which includes improved soil health, increased biodiversity,

and reduced greenhouse gas emissions, can have several advantages for farmers, including improved crop yields and increased revenues (IPCC, 2019; FAO, 2020).

5.3 Factors affecting cotton production in Zimbabwe Gokwe district

5.3.1 Gender

The observation that cotton production is associated with gender agree with the findings of Murithi et al. (2019) who observed that female farmers attained lower yields as compared to male farmers. One possible explanation to this is that male farmers have more access to credit and markets than female farmers. In most societies, gender power relations are in favour of men, with different values being assigned to men's and women tasks (March et al., 1999).

5.3.2 Level of education

The results showed that there was a significant association ($P < 0.658$) between level of education and gross margin. Thus the level of education in cotton production is essential as it contributes towards quick adoption of new technologies in cotton production (Resman, 1970). As observed by Bakhsh et al. (2005) and Earlier Wu (1977), the level of education holds a key role in the implementation of improved technology and harvesting higher yields. Adoption of innovation through education results in tasks being performed much easier resulting in improved production. (Nawaz (2001). The educated cotton farmers are able to tackle various farm practices in a better way as compared to less educated farmers. Farmers with higher level of education are postulated to quickly adopt development practices that contributes towards improved cotton production such as improved varieties, fertilizers and pest management strategies. The strategies are observed to contribute towards improved cotton yields (Davidon et al., 2017). The study conducted by Bakhsh et al (2005) also concluded that 1% increase in schooling year could improve cotton yield by 0.15%.

The low literacy levels amongst cotton farmer's results in challenges as farmers are unable to access and understand information on recent technologies that may occur. It is assumed that farmers with higher educational achievements are able to decipher agricultural information easier. As opposed to less educated farmers who takes long to decipher agricultural information from workshops arranged by extension workers or researchers (Adolwa, 2012).

5.3.3 Household size

The quantile regression analysis revealed that household size had a mixed impact on gross margin, with coefficients of 3.8 ($p < 0.466$) at the 25th quantile and -20.48 ($p < 0.124$) at the 75th quantile. This suggests that the relationship between household size and gross margin is complex and may vary depending on the specific context and farming practices. At the 25th quantile, the positive coefficient suggests that larger household sizes may be associated with higher gross margins, potentially due to the added labour that larger households can provide. However, the relationship is not significant, indicating that the impact of household size on gross margin may be limited at this quantile. Household size from the results of the study was found to affect cotton production among farmers in Gokwe. These results are supported by Ghambi (2015) who explains that families with large household size tend to benefit from availability of labour, making household size as a crucial factor in cotton production. Cotton production activities are labour-intensive, hence a family with high household size will likely benefit. In addition, household size is a significant factor in cotton production as it contributes towards resource allocation. Smaller households are most likely to have limited resources which includes labour, land, and capital. This can be a severe constraint in cotton production (Singh et al., 2015). The results of this study are supported by the study by Bakhsh et al. (2005) and Singh et al. (2015) who concluded that there was a positive correlation between household size and cotton production, suggesting a tendency for higher production in larger households. This is because families with larger household sizes have more labour availability than smaller households (Binswanger & Rosenzweig, 1986). Also the idea that household size affects cotton production is also supported by Chamberlin et al. (2019) who observed a non- linear relationship between household size and cotton production.

5.3.4 Marital status

The quantile regression analysis revealed that marital status had a positive impact on gross margin, with a coefficient of 24.76 at the 25th quantile, although the relationship is marginally significant $P < 0.066$ Table 4.10. This suggests that married farmers tend to have higher gross margins compared to their unmarried counterparts, potentially due to the added stability, support, and labour that marriage can bring to a household (Boserup, 1970; FAO, 2018). The positive coefficient shows that being married is associated with a 24.76 unit increase in gross margin, holding other factors constant. This results shows the significance of household dynamics in cotton in cotton production (Ellis, 2000).

This finding is consistent with previous studies that have shown that married households tend to have more stable and secure livelihoods, which can lead to improved agricultural production and profitability (Abdullah et al., 2019; Smith et al., 2014). The added labour and financial support that marriage can bring to a household may enable farmers to invest more in their farms, adopt new technologies, and manage risks more effectively, ultimately leading to higher gross margins (Mincer, 1978; Schultz, 1988).

5.3.5 **Seed type**

The quantile regression analysis revealed that seed type has a significant positive impact on gross margin, with coefficients of 103.84 ($p < 0.000$) and 247.75 ($p < 0.000$) at the 25th and 75th quantiles, respectively (Table 4.10). This suggests that the use of hybrid seeds is associated with higher gross margins compared to other seed types. Hybrid seeds are designed for their improved yield potential, disease resistance, and adaptability to different environmental conditions, which can lead to increased productivity and profitability for cotton farmers. The significant positive relationship between hybrid seeds and gross margin highlights the importance of adopting improved agricultural technologies in cotton production. The use of hybrid seeds can help farmers increase their yields, reduce crop losses, and improve their overall profitability. This finding is consistent with previous studies that have indicates the benefits of adopting hybrid seeds in improving agricultural productivity and profitability (Ali & Abdulai, 2010; Langyintuo & Mungoma, 2008).

