

# The Challenge of Change: A Case of Introduction of Genetically Modified Cotton in the Kingdom of Eswatini

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**Abstract**— In Eswatini cotton contributes merely 2.1 % of the country's Gross Domestic Product owing to viability challenges. Farmers grow hybrid cotton which is now in the decline stage of its life cycle, no longer profitable and causing persistent challenges to farmers. Other cotton growing countries like United States of America, Canada, Australia and South Africa have replaced hybrid cotton with the more profitable genetically modified cotton. This strategy can be a viable alternative for the Eswatini cotton industry too. The study identified perceptions that Eswatini cotton industry stakeholders have towards genetically modified cotton. In-depth interviews were held with 8 informants selected based on their experience and knowledge about the cotton industry. The study revealed that 2/3 of cotton farmers suspended growing cotton owing to viability problems. Although genetically modified cotton has higher input costs these were easily offset by higher yields and less use of pesticides and labour. The study indicated that farmers required additional capacity to be able to grow genetically modified cotton. The study recommended that industry stakeholders must adapt to change and embrace genetically modified cotton which was successfully implemented in other countries. Liberalisation of the cotton industry was also recommended to pave way for the farmers to try the new product. Training of farmers was recommended as a strategy of capacitating the farmers on how to manage genetically modified cotton and challenges associated with the new technology. Further research is recommended about the modalities of optimising the benefits of genetically modified cotton and how cotton farmers can be supported.

**Keyword**—Adaptable to change; Eswatini cotton industry; Genetically modified cotton; New product development; Product life cycle.

## I. INTRODUCTION

This paper is about introducing genetically modified cotton in the Kingdom of Eswatini. Discussions in the paper are guided by management processes of

introducing a new product or new technology in a market. In the Kingdom of Eswatini, agriculture plays a major role in the economy; it's a major source of food, and also employs more than 60% of the country's population (Thomson, 2012; ISAAA, 2014). Eswatini's agriculture is mainly dependent on sugar cane, cotton and forestry. Cotton is the second biggest cash crop after sugarcane in Eswatini. It is an important cash crop for most Swazis who live in drought prone areas and smallholder farmers who are reliant on the crop for their livelihood (Central Bank of Swaziland, 2013). Eswatini farmers are still entirely reliant on conventional hybrid cotton seeds. Hybrid cotton seeds have long been used in the industry as the sole means for cotton production. Genetically modified cotton is a variety of cotton that has been modified through a biotechnological process in order to achieve a higher yield. Bollworm resistant, *Bacillus Thuringiensis* (BT) cotton is the most popular genetically modified cotton seed used throughout the world. Genetically modified cotton was first introduced in the early 1990s and has since been adopted by major cotton producing countries such as the USA, India, China and South Africa (James, 2011). Genetically modified cotton seeds are engineered via a biotechnological process to reproduce the soil bacterium *Bacillus Thuringiensis* in a crystal form in order to exterminate certain types of insects and pests which damage the cotton crop and reduce farmer's yields (Craig *et al.*, 2008). The new genetically modified seed has outstripped its traditional hybrid counterparts in terms of yield (Brookes & Barfoot, 2013).

The Eswatini cotton industry is currently facing a decline in production and this has affected the textile industries which relied on Eswatini cotton as their main source of inputs. Most textile industries have closed due to the shortage of cotton. The few textile factories that are operational survive through importing cotton to supplement locally depressed supplies for the daily operations. The government of Eswatini has to revive the cotton industry by introducing a new product in the market. The purpose of this paper is to investigate the

costs and benefits of changing from hybrid cotton to genetically modified cotton in Eswatini. The paper will evaluate business opportunities, capacity requirement, economic benefits and cost associated with adopting genetically modified cotton in the Kingdom of Eswatini.

The cotton industry in Eswatini is currently facing many challenges. The country's largest cotton ginnery which is under the stewardship of the Swaziland Cotton Board (SCB) and located at Big Bend, has a capacity to handle 25 000 metric tons of cotton. Currently, a mere 10% of the ginnery's capacity is being utilised owing to unavailability of inputs and decreased cotton production, among other reasons (Mavuso, 2014). The cotton industry is solely dependent on conventional hybrid cotton seeds. All cotton farmers have been using hybrid cotton seed for the past two decades (Cotton Board, 2014). However, the hybrid cotton seed has reached the decline phase of its life cycle which is characterised by a rapid decrease in the yields and it is no longer profitable for farmers to grow cotton. The decrease in cotton production threatens the 90 ginnery employees' jobs at the Big Bend ginnery (Cotton Board, 2014).

Hybrid cotton that is currently grown by Eswatini farmers is no longer producing high yield as it used to do in the past years. The product has reached a decline phase which is characterized by high production cost, low yields, and heavy pesticides application requirements. From a management point of view a product in decline phase needs to be phased out and replaced because it will be fool hardy to rejuvenate the product (Kotler, 2012). Cotton acreage has drastically reduced from 30,000 hectares to merely 3000 hectares (Cotton Board, 2013). Correspondingly, the number of cotton farmers in Eswatini has also decreased from 9000 to 3000 in the past 6 years (Cotton Board, 2013). The sector's capacity to create employment directly, in cotton farms and indirectly, in the textile industry, and ginning, spinning, and weaving of fabric has gone down drastically. This has been aggravated by labour migration from rural areas to the cities (Thomson, 2012). The country has to find strategies of filling the demand gaps created by dwindling cotton production over the years and cheaper technology to continue producing enough cotton to meet increasing demand. Opportunities that are not utilised when they arise will always be taken up by one's competitors (Bimha & Bimha, 2018). Therefore, it is the researchers' conviction that the introduction of genetically modified cotton seed is one of the viable options to tackle the cotton industry's prevailing challenges. There is an urgent need to ascertain stakeholder willingness, capacity requirements and readiness to adopt genetically modified cotton technology to replace hybrid cotton seed which has passed the maturity phase and is no longer economically viable. In

the public domain, no research has been carried out to ascertain the costs and economic benefits of introducing genetically modified cotton in the Kingdom of Eswatini.

