The potential of Bt cotton to diversify the farm input subsidy program for smallholder farmers' income enhancement in Balaka and Chikwawa Districts in southern Malawi

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Abstract

The topic of genetically modified (GM) crops elicits a considerable degree of controversy within the field of agriculture. While certain nations are actively embracing the advantageous aspects associated with technological advancements, others demonstrate reluctance towards adopting such innovations due to a multitude of reasons. However, despite these controversies, the progress of technology adoption in countries like Malawi is not impeded. Nevertheless, the exorbitant expenses associated with Bt seed jeopardize its affordability and accessibility, thereby presenting significant obstacles for adoption amongst smallholder farmers facing limited resources. Malawi is among the nations that have embraced the commercialization of Bt cotton subsequent to the achievement of effective confined field trials. Given the considerable costs associated with Bt seeds, this research aims to examine the potential of Malawi's farm input subsidy program (FISP) in diversifying the smallholder farming portfolio with Bt cotton for the purpose of improving livelihoods. The study utilizes mixed methods to investigate the socioeconomic profile of farming households in Malawi. Furthermore, the research documents the perspectives of key informants and farmers regarding the usefulness of FISP and the potential of Bt cotton in the context of Malawi. The findings indicate that cotton holds substantial economic value as a cash crop for Malawi. However, it is evident that a significant number of cotton farmers lack sufficient access to the necessary inputs including high value seeds, have deficiencies in technologies and extension services, as demonstrated by the farmers' limited understanding and awareness of Bt cotton. The research outcomes also delineate the impact of FISP on maize cultivation within the smallholder farming community. It further demonstrates that FISP has the capacity for incorporating modifications, thereby offering potential avenue for diversification with crops beyond maize and include cash crops such as Bt cotton. Nevertheless, the financial requirements associated with the inclusion of the expensive Bt seed may present challenges in terms of budgetary constraints for FISP.

Keyword: Agriculture, Bt cotton, diversification, farm input subsidies, smallholder farmers

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Abbreviations

AIP	Affordable Input Program
ACC	Africa China Cotton
ATDC	Agricultural Technology Development Centres
ADMARC	Agricultural Development Marketing Cooperation
AICC	African Institute of Cooperate Citizen
Bt	*Bacillus thuringiensis*
CCM	Cotton Council of Malawi
COFA	Cotton Farmers Association
CPUM	Cotton Production Up-scaling Model
FISP	Farm Input Subsidy Program
FAO	Food and Agriculture Organization
GE	Genetically engineered
GMO	Genetically Modified Organism
GoM	Government of Malawi
GR	Green Revolution
GDP	Gross Domestic Product
HDI	Human Development Index
LUANAR	Lilongwe University of Agriculture and Natural Resources
MNPGRC	Malawi National Plant Genetic Resource Centre
MOST	Malawi Oil Seed Trust
NCST	National Commission for Science and Technology
RSA	Republic of South Africa
SAP	Structural Adjustment Programs
SDG	Sustainable Development Goals
SSA	Sub Saharan Africa
UN	United Nations
UNDP	United Nations Development Program
USAID	United States Agency for International Development
WCA	West and Central Africa
WB	World Bank
WDR	World Development Report

1. Chapter one

1.1 Introduction

This chapter serves as the introductory segment of the thesis, presenting the contextual information required for providing an overview of the comprehensive study centred around Bt cotton. The study aims to explore the potential of Bt cotton as an agricultural biotechnology in expanding the scope of the farm input subsidy program (FISP), with the objective of enhancing income for smallholder farmers in Malawi. The primary focal point of this study is centred upon the examination of the dynamics associated with cotton farming and the consequential effects it has on food security and livelihoods. The topic of cotton has become a subject of global debates in recent years (Flachs 2019). Cotton in the Sub-Saharan Africa (SSA) region is commonly depicted as a multifaceted entity embodying various dynamics including development, poverty, wealth, transformation, trade conflicts, and environmental degradation (Moseley & Gray 2008). This discourses reflect national, regional, and international dialogues pertaining to various implications in the globalization debate, namely privatization, structural adjustment, food security, biotechnology, agricultural subsidies, poverty alleviation, and sustainable development (Tausif et al. 2018) requiring a holistic approach to understand its consequences on livelihoods. Cotton cultivation, akin to other cash crops, involves individuals undertaking certain financial risks through loan acquisition and employing hazardous pesticide practices due to their livelihood dependence on the resultant income. Consequently, cotton farming represents a pathway to prosperity for numerous farmers, yet perpetuates impoverishment for others (Moseley & Gray 2008; Luna et al. 2021). Cotton is one of the important crops in agriculture (Ahmad et al. 2018). It is the world's leading natural fibre produced and commercialized

(Khan et al. 2020). Although, there are numerous cotton producing countries, global production is largely dominated by China, USA and India (Shahrajabian et al. 2020). There are about 150 countries involved in the cotton industry providing income to about 100 million families who are cultivating the crop (Tarazi et al. 2019). Cotton is a main source of livelihoods and revenue for up to 1 billion people, out of which 250 million work in cotton processing (Voora et al. 2020).

1.2 Cotton in African agriculture

Cotton is essential to the economies of several African countries, providing livelihoods to lots of smallholder farmers. In some countries, it is known as "white gold" because it produces so much revenue (Ali et al. 2014). Africa contributes about 8% of the global cotton production (Amanet et al. 2019). The African continent is home to six distinct cotton basins, with the West African basin holding the utmost significance (Amanet et al. 2019). Among the 54 countries that comprise the African continent, cotton production is observed in a total of thirty-seven nations, of which thirty nations engage in exporting the commodity (Ibid). West African nations are at the forefront of global cotton exports and is said to have the best quality (Ibid). The designation of African cotton as possessing superior quality stems primarily from the meticulous hand picking approach employed during the harvesting process (Majumdar et al. 2019).

Despite the quality of Africa's cotton, the climatic conditions within Sub-Saharan Africa are favourable for the proliferation of pests, which subsequently inflict damage on cotton crops, leading to a significant reduction in yields (Ibid). In the western regions of Africa, alone pest-related losses account for approximately 25-35% of the overall cotton yield (Ibid). Other than the climate related problems, cotton farmers in Africa encounter numerous challenges encompassing issues such as inadequate seed quality, exorbitant expenditure on inputs including seeds, pesticides, and fertilizers, low levels of literacy, as well as insufficient access to training opportunities (Amanet et al., 2019). There exists

an imperative to provide adequate support for cotton production within Africa, namely through measures such as boosting seed availability, fostering research in agriculture, and implementing a capacity-building strategy. These interventions are crucial in enabling farmers to obtain optimal returns from their cotton cultivation endeavours (Amanet et al., 2019).

According to OCDE/FAO, (2016), in Sub-Saharan Africa (SSA), cotton has garnered government attention through empirical investigations and is deemed a vital commodity crop with projected growth of 14% by 2025. This growth is anticipated to equate to approximately 15% of the worldwide cotton lint exchanges. While continuing increases in farm labour costs and competition for resources with other agricultural crops place significant constraints on growth in global cotton production, higher productivity driven by technological progress, including greater adoption of bio-tech cotton, creates substantial potential for cotton production to expand in the next decade.

The resurgence of cotton farming in several African nations, including Malawi, is underway in order to foster and ensure the sector's long-term viability (Partzsch et al. 2019). The increasing significance of African cotton can be attributed to a fusion of state-driven strategies, particularly observed in the francophone West African region, and export promotion policies advocated by the Bretton Woods institutions (Lorenzetti 2022). During the period spanning from 2016 to 2018, there was noticeable fluctuation in the supply and demand dynamics pertaining to cotton. The spinning mill witnessed a surge in demand, surpassing the available supply, consequently leading to a deficiency in global cotton reserves due to unfavorable climatic conditions and pest-related challenges encountered in prominent cotton-producing nations like the USA and India (OECD, 2019). The continuation of this deficit is anticipated, although it may experience a slight equilibrium in the short run contingent upon the COVID-19 crisis' influence on cotton demand (Voora et al. 2020).

Economically, the cotton sector already faces significant price volatility due to several factors, including the high vulnerability of cotton to climate change (Amouzou et al. 2018). This result in farm cotton prices being lower, adversely

affecting producers' livelihoods. These prices are often the result of unfavourable trade terms and high subsidies provided to cotton producers in some developed countries and emerging economies (Sucker 2021). Subsidies provided by rich countries distort global markets and depress prices, undermining the competitiveness and incomes of poor farmers in the developing world (Hopewell 2019). As a result, less developed producing countries cannot offer product specific support to cotton farmers losing competitiveness in the market, and the farmers end up selling their produce at unfavourable prices. In West Africa, for example where cotton is an important cash crop, recent research found a direct correlation between a decrease in cotton prices and an increase in farmer poverty levels (Maboudou Alidou & Niehof 2020). According to Hopewell (2022) and Sucker (2021) the inability of developing countries to compete with the subsidized agriculture of developed countries prompted some of West Africa's cotton producing countries including the "Cotton-4," Benin, Burkina Faso, Chad, and Mali to have long sought negotiated reforms to the World Trade Organization's (WTO) farm subsidy rules in relation to cotton.

Cotton is known for its high utilization of pesticides and herbicides, contributing to an environmentally intensive cultivation process. The industry is accountable for the application of 16% of insecticides and 6. 8% of herbicides on a global scale (Lee 2017; Tausif et al. 2018). Some of these chemicals wash into water sources, contaminating them and affecting the marine ecosystem (Mojiri et al. 2020). The recent decades have witnessed an introduction of genetically modified (GM) cotton seeds in the cotton sector as a response to the significant utilization of pesticides. These aforementioned GM cotton seeds exhibit enhanced resistance against pests (Veettil et al. 2017). Numerous farmers have developed a reliance on these seeds (Qaim et al. 2013). Scholarly literature has projected substantial advancements in crop productivity and financial gains as a result (Noman et al. 2016; Kranthi & Stone 2020; Luna & Dowd-Uribe 2020). Among the prominent cotton-growing regions worldwide, Africa is currently producing the smallest quantity of genetically modified (GM) cotton (Kedisso et al. 2022).

In the year 2020, it was observed that a mere seven out of the total 54 countries in Africa had embraced the utilization of genetically modified (GM) technology (Gbashi et al. 2021). Specifically, these nations included South Africa in 1997, Eswatini and Sudan in 2012, and Ethiopia, Kenya, Malawi, and Nigeria in 2018 (Gbashi et al. 2021; Turnbull et al. 2021; Gbadegesin et al. 2022a; Kedisso et al. 2022). In certain instances, the implementation of genetically modified (GM) seeds has resulted in adverse repercussions on the overall quality of cotton, leading to a shift in preference among cotton cultivators (Gbadegesin et al. 2022b). Four African countries, namely Algeria, Burkina Faso, Egypt, and Madagascar, have implemented regulations that cease or restrict the utilization of genetically modified (GM) cotton or genetically modified organisms (GMOs) in a broader context (Bavier 2017, Gbadegesin et al. 2022a). Although the current adoption of GM technology in Africa may appear to be limited, there is an increasing number of countries that are either granting or contemplating the permission for its use. This trend presents significant prospects for enhancing agricultural yields through the implementation of improved farming techniques and technological advancements (OECD, 2016). Therefore, embracing the agricultural technologies in cotton farming and providing input subsidies should be considered with high regards if farmer livelihoods are to be sustained.

1.3 Cotton subsector in Malawi

Malawi is an export dependent country where agricultural commodities represented 92.3 per cent of exports in 2018-2019, increasing from 90.4 per cent ten years earlier (UNCTAD, 2021). Agriculture accounts for 31 per cent of the GDP but employs 76 per cent of the workforce. Women represent more than half of the agricultural workforce (GoM, 2022). The agriculture sector, comprising estate and smallholder farming, accounting for almost 90 per cent of export revenue (Ibid). The four leading commodity exports are tobacco, tea, sugar, and cotton. Cotton is mainly produced by smallholder farmers in Malawi, where labour productivity in the agricultural sector remains very low (Phiri, 2018). Over 200,000 smallholder farmers use their income from cotton to buy food and pay for other necessities (UNCTAD, 2021). This is particularly crucial in cotton growing areas where food crops such as maize are constrained due to adverse

weather conditions (Magombo et al. 2017). Nearly 50% of cotton produced in Malawi is traditionally produced in drought prone areas of the country where cotton can provide a valuable source of cash when other crops fail (Kumwenda and Madola, 2005). Historically, Malawi has been growing cotton traditionally produced in five of the eight Agricultural Development Divisions (ADDs), where it provides a valuable source of revenue to drought-prone areas of Karonga, Salima, Blantyre, Machinga, and Chikwawa and Nsanje districts of Shire Valley (Mandala 1982). Cotton was historically grown by over 250,000 smallholder farmers on 150,000 h. of land (Kenamu-Phiri, 2014). Over the years, the cotton industry has experienced a reduction in domestic demand for cotton lint as a result of a shrinking domestic textile industry especially since the 1990s contributing to low cotton production volumes. The growth in the cotton sub-sector has been static as evidenced by the insignificant difference in the area planted and production volumes before and after the structural adjustments programs (Kenamu and Phiri, 2014).