5.3.6 Pest management

The quantile regression analysis shows that pest management has a positive coefficient at the 25th quantile (coefficient = 23.76, P = 0.103), although the relationship is not significant at the 10% level. However, at the 75th quantile, the relationship is not significant (coefficient = 10.2, P = 0.836). This suggests that effective pest management practices may have a positive impact on gross margin, particularly for farmers with lower gross margins (25th quantile). The positive relationship between pest management and gross margin highlights the importance of protecting cotton crops from pests and diseases. Effective pest management practices can help farmers reduce crop losses, improve yields, and increase their viability. These results are similar with previous studies that have indicated the benefits of integrated pest management (IPM) in improving agricultural productivity and profitability (Pretty, 2008; Oerke, 2006).

However, the non-significant relationship at the 75th quantile suggests that the impact of pest management on gross margin may vary depending on the specific context and farming practices. Further research is needed to explore the specific mechanisms through which pest management affects gross margin in cotton production and to identify effective pest management strategies for farmers in different contexts.

5.3.7 Distance to the market

The results showed that there was a significant association ($P < 0.05$) between distance to the market and cotton production. The results of the study are similar to study by Muriithi et al. (2017) who discovered that distance to the market was a crucial factor in determining cotton production. In the study observations indicated that farmers who were closer to the market tend to attain higher cotton output as compared to farmers who lived far away from the market. To further support the results, a study by Kariuki et al. (2015) in Kenya found that farmers who lived closer to the market attained higher cotton production. Thus distance to the market as observed in the result is a crucial factor in cotton production. This finding implies that farmers who are closer to markets may have better access to inputs, information, and buyers, enabling them to produce more cotton.

5.3.8 Farmer's membership to farming associations

Farmer's membership to farmer association was observed to have a significant effect on cotton production from the Chi-Square results on Table 5.1. The results showed that there was a significant association ($P < 0.05$) between farmer's membership to farming associations and cotton production. As explained in literature farmer's membership to farming associations plays a crucial role in the cotton production as it provides the following, access to information and resources. It is essential as it provides farmers with information which can range from new technologies, new ideas and market trends. These benefits capacitate farmers in making informed decisions. This results in farmers attaining improved yields which results in better cotton production (Kariuki & Ng'ang'a, 2018). These results highlight the importance of strengthening farmer organizations and promoting membership among cotton farmers, particularly in areas where access to resources and markets is limited.

In addition, the farmer's membership to farmers associations offers the benefit of collective bargaining power when associating with stakeholders (Muriithi & Gichuru, 2019). In addition, farmers through farmer associations are able to bargain and attain benefits in production. These

benefits may include discounts in buying inputs, improved access to quality inputs and good market conditions. This results in improved cotton production of farmers thereby supporting the results that farmer's membership to associations is essential in cotton production (Muriithi & Gichuru, 2019).

5.4 Strategies for sustainable cotton production in Zimbabwe

5.4.1 Reducing gender discrimination

The results indicated that the association was statistically significant ($P < 0.05$).This shows that reducing gender discrimination on cotton production had a significant effect on improving sustainability of cotton production. In cotton production gender discrimination evolves in different ways which includes, reduced access to land, credit and extension services for female farmers (FAO, 2011). Female farmers are observed to face social and cultural barriers that discourage them from participating in cotton production (Moyo et al., 2015). This results in female farmers attaining lower yields, lower revenues and reduced opportunities for economic empowerment. Thus reducing gender discrimination in cotton production has crucial benefits for sustainability. Studies have observed that female farmers are likely to implement sustainable agricultural practices, which include conservation and organic farming (World Bank, 2014). Female farmers are also observed to have the potential to invest in the children's education and healthcare. This improves social, economic and environmental sustainability of cotton production (UN Women, 2018).

5.4.2 Training farmers

The results of the Chi-square test indicate that ($P < 0.05$). This indicates that training farmers is crucial in improving the sustainability of cotton production in Zimbabwe. Studies have indicated that trained farmers are more likely to acquire conservation practices and integrated pest management (FAO, 2017). These practices are crucial in attaining environmental sustainability through improved soil fertility, reduced soil erosion and increased crop yields. Research has shown that trained farmers in Zimbabwe were able to improve their output by 25% and their revenues by 30% (IFAD, 2019). In addition, as trained farmers are quick to adopt sustainable farming practices. This offers crucial benefits as study by FAO (2017) observed that trained farmers were able to lower their use of chemical fertilizers and pesticides by 40% (FAO, 2017). Also research has shown that trained farmers are able to increase their revenues by 50% and improve access to markets by 30% (ZCFA, 2020). This means that training of farmers is crucial in improving the economic sustainability of cotton production in Zimbabwe as supported by the results.