The paper aims to investigate the costs and benefits of phasing out hybrid cotton with introducing genetically modified cotton in the Kingdom of Eswatini.

The specific objectives of the study were to:

- Identify stakeholders' perceptions towards growing genetically modified cotton in place of Hybrid cotton in Eswatini.
- Identify challenges associated with the production of genetically modified cotton in Eswatini.
- Provide recommendations on how stakeholders in Eswatini can adopt and implement genetically modified cotton production

Based on the above objectives the research was designed to address the following questions:

- What are the perceptions of cotton industry stakeholders towards adopting genetically modified cotton in the Kingdom of Eswatini?
- What are the benefits of growing genetically modified cotton?
- What are the challenges of growing genetically modified cotton?
- What suggestions could be made to an industry that is considering the adoption of genetically modified cotton technology?

In other developing countries that have already adopted genetically modified seed as alternative technology agriculture contributes up to 11.9 percent to Gross Domestic Product (GDP) of those countries (Central Bank of Swaziland, 2014). Based on the fact that in Eswatini cotton contributes merely 2.1 percent of GDP, any research which seeks to improve cotton production methods may be of value to many stakeholders, including the Swazi farmers, Swazi textile manufacturers, cotton seed crushing companies and the Eswatini economy in general. The findings from this research can assist in generating new information for the farmers to appreciate the potential benefits and probable costs associated with producing genetically modified cotton. The study is also significant since it intends to investigate the capacity requirements and challenges associated with producing genetically modified cotton. In this regard, policy makers can use the research outcomes to plan the adoption of genetically modified cotton production.

In Eswatini, there is no research available in the public domain which discusses genetically modified cotton

as a concept, cost, benefits, capacity requirements and challenges associated with producing genetically modified cotton. This will be the first of its kind and it is hoped that the study will trigger progressive debate on the growing of genetically modified cotton. It is the researchers' conviction that, with the cotton industry in Eswatini facing a crisis, genetically modified cotton production may be the rational way to resuscitate the ailing industry. Therefore, this study will make an original contribution to the cotton industry, and turning around people's livelihoods.

The following section will critically analyse the literature related to cotton industry stakeholders' perceptions about change and the management processes of introducing a new product in the market. To replace an ailing product it is necessary to evaluate the product's life cycle and to understand the requirements for new product development.

## II. LITERATURE REVIEW

### 2.1 Perceptions towards change and implementing genetically modified technology

Farmers in Eswatini are used to growing hybrid cotton. To them, the introduction of genetically modified cotton constitutes introduction of change or a new product. From a management point of view, people generally resist change (Burnes, 1992). Change management researchers have identified the following factors being quoted as reasons why people resist different forms of change (Burnes, 1992; Thuis & Stuijve, 2012; Brevis & Vrba, 2014):

1. Habit-people are not happy to change from something they are used to
2. Security- people feel secure in a situation they know and find moving to a different situation to be threatening
3. Economic-fear of losing income
4. Fear of the unknown-people take fright at any change if they do not know what the change brings about
5. Lack of awareness-people resist things that are introduced without prior notice
6. Social factors- people are afraid of what others will think or say

Because people's perceptions will influence the decisions they will make the introduction of new technology has to be done with caution, taking into account the above issues. Strategies must be in place to deal with any form of resistance to be faced. Generally, this should include effective communication among

stakeholders, participation and involvement, facilitation and support, negotiation and consent, and manipulation and cooperation (Brevis & Vrba, 2014). Additionally reasons for the change must be explained to the affected. Some of the reasons given for redesigning or changing technology include:

1. Economic-when there is low demand for the old product and it is costly to produce. Brown, Bessant and Lemming (2013) suggest that, if costs are to be driven down then new ways of doing things are required.
2. Social and demographic-there is a lot of migration from rural areas to urban areas. The moves leave aging farmers with less labour hence the need for less labour intensive technology (Mavuso, 2014).
3. Political and legal- The stance that Government takes about the new technology must be understood by those affected so that they strengthen lobbying against policies that are unfavourable. In Eswatini, the Biosafety Act of 2012 is seen as a major hindrance to the procurement and use of genetically modified cotton seeds (Mayet, 2012).
4. Costs or availability of raw materials, components, labour and other inputs. Increase in costs directly or indirectly affects the cost of doing business hence they have an impact on the company's bottom line (Stevenson, 2012; Coyle et al., 2017).

### 2.2 The Concept of Product life cycle

Product life cycle concept describes how a product goes through the four phases of introduction, growth, maturity and decline from the time a product is launched till it is phased out of the market (Palffy, 2015). To evaluate the potential of a new product in the market, organizations must review the sales performance of the product at each stage of the life cycle (Kotler & Keller, 2012; Palffy, 2015). Therefore, the stage where a product is in its life cycle is associated with its performance and profitability. Each life cycle stage requires a different mix of marketing strategies (product strategies, pricing strategies, promotion strategies and distribution strategies) to maximize the lifetime profitability of the product. A product can be phased out when its sales stall and continue to fall. Additionally when old products are no longer grabbing new market share, management should consider launching new product to continue generating revenue for the entrepreneurs (Brown, Bessant & Lemming, 2013). Figure 2.2 below illustrates the product life cycle.