Prior to market liberalization in the 1980s, Cotton enjoyed the same level of protection offered to cash crops such as tea and tobacco under the Special Crops Act of 1972 (GoM, 2015). Until the 1980s, seed cotton was bought and processed by the government-owned Agricultural Development and Marketing Corporation (ADMARC) and processed through a government-owned ginnery. The arrangement had undeveloped elements of contract farming since ADMARC provided cotton inputs to farmers and bought seed cotton from them after production. After market liberalization, private sector ginners entered the cotton business (WTO, 2019). The invasion of private sector players in Cotton trade, formed cartels which had an effect on farm gate prices (GoM, 2017).

According to the Cotton Council of Malawi (2019), the country has the potential to produce more than a hundred thousand metric tonnes of seed cotton annually if farmers were mobilised, input supply systems were effective, and seed cotton prices were attractive to smallholder producers. However, since 2015, annual seed cotton production has mostly been around only 20,000 MT, and planted area has been gradually receding down to about 17,000 hectares in 2020-2021 season (See Figure 1). In efforts to revive the sector the government promoted

the private partnership investment. It also launched the scale up strategy and the National Agriculture Investment Plan (NAIP) (Ochieng 2017) alongside supporting irrigation to cotton under the Green Belt Authority (GBA), where for the first time irrigated cotton is being harvested in the country (GoM, 2022). This resulted in all Agricultural Development Divisions (ADDs) to experience relatively high levels of cotton production between 2011-2014. Just like Production at national level peaked in 2011/12 growing season mainly due to Cotton Production Up-scaling Model (CPUM). Following the end of CPUM, the cotton industry experienced a downward trend again (UNCTAD, 2021).

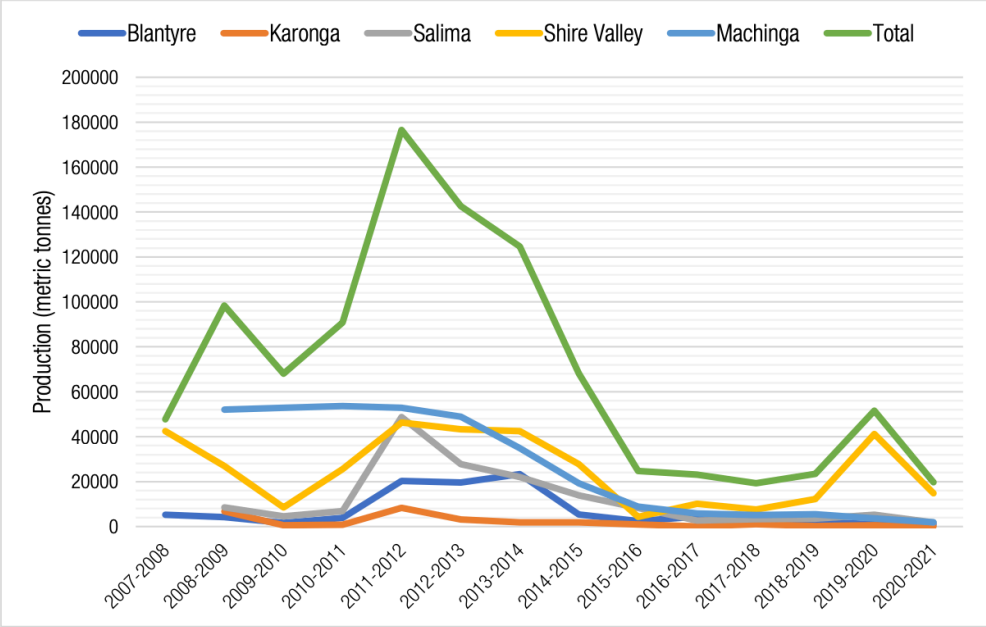

Figure 1. Malawi cotton production trends by Agricultural Development Division (ADD) in metric tonnes (2008-2021) source (UNCTAD 2021)

The promotion of private partnership investments gave birth to the Cotton Council of Malawi (CCM) a subsidiary of the Africa China Cotton (ACC) which was established to support cotton developments in Malawi. (Chiudza Banda & Kayira Wasambo 2022). The CCM supported the establishment of the Cotton Farmers Association (COFA) as a voice for cotton farmers. This preceded the investment in Agricultural Technology Development Centres (ATDC) by the Chinese company to advance agriculture development, and cotton was the main crop of focus especially in Salima district where much of cotton research and investment were being done. (Chiudza Banda & Kayira Wasambo 2022). In 2018, the Chinese company handed over the ATDCs to the government of

Malawi. Despite these efforts, the CCM had no shares held by the Malawi government nor Malawi citizens and it came to reveal that the ATDC led to monopoly of the cotton markets as it had created a zoning systems (A total of 66 zones were established) where farmers were mandated to affiliate and sell their cotton to a company that sell them inputs (Chiudza Banda & Kayira Wasambo 2022).This led to on average 10,000 farmers abandoning the crop in the 2020/2021 growing season (Ibid). Cotton production in Malawi continues to experience challenges such as use of low yielding seed varieties, high input costs, uncoordinated marketing infrastructure, weak and unenforceable contractual arrangements between farmers and buyers, and stiff competition from cheap imports as well as globally decreasing cotton prices (Andrew et al. 2019). In particular, Covid 19 also scaled down cotton sells in Malawi below the govt. approved price of 320 Malawi Kwacha/kg (equivalent of USD 0.4) which has further undermined interest in the crop (Chiudza Banda & Kayira Wasambo 2022). Production challenges are further compounded by increased climatic variability and change leading to a reduction in the number of ginners from 12 in 2015 to 4 by 2019 (CCM, 2019). Introduction of new cotton varieties through research at Makoka research station and the commercialisation of Bt cotton in Malawi is among other factors instilling hope to revamp the cotton industry (Ochieng 2017; Akinbo et al. 2021) Therefore, there is need to continue embarking on further efforts to improve the productivity of the cotton farmers in order to compete for better global cotton prices. Thus, this study intended to examine the potential of Bt cotton to diversify the FISP with Bt cotton for smallholder farmers livelihood enhancement.

1.4 Problem Statement

Despite Malawi being well known for tobacco production as the leading export crop, its overproduction particularly of burley tobacco, poor leaf quality and anti-smoking campaigns have caused market prices to drop, thereby significantly reducing foreign exchange earnings since the late 1990s (Shah et al. 2022) Tobacco is also said to be encouraging deforestation which have serious implications for Malawi (Ngwira & Watanabe 2019). The international donors and health organizations, have long recommended that the Malawian

government should help smallholder farmers move out of tobacco citing negative health risks associated with consuming tobacco with evidence that it pose direct risks to farmers besides affecting children schooling due to child labour in tobacco estates which also escalate the green tobacco sickness amongst children aged five to fourteen who are engaged in tobacco farming households (Xia & Deininger 2019). To tackle the problem of overproduction, the Government re-introduced a quota system to regulate production, address quality issues and reduce supply. Despite these efforts and looking at the adverse health effects, farmers are likely needing a clear profit incentive to move away from tobacco production on their own. Otherwise policy interventions such as taxes and subsidies are needed to change relative profitability and induce farmers to leave tobacco and move to other crops such as cotton (Shah et al. 2022). Cotton has a relatively long value chain comprising, in addition to its production, the processing industry in terms of ginning, oil crushing, spinning and weaving companies, as well as textile and garment retailers (CCM,2019). Despite the importance of cotton as a cash crop in Malawi, its yields are generally low, hovering between 200 and 300 kg/ha of lint in the past three decades (AICC, 2021) which is attributed to among other things poor or inadequate insect and pest management, high investment requirements aggravated by high levies on inputs such as pesticides, spraying equipment, protective clothing, fertilizer and seeds (GoM, 2022). Unlike tobacco which is the only sector in the Malawi's national economy where capital has accumulated (Klein et al 2019). Efforts to promoting cotton farming were observed through the inclusion of cotton seeds and chemicals in the Farm Input Subsidy Program (FISP) during the 2007/08, 2008/09 and 2011/12 cropping season where around 200 000 cotton farmers are believed to have benefited from the intervention (Chirwa and Doward, 2013), however, support to cotton production remains low in terms of public spending, accounting for only 1 percent of public expenditure in support of agriculture. Unlike the well managed tobacco, total support to cotton production was diversified, with 71% of the cotton budget support allocated to extension and transfer of technologies, 22 % to training, 5 % to marketing activities, 1% to inspection services and 1 % to general value chain support (FAO, 2020). Thus, affecting its production. The commercialisation of Bt cotton in Malawi presents an opportunity to advance cotton farming (Kedisso et al. 2022), however, the

high seed costs and the limited cotton seed companies pose challenge to farmers' access. So far Monsanto is the only company offering Bt seed. On the other hand, the limitations of FISP towards food crops (Nkhoma 2018; Matita et al. 2022) further exacerbate challenges for farmers to diversify their farming portfolio with cash crops.

1.5 Study objective

The overall objective of this study was to examine the potential of diversifying the portfolio of the farm input subsidy programme (FISP) with Bt cotton and how that could contribute towards improving the income and livelihoods of smallholder farmers in Malawi.

1.6 Research Questions

To achieve the research objective, three research questions were addressed in this research study including the following:

1. How has the FISP program changed over the past 10 years (2005-2015)?
2. What could be the impact of Bt cotton in the Malawi agricultural sector?
3. Can Bt cotton be an alternative cash crop to tobacco in contributing to Malawi's GDP and small-scale income enhancement?

2. Chapter Two:

2.1 Literature Review

2.1.1 Agricultural Technologies and the Green Revolution

Every farmer looks up to how much s/he can produce at the end of the growing season. Weather it is enough for consumption or there is surplus for sale, still crop yields remain agriculture's principal unit of productivity measurement (Barry 2009). Along the years, agriculture productivity has faced several changes of which many has resulted from numerous technological impacts. For the past 75 years, agriculture has experienced dramatic and widespread yield increases due to technology advancement (Armanda et al. 2019). These advances impact food sustainability, economic growth, world hunger, energy markets, and the ability to mitigate or enhance potential climate change effects (Jez et al. 2016). There was a revolutionized crop breeding through large-scale crossing based on a then-modern understanding of genetics by institutions that had access to a wide range of genetic material, having assembled large collections of traditional crop varieties that had not previously been available to breeders and this brought the rise of the early green revolution technologies (Abdulai 2022). In particular, the high yielding varieties were closely associated with the creation of new internationally funded research centres and the large-scale mobilization of scientific resources (Gollin et al. 2021). The word "Green Revolution" was coined by William S. Gaud of United States Agency for International Development (USAID) in 1968, for the introduction of new technology and policies implemented in the developing nations with aids from industrialized nations between the 1940s and the 1960s to increase the production and yield of food crops (Conway 2019)

The Green Revolution (GR) programmes during the 1950s and ‘60s was to alleviate hunger by boosting food production. The programmes greatly increased yields as well as overall food production so that in several of the host countries food imports were no longer necessary (Harwood 2019). Accordingly, with its package of inputs of high yielding cultivars, agrochemicals, irrigation, and subsidies, there was a dramatic increases in maize, rice and wheat production in the 1970s and 1980s in Asia and Latin America but it did not take place in sub-Saharan Africa (Conway 2019). This, is due to a host of reasons. One of the main reasons is the weakness of the public breeding systems in sub-Saharan Africa, which have been able, in only a very limited way, to respond to and address the challenges facing resource poor small-scale farmers (Djurfeldt et al. 2005). It is against this background that it is now commonly viewed as critical and urgent to produce resilient and high yielding cultivars addressing the needs of African farmers as expressed strongly that African smallholders are lagging behind because they have not adopted modern, higher-yielding crop varieties (Djurfeldt et al. 2005). Thus, genetically modified (GM) crops represent a pivotal subject in the discourse surrounding Africa's green revolution (Fischer 2022).

Genetically modified organisms (GMOs) are plants, animals or organisms whose genetic material has been specifically modified using genetic engineering tools (FDA,1992).

A limited number of countries are employing genetically modified organism (GMO) crops to enhance agricultural productivity for their farmers. Burkina Faso is extensively documented for its cultivation of Bt cotton and the involvement of smallholder farmers, while South Africa has similarly recorded the use of genetically modified (GM) maize. Together, these nations represent some of Africa's earliest adopters of GM technologies as a strategy to combat poverty. Despite this pioneering status, the empirical evidence regarding the impact of these technologies on poverty alleviation remains limited (Fischer & Hajdu 2015). Recently, Burkina Faso's withdrawal from the cultivation of Bt cotton has contributed to the prevailing discourse surrounding the perception of failure associated with the African Green Revolution, particularly in the context of genetically modified (GM) technologies. In the context of a significant

number of African nations grappling with a politicized and polarized discourse surrounding the adoption of new breeding technologies (Dowd-Uribe & Schnurr 2016), instances such as Burkina Faso's decision to reverse its stance on Bt cotton further exacerbate the erosion of public trust in genetically modified (GM) crops throughout the continent. It is essential to acknowledge that the success of the Green revolution in Asia was attributable not only to technological advancements but also to a combination of factors including government funding for agriculture, the formulation of supportive policies, enhanced usage of fertilizers, the implementation of irrigation practices, and the mechanization of farming processes. Additionally, investments in input subsidies played a crucial role in facilitating these advancements (Djurfeldt et al. 2005). Hence, for countries like Malawi that has a big portion of their budget on agriculture and has subsidy programs already in existence, Bt cotton will present an opportunity for its government to support farmers to diversify their farming portfolio.