5.4.3 Increased family size

As cotton production is labor-intensive, increased family size was observed to provide the benefit of additional labour. With a huge family size, farmers are able to acquire benefits of improved labour availability and increased production (Nyakudya, 2015). In addition to the benefits, family labour is observed to be reliable and flexile as compared to hired labour. This can be crucial in improving social sustainability of smallholder farmers who often face challenges of labour availability (Makombe, 2017). There is also the benefit of information dissemination through the use of family labour. Thus older family members can quickly disseminate information, knowledge and skills to younger family members. This helps in preserving traditional farming practices which are often sustainable (Chikwati, 2018).

5.4.4 Increased extension frequency

Regular extension visits offer crucial benefits in guaranteeing the sustainability of cotton production in Zimbabwe. Research has indicated that farmers who received frequent extension visits were more likely to adopt improved agricultural practices, such as conservation agriculture and integrated pest management (FAO, 2017). Study by Makombe (2017) discovered that farmers who received regular extension visits attained higher cotton output, as compared to farmers who received less extension visits.

5.4.5 Improved number of cattle owned by farmers

The improved number of cattle owned by farmers was found to be significant in attaining the sustainability of cotton production in Zimbabwe. As farmers increase size of cattle herd, they are able to quickly tackle tasks more efficiently, thus reducing the time and labour required for cotton production (Mupangwa et al., 2017). This results in improved production and lower labour costs, ultimately improving the sustainability of cotton production. Also as postulated by FAO (2015), increased number of cattle owned by farmers results in implementation of conservative farming practices which are sustainable. As preparations of fields is made easier, soil fertility and structure is improved. Thus attaining sustainability in cotton production.

5.4.6 Bringing markets close to farmers

Bringing markets closer to farmers is an essential strategy for improving the sustainability of cotton production. As the distance between farmers and markets is reduced. This results in farmers increased access to markets, thus improving the bargaining power of the farmers. In return this results in farmers

benefiting as they receive better prices for their cotton produced (Okello et al., 2017). This in turn also results in farmers attaining improved revenue which can revive their standards of living and enable them to invest in more sustainable farming activities. Indications have showed that through bringing markets closer, sustainability is guaranteed as this can result in improved cotton produced (Chikwati, 2018). As the time and distance between harvesting and marketing is reduced, farmers can improve the quality of cotton produced. This results in better prices and improved revenues. This in return improve sustainability of cotton production, as farmers are able to invest in more sustainable farming practices.

5.4.7 Promoting farmers membership to farmer organizations

As farmers are involved in farmer organizations, sustainability of cotton production is improved. Farmer's organizations are associated with several benefits which includes, the ability to negotiate with buyers, improve market access and attainment of training and extension services (Kherallah et al., 2002). This results in farming benefiting from bargaining power, improved prices of cotton produced and improved revenue. Farmers' membership in farming organizations is significant, as it enables them to access inputs like seeds, fertilizers, and pesticides at relatively lower prices (Moyo et al., 2015). This improves the production capacity of farmers and enable them to attain more revenue. Thus improved revenue attained helps improves the sustainability of cotton production in Zimbabwe.

5.4.8 Improved mechanization

As observed in the results on Table 3.5 improved mechanization is essential in improving the sustainability of cotton production in Zimbabwe. Mechanization involves use of machines and equipment to improve the production capacity in cotton farming operations (Pingali, 2007). Thus mechanization has the potential to improve yields as machines are efficient (Mamman & Aminu, 2020). As mechanization is introduced, policy makers and stakeholders attain the objective of improved sustainability of cotton production as efficiency and productivity of farming operations contributes towards sustainable cotton production.

5.4.9 Improved access to credit for farmers

Improved access credit is essential in promoting sustainable cotton production in Zimbabwe. As farmers are given access to credit they can invest in essential inputs such as seeds, fertilizers and equipment, which can increase the crop output and quality (Okello et al., 2017). As farmers are equipped with funds through credit, they are able to sponsor good farming practises which includes

conservation agriculture and integrated pest management. This lower the environmental implications of cotton production (Moyo et al., 2015). Thus explains the results that supports that access to credit for farmers has a significant effect on sustainability of cotton.

5.4.10 Improved technology

The improved technology in cotton production is effective in ensuring the sustainability of cotton production in Zimbabwe as shown by the results on Table 3.5. The implementation of advanced recent technologies, such as precision agriculture, drip irrigation and mobile application. This results in improved crop yields, water and fertilizer usage and helps improve the overall farming efficiency (FAO, 2017). An example of precision agriculture can be essential to help farmers effectively use fertilizers and pesticides application, thus lowering waste and environmental pollution. As farmers engage in adoption of improved technology, they attain benefits which includes better risk management on factors such as climate change and market fluctuations (Okello et al., 2017). Mobile applications, for example can help farmers track current and future weather forecasts, market prices and are able to make informed decisions. Also through improved technology, environmental impacts of farming operations are effectively managed. Drip irrigation is responsible for reduced water consumption, whilst precision agriculture is essential for soil degradation and erosion (Moyo et al., 2015).