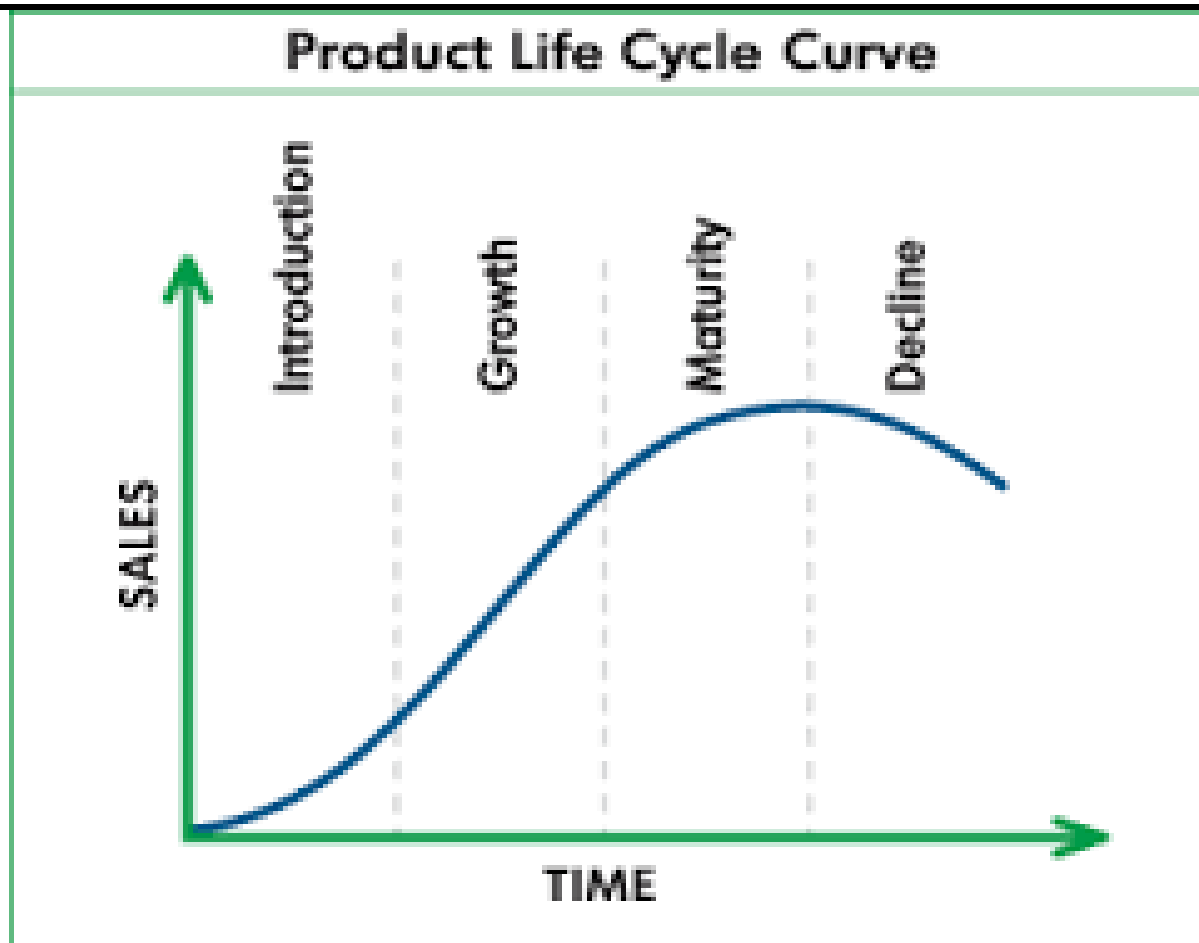


Fig.2.2: Product Life cycle concept

Source: Kotler and Keller (2012)

While the model does not predict sales, when used alongside carefully analysed sales figures and forecasts, it provides a useful guide to marketing strategies that may be most appropriate at a given time (Kotler& Keller, 2012). Therefore, it is novel and ideal to plan for the exit of a product because no product can survive for ever owing to reasons which includes increasing competition, changing customer tastes and priorities, changing production processes and technology (Brown, Bessant& Lemming,2013).

The cotton industry is currently striving on conventional cotton which is in its decline stage.(Cotton Board, 2014). Farmers are no longer interested in the product due to shortage of labour and high pesticides application requirements. The product has proven to be low yielding and labour intensive. There is a need for a new product in the market. Conventional cotton is at the decline stage of its life cycle, and the product is no longer profitable to the farmers. There is a need for the industry to introduce a new product to the market. This view is supported by Kotler and Keller (2012) who note that a company must have a different set of strategies at each

product life cycle phase including phasing out old products which are no longer profitable.

### 2.3 New product development concept

Genetically modified cotton is a new product that will replace conventional cotton; an old product that has reached its decline phase. The product will be successful in the market if it undergoes known stages of product development. Product ideas are consummated and developed into ideas which then go through a screening process. Only those ideas with potential to survive the market go through all development stages like product prototype development,market testing and commercialisation (Kotler, 2012; Stevenson,2012; van Weele, 2018). The genetically modified cotton seed has gone through the rigorous new product development process and Eswatini does not need to repeat these processes again.vanWeele (2018) points out that all these stages should involve strategic planning to provide the necessary infrastructure for future technological collaboration with suppliers and operations management processes that relates to the management of individual developmental projects.

