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„Monsanto's Entwined Threads in Africa: GM Cotton and Glyphosate in Global Production Networks – Lessons learned from Burkina Faso and South Africa"

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ACB	African Centre for Biodiversity (formerly African Centre for Biosafety)
AICB	Association interprofessionnelles de coton du Burkina Faso
BT	Bacillus Thuringiensis
CPB	Cartagena Protocol on Biosafety
CFDT	Compagnie française pour le développement des fibres textiles
CSNB	Comité Scientifique National de Biosécurité
DRDLR	Department: Rural Development and Land Reform
FAO	Food and Agricultural Organization of the United Nations
GCC	Global Commodity Chain
GDP	Gross Domestic Product
GM	Genetically Modified
GPC	Groupments des Producteurs du Coton
GPN	Global Production Networks
GVC	Global Value Chain
HT	Herbicide Tolerant
ICAC	International Cotton Advisory Committee
INERA	Institut de l'Environnement et de Recherches Agricoles du Burkina Faso
ISAAA	Acquisition of Agri-Biotech Applications
LMO	Living Modified Organism
NBO	National Biosafety Observatory
NGO	Non-Governmental Organisation
R&D	Research and Development
SAGENE	South African Committee for Genetic Experimentation
SANBI	South African National Biodiversity Institute
SANSOR	South African National Seed Organization
UNPCB	Union nationale des producteurs de coton du Burkina

1. Introduction

Grown in over 100 countries and occupying 2.5% of arable land globally, cotton provides a livelihood for millions of people (Gray and Moseley 2008). In countries of the Global North, like the US, the cotton sector is highly subsidised and therefore independent of world market prices (Bassett 2008). In contrast, cotton producers of the Global South are highly sensitive to price fluctuations in cotton world market prices. West African cotton growing countries like Burkina Faso were known for their quality cotton and dependent on the higher prices they could achieve by selling their long-fibred, high-quality cotton to the world market (Bourgou 2020).

Cotton, as a highly sensitive crop, is very vulnerable ‘to frequent droughts and insect damage, making cotton highly dependent on insecticides’ (Compaore 2018). The use of the latter led to a strong resistance of pests to pesticides (Vitale 2018). There was a loss in yields perceived in African countries in the 1980s and mid-1990s. While in other cotton-growing regions of the world like China, Brazil and the US, the yields of the crops increased in the last decades, the gains from yields in African countries still decreased due to high pest pressure. A loss in yields and increased production costs were mainly caused by plagues, soil degradation and bad seed quality (Vitale 2018, Compaore 2018). To fight pest pressure and satisfy the demand of traders, genetically modified (GM) cotton was introduced in the late 1990s. It was intended to increase yields by maintaining quality and fighting insect pests that appear with monocultures. Furthermore, it should have contributed to a reduction of spraying toxic pesticides.

The first countries to introduce GM cotton in the form of Bt cotton were the US, Mexico and Australia. Soon other countries like China, India and Brazil followed (James 2010). Only one African country was an early adopter of GM cotton, namely South Africa in the 1997/98 growing season (Fok, Gouse, Hofs, Kirsten 2007: p. 6), which was joined only by Burkina Faso in the 2008/09 cotton growing season (James 2008: p. 9). In the 2010s other countries like Sudan, Nigeria, Eswatini and Ethiopia followed in adopting GM cotton for production, while Burkina Faso had already started fading out its production after 2016. Fibre quality issues resulted in big losses on the Burkinabe side, resulting from producing with Bt cotton (Dowd-Uribe and Schnurr 2016). But in contrast to Burkina Faso, the early adopter South Africa still produces it.