5.4.11 Improved pest and disease control

As shown on the Table 3.5, improved pest and disease control was found to be essential in ensuring the sustainability of cotton production in Zimbabwe. As literature has shown that cotton is prone to numerous pests and diseases which includes cotton bollworm, aphids, and fusarium wilt. These have the potential to lower the output and quality of cotton produced (ICAS, 2019). Poor management of pests and diseases can result in resistance of pests and diseases, this in turn results in reduced cotton output and reduced farmer revenues (FAO, 2017). Thus improved management of pests and diseases is essential in attaining sustainability in cotton production as it results in more yield and revenue.

5.4.12 Timely arrival of inputs

Timely arrival of inputs from the results of Chi-Square was discovered to be essential in improving the sustainability of cotton production in Zimbabwe. This aligns with Bishi et al., (2020) who postulated that timely arrival of inputs, lowers the risks in cotton production which includes climate change and market changes. This is attained, as farmers received inputs on time, they are able to make quick informed decisions to manage risks in cotton production. Hence this contributes positively towards improving the sustainability of cotton production in Zimbabwe.

5.4.13 Early land preparation

Early land preparation, which provides essential benefits such as optimal soil conditions, moisture conservation, and crop growth, is crucial for ensuring the sustainability of cotton production in Zimbabwe (Hove et al., 2017).The results on Table 3.5 supports the notion of improving sustainability of cotton in Zimbabwe. In addition, early land preparation is responsible for reduced soil erosion, improved water infiltration, and increased crop output (Mashonjowa et al., 2018). In Zimbabwe, areas where cotton is grown are usually characterized by poor soil quality and reduced rainfall. Thus early land preparation is essential for ensuring sustainable cotton production in Zimbabwe (FAO, 2013).

5.4.14 Favorable temperatures

As postulated by the results of the Chi-Square tests, favorable temperatures have an influence on cotton production in Zimbabwe Gokwe district. The study observed that cotton is very sensitive to temperature fluctuations. The standard optimal temperatures for growth is 20 to 30 degrees Celsius, thus fluctuations from this range affects cotton production negatively (Singh et al., 2017). Empirical studies have reviewed consistent results supporting the notion that favorable temperatures have a significant effect on the sustainability of cotton production. A study by Mupangwa et al. (2019)

highlighted the significance of conservation agriculture in improving soil health and lowering soil erosion. Also discoveries by Masvaya et al. (2018) demonstrated that integrated pest management practices can enhance cotton productivity, while reducing environmental impacts. These studies support the notion that addressing these key factors is essential for determining the long-term sustainability of cotton production in Zimbabwe.

CHAPTER6: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter brings together the key findings from the study, as presented in the preceding chapters. By synthesizing the insights from literature review, methodology, and analysis, this chapter provides a comprehensive overview of the study's contributions to our understanding of the economic, social and environmental sustainability of cotton production. The chapter distills the main conclusions, highlighting the crucial factors influencing the sustainability of cotton production in Zimbabwe, and provides actionable recommendations for stakeholders, including policymakers, farmers, and industry practitioners. The recommendations aim to inform policy interventions, industry initiatives, and future research directions that enhance the economic sustainability of cotton production in Zimbabwe. Thus ultimately contributing to the country's agricultural development and economic growth. This chapter concludes the study by highlighting its implications and suggesting avenues for further research and exploration.

6.2 Summary of key findings

Results indicated that small producing farmers attained negative profits with an average of -US$51.63 while medium and high producing farmers were observed to attain positive profits of US$23.16 and US$ 283.97, respectively.

The social sustainability of cotton production was assessed by analyzing data collected via a Likert scale, using Chi-Square tests in SPSS, focusing on factors such as access to markets, community engagement, fairness of labor practices, and access to resources. The results revealed that these factors were essential for the sustainability of cotton production in Zimbabwe.

The results also revealed that soil management, water conservation and frequency of using chemicals were significant in improving environmental sustainability.

Factors such as gender, level of education, farming experience, extension frequency, number of cattle owned, distance to market, and farmer's membership in a farming community were observed to impact cotton production in Gokwe district, Zimbabwe.

The results further showed that factors such as reducing gender discrimination, training of farmers, increased family size, increasing extension frequency, improved number of cattle owned by farmers

among others, were essential for improving sustainability of cotton production in Gokwe district, Zimbabwe.