Because genetically modified cotton was consummated in the 1990s in the global market it has already gone through the new product development stages in the above model. Adopting the new technology for Eswatini is a question of introducing the technology already in use in other cotton growing countries such as India, South Africa and Brazil. However, Phipps and Park, (2002) recommended that to create genetically modified cotton seeds, scientists must adhere to 5 stages of genetic engineering:

- Identify the selected gene that requires modification,
- Apply the appropriate gene transfer technology,
- Achieve regeneration ability from tissues (or protoplasts and callus),
- Express the gene of the product at the desired level, and
- Reintegrate the gene in order for it to be carried via reproduction

To date, technology has facilitated the first four stages of genetic modification. These four stages of genetic engineering are critical to the transfer of the foreign gene into the cotton crop. Scientists employ various transfer strategies including, micro-injection, direct DNA absorption, bombardment of particles or the plasmid method (Stone, 2007). Cotton genotypes have proved to be unsusceptible to regeneration and this is considered as a barrier to the reuse of genetically modified seeds. Once sowed and grown and harvested, the cotton bolls produced by genetically modified seeds are indistinguishable from those cotton bolls produced by conventional cotton seeds (Quim, 2009).

#### **2.4 Benefits that can be derived from the production of genetically modified cotton**

The most important benefit of genetically modified cotton relates to the reduction in pesticide use and weed control using herbicides. Since genetically modified cotton is purposely created to be resistant to many types of worms and insects, cotton farmers find that there is no need to excessively spray different types of pesticides to protect their cotton crops (Morse & Mannion, 2009). The use of fewer pesticides is associated with lower cost of production. This can lead to lower risk exposure for the farmers owing to the handling of fewer harmful chemicals. Organisms in the soil are also preserved due to lower quantities of pesticide use and this ultimately results in better soil quality over time (Anderson, Valenzuela & Jackson, 2008).

In the United States of America (USA), the introduction of genetically modified cotton resulted in a reduction of pesticide consumption of up to 60%, in China, pesticide

use decreased by up to 80% after the introduction of genetically modified cotton and in South Africa pesticide use decreased by 66% (Hossain *et al.* 2004). In addition, the reduction in pesticide production, distribution and use reduces environmental impacts of the harmful pesticides throughout the supply chain (Ali & Abdulai, 2010).

Morse and Mannion (2009) note that, cultivating genetically modified cotton instead of traditional cotton leads to increased yields. The increased yields are a result of better soil quality from lower pesticide use as well as the elimination of most crop destroying worms and insects such as Lepidoptera's specie (Ibid). The crop destroying worms are usually responsible for significant yield reduction. Therefore, with the introduction of genetically modified cotton, farmers are able to benefit from increased yields within the same acreage. In India, research determined that, genetically modified cotton produced a yield that was almost double to that of traditional cotton – on the first yield and the study reported increases in earnings of 60% after planting genetically modified cotton. In the same study, the farmers reported increases in earnings by up to 50-60% after planting genetically modified cotton (Bennet *et al.*, 2005).

Farmers who require fewer pesticides also require less labour since the frequency and application of pesticides decreases. The reduction in pesticide application also implies that farmers are able to lower the costs associated with the maintenance and running of pesticide application equipment. The reduction of pesticide application reduces soil compaction since large equipment is not rolled over the land as many times (Qaim & Zilberman, 2005).

According to Stone (2007), the cultivation of genetically modified cotton is also beneficial from an environmental perspective. Genetically modified cotton is regarded as the eco-friendly alternative to traditional cotton cultivation since it does not have adverse effect on parasites, predators, beneficial insecticides and organisms present in soil. The biodiversity of the cultivated area is preserved for a longer duration, thus reducing the costs associated with rehabilitating soil and the land in general.

Farmers in USA reported a \$20 per hectare increase in net income and overall, the growing adoption of genetically modified cotton in USA was estimated to increase cotton income by \$103 million in 2010, Chinese farmers reported an increase in income of approximately \$350 to \$500 per hectare and in South Africa, the return on investment in genetically modified cotton ranged from a \$20 to \$50 increase in net earnings per hectare (Morse & Mannion, 2009).

It is also important to note that genetically modified cotton cultivation requires less management and involvement. As such, farmers have more time available to

spend with their families as well as engage in other income generating activities (BenNETT *et al.*, 2005; Qaim&Zilberman, 2006; Morse & Mannion, 2009). A similar study conducted by Qaim (2009), found that, cotton farming families were able to plan better financially, based on the dependability and resilience of the crop to yield predictable harvests.

## 2.5 Costs associated with Genetically Modified Cotton Production

Vitale *et al.*, (2011) found that the initial costs of producing genetically modified cotton are usually more than the cost of producing traditional cotton. The additional cost is largely attributable to fees related to investment capital. The initial costs, however, are offset over time, due to increased yields and the savings realised through the use of less pesticides. Kambhampati *et al.*, (2006) found that typical small to medium scale cotton farmers experience additional costs of modifying the seeds via biotechnology before it is planted. The costs associated with human labour were found to decrease with the use of genetically modified cotton production. This is attributable to the fact that genetically modified cotton requires a lower level of pesticide application, thus reducing the hours of human labour required (Qaim&Zilberman, 2005). Costs associated with the use of tractors increase by almost one third owing to a more technologically inclined approach to growing and harvesting genetically modified cotton, (Kambhampati *et al.*, 2006).