In advocating for the modern green revolution, biotechnology has demonstrated its significance not only in enhancing crop yields but also in improving various agronomic traits that extend beyond yield enhancement, a primary focus during the Green Revolution. Biotechnology offers advancements in multiple domains, such as pest and disease tolerance (Mojiri et al. 2020), enhancement of crop-based essential nutrition, which serves as a crucial strategy to address malnutrition in developing countries (Sangam, Garcia-Oliveira, Govindaraj, and Ortiz 2023). Products generated through agricultural biotechnology are rapidly emerging as one of the foremost commodities in global agricultural trade. These products play a crucial role in various sectors, including the provision of clothing, the feeding of livestock, and the fuelling of environmentally sustainable vehicles. The adoption of genetically modified (GM) organisms is experiencing a notable increase, despite the presence of non-uniform regulatory frameworks across different regions worldwide. These frameworks include a spectrum of measures, ranging from outright suspensions and prohibitions to various regulatory constraints. Given the extensive surface area under cultivation, the necessity and acceptance of biotechnology-derived crop varieties are no longer subjects of dispute (Turnbull et al. 2021). Humans have always found a way to build on previous knowledge to improve agricultural capabilities

and it is these improvements that have led to higher production and access. The employment of biotechnology is just one part of agricultural innovation that contributes to modern agricultural success (Aven 2016) .

Biotechnology is defined as:
"The application of scientific techniques to modify and improve plants, animals, and microorganisms to enhance their value.." (Wieczorek 2003)

Today multitudes of farmers are deciding to utilize biotechnology for higher yields and reduced production costs (Shavanov et al. 2022). Farmers have adopted crops genetically modified through modern biotechnology with the fastest adoption rate of any crop technology (Zambrano et al. 2022). The cultivation of GM crops has increased over the years from just a handful of countries in 1996, to 29 adopting countries in 2019 (ISAAA, 2019). In Sub–Saharan Africa, outside of South Africa, the momentum in African economies towards authorizing the cultivation of GM crops appears to be building up (See table 1) . In 2019, the Kingdom of Eswatini (formerly Swaziland) joined South Africa and Sudan in planting GM crops, with commercial planting of insect resistant Bt cotton. In that same year Nigeria, Ethiopia, Kenya, and Malawi granted approvals for planting GM cotton. However commercial cultivation of GM crops is still largely confined to Maize, cotton, cowpeas and canola (Zambrano et al. 2022)

Country	**GM crop/trait**	**Area planted (hectares)**	**Year**
Eswatini	Insect-resistant cotton	403	2019
Ethiopia	Insect-resistant cotton	311	2019
Kenya	Insect-resistant cotton	n.a.	2020
Malawi	Insect-resistant cotton	6,000	2019
Nigeria	Insect-resistant cotton	700	2019
	Insect-resistant cowpea	n.a.	2021
South Africa	Insect-resistant, herbicide-tolerant maize	2,134,000	2020
	Herbicide-tolerant soybean	785,745	2020
	Insect-resistant cotton	16,176	2020

Country	GM crop/trait	Area planted (hectares)	Year
Sudan	Insect-resistant cotton	236,200	2019

Table *1. GM crop cultivation in Sub-Saharan-Africa. Source (Akinbo et al. 2021)*

In contrast to the crops developed during the Green Revolution, those cultivated through agro-biotechnology are purported to necessitate fewer modifications in agricultural practices and extension services. The Green Revolution necessitated, in many instances, a robust network of agricultural extension specialists tasked with collaborating closely with farmers to facilitate the transformation of agricultural practices (Qaim et al. 2013). In the context of crops developed through agro-biotechnology, including genetically modified (GM) varieties, the technological innovations are embedded within the seed itself. Should the technology be applied to suitable local planting materials, the resultant crops would not necessitate significant alterations in cultivation methods or supplementary management practices (Virgin et al.2007). The functionality of the system is influenced by the underlying concepts and practices that have informed its evolution, as well as by the ways in which it is adopted, adapted, and interpreted by the end-users (Schnurr & Gore 2015) .

2.1.2 Opportunities offered by agriculture biotechnology

Advancements in plant biotechnology have significantly expanded the genetic diversity available for agricultural applications, facilitating the precise transfer of specific genes into a wide range of major food and non-food crops (Vasil, 1998). Furthermore, biotechnology-derived crops possess the potential to mitigate both biotic and abiotic challenges associated with the production of food, feed, and fibre (International Food Policy Research Institute [IFPRI], 2013). Genetically modified (GM) crops have the potential to significantly enhance agricultural productivity, improve pest and weed management, and increase tolerance to abiotic stresses such as drought and salinity (Qaim 2020). Conversely, these crops may contribute positively to public health by reducing pesticide applications and enhancing nutritional quality through the incorporation of micronutrients into staple crops (Sheoran et al. 2022). In this manner, they have the potential to address several significant challenges.

Nutrition enhancement through biofortification

Hidden hunger is a major global challenge and a leading cause of malnutrition and stunted growth in children under 5 (Sheoran et al. 2022). Approximately 2 billion people globally suffer from micronutrient malnutrition, or "hidden hunger," despite a carbohydrate-rich diet, leading to ongoing deficiencies (Hodge 2016). Many micronutrient deficiency disorders can be reversed with a proper diet, but some, like iodine deficiency in early pregnancy, lead to lifelong impairments such as intellectual disabilities. To achieve a healthy world, eradicating malnutrition is essential. Biofortification offers a solution to these challenges, originating during the Green Revolution (1966–1985). Sustainable biofortification can be achieved through conventional plant breeding, molecular breeding, genetic engineering, and agronomic methods (Sheoran et al. 2022). Biofortification enriches staple foods like wheat, rice, maize, and beans with essential micronutrients, as many people rely on these crops and cannot afford a diverse diet (Bouis 2018). Biofortification is the enhancement of staple food crops' nutritional profiles by boosting nutrient content or bioavailability. For example, the golden rice which is enhanced with Vitamin A. Genetic biofortification is a cost-effective solution for hidden hunger, requiring a one-time investment instead of ongoing purchases needed for traditional fortification methods. Biofortifying staple crops with micronutrients is a sustainable solution for addressing malnutrition (Sheoran et al. 2022).

Biotic and abiotic stress resistance

Abiotic stress is crucial in plants' natural environments. Stressors like drought, flooding, extreme temperatures, salinity, and toxicity can negatively impact plant metabolism, growth, and development. Severe stressors can lead to plant mortality and hinder productivity, causing significant economic losses (Smith et al. 2021). Globally, around 70% of crop production is affected by extreme abiotic stresses (Smith et al. 2021). Biotechnological methods such as marker-assisted selection, tissue culture, in vitro mutagenesis, and genetic transformation have enabled the creation of many plant varieties tolerant to abiotic stresses (Das et al. 2023). In recent years, "omics" technologies and model plant species have enabled innovative strategies to understand the molecular and genetic basis of stress resistance. Gene editing technologies have

been used to improve the shelf life of food crops, potentially reducing food waste in the supply chain (Alexander et al. 2017). Biotechnology could reduce reliance on fertilizers and pesticides in agriculture, improving the quality of soil, air, and water for example the use of Bacillus, Pseudomonas, Arthrobacter as biocatalysts for bioremediation. Biotechnology is a key method for developing high-yield, stress-tolerant crops (Barrows et al. 2014).

Pest resistance

The development of insect-resistant transgenic plants represents a significant advancement in the field of agricultural biotechnology, as evidenced by the extensive research efforts undertaken by both public and private sector institutions in this domain. The preeminent example of a commercially utilized transgenic plant is one that incorporates cry genes derived from the bacterium Bacillus thuringiensis (Bt) (Sheikh et al. 2017). Specifically, transgenic varieties of cotton (Gossypium hirsutum) and maize (Zea mays) have exhibited notable resistance to lepidopteran and coleopteran larvae, including caterpillars and rootworms (Das et al. 2023). This genetic modification has resulted in substantial decreases in pesticide application and production expenditures, concomitantly enhancing crop yields.

2.1.3 Biotechnology and development of Bt cotton

Breeders cultivated cotton using classical methods for many years but due to increasing demand, climate change and losses due to pests, there is a decrease in growth and yield (Schnurr & Gore 2015; Noman et al. 2016). Bt-cotton, which is a genetically modified cotton, gets its name from an aerobic gram-positive soil bacterium *Bacillus thuringiensis* (Bt) a world widely used biological pesticide and is the first non-food transgenic crop which serves as an effective tool on lepidopteran and coleopteran insects(Noman et al. 2016). In 1901, the bacterium was isolated from dead silkworm larvae during the investigation of sotto disease in silkworms. Bt is also characterized by forming crystal inclusions such as Crystal (Cry) and Cytolytic (Cyt) toxins during sporulation while crystals dissolved in the midgut of insects after ingestion, proteolytically activated by midgut proteases and after binding to special receptors on the insect cell membrane, they induce cell disruption and cause death of the insect (Ibrahim et

al. 2010; Srikanth et al. 2019). Another important feature of the Bt-cry protein is that it is nontoxic to humans and animals (Sheikh et al. 2017) All these advantages make Bt-cotton important in agriculture.

Developments in biotechnology promoted the commercialization of Bt cotton and it has been widely adopted by farmers, especially in developing countries (Siddiqui et al. 2019). Despite the large numbers of adoption, the modified Bt seeds are more expensive than non-modified due to the intellectual property rights of the agribusinesses that produce them, but the technology is meant to reduce labour and cost inputs mainly from a reduced need for pesticides and increased yields (Schnurr 2013; Schnurr & Dowd-Uribe 2021)

2.1.4 Benefits and constraints of GM technology in Africa

For decades, the pro and anti-GM crops campaign dominated the development of biotechnology and caused distrust between policymakers, scientists and farmers. Noteworthy, a critical examination of GM crops in Africa is necessary since numerous reports on the impacts and performance of GM crops are largely varied and socio-economically different. ~~A~~ major and polarizing debates about GMOs have been a major issue starting from 1990s (FAO 2017). These debates revolve about the possible effect on human being and animal health, the environment, plant biodiversity and the world food chain. It is believed that crop genetic engineering can aid in most conditions on food security as it improves crop productivity and quality (FAO, 2017). However, genetic modification of crops raises worries on potential hazards to living things and environment where the probable challenges and opportunities need to be cautiously assessed on a case-by-case base (Gebretsadik & Kiflu 2018). There is need for advancing country-based control framework to include consideration of current biosafety contexts and functionalities.

Although there is a consensus on the potential of GM crops to ease hunger and food shortage in the world, especially in Africa. Some African countries welcomed the development of GM technology to improve agricultural production efficiency and enhance the nutritional value of foods (Bawa & Anilakumar 2013), while some countries opposed it, stating safety concerns,

intellectual property rights, environmental impact and ethical uncertainties (Aerni 2018; Muzhinji & Ntuli 2021).

Low income economies are more concerned about economic costs and benefits of GM technologies in their agricultural sector (Azadi et al. 2016) which includes a large number of smallholders. Results of many studies suggest that farmers in these countries may economically have a lot to gain through the application of GM crops compared with their counterparts in developed countries. (Hall & Moran 2006; Adenle et al. 2013; Muzhinji & Ntuli 2021). For example, in 2007, 58% of farm incomes were earned by farmers in some developing countries, mostly by the cultivation of GM cotton. These impacts have been examined in some studies such as in Burkina Faso and it has had a positive impact on farmers' revenues. It is important to note that in this case, the real benefit is not because of reduced cost but rather due to higher yields (Bennett et al. 2006; Qaim et al. 2013). It was also found that this higher level of subsistence had a major role in further investment in family education, healthcare, and leisure activities. This yield increase, however, is necessary but not sufficient to estimate the overall farm-level economic benefits of growing GM crops. According to (Ahmad et al. 2021) costs and returns associated with the application of such technologies must be taken into account simultaneously. Furthermore, it remains questionable whether or not it is possible to generalize the economic benefits attributed to GM crops since their performance and thus profitability depends strongly on agronomic, social and institutional factors which shape the context of production (Ahmad et al. 2021; Muzhinji & Ntuli 2021; Fischer 2022)

From the environmental viewpoint, benefits of growing GM crops are said not to be limited to the reduction of toxic chemical inputs but also contribute to the positive effects of other components of agricultural emissions, particularly by reducing energy and fossil fuel use. It then enables reduced tillage and no-tillage agricultural practices thereby help reduce soil erosion and increase organic matter of soil (Brookes & Barfoot 2020). Traditionally, tillage and herbicides are used to prevent unwanted weeds growing in the field. Herbicides are toxic to most plants and must be applied in absence of the crop. Herbicide resistant crops allow for herbicide application at the presence of the crop. Herbicide eliminates

the weeds, and the GM crop is left unharmed thus GM technology impacts the environment positively (Zilberman et al. 2018). While concerns have also been on the health of both human and animals. The effects of GM crops on small-scale farmers' healthcare are both direct and indirect. The former includes less exposure to toxic chemicals (Qaim et al. 2013) during spraying due to less use of pesticides and herbicides in developing countries where farmers mostly apply these toxic chemicals without proper equipment and lacks knowledge about their unhealthy side-effects (Qaim et al. 2013). For instance a survey conducted in South Africa revealed that there was reduced incidence of pesticide poisoning as a result of growing Bt cotton (Bennett et al. 2006)

Regardless of all the claimed benefits, public awareness of GM crops is limited in Africa, and there is a need to ensure that adequate information is communicated to the people. For example, in a survey of public knowledge and understanding of GM crops among adults in South Africa, it was revealed that a large majority have never heard of GM products, even as the first African country to have adopted GM crops (Hallerman & Grabau 2016). Moreover, Adeoti & Adekunle (2007) and Herring & Paarlberg (2016) suggested that public enlightenment on GM technology was inadequate in some countries including Kenya, Nigeria and Ghana and has affected its acceptance. Munisi (2020) on the other hand reported a slow and delayed GM adoption rate in Tanzania citing unfavourable policies, legislation, and regulations for developing and deploying GM crops. In Burkina Faso, over $80 million was reported from cotton pest infestation, which prompted an attempt to introduce insect-resistant Bt cotton in 2008, but this was faced with regional constraints, possibly due to unclear ratification of GM cultivation policies in the region and the fear of *trans*-border contamination (Munisi, 2020).