6.3 Conclusion

The study analyzed the social, economic, and environmental sustainability of cotton production in Gokwe district, Zimbabwe. The outcome indicated that cotton production was more profitable among high producing farmers, whilst medium and low producing farmers attained low profits. Soil management, water conservation and frequency of using chemicals were observed to have an effect on environmental sustainability. Access to markets, community engagement, fairness of labour practices and access to resources were observed to influence social sustainability.

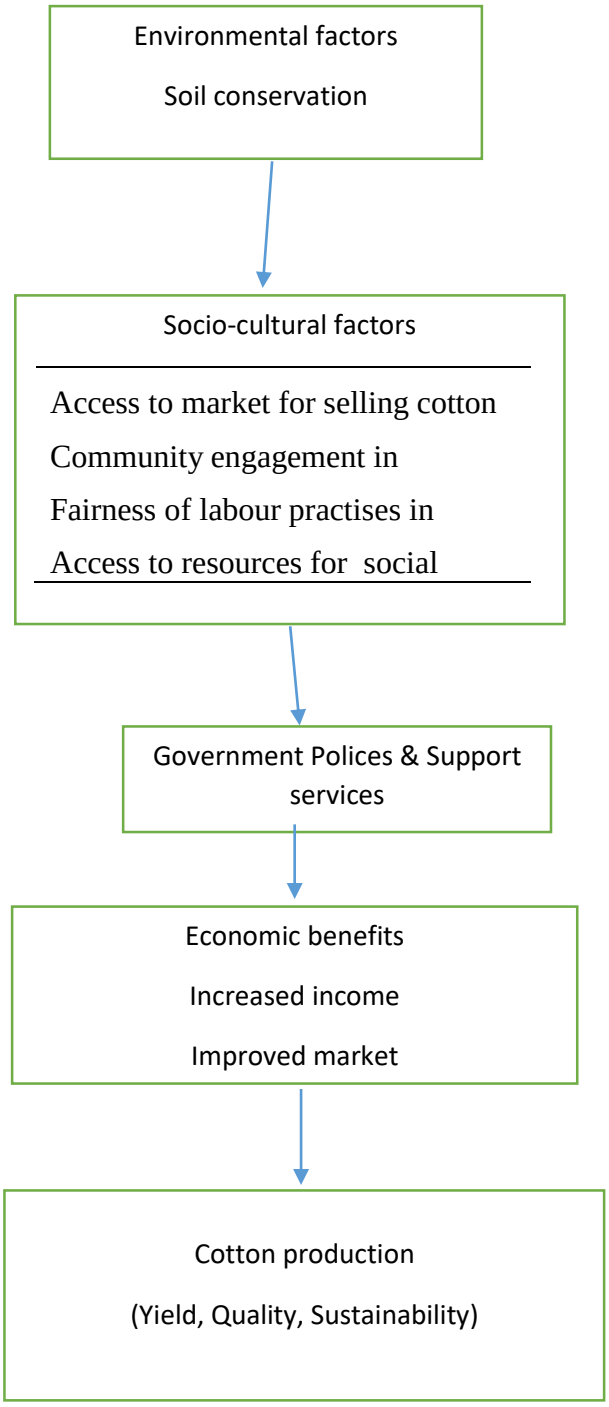
6.4 Recommendations

It is recommended that farmers should adopt good soil management, water conservation, and community engagement, fair labour practices, financial literacy and mechanization in order to enhance sustainability of cotton production. Also, farmers should be trained on best practices, efficient farming techniques, and business management to help smallholder farmers increase productivity and reduce costs. In addition, farmers should be given access to affordable credit facilities and subsidies to help them invest in their farms and improve profitability. Policy makers are recommended to promote establishment of market support systems, enforcement of labour laws and regulations, encourage private sector investment and monitor and evaluate policy impact.

6.5 Further research

This study's discoveries provide a foundation for further research on the sustainability of cotton production in Zimbabwe. Further studies could explore the impact of climate change on cotton production, investigate the effectiveness of specific interventions aimed at improving farmer livelihoods, or examine the role of technology in enhancing productivity and sustainability. Additionally, comparative studies with other cotton-producing countries or regions could provide valuable insights into best practices and policy lessons. By building on this research, future studies can continue to inform strategies for promoting sustainable cotton production and improving the livelihoods of farmers and communities in Zimbabwe.

6.6 Diagrammatic synthesis in line with Education 5.0



The synthesis represents a flowchart illustrating the factors influencing cotton production, with government support services at the forefront. The chart is divided into five main sectors, each representing a distinct aspect of cotton production, underscoring the pivotal role of government policies and support services in shaping the cotton production landscape. As the major stakeholder, the government's influence on distribution and marketing of cotton products is crucial. The synthesis further highlights the interconnectedness between environmental factors, socio-cultural factors, and economic factors on cotton production, all of which are impacted by government support. The cotton production (yield, quality, sustainability) depicts the overall goal of the flowchart, which is to enhance cotton production through effective government support. In summary, the synthesis provides a clear and precise overview of the factors that impact cotton production, with government support at the center, enabling stakeholders to work together to improve cotton production and promote sustainable practices in the industry.