Whilst the cost of fertilisers increases significantly (more than 45%), this cost is partially offset by the use of less pesticides (approximately one third less). There is a negligible change in the cost of irrigation, since, in most cases, traditional and genetically modified cotton were found to require similar volumes of irrigation in small to medium operations. This notion, however, is not replicated in larger operations – where it was noted that genetically modified cotton required significantly less volumes of irrigation as compared with traditional cotton irrigation requirements. Other operational costs also increased significantly (more than 250%). However, it is important to interpret this increase in a broader context, where it should be noted that other operational costs only make up a small component of the total costs. The increase in other operating costs could be due to the fact that genetically modified cotton requires more sophisticated equipment, and as a consequence, the associated costs may rise (Kambhampati *et al.*, 2006; Stone, 2007).

Anderson, Valenzuela and Jackson, (2008) found that, besides the direct costs associated with the introduction of genetically modified cotton, there are also indirect costs borne by stakeholders along the production value chain. Although it is difficult to actually measure the

indirect costs, there is conclusive evidence to support the assertions. Research findings by BenNETT *et al.*, (2006), indicated that the small cotton farmers often stand to lose their holdings when genetically modified cotton is introduced. In the absence of sufficient government support, small scale farmers find it difficult to absorb the high initial costs of adopting the new genetically modified product and the additional capital requirements.

## 2.6 Capacity requirements of genetically modified cotton production

Eswatini currently has a ginnery with a capacity of 25 000 metric tons and is currently operating at 10 percent. The introduction of the new product will increase yield and supply of cotton to the ginnery to meet the throughput. Farmers will require training to be able to manage the new product. Genetically modified cotton is different in that it requires planting of a refuge. The refuge harbour susceptible pest for future breeding of the cotton pest. This is required to minimise resistance on the future generation. There will be no additional equipment required for the new product except for training of farmers on management (Herrera-Estrella, 2000).

## 2.7 Potential challenges associated with the production of genetically modified cotton

A cursory review of the majority of literature relating to the production of genetically modified cotton indicates that the advantages far outweigh the disadvantages. In fact, very few disadvantages and challenges have been documented with regards to the adoption of genetically modified cotton. In addition, the previous section has alluded to the fact that little to no additions are necessary to the production process once the genetically modified seeds have been procured. The literature relating to genetically modified cotton production indicate that the adoption and change-over process is relatively simple. Furthermore, numerous national research agencies (for example, in the USA, Australia, and China and in India) have concluded that genetically modified cotton should be promoted by governments and that grants and subsidies need to be provided to farmers, given the limited requirements for adoption (Morse & Mannion, 2009).

Despite the minimal challenges identified regarding the adoption of genetically modified cotton, Qaim and Zilberman, (2006) point to a very important consideration and potential challenge to farmers. First, it is important to note that, given the science of genome alteration, scientists have claimed that genetically modified seeds cannot be re-used. This has important implications for farmers, who are now unable to reuse seeds, like they did with the production of traditional cotton crops. Furthermore, with only a few international

companies specialising in the production and distribution of genetically modified cotton seeds, local farmers are at the mercy of these organisations, should production decrease and prices increase. The other potential challenge is associated with the import of the genetically modified cotton seeds. The global economy is currently extremely volatile and brings with it many potential challenges, especially with regards to exchange rate, which will inevitably influence the costs of seeds and thus the cost of production for cotton farmers (Craig *et al.*, 2008).

### III. RESEARCH METHODOLOGY

The phenomenological research philosophy guided the study. Phenomenology entails the use of qualitative research approaches which endeavour to understand meanings as constructed by participants. It is more reflective of reality for research subjects' opinions and perceptions (Leary, 2011; Creswell, 2014; Smith, 2015; Maree, 2016). In the study empirical data was used to understand contemporary phenomena; the introduction of genetically modified cotton from the perspective of participants (Richey & Klein, 2014). The research therefore, uses the Swaziland cotton industry as a case in order to study the potential costs, benefits, capacity requirements and challenges associated with the introduction of genetically modified cotton.

Selecting the most appropriate research design is important since different designs yield different outcomes (Pickard, 2012). The study was an exploratory research design. Exploratory research designs promote a broader research scope than other research designs, thus enabling the researcher to explore as many variables as possible (Creswell, 2014; Bryman *et al.*, 2014). The purpose of exploratory research is to gain familiarity with a given phenomenon. More importantly, exploratory research is often conducted in business settings to explore the potential impacts of anticipated phenomena (Pickard, 2012). However, exploratory research findings may not be generalizable to the target population even though it enables the researcher to gain significant insight into the phenomenon being investigated (Leary, 2011).

The target population for this study includes all key informants in Eswatini's cotton value chain who were selected based on their knowledge and understanding of the current dynamics in Eswatini's cotton industry. The study relied on the informants' years of experience and product knowledge. These qualities can enable them to fairly and accurately assess the potential costs, benefits, capacity requirements and challenges associated with the introduction of genetically modified cotton in the country. There are approximately 18 senior managers employed throughout the cotton value chain in Eswatini. Time and financial limitations prevented the researchers from

conducting a census. Thus, only 8 of the 18 managers were purposively sampled and interviewed.

Purposive sampling is entirely guided by the researchers' judgement and ability to select participants who can contribute to the study in a meaningful way (Maree, 2016). Thus, the researcher should be knowledgeable about the participants' knowledge, capacity and ability to add value before approaching them (Creswell, 2014). The selection process targeted to have at least a representative from each sector in the cotton industry value chain.