Other countries express concerns that the adoption of GMO products could instigate the development of monopolies when patents and intellectual property rights owners of transgenic crops capture the market (Mbabazi et al. 2021). Nevertheless, critics tend to ignore the benefits and the potential of GM technology to safeguard environmental resources. Currently, many African countries are opening for projects and opportunities to incorporate GM

technology. However, there are critical constraint is the lack of funds and expertise in acquiring and utilising GM technology in the African region (Oloo et al. 2020). Opposition to public policies, laws and regulations that satisfy the actors and multinational companies' funding and providing expertise on GM technology have prevented widespread acceptance of GM crops in many African countries. A case study of Ghana, Burkina Faso and South Africa revealed that widespread adoption of GM crops in Africa would require coordinated efforts by African policymakers, international organisations, media and multinational donors to address the social, religious, political, scientific and economic factors constraining biotechnology in the region (Schurman 2017; Aerni 2018)

2.1.5 Farm input subsidy and crop diversification in Malawi

Whilst many input subsidy programs in Africa promote staple crops such as maize, rice, and wheat (Mason & Ricker-Gilbert 2013) a few countries have expanded targeted crops, for example Zambia and Malawi have included nutrient-rich legumes. In Zambia, groundnuts were included as part of a crop diversification initiative (Mason & Ricker-Gilbert 2013) and Malawi provided a subsidy for legumes from 2008 to 2020 as part of the FISP (Matita et al. 2022). Evidence from several regions suggests that the relationship between production diversity and food security is positive although it varies by context (Pandey et al. 2016; Sibhatu & Qaim 2018; Sibhatu et al. 2022). This is essentially because people's choice of foods, and diets, are most proximally influenced by context-specific characteristics of local food environments such as food availability, affordability, and diversity (Turner et al. 2018).

Agricultural input subsidy program in Malawi have taken different names, forms, and functions over time; ranging from assisting with drought recovery, alleviating hunger, addressing declining soil fertility, and improving maize productivity. Currently the FISP was replaced by the Affordable Input Program (AIP) in 2020, largely due to political sensitivities related to the change of government at that time. However, with all the subsidy types, there are several common concerns, on distortion of private sector input delivery, increased inappropriate dependence on maize, huge cost vis-a-vis opportunity cost, and

operational challenges. And the input subsidy programs designed to address these challenges are branded as 'smart subsidies' and the FISP included some of these features (Dorward & Chirwa 2013).

The primary aim of Malawi's FISP was to improve food production and raise farmers' incomes. The targeted beneficiary numbers changed over time, but ranged between 900,000 and 2.2 million farming families (Nkhoma 2018) and recently 3.8 million under the recently named AIP (GoM, 2021). The FISP underwent several reforms to improve its efficiency and outcomes, including the introduction of private input suppliers in 2016/17 and increases in farmer contribution. Prior to 2015/16, beneficiary selection and coupon allocation involved local communities, but from 2015/16 the Ministry of Agriculture piloted a random selection of beneficiaries in a bid to target productive farmers rather than those favoured by distribution at the community level (Nkhoma 2018). Several modifications have been made to the FISP's replacement, the AIP, namely: the use of biometric data to redeem inputs; expansion of cereal types to include a choice of maize or sorghum or rice; and the discontinuation of legumes in the programme due to fiscal space (GoM, 2021). However, with all the changes over time in FISP, cash crops such as cotton continue to not fully been recognized in its diversification despite being an important cash earning crop playing a fundamental role in farming livelihoods in Malawi. For most cotton farmers today, they still use recycled or inferior seeds which is a problem to improving yields, and it supresses international exports (Ghambi 2015).

3. Chapter Three

3.1 Contextual Analysis

3.1.1 Agriculture in Malawi

Malawi is landlocked and one of the poorest countries in the world. It is ranked 169 out of 191 countries in the UN Human Development Index (HDI) (UNDP 2022), with an average per capita income per annum in 2021 of USD 635 or USD 1.74 per day (WB 2023). Agriculture is the mainstay of Malawi's economy, contributing approximately 31% of its GDP. Overall, 83% of households in Malawi are engaged in agricultural activities with women representing more than half of the agricultural workforce. However, the agricultural sector is dualistic. Estate agriculture accounts for more than 25% of agricultural GDP and 90% of export earnings. The main cash crops are tobacco (60%) tea (20%), and sugar (18%) with cotton on the least contributing approximately less than 5% (NSO, 2017). Cotton is ranked one of the potential cash crops in Malawi. Unfortunately, cotton has been a troubled agricultural product for the country, and several issues continue to impede its value in the marketplace (Kumwenda & Madola, 2013).

Despite being an agro based economy, Malawi faces persistent challenges of low productivity, weather variability related to climate change, soil degradation and land pressures which presents a substantial threat to food and nutrition security. Periodically, Malawi has been experiencing food crises, notably in 1992–93 and 2001–03 (Harrigan 2008) and undernourishment affects nearly 20 percent of the population (FAO et al. 2017) with high prevalence of stunting in children under the age of five at 37 % in 2017, although down from 49 percent in 2000 (NSO, 2017, Verduzco and Ecker, 2014).

To attain food and nutrition security, the Malawi government has been implementing a Farm Input Subsidy Programme (FISP) where resource poor smallholder farmers access fertilizer and hybrid seed at a subsidized price (Chirwa 2011). Prior to structural adjustment policies (SAP), many sub-Saharan governments subsidized fertiliser prices to stimulate smallholder farmers' agricultural productivity and food security (Xu et al 2008, Juma 2010). After the structural adjustment policies period, only few countries continued to provide subsidies to their farmers. Malawi is one of the few countries currently providing farm input subsidies at a national level. Agricultural input subsidies have been often utilized in Sub-Saharan Africa (SSA) to develop the agricultural systems and increase food security since they allow market frictions to be reduced by modifying relative prices and incentivize farmers to increase the use of fertilizers and hybrid/modern seeds (Holden & Lunduka 2014). Despite that Malawi continues to have FISP to date, it was not spared from the donor community sceptism following negative renens, nevertheless, the program proved to be a huge success.

The Farm Input Subsidy Programme (FISP) in Malawi was introduced in the 2005/2006 season against a background of weather shocks affecting productivity, food security and high input prices. The primary purpose of the programme was to increase resource-poor smallholder farmers' access to improved agricultural farm inputs in order to achieve food self-sufficiency and increase income through enhanced maize production (Chibwana & Jumbe 2010). To this end, vouchers are distributed throughout the country, thereby empowering eligible farmers to redeem them at subsidized prices in exchange for fixed quantities of improved maize seeds or chemical fertilizers. While maize productivity shifted on average from 1480 kg/ha in 2006 to 2100 kg/ha in 2013 (FAOSTAT, 2015), there is still concern about the stability of food security as well as the distributional impacts of the FISP. There has been increasing debate at national level and in academic literature on the FISP's potential that has not been fully exploited yet. In particular, the targeting criteria used to define eligible farmers has been highlighted as one of the main structural issue to review in order to improve programme effectiveness (Chibwana et al. 2012; Dorward & Chirwa 2013).

Eligibility for obtaining vouchers was originally based on the status of individual vulnerability. Targeted farmers had to be smallholders and/or female-headed households that were severely cash constrained or had limited wealth endowments (Lunduka et al. 2013). Nevertheless, the disregarding of these targeting guidelines at local level has been leading to confusion in allocation procedures and widespread ambiguity on the real impact of the targeting criteria. Many studies have highlighted the FISP as concentrating on rural middle-income or higher-income households at the expense of poor productive farmers (Dorward & Chirwa 2013). Moreover, whether the aforementioned criteria are actually able to identify efficient farmers and whether ultra-poor farmers can really exploit the potential benefits arising from receiving vouchers is an area yet to be explored. For farmers who are severely cash constrained, the purchase of subsidized inputs is said not to be a feasible option as many of such farmers resort into selling their vouchers in exchange for cash for basic needs such as food (Chibwana et al. 2012).

The other concerns of the FISP have been related to the proportion of the agricultural budget that is going towards the programme which only support a limited number of crops with little room for diversity, investment in other crops, technologies, and infrastructural programmes (Ragasa & Mazunda 2018). The FISP, which targets about 1.5 million farming families annually, is the single largest public investment in the agricultural sector in Malawi, utilizing 40–70 percent of the agriculture ministry budget and close to 10 percent of the national budget (Dorward & Chirwa 2013). Despite its probable role in abating food crises, there is criticism that the programme overshadows alternative investments in agriculture (Dorward & Chirwa 2013; Ragasa & Mazunda 2018). Due to changes in the political regime in 2020, the FISP was replaced or rather renamed the Affordable Inputs Programme (AIP), which has a similar design but is claimed to target more farmers still with no room for crop diversification (GoM, 2021).

3.2 Theoretical framework

3.2.1 Theory of access

This study was framed utilizing application of the Ribot & Peluso's access theory as used by Mutea, Rist and Jacobi (2020) and Myers and Hansen (2018) as theoretical framework. The theory of access centres on power and property rights. As defined by Ribot & Peluso (2003, page 154) access theory classifies various mechanisms of gaining, maintaining, and controlling a particular access. It also finds various mechanisms where different actors get engaged to gain, control, and maintain the flow of advantages and its distributions (Bene et al., 2009). Thus, different individuals, groups and institutions may present opportunities or limitations on farmers access to new innovations and technologies including genetically modified technologies. Thus, it focuses on providing a better understanding of the opportunities and constraints embedded within the power structures and how that influences access to resources (Mutea, Rist and Jacobi, 2020).

With regards to this, farmers access to biotechnology including genetically modified seeds such as Bt-Cotton is dependent upon power structures embedded in institutions and policies that drive decisions. Thus, access theory engages with both structure and agency (Myers & Hansen, 2018). Agency refers to the capacity of individuals and groups to exercise a degree of control over their own circumstances (to make choices about what crops they grow, the technologies they adopt and how they access it, etc.) and to provide meaningful input into governance processes that shape food systems (Clapp J., et al. 2020). Farmers could show agency but may not necessarily embrace the technologies due to multiple factors such as rights and authorities which may hinder their access. In the biotechnology sector, the interplay of politics is prominently manifested in the patenting of novel technologies by companies that develop these innovations, with a significant emphasis on profit motivations. Farmers, as the ultimate beneficiaries of these technologies, often possess limited agency regarding the optimal means of accessing patented products (Fischer & Rock 2023).The variation between rights and power or authority, is the most basic distinction within the access theory. Rights are based on doing a thing because one finds the

entitlement and capabilities to carry and benefit from it (Sen, 1994). This framework is further informed by the ownership of resources, which serves as a critical foundation for the realization of such rights (Mutea, Rist, & Jacobi, 2020). It has been observed that in the context of genetically modified (GM) technologies, access is predominantly afforded to resource-rich farmers, who typically engage in commercial agricultural practices (Khanal & Omobitan 2020) and can afford quality inputs (Blekking et al. 2021). Conversely, resource-constrained farmers continue to experience significant barriers that hinder their ability to access these technologies (Fischer & Rock 2023).

On the other hand, power looks at the authority that enables or inhibit farmers' access to resources based on rules and regulations often found in formal and informal institutions which guides the control over and access to resources through a web of powers (Choudhury et al., 2016). For instance, both formal and informal institutional policies have both limited and driven farmers' access to technologies through laws and regulations. Malawi's focus on moral problems, regulatory frameworks, and public opinion has impacted farmers' access to GM technologies. To make this more specific, there have long been concerns over the ethics of hybrid seeds, and plant breeders' rights (Kedisso et al. 2022). Furthermore, farmers' access to information (Mugede, 2015), is also crucial in determining their access to resources and technologies. This regulates how farmers can access agricultural inputs including GM seeds and how they can market their products (Ricroch et al. 2022).