In 2003 biotech company Monsanto started field trials with a GM cotton variety in Burkina Faso, authorised by the Burkinabe government. Bollgard II, owned by Monsanto/Bayer, is a cotton variety that carries the soil bacteria Bacillus thuringiensis (further referred to as *Bt* or *Bt* cotton). It contains a naturally occurring soil bacteria, toxic to certain insect pests that cotton is plagued by in this area (ACB 2005). A few years later, in 2008/09, it was introduced by small-scale cotton farmers for commercial production (Wambugu 2016, Vitale 2018). A legal framework was put in place in accordance with the Cartagena Protocol on Biosafety (CPB 2000) to guarantee and regulate a safe handling of GM organisms on a nation-state level. Seeds were distributed by all three cotton companies in Burkina Faso: Sofitex, Faso Coton and Socoma. They provided inputs like fertilisers, seeds and pesticides for producers. At the same time they had a monopsony in buying cotton in this region. Sofitex is the biggest one, with a market share of around 80% (Bassett 2008), which at the same time is still predominantly state owned. The national cotton value chain also includes various other actors like ‘seed research institutions, input suppliers and cotton farmers’ (Staritz 2015: p. 12). Even though the first years of producing with Bt cotton were evaluated as benefiting cotton producers (Wambugu 2016, Pertry 2017, Vitale 2018), Bt cotton was again replaced by conventional cotton in 2016, and the use of GM cotton for commercial cultivation was abandoned as a result of quality issues (Bavier 2017).

In South Africa Bt cotton was adopted for commercial production in 1998/99. Cotton was already a small sector in South Africa then, and most of the cotton produced was produced on a large scale. However, a region in north-eastern South Africa, the Makhathini flats, was used as a showcase to prove that Bt cotton can be used to economically benefit smallholder farmers. Early research portrayed a positive economic, environmental and health impact on smallholders (Bennett 2004). This finally legitimated a full adaptation of the cotton sector to GM cotton. Even though there was already less biased research done by NGOs like the African Centre for Biodiversity (ACB, formerly African Centre for Biosafety). Their research evaluated a negative impact Bt cotton had on smallholders, including increased debts for already poor producers (Mayet 2007: p. 5).

The South African cotton value chain is organised under Cotton SA (cottonsa.org.za) and followed the dissolved *cotton board*. There was also a national seed authority

established, *Sansor*, in charge of guaranteeing the provision of quality GM cotton seeds (interview Sansor). Furthermore, the *South African GMO Act (1997)*, a legal framework, was put in place to regulate the safe handling of GMOs in South Africa. It was adapted in accordance with the CPB in the early 2000s.

Up to the present all cotton available in South Africa has been GM (interview 5, 6, 7, 8). But the GM traits used in the cotton industry at present are not the same traits introduced and researched in the late 1990s and early 2000s. In addition to Bt cotton, which inherits and expresses a naturally occurring soil bacterium that is toxic to certain caterpillars, *herbicide tolerant* (HT) crops and *stacked varieties*, including both characteristics, were introduced (interview 7,8). HT crops are genetically modified to express tolerance to *glyphosate*, a broad-spectrum herbicide developed by Monsanto. The fact that all cotton produced in South Africa is GM and nearly all cotton also expresses herbicide tolerance also led to major alterations in the cotton production network, which has not yet been researched.

The South African model and history of introduction of GM cotton for smallholders served as a model for Burkina Faso to introduce it about ten years later. Yet, there have been different outcomes in both country contexts. The first results of research in the respective countries were similar and, in general, evaluated as positive. A strong focus of early research was on economic benefits for producers. And even though Bt cotton was abandoned in Burkina Faso after less than ten years of production, in South Africa the introduction of GM cotton has led after 25 years of producing it to a market monopolisation of the latter with the whole industry being adapted to it. This very different outcome leads to the following research questions:

- What was the role of Monsanto and its relation to states in the introduction of Bt cotton in Burkina Faso and South Africa? What was the role of other actors in the introduction?
- What were the environmental, social and livelihood implications of introducing Bt cotton in Burkina Faso and South Africa?
- Which actors were involved in the abandonment in Burkina Faso? How were the losses split among different actors?
- Why is Bt cotton still cultivated in South Africa but not in Burkina Faso?