Qualitative research employs a variety of research instruments for the collection of raw data. Observations, focus groups and personal interviews are among the more popular qualitative research instruments. Observations would not yield the desired raw data and focus group interviews were irrelevant because the targeted informants were of varied orientations and background. Therefore, the personal, face-to-face interviews with key informants were used as the research instrument (Leary, 2011). A semi-structured, face-to-face interview was used to collect qualitative data for analysis. Semi structured interviews can offer flexibility that allow the researcher to probe and follow-up questions based on the participants' responses.

During the recording key words were marked to be used in word and tree clouds graphical representation. Finally, the transcribed interviews were submitted to informants for verification, to ensure that what they had said during the interview was correctly understood and transcribed by the interviewer (Creswell, 2014). In this study Dedoose-version 6.2.21 Word cloud and Word tree was used to analyse the data. Word and tree clouds are graphical representations of words frequency that give greater prominence to words that appear more frequently in a source text. This allows themes to emerge from the responses of participants that may enable the researcher to answer the research questions. In order to add further value to the analysis identification of sub-themes under each major theme was conducted. Sub-themes assist the researcher in identifying the major variables that influence each major theme (Maree, 2016).

In qualitative research, it is advisable to sample until saturation; researchers continue to look for information until they are satisfied that all information required has been collected (Creswell, 2014). However, due to time and financial constraints, the search for data was limited to 8 key informants. As such, the findings may not be as insightful as a larger sample could have achieved. Additionally, the concept of genetically modified cotton is fairly new, having been discovered in the 1990s. Therefore, there is limited literature about genetically modified cotton's costs, benefits, capacity requirements and challenges associated with introducing genetically

modified cotton technology. Researchers are therefore forced to be heavily dependent on information and opinions of the sampled informants.

#### IV. DISCUSSION OF FINDINGS

A total of 8 informants representing cotton farmers, seed suppliers, chemical suppliers, ginning sector (primary processors), spinners (secondary processors), the regulator, Government and other stakeholders participated in the study. The informants had cotton industry experience ranging from 5 to 21 years and they hold key positions within the cotton industry. The findings are discussed based on four themes that emanated from the 8 interviews. The four themes are the benefits of introducing genetically modified cotton, the costs of introducing genetically modified cotton, capacity requirements for introducing genetically modified cotton, and challenges associated with genetically modified cotton. The views given by the informants were personal and did not represent views of the companies they worked.

## Theme 1: The benefits of introducing genetically modified cotton in Eswatini

Informants were asked to name and explain possible benefits that genetically modified cotton can bring to Eswatini. The key word “pesticide” was used more often by informants. Other common words were yield, reduction and lower. Table 4.1 and Figure 4.1 below summarise the analysis of words used to describe the benefits of introducing genetically modified cotton.

*Table.4.1: Benefits of introducing genetically modified cotton*

Key Benefits	Frequency
Lower use of pesticides	4
Increased crop yield	2
Reduction in production cost	1
Lower labour costs	1
<b>TOTAL</b>	<b>8</b>



*Fig.4.1: Word cloud of potential benefits from introducing genetically modified cotton in Swaziland*

It emerged that informants believed that introducing genetically modified cotton would impact pesticide application and use. This is most probable due to the informants' knowledge of the scientific process behind the genetic modification of cotton seeds as well as their knowledge of other countries' experiences of cultivating genetically modified cotton. The fact that growers of genetically modified cotton use fewer pesticides is the most important benefit cited by the informants.

Informant 1 mentioned that:

*“The introduction of genetically modified cotton will significantly reduce the efforts that farmers invest in pest management and will assist in making their pest management strategies more attainable with fewer resources...”*

Informant 2 explained that:

*“By virtue of their genetic structure, these modified seeds are naturally resistant to certain types of worms which are known to*

*destroy the crop. Therefore, it is not surprising that many farmers around the world, who plant genetically modified cotton seeds, have noticed that the need for large volumes of pesticides is drastically reduced”.*

The above observations are in line with the fact that, since genetically modified cotton is purposely created to be resistant to many types of worms and insects, cotton farmers find that there is no need to excessively spray different types of pesticides to protect their cotton crops. Thus, the introduction of genetically modified cotton reduces the use of pesticide (Anderson, Valenzuela & Jackson, 2008).

Informants concurred that genetically modified cotton has the potential benefit to increase yield of the cotton crop in a given cultivation area. Informant 8 highlighted that genetically modified cotton tends to produce higher yields because there is less crop damage since the modified crop is resistant to worms.

*“I will put it to you simply; traditional cotton yields are drastically reduced from damage caused by different pests. In genetically modified cotton plants, there is less damage and therefore more cotton to harvest. ”*

Informant 4 added that,

*“Genetically modified cotton seeds are manufactured for high yield. The scientific process involved in the biotechnology is a proven technique worldwide and serves to enhance the capability and potential of each cotton seed. In essence, we are removing, or lowering the chances of crop failure by introducing a seed that is proven. Farmers can expect higher yields per hectare after planting these seeds.”*

Perceptions of informants that genetically modified cotton seeds produce higher yields is supported by evidence presented by Arundel and Sawaya (2009) who found that the increased yields are a result of better soil quality from lower pesticide use and the elimination of most crop destroying worms and insects such as Lepidoptera species. These crop destroying worms are usually responsible for significant yield reduction. Therefore, with the introduction of genetically modified cotton, farmers are able to benefit from increased yields within the same acreage. All of the informants agreed that grow traditional cotton faced hardship due to low yields stemming from damaged crops and drought. It also emerged from the interview that as use of pesticides goes down and farmers have better yield there was great potential to boost farmers’ earnings and eventually quality of life.