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APPENDICES

Appendix 1: Questionnaire

1. **Respondent details**

Section A: Demographic Data

NB: Please tick where appropriate.

1. Sex

a. Male ( ) b. Female ( )

1. Age

a. 18-27 ( ) b. 28-37 ( ) c. 38-47 ( )

d. 48-57 ( ) e. 58 and above ( )

2. Level of education

a. Master Farmer ( ) b. National Certificate ( )

c. National Diploma ( ) d. Degree ( )

e. No training ( ) f. No training ( )

4. Marital status

a. Single ( ) b. Married ( )

b. Widow/widower ( ) d. Divorced/separated ( )

e. Never married ( )

5. Household size

a) 1-2 ( ) b. 3-4 ( ) c. 5-6 ( )

d) 7-8 ( ) e.9+ ( )

6. Number of years in farming

a) 5 years and below ( ) b) 6- 10 years ( )

c) 11-15 years ( ) d) 16-20 Years ( )

e) 21- 25 years ( ) f) 26 years and above ( )

7. Land tenure system

a) Communal ( ) b) A1

c) Small scale commercial d) A2

e) Old resettlement f) Large scale commercial

Section B: This section seeks to determine factors affecting cotton production

Quantitative Survey Questions to Determine Factors Affecting Cotton Production

1. What is your farming location? (Select one)
   - ☐ Region A ☐ Region B ☐ Region C ☐ Other (please specify): _____
2. What is the size of your cotton farm in acres?
   - ☐ Less than 5 acres ☐ 5-10 acres ☐ 11-20 acres ☐ More than 20 acres
3. How many years have you been involved in cotton production?
   - ☐ 0-5 years ☐ 6-10 years ☐ 11-20 years ☐ More than 20 years
4. What type of cotton seed do you primarily use? (Select one)

- ☐ Hybrid ☐ Open-pollinated ☐ Other (please specify): ____..______

5. How often do you apply fertilizers to your cotton crops?
   - ☐ Once a season ☐ Twice a season ☐ More than twice a season ☐ Never
6. What pest management strategy do you primarily use? (Select one)
   - ☐ Chemical pesticides ☐ Organic methods ☐ Integrated pest management ☐ Other (please specify): _____

7. How would you rate the quality of your soil for cotton production? (Select one)
   - ☐ Poor ☐ Fair ☐ Good ☐ Excellent
8. How would you rate the availability of water for irrigation? (Select one)
   - ☐ Very insufficient ☐ Insufficient ☐ Sufficient ☐ Very sufficient

9. How would you rate your ease of access to markets for selling cotton? (Select one)
   - ☐ Very difficult ☐ Difficult ☐ Neutral ☐ Easy ☐ Very easy
10. On a scale of 1 to 5, how much do rising input costs affect your cotton production decisions? (1 = Not at all, 5 = Very much)
    - ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

11. Which of the following technologies do you use in your cotton production? (Select all that apply)
    - ☐ Tractors ☐ Irrigation systems ☐ Pest monitoring devices ☐ Agricultural software ☐ None
12. How would you rate your access to information on cotton farming best practices? (Select one)
    - ☐ Very poor ☐ Poor ☐ Fair ☐ Good ☐ Excellent

13. On a scale of 1 to 5, how significant are the following challenges to your cotton production? (1 = Not significant, 5 = Very significant)
    - **Pests and diseases**: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
    - **Climate change**: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
    - **Labour shortages**: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
14. On a scale of 1 to 5, how much potential do you see for improving cotton production in your area? (1 = No potential, 5 = High potential)
    - ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

14. How much do you agree that the following factors affect cotton production in your area?

	SD	D	NS	A	SA
Gender					
Level of education					
House hold size					
Farming experience					
Extension frequency					
Number of cattle owned					
Distance to the market					
Farmers membership to farming association					
Ownership of farming equipment					
Access to credit					
Access of cell phone					
Access of radio					
Quality of rainfall season					
Free input programs					
Temperature					
Improved technology of producing cotton					
Price of inputs					
Number of cotton sprayers					
The value of capital					
Inputs availability					
Soil fertility					
Pests					
Diseases					

The use of genetically engineered seed					
Contracting farming					
Side marketing in contract farming					
Government policy on destruction of cotton stock by end of planting season					
Government policy on export permits for cotton					
Arrival time at market place					

14. Constraints encountered during crop production

Constraints encountered during crop production	**Tick** for every problem encountered	SCALE (1 - 3) 1= low 2= moderate 3= high		
		1	2	3
Shortage of water				