The operationalisation of these research questions results in an analysis of the upstream end of the cotton commodity chain, the cotton industries and actors, with a focus on producers in Burkina Faso and South Africa. They assess the environmental, social and livelihood impacts Bt and HT cotton crops in the respective country contexts had and still have. The focus of my research lies on different groups of farmers, with a focus on smallholder producers, who perceived Bt cotton as an opportunity to improve their overall livelihood. But it also examines the legal framework to protect the environment and producers. The assessment of the latter is necessary to understand the role of nation-states and their positioning within national production networks. Furthermore, it looks at different actors and how an introduction of GM cotton also influenced actors and power relations, and how, vice versa, these actors and several other factors influenced the final outcome.

To understand what happened during the time of introducing and producing Bt and HT cotton I will use the global commodity chain (GCC) and global value chain (GVC) approaches (Bair 2005, Gereffi, 1994, Hopkins and Wallerstein 1977). Theory on global production networks (GPNs) is of significance, not only to position the role of the nation-state within these GVCs/GPNs (Horner 2017) but also to contribute to understanding the social and environmental impacts Bt and HT crops had on the industry and for producers. The concept of *economic upgrading in primary production* (Gibbon 2001) will assist in understanding the intention of introducing Bt cotton in Burkina Faso and South Africa. Within this concept traders are identified as lead firms. The concepts of *environmental up- and downgrading* (Campling and Havice 2019, De Marchi et al 2013) will be used to assess the impact on environment and biodiversity and the potential for human health. The concept of *livelihood upgrading* suggested by Neilson (2019) will be used for Burkinabe and South African cotton producers to evaluate if there was and still is an overall livelihood improvement for different groups of farmers, resulting from the introduction of GM cotton.

To answer my research questions, I was able to draw on a large body of literature already published on these cases. Data generated from national legal documents, but also from sources like *Statista*, *FAOSTAT*, and *cotton SA*, helped to assess the impact on environment within a national context and how introducing GM cotton led to major alterations there. It also contributed to portraying how the use of GM cotton increased on a global scale. Additionally, I conducted online interviews via Zoom and

MS teams with scholars who did fieldwork in Burkina Faso when it was introduced, but also when it was abandoned, and other people employed in different firms and institutions within the South African cotton production network. Additionally, two people from NGOs opposed to the use of GMOs in agriculture contributed to portraying how controversial this topic is.

This thesis concludes that the role of nation-states is crucial within cotton GPNs for different reasons. First, they provide a legal framework to enable the production of and with GMOs. Secondly, these regulations are built to not only protect producers and society, but they were aimed at attracting and enabling foreign investment through the biotech corporation Monsanto. In the case of Burkina Faso, regulations have been changed to fit their terms (Wikileaks 2008). But also, in South Africa, the whole cotton industry was adapted to production with GM cotton, without statal interference, thereby excluding the possibility of alternatives to producing GM cotton. Thirdly, the state takes a key role in enabling GM cotton production for smallholders. While the modalities differ in the respective contexts, a production of smallholders without statal support would not be possible. Further, the level of liberalisation of the industries strongly contributed to different outcomes. While in South Africa the sector is already very liberalised, in Burkina Faso there is still statal involvement in the main cotton company Sofitex. The Burkinabe state through its role as regulator decided to stop production with Bt cotton in 2016. The background of the abandonment was a loss in quality resulting in big losses that also directly affected the government. But the previously introduced price-smoothing mechanism (*fonds-de-lissage*) protected producers from being immediately affected from the price drop.

Early research shows a positive economic, social, environmental and health impact on smallholder producers. However, the result of literature-based analysis on the first years of producing with Bt cotton is very narrow, on close analysis, both contexts are lacking in analysing certain aspects. While in South Africa the research only focused on early years, follow-up research is lacking. Not only is an impact study on a timespan of over ten years of producing with GM cotton missing, but also the whole production with HT cotton has not yet been researched. In Burkina Faso there are claims of negative impacts, both environmental and health related, which result in allegations that do not have any evidence due to the fact that there has been a lack of follow-up research after the abandonment of Bt cotton.