In the realm of food security, the vulnerability of farmers has been linked to several factors, including climate variability, biotic and abiotic stresses, limited access to innovative technologies, and the influence of institutional and political interference in decision-making processes (Myth, 2021). Genetically modified crops possess the potential to enhance food accessibility by contributing to increased income, improving nutritional standards, and fostering sustainable agricultural practices (Rasheed., et al 2022). While agriculture technologies are positively linked to food and nutrition security, they are generally perceived to be financially intensive (Barrett & Rose, 2020) posing significant challenges for their implementation, particularly for smallholder farmers in Africa. In

numerous African nations, the adoption of genetically modified (GM) crops has been demonstrated to enhance agricultural productivity and increase farmers' incomes (Kedisso et al. 2022). Notwithstanding the advancements associated with genetically modified (GM) seeds, their elevated costs render their deployment largely inaccessible to smallholder farmers at present (Jellason et al. 2021). In addition to health, ethical, and legal considerations, the exorbitant pricing of seeds serves as a substantial barrier to farmers' access to this technology. Consequently, integrating GM seeds into initiatives such as the Farmer Input Subsidy Programme (FISP) may provide smallholder farmers with the opportunity to access high-value seed varieties.

4. Chapter Five

4.1 Research methods

The research employed an exploratory mixed-methods approach, with a predominance of qualitative methodology. Mixed methods research is defined as the systematic collection, analysis, and interpretation of both quantitative and qualitative data within a single study or across multiple studies that examine the same phenomenon (Leech & Onwuegbuzie 2009). To facilitate data collection and analysis, the study utilized two qualitative instruments alongside one quantitative tool. In terms of qualitative methods, key informant interviews and focus group discussions were conducted. Conversely, the quantitative aspect utilized a household survey targeting smallholder farmers.

4.1.1 Research approach

Overall, the decision involving which approach to adopt for a study should be informed by the philosophical assumptions brought to the study which are based in the research designs, research methods and interpretation (Halcomb 2019). Selecting the desired approach is based on the nature of the research problem or the issue being addressed, researcher's personal experience and who the study is intended for. In this study, to address the research problem, a pragmatic worldview was chosen (Brierley 2017). It was selected based on its flexibility to combine two or multiple approaches without sticking to a single worldview of the studied phenomena. Thus, it allows a researcher to go back and forth different viewpoints more like swinging in a continuum (Onwuegbuzie et al. 2009; Brierley 2017). To understand cotton growing and in particular the potential of Bt cotton in Malawi, it was useful in exploring perceptions and motivation through the lens of the smallholder farmers and the key policy makers. Hence in this exploratory mixed method, qualitative data was collected first followed by quantitative data (Creswell 2010).

Key informant interviews (KII) were conducted with six informants representing different stakeholders in the cotton sector. It was complemented by focus group discussion with farmers who were observers of the Bt cotton trials. This was followed by a quantitative survey with 50 participants from farming households that were part of the observers of the Bt cotton trials. The reason behind the adoption of a mixed method was to allow for development of a complete understanding of the existing problem by obtaining different but complementary data without falling into one or the other worldview (Onwuegbuzie et al. 2009; Bell et al. 2022). Using multiple methods increases the Vigor of results because findings can be strengthened through triangulation or when an explanation is developed for all the data when they diverge (Johnson et al. 2007).

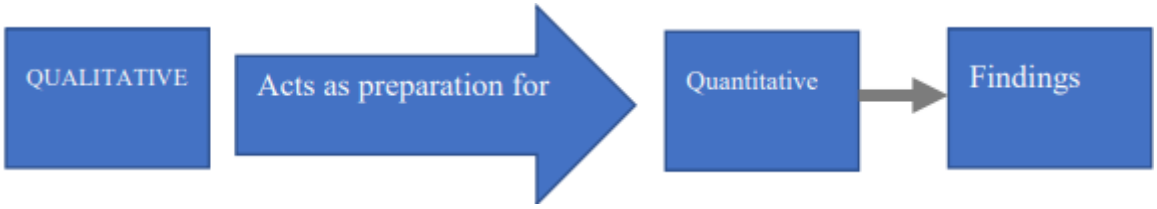

Figure 2. *Diagram showing exploratory design source: (Bell et al. 2022)*

4.1.2 Description of the study site

The present study was structured as a comparative analysis, conducted at Toleza in the Balaka District. This site was selected for comparison with Kasinthula in Chikwawa, Makoka in Salima, and Bunda in Lilongwe, all of which have previously undertaken field trials for Bt cotton in Malawi. Regrettably, my arrival in Malawi coincided with a period during which several trial sites, including Kasinthula in Chikwawa, Bunda in Lilongwe, and Makoka in Salima, experienced delays in their engagement with the second phase of the trial. These delays were attributed to logistical challenges that impeded their operations. Nevertheless, I turned to Kasinthula in Chikwawa and Toleza in Balaka, as these locations demonstrated a level of convenience that was particularly advantageous given the constraints of limited research funding. Additionally, they were characterized by a stable monitoring environment at that time. The selection of the sites was influenced by their accessibility, as both are located within the southern region. This geographic proximity facilitated coordination and enhanced logistical feasibility. Although Toleza was regarded as the primary research site due to its well-organized structure in Bt cotton trials, in contrast to

Kasinthula, which was classified as a minor research site, there were no significant distinctions in the research activities conducted throughout the study, except for the number of participating farmers.

Toleza is in Balaka District, while Kasinthula is situated in the Chikwawa District, both of which are found in the southern region of Malawi. Balaka is located approximately 8 kilometers northeast of the Balaka township, along the S133 road prior to reaching Mbela. Balaka is strategically located along the primary roadway connecting Lilongwe and Zomba, as well as on the principal railway corridor linking Blantyre and Salima. The location is approximately 130 kilometers to the north of Blantyre and approximately 200 kilometers to the south of Lilongwe, the capital city. Toleza encompasses an area of 4,500 acres and is characterized by the cultivation of cotton, which serves as one of the primary crops integrated into both experimental and established agricultural practices. Toleza is situated at a latitude of approximately 14° 56" S and a longitude of approximately 35° 1' 30" E, with an elevation of 659 meters above sea level. The Balaka district encompasses a total area of 211,716 hectares, of which 188,062 hectares are designated as customary land utilized predominantly by smallholder farmers. In the Balaka region, the primary food crops cultivated include maize, groundnuts, sorghum, as well as various root vegetables and tubers. In contrast, cotton and tobacco serve as the predominant cash crops. Toleza, a privately owned estate, constitutes one of the two estates located in Balaka and encompasses an estimated area of 1,800 hectares. Balaka Social Economic Profile (2014). Conversely, Chikwawa District is notable for its geographical positioning as one of the border districts that shares an international boundary with Mozambique to the west. It is bordered by Mwanza District to the north, Thyolo District to the east, Blantyre District to the northeast, and Nsanje District to the south. The primary topographical characteristics of the region include the flat basin of the Shire River, situated along the Great African Rift Valley, as well as the Thyolo-Chikwawa Escarpment. In relation to its land area, Chikwawa encompasses approximately 4,755 square kilometres. Chikwawa is home to a population of 566,283 individuals. The principal crops cultivated in the region encompass maize, sorghum, rice, cotton, millet, pigeon peas, and sweet potatoes. These staple crops are further supplemented by the

cultivation of beans, fruits, and various vegetables. Minor crops include sesame (Sesamum indicum), cowpeas (Vigna unguiculata), cassava (Manihot esculenta), and groundnuts (Arachis hypogaea). Cotton continues to serve as the predominant cash crop within the district, as evidenced by the socioeconomic profile of Chikwawa conducted in 2014. Nevertheless, farmers in both Balaka and Chikwawa are gradually becoming disillusioned with the cultivation of the crop, attributed to inadequate market incentives and insufficient availability of essential agricultural inputs for production (GoM, 2014).

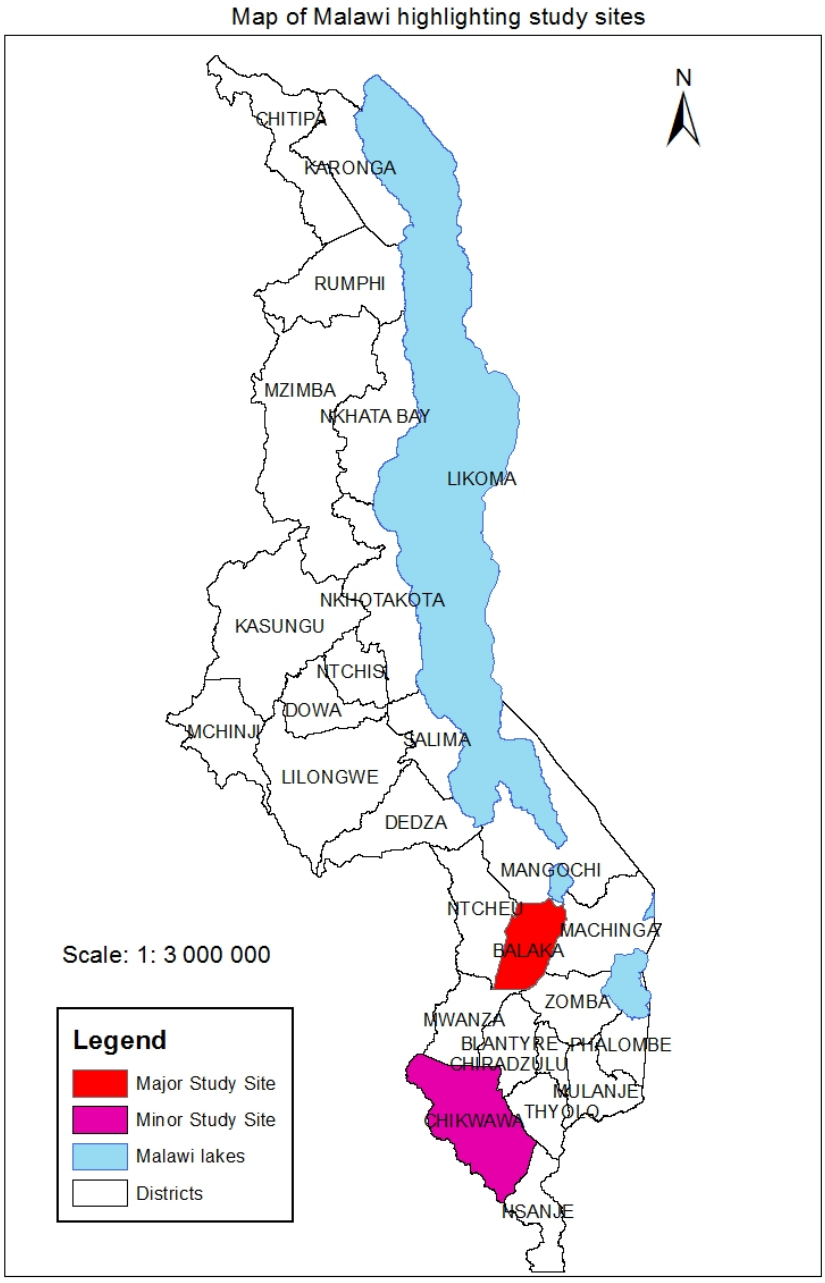

Figure 3. *Map of Malawi showing the study districts (Source: Authors own)*

4.1.3 Ethical considerations

Consent

The study sort consent from the Malawi National Commission for Science and Technology. Further consent was given from the management of the study sites and individual consent was also collected at the beginning of the data collection.

Limitations

The data in this study has encountered several challenges. The integrity of the primary data collected for this research has been somewhat compromised due to the inconsistent availability of personnel to provide information. Additionally, the reticence of individuals to disclose information can be attributed to the fact that Bt cotton was still undergoing trials during the period of this study, which resulted in limited public dissemination of relevant data. Recruiting participants for a focus group discussion presented significant challenges, particularly in Kasinthula, where farmers ceased visiting the research site following their initial harvest. Furthermore, the majority of country-specific data pertaining to secondary sources was obtained through online platforms. It is noteworthy that many of these online resources were primarily confined to newspaper archives, which often provided limited and superficial information regarding Bt trial articles in Malawi. Although several of the selected textual sources pertain to the period of implementation of confined trials for Bt cotton (2013), there is a notable scarcity of country-specific studies published immediately prior to this period, as well as a limited availability of such studies in the timeframe following the designated study period. Consequently, the arguments presented are largely derived from the data and experiences of other countries that cultivate Bt crops. To address the identified barriers, I chose to concentrate my efforts on the Kasinthula and Toleza areas within the southern region. The researchers involved in the trials exhibited a cooperative disposition, which facilitated the provision of a sample frame for the observational participants. This arrangement proved instrumental in coordinating and engaging local farmers for the focus group discussions and surveys conducted during the study. In the process of conducting interviews with key informants, I leveraged my social networks to identify individuals who could provide valuable insights. These informants were instrumental not only in furnishing pertinent information but also in suggesting

additional potential informants who agreed to participate in the study under conditions of confidentiality.

4.1.4 Data analysis

Data entry and analysis of the survey were conducted utilizing version 14. 0 of the Statistical Package for the Social Sciences (SPSS). Descriptive statistics, including percentages and frequency distributions, were employed to elucidate the demographic characteristics of the participants. This information is essential for comprehending the potential of farmers to diversify their agricultural portfolios with Bt cotton. Thematic analysis was employed to analyse the qualitative data, during which the transcripts were transcribed, coded, and subsequently interpreted (Kimmons 2022).