Constraints encountered during crop production	**Tick** for every problem encountered	SCALE (1 - 3) 1= low 2= moderate 3= high		
		1	2	3
Pests				
Diseases				
Access to inputs				
Lack of improved varieties				
Lack of labour				
Marketing problems				
Others (specify)				
Number of family members				

SECTION C

To assess the sustainability of cotton production in Zimbabwe

1. What soil management practices do you employ? (Select all that apply)
   - ☐ Crop rotation ☐ Cover cropping ☐ Reduced tillage ☐ None
2. Do you use any water conservation methods? (Select one)
   - ☐ Yes ☐ No
3. How often do you use chemical fertilizers in your cotton production?
   - ☐ Never ☐ Once a season ☐ Twice a season ☐ More than twice a season
4. What is your average profit margin from cotton production? (Select one)
   - ☐ Less than 10% ☐ 10-20% ☐ 21-30% ☐ More than 30%
5. How would you rate your access to markets for selling cotton? (Select one)
   - ☐ Very poor ☐ Poor ☐ Average ☐ Good ☐ Excellent
6. How involved is your farm in community engagement activities? (Select one)
   - ☐ Not involved ☐ Slightly involved ☐ Moderately involved ☐ Very involved
7. How would you rate your labour practices in terms of fairness and working conditions? (Select one)
   - ☐ Very poor ☐ Poor ☐ Average ☐ Good ☐ Excellent
8. How aware are you of sustainable farming practices for cotton production? (Select one)
   - ☐ Not aware ☐ Slightly aware ☐ Moderately aware ☐ Very aware
9. On a scale of 1 to 5, how willing are you to adopt more sustainable farming practices? (1 = Not willing, 5 = Very willing)
   - ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

10. On a scale of 1 to 5, how significant are the following challenges to sustainable cotton production? (1 = Not significant, 5 = Very significant)

- **Climate change**: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
- **Pest management**: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5
- **Market fluctuations**: [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5

11. How would you rate your access to resources (e.g., information, funding) for implementing sustainable practices? (Select one)
    - ☐ Very poor ☐ Poor ☐ Average ☐ Good ☑ Excellent

12. Kindly indicate the clothing that you or any other people working on your field put on when applying pesticides in cotton field

- ☐ Work suits and Gumboots ☐ Work suit only ☐ Casual clothes ☐ other Specify……
  ……
  ……
  …….. ☐

13. If crop chemicals are used how do we get them disposed

    1= burring 2= burning 3 Cleaning for other purposes (Specify) 4= other specify

14. How do you determine the application rate for your pesticides you apply in the cotton field?

    1= Estimation 2=Pesticides 3= Using previous experiences 4= Help of AGRITEX Officers 5= other specify

15. Have you received any form of training on pesticides use?

    1= Yes 2 No

16. Kindly indicate non-chemical methods you use to control pests in your cotton fields?

    1=Flame weeding 2=Cultivating 3=Mulching 4=Thermal weed control 5 other specify

17. How often do you clean application equipment for chemicals after use?

    1= every day after use 2= Seven day after use 3=Just before use 4 A month after use

18. Under what circumstance would you use a lower or increase fertilizer application rate that specified on the pesticide container label

    Above……
    ……
    ……
    ……
    ……
    ……
    ……
    ……

19. Do you have access to insurance for the cotton fields you have?

    a) = YES
    b) = NO

20. In cotton production are women given leadership roles at community level?

1= Yes 2=No

21. How do you prepare your cotton fields

1= Manual 2 = Ploughing 3= Ploughing only using a tractor drawn plough 4= Ploughing + discing using tractor-drawn plough

5= Ploughing + discing using tractor-drawn implement 6= Minimum tillage (Rip lines) 7= other specify

22. How many hours do you work per day in cotton farming?

1= <5 hours 2= 6-8 hours 3= 9-10 hours 4=≥10 hours

23. Do you have any access to any social protection group?

1= Yes 2= No

24. Do you consider gender when allocating agricultural inputs

1= Yes 2= No

25. Is it mandatory for farmers to join association groups?

1= Yes 2= No

Section D

Objective: To assess the sustainability of cotton production in Zimbabwe Gokwe District. (Cost and revenue attained)

1.

Area planted	Fertilizer applied			Other items received as payment (list items and their quantities) Item	Quantity produced
	Type	Quantity	Unit cost		

2.

Activity	Estimated cost	Type and quantity used
Which types of fertilizers did you apply		
Which types of pesticides did you apply		
Which types of Herbicides did you apply		
Labour		
Land preparation		
Planting		
Labour for thinning		
Labour for Herbicide application		
Labour for weeding		
Labour for Scouting		
Labour for harvesting		
Labour for Grading		
Labour for packing		
Labour for loading		
Transport		
Land Preparation		
Fuel		
Seed		

3.