All things considered, there are huge differences in these two country contexts when it comes to cotton production, most of all for smallholders, that make a comparison difficult. Although South African smallholder production served as an example for introducing Bt cotton in Burkina Faso, I conclude that different parameters are responsible for very different outcomes. Scale is one of them, which refers not only to dominance of large-scale production in South Africa but also includes the size of the cotton sector in total and its importance for national gross domestic product (GDP). Another one is infrastructure and institutional context, including disparities in the positioning of research and development (R&D), which is crucial for cotton production. Further loss, the size of loss and the role of government in bearing debts contributed to very different outcomes. While cotton quality is responsible for the size of loss occurring in Burkina Faso, the degree of liberalisation of the sector determined the bearer of debts. This latter aspect not only reflects the transference of debts to producers in different ways. It is also expressed in different approaches to funding cotton production for poorer farmers, who are often simultaneously smaller scale. Traders are identified as lead firms within these cotton production networks, though they, vice versa, blame big retailers that are responsible for demand on the global cotton market and thereby strongly influence price creation globally (interview 5). But most importantly, biotech corporations like Monsanto/Bayer are also identified as lead firms. They play a key role and have great influence on price creation and the whole cotton production once implemented permanently.

This thesis continues with Chapter 2 and an introduction to the chain and network approach used to analyse the case studies. It uses theory on states' roles within GPNs, concepts of upgrading in primary production and theory on environmental, social and livelihood up- and downgrading. Firstly, the theory helps to localise different actors involved in the introduction and abandonment in the case of Burkina Faso. Secondly, it is used to evaluate the impact it had on different groups of farmers, but overall, the South African and Burkinabe cotton value chain and production network. The chapter on methods (Chapter 3) introduces the methods used to answer my research questions. In addition to a broad literature review, online interviews with different participants within and outside the national and international cotton value chain are included. Also, data gathered by different sources and text and document analyses contributed to answering the research questions. Further, this section includes limitations of the chosen methods. In Chapter 4 I will discuss the

importance of the cotton industry on a global scale, with a focus on GM cotton and its dominance. I will introduce the country-specific cotton production networks, actors within them, and the institutional and regulatory framework in Chapter 5. Additionally, a brief historical overview of both cases is provided. Chapter 6 includes the analysis of case studies. It assesses the environmental and social impact that different forms of GM cotton traits had on the sectors in general, including different groups of farmers. Furthermore, it compares both cases and concludes that there are reasons for different outcomes in both country contexts (Chapter 7). Finally, it closes with the major findings of this thesis, including the main arguments, and gives an outlook that includes further relevant questions (Chapter 8).

2. Theoretical framework

Research and analysis of GCCs and GVCs emerged from the ‘World System Theory’ and its examination of ‘commodity chains’, coined as a term by Immanuel Wallerstein and Terrence Hopkins in the 1970s (1977, Bair 2005). Originally, research on commodity chains included the historical perspective and a retracing of different material components, but also the services and labour power inherent in a product. The focus was on historical changes in core-periphery relations (Wallerstein 1977). It was mainly concerned with ‘unequal distributions of rewards’ (Arrighi and Drangel 1986, Bair 2005) resulting from globalised production processes and division of labour (Bair 2005: p. 156).

2.1 Chain and network approaches

GCC analysis, thereafter, was more focused on consumer goods in ‘today’s global economy’ (ibid). It ‘allows us to pose questions about contemporary development issues that are not easily handled by previous paradigms’, according to Gereffi et al. (1994: p. 2). One major difference compared to previous approaches is understanding the purpose of the research. GCC analysis has a strong focus on identifying the actors involved in production; the goal is to understand ‘where, how and by whom value is created and distributed along a commodity chain’, as stated by Bair (2005: p. 157) who refers to GCC scholars Appelbaum and Gereffi. It has a strong focus on ‘governance dimensions’ (ibid) and power relations. In addition, there is a shift from an examination of nation-states as actors that are responsible for development to lead firms as major players in different industries and thereby ends the myth of simple ‘national development’ (Bair 2005: p. 157). Lead firms are defined in this context according to Österblom et al. (2015) as having a ‘disproportionate influence on the structure and function of ecosystems’ (Ponte, Sturgeon, Dallas 2019: p. 120) resulting from different activities, like selecting suppliers, placing orders, setting requirements and coordinating between ‘suppliers and affiliated companies’ (Gereffi 1994, Ponte et al. 2019: p. 120).