4.1.5 Data Sources

4.1.6 Qualitative data

Key Informant Interviews (KII)

To conduct KII, sampling was necessary. Sampling procedures in the behavioural science are divided into two groups - probability and purposive, but in essence, there are four broad categories which are probability, purposive, convenience and mixed methods sampling (Teddie 2007). Purposive sampling techniques are used in qualitative studies and can be defined as selecting units based on specific purposes that relate with answering the questions of a given study. In this sampling method, appropriate settings, persons, or events are chosen for the information they can give that cannot be gotten as well from other sources (Teddie 2007). In this qualitative approach, purposive sampling was necessary as it was key to target experts dealing with Bt cotton trials in Malawi. To select the respondents, a snowball sampling technique was employed whereby, the first experts approached recommended other potential respondents through their professional network. Firstly, phone calls were made to two potential respondents in the ministry of agriculture and at the Malawi Oil Seed Trust (MOST) based on the researcher's social network requesting them to participate in the study. Upon acceptance to participate in the study, an email

detailing the study objectives and interview dates, and time were set. During the interviews, I introduced the research topic to them, requested for consent and then proceeded with interviews. Participants were allowed to ask questions at any point in time if they require clarifications. At the end of the interview, they were requested to recommend other potential respondents and in total, 6 key informants were reached and interviewed for this study. To identify the informants, codes were attached for their anonymity as shown in Table 2 below

Table 2. Key informant profiles Source (Primary data)

Key informant code	**Affiliation**
K101	Ministry of agriculture
K102	National commission for science and technology
K103	Malawi Oil Seed Trust
K104	Bunda College of Agriculture
K105	Monsanto
K106	Toleza Farm

Focus Group Discussion (FGD)

Unlike KII which is an individual interview, a Focus Group Discussion (FGD) is a type of group interview set in a discussion forum (McLafferty 2004). The purpose of the FGD setting is to allow people to express their opinions, encourage open expression among participants, query one another's explanations, and explain their answers to one another (Gubrium & Holstein 2002). The aim of this research is to investigate the potential of Bt cotton for smallholder farmers and to assess the role of the Farm Input Subsidy Program (FISP) in diversifying their farming portfolios with Bt cotton. To achieve this objective, the study examines the perceptions, understanding, and knowledge of smallholder farmers regarding Bt cotton, drawing upon their experiences and observations from participation in Bt cotton trials. The selection of participants for the focus group discussions (FGDs) was conducted under the guidance of the lead extension officers at the respective sites. Farmers were recruited to participate in focus group discussions (FGDs) through a referral system facilitated by the extension officer. Two focus group discussions (FGDs), consisting of a diverse mix of male and female participants, were intentionally selected for this study. One discussion was conducted in Balaka and the other in

Chikwawa, with participants chosen specifically based on their involvement in Bt confined trials. Given the limited number of participants available for the observations, gender was not prioritized in the focus group discussions (FGDs). Consequently, we conducted two FGDs, comprising 10 participants in Balaka and 6 participants in Chikwawa. The recruitment of participants in Chikwawa presented challenges, as individuals were no longer engaged in site trials. In contrast, participants in Balaka were more readily accessible on-site. Morgan (1997) posits that the determination of group size in focus group discussions should be guided by several key factors. These factors include the anticipated contributions of information from each participant, the level of detail necessary for the thematic exploration, and the moderator's capability to effectively manage the dynamics of the focus group discussion. There is no consensus regarding the optimal number of participants for effective group interaction; however, Morgan (1997) suggests that a preferred group size typically ranges from six to twelve participants. Morgan posits that achieving the objectives of the discussion may prove challenging with either a greater or lesser number of participants than the specified range. Consequently, the researcher expressed contentment with the number of participants in each focus group discussion. In March 2014, focus group discussions (FGDs) were conducted at the Toleza research site located in Balaka, followed by additional FGDs conducted in April 2014 at Kasinthula in Chikwawa. The focus group discussions (FGDs) had an average duration of one hour. Both male and female farmers, representing a range of ages and levels of farming experience, participated in each discussion session. The focus group discussion (FGD) guide was not subjected to prior testing before its implementation, attributable to constraints related to time and logistical challenges. The discussion encompassed several key themes, notably the participants' experiences in agriculture, with a particular focus on cotton farming and the Farm Input Subsidy Programme (FISP). Additionally, it explored participants' perspectives on Bacillus thuringiensis (Bt) cotton and the ongoing trials associated with it, as well as their aspirations concerning the future of Bt cotton cultivation. The focus group discussions (FGDs) were facilitated in collaboration with extension officers, who played a vital role in maintaining time management and documenting the proceedings, while the researcher moderated the dialogue. The discussions were recorded with the participants' consent to

facilitate the identification of any significant points that may not have been adequately captured during the meeting, thereby enhancing the thoroughness of the subsequent analysis.

4.1.7 Qualitative data analysis

Data analysis in qualitative research is recursive and dynamic (Merriam & Grenier 2019). It is a process that involves arranging and reviewing transcripts of interviews systematically to build up the researcher's understanding of the phenomena under research Ritchie et al., 2013 in (Azungah 2018). It is challenging when researcher has to make sense of massive amounts of data, reduce the volume of information, identify significant patterns, and construct a framework for communicating the essence of what the data reveals (Patton 1990). To analyse qualitative data, a broad range of analytic methods can be adopted. For this study thematic approach was used to analyse the KII and the FGDs data. In a thematic analysis, the aim is to identify, analyse and report patterns within data (Braun & Clarke 2012). The strength of a theme is not so much about quantifiable measures, but rather, on whether it captures something important concerning the overall research question (Braun & Clarke, 2012). Themes and patterns are usually extracted from within the data in one of two ways in a thematic analysis, either as an Inductive approach or a deductive/theoretical approach. In an inductive approach, identified themes are strongly linked to the data themselves (Patton, 1990). Using NVivo version 11, qualitative data was analysed following a 6 step by step process of the thematic analysis as below:

- **Step 1**: Familiarization with data: I had to rea and re-read all records of all data from the field notes, listened to recorded transcripts again and again to get familiar with the data until I became aware of the depth and breadth of the content. This, amongst others, included taking notes of initial ideas.
- **Step 2**: Generating initial codes: in this phase, I had to generate codes from the themes and sub themes. It involved coding relevant features within the data in a systematic way that allowed the researcher to collect data suitable to each code.

- **Step 3**: Searching for themes: I had to make sense of theme connections, keep detailed notes about development and hierarchies of concepts and themes and divide the codes as mentioned earlier into different themes and, hereafter, search for all relevant data relating to them.
- **Step 4**: Reviewing themes: I had to do vetting of the themes and subthemes in reference to the raw data which led to development of a thematic map.
- **Step 5:** Defining and naming themes: In this phase, I had to give names to the themes and create clear definitions for each.
- **Step 6:** Producing the report: Finally, I had to compile report on the findings of the study which is the actual findings of the analysis.

4.1.8 Quantitative data

In this study, quantitative data were collected through the implementation of a survey employing probability sampling methods. A multistage sampling procedure was utilized for the selection of respondents, whereby the Balaka and Chikwawa districts were purposively chosen due to their designation as active sites for Bt trials within the same region. In the context of Balaka and Chikwawa districts, the Kasinthula and Toleza research units were selected through purposive sampling, as they represented the sole locations undertaking trials of Bt cotton. Subsequently, a simple random sampling technique was employed to select a cohort of smallholder farmers from the sampling frame obtained through the extension officers responsible for coordinating observations of Bt trials. A total of fifty respondents were systematically selected from Balaka and Chikwawa districts for the study.

Conducting survey

A sample frame was acquired from the extension officer who was assisting in coordinating farmers for the Bt cotton trials. From this sample frame, randomly selected farmers were invited for a survey. The researcher visited the farmers in their respective homes as it was convenient to do so. Before the actual data was collected, the questionnaire was pre-tested on selected farmers to evaluate the appropriateness of the design, clarity, and relevance of questions. The survey through a semi structured questionnaire was administration to the 50 respondents

in the study areas. The questionnaires were administered to the farmers by the researcher. Descriptive statistics were used to analyse the socioeconomics characteristics of the sampled farm households. The tools of analysis involved the use of measures of central tendency such as frequency and percentages using Microsoft Excel and Statistical Package for Social Science (SPSS).

4.2 Analysis and presentation of the study findings

Socio-economic Characteristics of Respondents

The pertinent socio-economic characteristics of the 50 respondents participating in this study are consequently presented herein. The socio-economic characteristics examined in this study encompass gender, marital status, levels of education, primary occupation, access to resources and inputs for farmers, as well as their predominant livelihoods. The findings are consolidated and are subsequently presented in Table 3 below. The characteristics of the respondents are critical for presenting an overview of their backgrounds and assessing their appropriateness for this investigation.

Table 3. *socioeconomic characteristic of respondents (N=50) (Source primary data)*

Characteristic (N=50)		Frequency	percentage
Sex	Male	39	76.7
	Female	11	23.3
Marital status	Married	45	89.0
	Single	2	4.0
	Widowed	3	7.0
Occupation	Farming	48	96.0
	Piece work	1	2.0
	Other	1	2.0
Education	No education	5	10.0
	Primary education	37	74.0
	Secondary Education	8	16.0
Access to inputs	Seeds	36	72.0
	Fertilizer	7	14.0
	Pesticides	5	10.0
	Other	2	4.0
Livelihood Activities	Cash crops	32	64.0
	Food crops	17	34.0
	Other	1	2.0

4.2.1 Respondents' Sex Distribution

Approximately 77% of the respondents identified as male, while the remaining 23% identified as female. The data, when directly interpreted, indicate that the majority of cotton farmers are male. This finding contradicts the assertions made by Doss et al. (2014), which claim that approximately 70% of farming activities in sub-Saharan Africa, as well as in numerous low-income economies globally, are predominantly carried out by women. The identification of 23. 3% of female respondents as cotton farmers highlights a paradoxical and often obscured reality regarding the contributions of women in the cotton farming sector. The predominance of patriarchal kinship structures in many African communities, where male-headed households are often regarded as the normative family model, is evidenced in the representative communities of Balaka and Chikwawa. This sociocultural dynamic results in a notably lower representation of women as household representatives within these communities.

4.2.2 Respondents' Education Levels

The findings of the study indicated that approximately 10% of respondents had not participated in a formal education system. In contrast, 74% of the respondents reported having completed primary school education, whereas only 16% achieved secondary school level education. The findings of the study indicate that the majority of cotton farmers within the examined region have attained an education level of primary school or lower. The data pertaining to the general education levels of cotton producers suggests that there exists a prevalent deficiency in their comprehension of technical issues within the industry.

4.2.3 Respondents' Marital status

Regarding marital status, the study indicated that approximately 89% of cotton producers were married. The remaining respondents were either single, widowed, or did not have a marital status. This finding suggests that cotton cultivation is predominantly practiced by households consisting of married couples. It was additionally observed that the couples engaged in cotton farming were

predominantly of a younger demographic. This phenomenon can be attributed to the widespread assumption that, due to their inability to pursue secondary education, a significant number of villagers have turned to cotton farming as a primary livelihood activity.

4.2.4 Respondents, main occupation

Many respondents indicated that farming constitutes their primary occupation. An analysis of household employment revealed that 96% of households were primarily engaged in farming activities, while 2% depended on piecework (short term employment, i.e. on other people's farms) as their source of income. The remaining percentage of households participated in various other economic activities. Among the surveyed farmers, 64% classify themselves as cash crop producers, while 34% identify as food crop cultivators. The remaining individuals are involved in various other agricultural practices.

4.2.5 Respondents' access to inputs

Regarding the inputs utilized in agricultural practices, 72% of the respondents indicated that they have access to seeds, while 14% reported access to fertilizers, and 10% noted that they have access to pesticides. Consequently, a significant proportion of the study population faces constraints in accessing necessary inputs.

4.3 Qualitative findings

The analysis of the focus groups and key informant data revealed several prominent themes. The selection of the codes was informed by the research questions that the study aimed to address. The chosen codes focused on several key areas: the socioeconomic potential impacts of Bt cotton as an agricultural technology, the biosafety regulations associated with its use, the political dynamics surrounding the governance of Bt cotton, and the experiences of farmers with agricultural input subsidy programs. The process of theme identification and selection was systematically developed to address the research questions directly, drawing on the

coded data for the selection of relevant themes. Consequently, the three principal themes identified were

.

- Poor agriculture technology knowledge
- Limited resources for agriculture technology support and predominance of gender in determining agricultural resource acquisition.
- Regulatory frameworks and potential of FISP for Bt cotton

4.3.1 How has FISP program changed over the past 10 years, (2005-2015)?

The focus group discussions (FGDs) further explored the aforementioned research question. Farmers have articulated their experiences in agricultural practices and how their portfolios have been influenced by governmental initiatives, particularly the FISP.

"I have been a farmer for ages and have experienced how maize farming is well supported, previously we relied on indigenous seed which we preserved year in year out, until the hybrids came in, they were expensive but the government made us believe it's the way to go and supported them through the coupons [FISP], I keep asking why they don't do coupons for other crops like cotton, why are we seen as less of farmers?"