Revenue received from cotton production

Total output produced	Payment received per kg produced	Other items received as payment (list items and their quantities) Item

Section E

To suggest strategies that can be used to sustainably produce cotton in Zimbabwe

1. To what extent do you agree that the following helps improve sustainability of cotton production in Zimbabwe

	SD	D	NS	A	SA
Reducing gender discrimination on cotton production					
Training farmers					
Increase family size					
Increasing Extension frequency					
Improved number of cattle owned by farmers					
Allocation of markets near farmers					
Increasing farmers membership to farming organisations					
Improved mechanisation of farmers					

Improved access to credit to farmers					
Allocation of cell phone to cotton farmers					
Allocation of radios to cotton farmers					
Improved rainfall					
Allocation of free input programs					
Favourable Temperature					
Improved technology of producing cotton					
Reduced prices of inputs					
Increased number of cotton sprayers					
Increased capital allocation					
Increased input availability					
Improved Soil fertility					
Improved Pests control					
Reduced Diseases					
The use of genetically engineered seed					
Contracting farming					
Side marketing in contract farming					
Government policy on destruction of cotton stock by end of planting season					
Favourable Government policy on export permits for cotton					
Reducing the arrival time at market place					
Increasing the land ownership					
Engaging in irrigation					
Engaging in plant protection measures					

Early land preparation					
Quick dissemination of information					
Timely arrival of inputs					
Improved government support to farmers					
Increased extension services					

Appendix 2 Results for effects of access to markets, community engagement, fairness of labour practises and access to resources on social sustainability of cotton production in Gokwe district, Zimbabwe.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of B17.0 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
2	The categories of B17.1 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
3	The categories of B17.2 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
4	The categories of B17.3 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
5	The categories of B17.4 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix 3 Effects of soil management practices, water conservation and frequency of using chemicals on the environmental sustainability of cotton production in Gokwe district, Zimbabwe

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of B17.0 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
2	The categories of B17.1 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
3	The categories of B17.2 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Appendix 4: Quantile regression analysis, examining the impact of various factors on gross margin in cotton production in Zimbabwe's Gokwe district.

Simultaneous quantile regression — Number of obs = 300
bootstrap(100) SEs — .25 Pseudo R2 = 0.0382
.50 Pseudo R2 = 0.0304
.75 Pseudo R2 = 0.0868

grossmargin	Coefficient	Bootstrap std. err.	t	P>|t|	[95% conf.	interval]
q25						
gender1	25.4	13.30199	1.91	0.057	-.7799376	51.57994
age1	29.8	12.37763	2.41	0.017	5.439322	54.16068
education1	-3.8	12.35194	-0.31	0.759	-28.11012	20.51012
HOUSEHOLDSIZE	3.8	5.209781	0.73	0.466	-6.453482	14.05348
mstatus	24.76	13.43444	1.84	0.066	-1.680602	51.2006
seedtype1	103.84	27.0459	3.84	0.000	50.61039	157.0696
pestmgt1	23.76	14.53477	1.63	0.103	-4.846199	52.3662
_cons	-180	32.36396	-5.56	0.000	-243.6962	-116.3038
q50						
gender1	24	17.45122	1.38	0.170	-10.34612	58.34612
age1	46.6	11.97798	3.89	0.000	23.02589	70.17411
education1	4	11.79124	0.34	0.735	-19.20659	27.20659
HOUSEHOLDSIZE	-9.6	7.170395	-1.34	0.182	-23.71221	4.512207
mstatus	3	12.02275	0.25	0.803	-20.66223	26.66223
seedtype1	108.6	27.05674	4.01	0.000	55.34904	161.851
pestmgt1	1.2	14.25698	0.08	0.933	-26.85947	29.25947
_cons	-98.8	30.67541	-3.22	0.001	-159.1729	-38.42706
q75						
gender1	23.25	32.05377	0.73	0.469	-39.83572	86.33572
age1	157	33.60566	4.67	0.000	90.85999	223.14
education1	-13.48333	30.43183	-0.44	0.658	-73.37687	46.4102
HOUSEHOLDSIZE	-20.48333	13.2618	-1.54	0.124	-46.58417	5.6175
mstatus	-19.96667	36.012	-0.55	0.580	-90.84265	50.90932
seedtype1	247.75	46.01189	5.38	0.000	157.193	338.307
pestmgt1	10.2	49.27614	0.21	0.836	-86.78143	107.1814
_cons	-140.8167	81.05577	-1.74	0.083	-300.3443	18.71092

Appendix 5 Strategies for sustainable cotton production in Zimbabwe Gokwe district

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories of B15_i occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
2	The categories of B15_2 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
3	The categories of B15_3 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
4	The categories of B16 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
5	The categories of B17.0 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
6	The categories of B17.1 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
7	The categories of B17.2 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
8	The categories of B17.3 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
9	The categories of B17.4 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
10	The categories of B17.5 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
11	The categories of B17.6 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.
12	The categories of B17.7 occur with equal probabilities.	One-Sample Chi-Square Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.