Considering the different types of commodity chains, Gereffi distinguishes between ‘producer-driven (PDCC) and buyer-driven (BDCC) commodity chains’ (Bair 2005: p. 159) as major categories. He refers to producer driven as more capital intensive, such as products from the automobile industry. Buyer-driven chains are defined as

light manufacturing industries, like the apparel industry. The latter is often controlled by firms that do not produce themselves but have a big subcontracting network of which they sell the products under their label (Bair 2005).

Peter Gibbon added to the two categories in which GCCs are usually divided – producer- and buyer-driven commodity chains – a third category of 'international-trader-driven' GCCs"(Gibbon 2001). In countries where primary commodities like cotton are produced, he identified traders as lead firms. They influence and structure the commodity chain further upstream, namely producers of primary products and production processes on a national level. Gibbon points out that the characteristics for primary commodities belonging to this kind of chain are 'low value-to-weight ratios'; 'globally dispersed and locally discontinuous (including seasonal) supply pattern(s)'; 'strong tendencies toward market saturation, brought about by a combination of partial substitution by "new" agricultural or manufactured products'; and finally 'a demand side which is also […] dispersed', which is the case in cotton (Gibbon 2001: p. 351).

Additionally in the early 2000s Gereffi and other scholars agreed on expanding the chain theory to a GVC analysis in order to provide a concept that focuses on 'how inter-firm relations are shaped by the internal logics of sectors, such as industry structure and production-process characteristics' (Bair 2005: p. 164), while at the same time placing less consideration on the institutional contexts in which chains are embedded. It has a strong focus on how firms in 'developing countries can improve their position within these chains so as to generate and retain more value' (ibid).

While GVC analysis mainly focuses on firms as actors within GVCs, analysis of GPNs also brings in states and non-firm actors as central actors again. It thereby understands the interrelation and interaction of different actors more as a network, and it enhances the concept of chains to draw a more holistic picture of the complex relations between different actors.

2.2 The role of nation-states in GPNs

In GPN analysis the state is perceived as an 'integral part of a network [and] not just how the state influences GPNs but also how participation in GPNs influences the state and its policy choices' (Horner 2017: p. 4). It includes 'firm actors both vertically in the chain' (ibid.), meaning states interrelating with one another and different

regional actors within a nation-state horizontally interrelating with one another according to regional policies.

Within GPN theory it is argued that firms do not produce and act in an institutional vacuum (ibid.). Different roles of nation-states are identified within GPNs: the roles of ‘facilitator, […] regulator, producer and buyer’ (ibid: p. 2). While the state as ‘facilitator’ is mainly identified in ‘export-oriented models of development’ (ibid.: p. 7) that attempt to attract foreign investment, which has ‘locational choice’, it also ‘support[s] local actors’ (ibid), unlike the state perceived as ‘regulator’, who tries to limit and restrict ‘economic activities within its boundaries’ (ibid.). Gibbon (2001), to whom Horner refers, emphasises the ‘state marketing boards’ established in the 1980s during the era of ‘international commodity agreements’, which took the role of controlling prizes as well as managing the volumes of products reaching the world market. The role of state as ‘producer’ is defined by ‘owning […] state owned companies’ in which ‘states seek to take control of productive capacity in key-strategic sectors’ (Horner 2017: p. 8). The ascribed role of ‘buyer’ is defined by ‘large-scale purchases by states from private-firms’ (ibid.: p. 9).

2.3 Environmental and social upgrading in GVCs and GPNs

The term *upgrading* is very central and a key term present in GVC and GPN analysis. It should, by analysing the chains, provide a tool for different sectors and in different areas (e.g. industry, economy, employment, social, environmental, livelihood) to provide the opportunity of changing the position of different actors and contributors along the chain and thereby their share of gain from participating within it. This should result in value addition for different actors along the chain that are centrally considered as firms (Bair 2005, Ponte et al., 2019). While the origin of upgrading in GVCs was mostly concerned with industry upgrading and influenced by business literature and the economic aspects resulting from alterations in value chains (Bair 2005), the concept was expanded to other spheres like environmental, social and livelihood.