Informants 6 and 2 cited examples of China and India where cotton farmers were able to lower production costs by adopting genetically modified cotton seeds.

Informant 6 said Chinese farmers managed to reduce their operational costs after adopting genetically modified technology:

*“China, for example, assisted farmers and encouraged them to adopt genetically modified cotton cultivation techniques. After two years, small farmers reported that their costs had dropped because they used fewer pesticides and didn’t need to bear the cost of employing people to apply as much herbicides.”*

Informant 2 also explained that:

*“Indian farmers were extremely successful in the months following the uptake of genetically modified cotton. Farmers fast came to know that the seeds required less water and thus less manpower to grow.”*

Informant 8 added that:

*“...with the introduction of genetically modified cotton, farmers will expect a whole host of benefits. Ultimately, the reduction in stress alone, will improve their quality of life, let alone the improvement in cash stream. ”*

The findings of a study conducted by Nita, *et al.*, (2013) at the European Commission confirm that, the increased yields per hectare translate into more earnings. As a result, farmers enjoy higher profits and can thus experience a better quality of life. It is also important to note that genetically modified cotton cultivation requires less management and involvement. As such, farmers have more time available to spend with family as well as engage in other income generating activities.

## **Theme 2: The costs of introducing genetically modified cotton in Eswatini**

Informants identified and explained costs they associated with growing genetically modified cotton. Table 4.2 shows four key elements associated with cost of growing genetically modified cotton and Figure 4.2 below summarises common words and phrases used by participants in describing costs related to growing genetically modified cotton.

*Table.4.2: Costs of introducing genetically modified cotton in Eswatini*

Key costs	Frequency
Price of inputs	4
Seed cost	2
Increased hectareage	1
Capacity requirement	1
<b>TOTAL</b>	<b>8</b>



Fig.4.2: Word cloud summary of costs of introducing genetically modified cotton in Swaziland

The price of genetically modified cotton seeds, will be higher than traditional cotton seeds. This is attributable to the fact that there is a scientific, biotechnological process involved in the genetic modification of cotton seeds. Informant 6 explained that a farmer in KwaZulu Natal, South Africa indicated that while they expected the cost of seed to be higher, there was also an anticipated higher demand for farm land as more people had interest in growing genetically modified cotton.

Interviewee 2 predicted that:

*“...seed prices are bound to be higher for genetically modified ones...I have witnessed this trend in India, where seed prices increased by almost 110% and I am aware that in Australia, seed prices jumped to almost 260% more than that of normal cotton seeds. I therefore am fairly certain that farmers in Eswatini can expect to pay higher prices for seed if we allow genetically modified seeds...”*

The primary findings relating to the costs associated with introducing genetically modified cotton production

techniques in Eswatini are strongly linked with the findings presented by Nita, *et al.*, (2013) who found that genetically modified cotton has an impact on all input costs for the typical small to medium scale cotton farmer.

### Theme 3: Capacity requirements of introducing genetically modified cotton in Eswatini

Table 4.3 and Figure 4.3 below summarise the key words and common words and phrases used by informants in explaining capacity requirements for adopting genetically modified cotton.

*Table.4.3: Capacity requirements of introducing genetically modified cotton in Eswatini*

Key word	Frequency
Price	3
Seed	3
Increased	1
Requirement	1
<b>TOTAL</b>	<b>8</b>



Fig.4.3: Word cloud relating to capacity requirements of introducing genetically modified cotton in Swaziland.

Informant 3 hinted that, with the adoption of genetically modified cotton seeds, farmers would be required to modify their production techniques and adopt appropriate technology. Informant 6 also stated that;

*“Production techniques, including budgeting and forecasting must be improved if we are to be able to afford the cost of new seeds. This is critical because the genetically modified cotton seed cannot be reused. We must therefore consider our capacity to forecast our profits and budget for the cost of new seeds.”*

Informant 5 added that;

*"If we are adopting a new product, we cannot expect to use it or grow it with the old techniques. We must be clearer about how we structure our capacity to accommodate these new seeds. Farmers need to be able to produce cotton using a more advanced approach. They need correct seed to achieve a better yield."*

Informant 8 said :

*“Although the Government prohibits the use of genetically modified seeds, farmers were no longer interested in traditional cotton. Many farms lie idle because cotton is no longer profitable, people have no money for pesticides and there are no workers to work in the fields. It is not clear how the Government will help farmers on these issues”*

Respondent 7 explained that:

*“Eswatini’s cotton farmers would need to transcend from the traditional methods of cultivation to a newer more sophisticated approach. I am not saying that they need to*

*become scientists to plant genetically modified cotton. But they will need to know how to make the most from the newer and also more expensive seeds if they are to be successful at it. They need to start learning what the requirements are to make the most out of the new seed. For example, they should know that genetically modified seeds require more fertiliser and they must know when to apply this...*"

Informant3 asked some questions about genetically modified cotton

*“...have we considered what impact higher yield would have on farmer? Would they be able to harvest much more cotton in time with the machinery that they have? Can they get it to the ginnery in time? We know that the ginnery has the capacity, but are the farmers capacitated in this process?...the technology that must be introduced has a critical role to play in ensuring that the smaller guys are efficient in their operations and are not overwhelmed by the higher yields. We don't want a situation where they are incurring high costs to deal with the higher yields. This needs to be considered...”*

Informant 5 who urged for a conscientious approach said,

*"It may be an exciting opportunity for Eswatini's cotton farmers to improve their quality of life... certainly... but they should also be prepared in terms of the ability to process the higher yields and bigger*

*volumes of cotton from the harvest...Other countries have been doing this successfully for a long time and we could benchmark the average smallholdings farmer's operations in Eswatini and compare it to those countries...identify the key characteristics ...to be replicated here."*

#### **Theme 4: Challenges associated with introducing genetically modified cotton in Eswatini.**

Respondents were asked to state the major challenges which they believed would hinder the adoption of genetically modified cotton in Swaziland and how these challenges could be overcome. Table 4.4 summaries

key challenges and Figure 4.4 below summarise the key common words and phrases used by participants in responding to questions about key challenges.