The Farm Input Subsidy Program (FISP) was frequently referenced as an initiative aimed at promoting specific crops, with maize being identified as a critical staple for household consumption. In contrast to other crops, such as cotton—which are classified as cash crops and are essential for enhancing household welfare beyond mere food security—maize has been characterized as a defining element of agricultural practice in Malawi. Nonetheless, certain farmers express pride in the fact that cotton is ranked among the top agricultural commodities contributing to the Gross Domestic Product (GDP), in contrast to maize. However, these cotton farmers often fail to recognize the limited profits they derive from cotton cultivation. In addition to recognizing the economic importance of cotton, several farmers articulated their satisfaction with the advancements in cotton technology

that have culminated in the development of Bt cotton seeds. One participant from the focus group discussions elaborated:

"I have hope in cotton farming and this technology, it's a sign that we cannot do without cotton, we need it. Someday hopefully, it will get all the needed support but am grateful to our researchers for this milestone"

While certain farmers have expressed the view that the FISP lacks inclusivity, others have recognized that the program has evolved over time and is not characterized by rigidity. During the implementation of the Farm Input Subsidy Program (FISP), there has been a notable evolution in the types of vouchers offered. Specifically, in the 2005/06 growing season, the program exclusively provided fertilizer subsidies. However, over the years, the integration of voucher types has diversified to include a combination of seed and fertilizer vouchers. This shift reflects the program's adaptive response to agricultural needs and priorities. Nonetheless, participants in the discussion observed that transformations persisted in the ensuing years. Specifically, during the growing seasons of 2006/07 to 2008/09, a combination of subsidized fertilizers, maize, and legume seeds was implemented. In this context, beneficiaries received a fertilizer voucher for a 50 kg bag, regardless of the specific type of fertilizer provided. In addition to the provision of fertilizer vouchers, beneficiary farmers were allocated a voucher entitling them to 2 kilograms of hybrid seed and 3 kilograms of Open Pollinated Variety (OPV) seed. Several participants in the discussion highlighted the modifications made to the statement.

"From 2005 to somewhere 2010, even us cotton farmers enjoyed coupons [FISP], they were thoughtful of our needs and prioritized crops, and we grew cotton more than maize simply because it was on coupon [FISP]"

Notably, discussants recalled for a time when the FISP added a flexible voucher in the 2007/08 growing season. This voucher allowed farmers to purchase cotton, beans, soya, groundnuts, or more maize seed. In the 2009/10 growing season, the government changed from a generic fertiliser voucher to two specific vouchers of maize fertiliser for basal and top dressing, respectively. Unlike in the previous years, all these vouchers were now strictly for maize production. Additionally, the 2009/10 growing season discontinued the flexible seed voucher and replaced it with

a voucher that could only purchase legume seed including beans, cow peas, pigeon peas, groundnuts, or soya and that was the disappearance of cotton in FISP. Some discussants commented:

"We believe the changes will not end here and if we can get a strong voice that can speak on our behalf as cotton farmers, we can see cotton back in the FISP regardless of the cost"

While participants assumed that cotton could have been removed from FISP because of its high cost and declining profitability. Others acknowledged that the costs in farmers contributions to FISP were also being adjusted over time which could have obviously applied on cotton too. For instance, according to the ministry of agriculture in Malawi of which the discussants agreed with the variations were as in table below: [1]

Table 4. *FISP package price variation by year (Source primary data)*

Year	MK/ 50 kg Fertilizer	MK/ 5 kg seed
2005/06	950	
2006/07	900	Free
2007/08	800	90
2008/09	500	Free
2009/10	500	100
2010/11	500	100
2011/12	500	100
2012/13	500	150
2013/13	500	150
2014/15	500	100
2015/16	3500	1000

While participants believe the changes are benefits of the farmers, they also point out the political influences that drive FISP as observed in these statements:

[1] The Malawi Kwacha to US Dollar exchange rate was in 2006-2012 @ 0.007, in 2013 @ 0.003,in 2014-2015 @ 0.002 & in 2016 @0.00.

"From every political rally during campaigns, FISP is in the agenda, and our women are promised to be targeted, however, the realities differ from what we get…"

Another participant also added on the same as follows:

"*Talk of how they promise to increase numbers of beneficiaries [for FISP] when campaigning for political positions, sadly some of us even end up having coupons that cannot be redeemed because the inputs are not available"*

There was a consensus among participants that the primary determinant of the FISP is the extent of political will. It was suggested that if comparable political commitment were directed towards cotton farming, particularly in prioritizing Bt cotton seed within the FISP framework, then cotton production would likely become more profitable and gain recognition akin to that of the tobacco industry.

Despite the efforts of certain farmers to maintain cotton cultivation, participants in both FGDs articulated several challenges related to the marketing of cotton, in addition to difficulties in obtaining adequate and supported inputs that impact production. The participants indicated that the majority of cotton buyers are private entities, which results in diminished bargaining power for the farmers due to the absence of standardized pricing. Cotton farmers perceived that the cotton farming sector has been relatively overlooked in both production and marketing processes when compared to other cash crops, such as tobacco, which benefit from well-established and effectively managed government markets. One participant in the discussion remarked that.

"Much as tobacco has its ups and downs, at least, farmers do know where it will be sold and have an idea of the prices, we struggle to find proper markets and bargain for better prices as a result many buyers take advantage of our desperation and buy at lower prices…"

Another discussant articulated the potential of the FISP for cotton to mitigate the adverse effects of low market prices. It was suggested that this program could empower farmers, thereby enhancing their leverage in negotiations with private enterprises and the government. This engagement may lead to more equitable

pricing structures that consider the costs incurred by government on the crop. He stated:

"If government will spend more to include cotton seed and other inputs on FISP, it will definitely push for better sales of the product so as to maintain and balance its costs."

4.3.2 What could be the impact of Bt cotton in the Malawi agricultural sector?

To address the above research question, FGDs were employed, and the findings of this study indicate that the farmers who participated in the trials as observers exhibited a limited understanding of the foundational concepts associated with biotechnology, particularly with respect to Bt (Bacillus thuringiensis) technology. For example, the discussant provided commentary.

"We are just taken to the field to observe with strict rules, allowed a limited distance to the site and they expect us to learn and appreciate the technology? We wonder what will happen if we are to grow in our fields, we won't touch our crops?"

Participants in the discussion expressed concern that only a limited number of farmers were included in the observations of the confined trials. This raises questions regarding the dissemination of knowledge related to the technology, as those not involved in the observations may lack access to essential information. A significant number of observers did not receive training prior to the observation period, and the absence of information and sufficient training emerged as recurring themes during the discussions. The inadequacy in the provision of essential information and training has been attributed to the inefficiencies inherent in the public extension system. A female participant articulated her perspectives concerning the significance of information and training.

"Most of the farmers have not been educated on how dangerous or safe these technologies are to our health and environment. They are not even aware of

measures to follow at the moment as we just follow and do everything as told with no proper explanations."

Several informants exhibit enthusiasm regarding the profit narrative and have conveyed a willingness to adopt the technology, as evidenced by the following comment.

"Of cause, we understand the seed increases profits and that is our goal to rise as cotton farmers, so we definitely would adopt it"

The focus group discussions conducted with farmers revealed a diversity of opinions regarding agricultural technologies. Several farmers expressed positive evaluations regarding the advantages of Bt cotton, drawing upon their observations from the conducted trials. While some discussants completely questioned the viability of smallholder production of Bt cotton among resource-constrained farmers. More than fifty percent of the participants in the discussion articulated their concerns regarding the pricing of the seed, noting that, to date, a single company has been responsible for its management. The participants provided accounts of their experiences with contract farming, wherein companies engaged them in agreements concerning the provision of pesticides, seeds, and fertilizers; however, the companies ultimately procured their agricultural produce at a loss. The respondents articulated that a significant number of other farmers have ceased cotton cultivation due to the elevated costs associated with inputs. They expressed scepticism regarding their ability to bear the additional expense of seeds, especially when considering the various other financial pressures they face. As documented in one of the focus group discussions:

"Already we are struggling to buy cheap seeds, shall we manage extra cost on this new seed"

The focus groups indicated a pervasive sense of uncertainty regarding Bt cotton technologies. Nonetheless, there exists some optimism among certain stakeholders regarding the value of cotton farming, as well as the potential of associated

technologies. This potential, however, is contingent upon the implementation of supportive initiatives, such as subsidies. As noted in the aforementioned comment.

"You see, in this part of Malawi, maize does not do well but majority still grow maize because there are coupons to get maize and fertilizer at lower costs. Trust me… from what I have seen from this technology so far… am sure if we get same coupons for this seed, we can know the value of agriculture and revive cotton farming in Malawi"

Despite the farmers' apprehensions regarding the price of seeds, they acknowledged the advantages and quality of the cotton produced through Bt cotton technology. In summary, the farmers exhibited a significant interest in the adoption of the technology for their agricultural practices, contingent upon its commercialization. They perceived the technology as having the potential to enhance both the productivity and quality of their cotton crops. Consequently, the implementation of this technology could contribute to improving their economic circumstances and supporting their families following the sale of their produce. The significance of agricultural technologies was consistently emphasized across all focus groups examined. In one of the focus group discussions, a female participant articulated her general interest in the application of Bt cotton technology as a strategy to address challenges related to climate change. She recognized the significance of the issue at hand.

"As a country we are worried about climate change and so many pesticides that were effective for our cotton has been banned to protect the environment. Here is a technology that contribute to reducing sprays and preserve the environment. I must say this is what we as farmers want…"

The enthusiasm demonstrated by the participant, along with the sentiments expressed by numerous others, suggests the potential for the adoption of Bt cotton technology. Simultaneously, discussions regarding maize cultivation in comparison to other crops, particularly cotton, have intensified, with the FISP receiving significant attention within this discourse.

4.3.3 Can Bt-cotton be an alternative cash crop to tobacco in contributing to Malawi's GDP and small-scale income enhancement?

To address the final research question, both the Key Informant Interviews (KII) and the Focus Group Discussions (FGDs) made significant contributions. A comprehensive understanding from two distinct perspectives was essential to enhance and complement the findings.

key informant's perspective

According to the findings derived from the KIIs, most respondents expressed a favourable attitude towards the Bt technology. Five of the informants articulated a rationale for their comprehensive satisfaction with the technology, indicating their expectation that farmers would also experience a similar level of satisfaction. She stated:

"It's very rare to have a technology tested with farmers observing. Having farmers observing the trials mean that they can be guaranteed that Bt cotton is well tested, and safe to introduce to farmers." K105

Key informants indicated that farmers place a high value on technologies that they perceive to be reliable and trustworthy. The authors documented that farmers' experiences with technological innovations can significantly influence the acceptance or rejection of such technologies. This underscores the necessity for enhanced oversight and regulation of these technologies prior to their public marketing and advocacy. He elucidated

"*Not many will understand the value of delaying technology adoption to farmers until it is proven to serve their best interest…that is what we are currently doing" K102*

Another informant emphasized the necessity of evaluating not only the advantages associated with the technology but also additional factors, including environmental safety and the establishment of well-defined policy frameworks to effectively govern the application of these technologies, as evidenced by the comment made.

"Indeed, every farmer wants profit at the end of the day, but, that's not all that matter, we would not want to compromise our environment and health over profits that could be observed in a short run hence our efforts are on good and safe policies to guide farmers interests and also protect our mother nature and human life." K104

Informants indicated that as long as agriculture persists as the primary source of income, farmers will likely continue to depend on existing and emerging technologies and practices to enhance crop yields. The familiarity of farmers with emerging technologies serves as a significant determinant in their preferences regarding technological adoption. The respondents emphasize that prioritizing the provision of support to farmers through the implementation of emerging technologies should be a fundamental component of initiatives aimed at assisting agricultural practitioners, irrespective of their specific farming methodologies. According to the majority of the informants, this assertion was elucidated by the following statement.

"We are very aware of the biases in FISP over specific crops and technologies. It is our hope that as things are changing, it will meet the needs of every farmer and include a diversified crop that will cover for technologies too..." K101

Another informant, demonstrating considerable expertise in successful agricultural technologies within Malawi, initiated efforts to disseminate scientific information regarding Bt cotton in response to the increasing prevalence of anti-GMO campaigns within the country. He and his team were organizing seminars aimed at promoting awareness of Bt technologies. The targeted organizations engaged with farmers directly, with the aim of enhancing their comprehension of the technology, addressing any misconceptions, and assuring them regarding the safety measures implemented for crop management. He stated:

"*Generally, I think the measures taken by the national commission for science and technology are very informative, safe and serve the best interest of both science and agriculture development in Malawi and farmers can be assured of that..."K102*

The perspectives of informants regarding the future of Bt cotton as a viable technology for enhancing agricultural productivity and supplementing tobacco farming exhibited considerable variation. Several informants expressed strong conviction regarding the potential of cotton to significantly contribute to agricultural development in Malawi, citing that.

"I do believe cotton is one underexplored crop in Malawi and once its value is realized, we will have no second thought about it. Cotton is not only a source of fibre, but we also get cooking oil, animal feed and many other products, why should an investment in such a multiproduct crop fail to pay off?" K106

Another key informant agreed that cotton is indeed a crop of great potential in terms of its returns only if it is well supported.