*Table.4.4: Challenges of introducing genetically modified cotton in Eswatini*

Key word	Frequency
Price	3
Seed cost	2
Increased reliance on suppliers	2
Capacity requirement	1
<b>TOTAL</b>	<b>8</b>



*Fig.4.4: Word cloud of potential challenges associated with introducing genetically modified cotton in Swaziland*

Most important challenges are to do with capacity issues, as per the previous theme.

For example, Informant7 said:

*“I do not think we have enough capacity to handle genetically modified cotton....increased costs are the most important challenges and also capacity. These challenges are best managed through a proper strategy which must be created at a national level.”*

Informant 8 explained the challenges created by the high cost of the seeds by stating:

*"We all know that cotton farmers are in a bad state at the moment, they are suffering and do not have money to waste. It may be a big challenge for these poor guys to adopt a*

*new product that requires more money to be invested at the beginning, and by that I mean the high cost of the genetically modified seeds. To overcome this potentially disastrous challenge, we must explore ways of getting the new seeds subsidized by the relevant stakeholders, or even explore having small loans being made available to them just to get the running with the new seeds.”*

Globally, very few disadvantages and challenges have been documented with regards to the adoption of genetically modified cotton. The literature relating to genetically modified cotton production seems to indicate that the adoption and change-over process is relatively simple. Furthermore, national research agencies in the USA, Australia, China and India have concluded that

genetically modified cotton should be promoted by governments and that grants and subsidies need to be provided to farmers, given the limited requirements for adoption (Arundel & Sawaya, 2009). In line with the current findings, Herrera- Estrella (2002), elaborated the potential challenge created by monopoly of seed producers. This creates a supplier's market where farmers will always be vulnerable to the market conditions created by monopolies.

## V. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Conclusions

Based on the study's objectives and findings the following conclusions were made regarding the possibility of introducing genetically modified cotton in place of hybrid cotton in the Kingdom of Eswatini:

- Continued farming of hybrid cotton in Eswatini is no longer economically viable owing to high production costs such as prices of cotton seed, cost of pesticides and rural to urban labour migration.
- Cotton farmers and other cotton supply chain stakeholders in Eswatini are convinced that genetically modified cotton will earn them more revenue than the hybrid crop owing to anticipated higher yields per hectare and reduction in labour and pesticides costs which have been recorded in other countries.
- Farmers get motivation and encouragement from success stories of cotton farmers from countries such as USA, India, Australia and South Africa who have managed to improve their lives based on growing genetically modified cotton.
- Despite the fact that farmers are willing to adopt a new product in place of hybrid cotton it is clear that the farmers will not be able to engage in serious commercial farming without capital injection from either government or other financiers that need to be organised at national level. The said intervention is necessitated by the fact that genetically modified cotton inputs, especially seed is very expensive because of biotechnological processes involved in preparing the seed.
- Farmers are aware of the surmountable efforts needed to introduce genetically modified cotton for commercial purposes and they are looking forward to get subsidies and other forms of support from Government and other stakeholders.

### 5.2 Recommendations

- In any form of business, survival is not about being strong and / or having unlimited resources; survival is about the business being adaptable to change. It is

therefore recommended that, cotton farming strategies must change with time and in light of what is happening in successful cotton farming countries such as USA, India, Australia and South Africa. Farmers in these countries benefitted from genetically modified cotton. Eswatini cotton farmers can adopt the new technology based on careful benchmarking programmes.

- Liberalisation of the cotton industry and related legislative reforms can create opportunities for the cotton farmers because they will be able to try the new technology (genetically modified cotton) and attract investment partners at national, industry and individual levels. Therefore, it is recommended that the adoption of genetically modified cotton be implemented as one of the strategies to fast-track the revival of the moribund cotton industry.
- In light of the several challenges associated with introducing genetically modified cotton, the study recommends a robust training programme for farmers who are interested in genetically modified cotton. The farmers require training on the behaviour of genetically modified cotton and how it must be handled. Short courses on genetically modified seeds can be organised in liaison with colleges that offer agriculture courses, international sponsors and promoters of genetically modified cotton.
- To deal with the restrictive environment, it is recommended that the Government of Eswatini introduces a law that allows farmers to grow genetically modified cotton and provide capital and technical support to the farmers until such a time that the farmers are ready to sustain themselves through cotton farming without there being need for third party support. This recommendation will not require a lot of capital input from the farmers hence it can be implemented as soon as appropriate legislation is put in place.
- Genetically modified crops are resistant to harsh weather patterns and they are capable of flourishing in drier seasons. It is further recommended that the Eswatini government adopts genetically modified crop technology starting in drought prone areas first. The programme can be rolled out to other regions later in a phased approach.
- Finally, but not least, it is recommended that further research be conducted on the different types of support needed in a country that is adopting new product and new technology. Studies on effective strategies to deal with anticipated higher yields from genetically modified cotton and the management of the farmers' sustainability are also recommended.

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