"I personally would say lack of support for the cotton industry is what makes the crop dormant. Cotton can equally compete with and even surpass tobacco only if it can receive the same support and resources as tobacco." K101

On the other hand, some informants doubted that cotton would champion the agricultural development as tobacco does for Malawi. One informant said

"It's not easy to secure cotton markets for Malawi and not so many regions are good with its production. The question would also be the farmers willingness to grow cotton in those areas where it does well. As we know most farmers outside central region are not as proactive hence tobacco production still evolves than these other crops." K103

A few other informants also narrated how cotton farming involved more inputs including pesticides making the crop costly to produce. However, they hoped that the technology would help as it cuts on some input expenses. The question whether the costs are indeed cut is another issue to think of as it would also be that all other input costs have been diverted into the seed cost. Some of them had this to say

"Yes, the technology is a good development, but look at the seed cost, not only in Malawi as other countries such as Burkina Faso are growing Bt cotton and still cry over seed cost. Now is it not like to say that the money farmers would spend on

pesticides would be diverted to Bt seed? That's where it differs with tobacco, the seed costs cannot match that of cotton hence it will remain a preference for many farmers." K102

This quote is a clear indication of the controversies that prohibit and at the same time offer opportunities for better strategies on cotton farming as expected from the agricultural practitioners.

From FGDs (Farmers) perspective

Despite the farmers having little experience from Bt cotton of which many of them first learnt about it from the trials, they took interest to evaluate from the observations on what it could do to improve their livelihood and economic status. Many participants believed that Bt cotton could boost Malawi's agriculture and equally compete with tobacco. Citing setbacks in tobacco farming, some participants presented opportunities in cotton growing over tobacco. One said:

"The world is now in high demand of cotton fibre and is against tobacco smoking as a result of health hazards. This is promising that cotton could take over the fall of tobacco if the campaigns happen to get worst."

Other participants on the other hand cited the socio-cultural factors to be influencing farmers choice of crops. Factors related to the role of gender within agriculture were raised. The long-standing social practices and attitudes towards women was a central feature in influencing the type of crops and technology households could choose to apply on their farm. Women are typically considered to be subordinate to their husbands and must always consult their husbands in decision-making. Even though women are said to dominate farming in developing countries including Malawi, their role is usually undermined by male dominance in decision making and resource access and control. Informants stated how this is impacting agricultural growth as in the reported narrative

"Unless we recognize women as farmers too [especially] in cash crops then we have a long way to go to make cotton fruitful, we are not helpers, men need to understand this"

It has been observed that within the majority of agricultural households, men typically possess the authoritative decision-making power concerning farming activities, irrespective of their actual level of engagement in these practices. Furthermore, women face significant constraints in their legal entitlements to resources, such as land, and prevailing cultural norms perpetuate this disparity in ownership and agency. Consequently, a significant number of men ultimately acquire the legal authority to determine the technology to be implemented during a specific season, as well as to make decisions regarding land utilization during that same period. Occasionally, individuals may opt to lease their land despite their spouses expressing a willingness to engage in its cultivation. Recent initiatives aimed at empowering women, including the FISP, have highlighted land ownership as a critical criterion for participation. Consequently, many women are excluded from benefiting from agricultural development programs, which subsequently diminishes their opportunities to engage in cash crop farming, including the cultivation of cotton. A significant number of the female participants reported experiencing restrictions on their ability to participate in cash crop farming. Concurrently, their male counterparts acknowledged that land ownership predominantly rests with men, which consequently affords them the authority to dictate the agricultural practices implemented on that land as well as the manner in which their wives are involved in these practices. The majority of male respondents articulated that cash crops are inherently associated with masculinity, positing that women lack the capacity to manage the logistical challenges associated with their production and cultivation. Therefore, even if women engage in cotton cultivation to the same extent as tobacco, they would still be unable to oversee the marketing process. One individual stated:

"We spend days or months at the auction [tobacco market] and if that is adopted by a woman who will run the home? how safe are they? We cannot grow any other crop other than tobacco because it will distort families…"

The male participants, however, neither refuted the practice nor expressed an opinion regarding its moral standing. When this topic was introduced, the male participants either remained silent or expressed their agreement. Therefore, a

myriad of technical, cultural, environmental, and political factors must be taken into account when considering the prioritization of Bt cotton as a competitor to tobacco.

5. Discussion

The survey data indicate a notable predominance of cash crop cultivation within the study areas, as more than half of the households identified cash crop farming as their primary livelihood strategy. This underscores the significance of cotton cultivation in the study area. Nevertheless, concerning Bt cotton, the findings of this study indicate a deficiency in knowledge regarding Bt technology among the farming households in the study area. A parallel observation regarding the inadequate understanding, awareness, and knowledge among farmers has been reported in the research conducted by Sanou et al. (2018) in Burkina Faso and Lewis et al.(2010) in studies done in Tanzania concerning GM technology and terminology where majority of farmers rushed to adopt the Bt technology from a poorly informed point of view.

Our study found that the notion of cost saving options especially on pesticides leading to increased yield is what seems to be driving farmers interest in Bt cotton. As per their observations, farmers applauded high yield as the most sort after outcome as it would mean a boost in their economic and social wellbeing. This cements what drove farmers in Burkina Faso to adopt Bt cotton as found by Pertry et al. (2016). Nevertheless, this economic benefits narrative has been questioned and contended by Luna & Dowd-Uribe (2020) who cited that most authors like Okeno et al. (2013) who made such claims reported on reproduced same set of numbers of 20% or 30% yield improvement and a profitability of 51% that was based on a small number of studies from a narrow evaluation epistemology with significant methodological issues. Despite such a contention, (Luna & Dowd-Uribe 2020) acknowledges that Bt cotton growing indeed comes with several bracketed benefits with pesticide use reduction being the most notable one as well as yield and labour productivity improvements for some farmers as observed in their findings from Burkina Faso.

Equipping farmers with comprehensive, research-based knowledge regarding Bt cotton is of paramount importance (Luna & Dowd-Uribe, 2020). Furthermore,

where feasible, engaging extension workers in confined trials could significantly enhance understanding and maximize the potential of Bt cotton within the context of smallholder agriculture in Malawi. Our data noted that farmers received insufficient information support from institutions regulating Bt cotton trials in Malawi as raised in the lack of training prior to observations of the Bt trials.

Some farmers held on to views that Bt cotton contributes to increased incomes as it reduces on herbicides costs and thereby increases land productivity and preserve the environment. This affirmed reports on findings in other Bt growing countries in Africa where studies by Vitale (2016) claimed that Bt cotton increases land productivity compared to conventional cotton, which (all else equal) provides a positive impact on the environment by reducing pressure on agricultural land. Conversely, this was contended by Luna & Dowd-Uribe (2020) and substantiated by Sanou et al. (2018) who argued that all else isn't equal and that many Bt cotton farmers especially large scale farmers only experience decrease in labour requirements for insecticides spraying which propels them to increase acreage of cotton. Unlike in the context of Malawi, cotton farming is dominated by smallholder farmers whose land holding size is very small and not labour intensive.

The socioeconomic profile indicated that the farmers are constrained in their access to resources, and this resurfaced positively from the informants who cited that a cut in pesticides usage is termed as an achievement to boost savings for farmers. However, there were concerns over the high cost of the Bt seeds and this was a potential setback for most of them to think of adopting the crop once it is commercialised. The same conclusion was reached by Renaudin et al. (2012) who also highlighted the increased financial risks for smallholders due to the high cost of the Bollgard II seeds. This study showed that the level of satisfaction of farmers regarding Bt-technology depends on the type of farmer (small, medium, large). As many small-scale farmers were more neutral thus, neither positive nor negative about the technology. In contrast, Bennett et al. (2006) in South Africa, found that smallholders obtain greater economic benefits from growing Bt cotton than farmers with more land while a systematic review by Fischer et al. (2015) argued that the

economic impacts of GM cotton adoption for farmers were very diversified with other factors such as the politics and regulatory considerations being is utmost in determining Bt's success and profitability.

Informants in our study also reported Bt technology needs considerable time for safety assessments, hence the need for comprehensive checks and excellent sensitization and awareness building to the users, and even the general public at large. However, studies have shown that despite a number of successes with regard to the development of GM biotechnologies, there is a lack of appropriate biosafety regulations, protocols and stewardship schemes in many developing countries including Malawi (Conway 2003). On the other hand, the findings further reveal how monopolized the Bt seed is and how that affects farmers bargaining power. These findings echo the broader literature on how industry influences science and biotechnology evaluation, and specifically how Monsanto has regularly sought to shape and control scientific evaluations of its products in order to advance its economic interests (Mchenry 2018).

While our findings reveal, farmers fear to adopt Bt cotton over costs and its non-inclusiveness in the FISP. Informants also expressed indefinite views on the potential of Bt cotton to boost agricultural development just like tobacco does for Malawi, thus pointing to some studies that explain the role of institutional factors such as political will, the governance structure of the cotton sector and the power of cotton companies in the provision of subsidized synthetic fertilisers to farmers on credit (Métouolé Méda et al. 2018). They state that these factors are important in providing a comprehensive understanding of how farmers integrate such factors in their decision to adopt the cotton technologies. Emphasizing on the importance of subsidies for cotton farming. Laouan (2021) shared how developed countries maximise on subsidies and yet they put pressure on developing countries not to follow suit. This creates inequalities for these farmers and deprives them of fair competitiveness on the global market over the same products.

Agricultural input subsidy programmes (AISP) are among major public investments for achieving food and nutrition security in Africa (FAO et al., 2020).

From findings in this study, it is reported that cash crops are not priotised in subsidies as the focus is on food crops such as maize, this agrees with findings that national governments often use subsidies to address hunger and food insecurity through targeting staple crops, as researched by Jayne et al. (2018). On the other hand, participants in this study viewed Bt cotton as a cash crop that would influence farmers to allocate it more land if considered under subsidy programs. This agrees with other studies on other cash crops such as tobacco as observed by Karamba (2013) in Malawi where there was a substantial decrease in the share of land allocation to maize and an increase in land allocation to tobacco, on the views that allocating more land to tobacco would lead to earning more income which was vital in sustaining household food security.

The findings further reveal that subsistence farming in Malawi has the potential to diversity FISP to crops beyond the staple grains as witnessed in the changes in FISP over the years where at some point it had cotton seed as a component. Given the many critics of GM crops and its high seed costs, which is argued to favour commercial farmers and disproportionately affect small farmers as argued by Luna & Dowd-Uribe (2020), then programs such as the farm input subsidy would be handy for the smallholder farmers to grow Bt cotton if it in the FISP components. Having found that the FISP is not a rigid program and can be adjusted with time as observed in the findings of Mwale et al. (2022) where they stated how the Malawi FISP composition and supply chain has been modified over the course of programme implementation. They cited changes that occurred in 2005/06 and 2009/08, where the Government of Malawi distributed the subsidised fertiliser and seeds through privately procured retailers and then shifted in the 2008/09 where the privately procured retailers were excluded but only used in procurement and distribution of subsidised maize seeds (Jayne et al. 2018). It is further revealed that the changes continued as the Malawi government banned the participation of the private sector due to the absence of a system to monitor their operations and confirmed cases that they were being involved in the exchange of counterfeit vouchers (Kaiyatsa et al. 2019). Overall, the Malawi FISP has faced a number of implementation challenges (Lunduka et al. 2013; Nkhoma 2018) ranging from

political disturbance of the set beneficiary selection processes, leakages of inputs through secondary markets, mistargeting of beneficiaries due to undefined selection criteria, and untimely delivery of farm inputs to the selected farmers.

On the other hand as reported from the findings in this study, the adoption of technologies by smallholder farmers is affected by so many other factors including their control, access to and availability of inputs as influenced by sociocultural factors, among others (Croppenstedt et al. 2013). Besides, as per findings in this study, female and male farmers do not have the same level of access and control to resources, thus resulting in differences between these groups in the extent of which they are able to adopt technologies. These findings relates to what Asfaw et al. (2017) reported on gender constraints in the FISP targeting and how that affected women's opportunities to fully benefit from the initiative. Thus, gender is also an important area to consider when engaging farmers for different initiatives.

6. Conclusion

Cotton serves as a significant cash crop and necessitates appropriate levels of investment for its cultivation and production.

To ensure the successful integration of Bt cotton within the agricultural systems of countries such as Malawi, it is essential to consider a range of factors which include:

The dissemination of knowledge to farmers and the general public through strategically organized forums that are inclusive of multiple sectors and representative of gender diversity.

The government must assume a proactive role in regulating and establishing supportive frameworks and initiatives that facilitate the advancement of these technologies.

Additionally, to promote diversification among farmers towards cotton cultivation, particularly for the production of Bt cotton, it may be imperative to incorporate Bt seeds into agricultural input subsidy programs, given their prohibitive costs that render them unaffordable for many farmers.

Despite the inherent limitations of the FISP, attributable to its complexities and political influences, it nonetheless offers a significant opportunity to incorporate cash crops. This strategic inclusion has the potential to enhance food security by increasing incomes derived from crop sales. FISP is frequently perceived as a political instrument utilized to garner electoral support; however, it possesses the potential to significantly contribute to the empowerment of smallholder farmers, who represent a substantial portion of the electorate. The financial burdens

associated with the Farm Inputs Subsidy Program (FISP) may render its application to Bt cotton unviable. This stems from the fact that Bt cotton does not serve as a direct source of food within a context where the politics of hunger are paramount in development discourse, with maize continuing to be the focal point of these discussions.

Consequently, it is imperative to investigate the extent to which the FISP can address technological deficiencies in agriculture, as well as to assess the level of understanding that farmers may attain regarding the connections between Bt cotton cultivation and food security. This approach will facilitate a deeper understanding of the impacts associated with the commercialization of Bt cotton and the potential future modifications to the FISP aimed at enhancing the socio-economic benefits for farmers.

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