Liam Campling and Elizabeth Havice (2019) state that GVCs have an environmental influence in primary production as well as in ‘emissions produced in activities along the chain’ (Campling et al. 2019: p. 218). Although they mainly deal with environmental upgrading on the level of production and less on the level of primary

production, the statement of environmental upgrading as ‘a “problem-solving” mechanism’ suits both stages of production in GVCs. Firms’ ‘strategies [include] harnessing nature’s own biological properties and making them work harder and faster in order to transform them into industrial activities’ (Campling et al. 2019: p. 217).

As instruments for making nature more efficient they count ‘fertilizers, genetic modification’ or other instruments like ‘industrial aquaculture’ (ibid.). Environmental reactions to this industrialised appropriation of nature are ‘vulnerabilities to disease outbreaks or antibiotic resistance’ (ibid.) or pest resistance in the case of GM organisms, like GM cotton grown in India. Also, the question arises of ‘who actually captures the benefits or bears the costs (ecological as well as social) associated with accelerated biological returns’ (ibid.).

Campling and Havice state that ‘organizational dynamics of Global Value Chains [are] driven by three important capitalist dynamics” in the last decades” (cost minimisation, flexibility, speed) (ibid.: p. 233). According to them, ‘sustainability management’ (ibid.) should also be included as a fourth dynamic. They argue that this dimension ensures providing firms with ‘green capital’ instead of contributing to fighting climate change. Issues arise from overexploitation of nature and processes in and pollution through GVCs. But sustainability management is mainly concerned with damage control, instead of preventing it in a globalised economy.

Furthermore, Valentina De Marchi et al. (2019) define ‘*environmental upgrading* as any change that results in the reduction of the firm’s ecological footprint’ to which they account less greenhouse gas emissions, biodiversity losses and overexploitation of nature. In sum, there are more ‘environmental improvements’ than losses. They add the concept of *environmental downgrading*, which is a process that “contains product and organization improvements, which may result in negative outcomes on the natural environment’, such ‘as reduced resource efficiency, increased levels of pollution and lower levels of biodiversity’ (De Marchi et al. 2019: p. 320). They also state that environmental downgrading might be harder to recognise than other forms of downgrading, like social and economic (ibid). Another very important aspect they point out is that ‘environmental upgrading cannot be studied in isolation from other forms of upgrading’ (ibid.: p. 313). While they see economic upgrading as a precondition for social upgrading, they remark that still more research needs to be

done on the links between the three forms of upgrading and how they are intertwined with one another.

In the beginnings of GVC analysis it was assumed that successful economic upgrading would automatically lead to more social wellbeing of contributors in GVCs. The labourer engaged in a GVC was considered as a static entity or ‘passive victim’ of ‘cheap labour’ (Selwyn 2013: p. 77). This was already proven wrong by different scholars like Ben Selwyn. Economic upgrading and the changing of firms’ positions within GVCs might lead to social disadvantages for workers along the chain.

Still, the concept of social upgrading is mostly concerned with workers’ rights within GVCs, and according to Rossi (2019) who refers to Barrientos et al. (2011), is ‘the process of improvement in the rights and entitlements of workers as social actors, which enhances the quality of their employment’ (Rossi 2019: p. 273, first 2013, Barrientos et al. 2011). It is therefore difficult to apply to small-scale cotton farmers to locate alterations in their social realities.

With *livelihood upgrading*, Jeff Neilson, in the Handbook on GVC, provides a concept to analyse smallholders’ actions, who act differently to firms and in contrast do not simply aim to maximise their profits. Neilson’s critique regarding the concept of social upgrading is ‘that smallholder households cannot be neatly conceptualized as firms (capital) or as labour within firms’ (Neilson 2019: p. 296). It includes the analysis of social aspects combined with other factors that should contribute to improve livelihood opportunities.

The environmental impact, the institutional context, and also the wider political framework matter for positioning smallholders within GVCs/GPNs. The context thereby contributes to eventual benefits arising from participation. At the same time, downstream movement in the value chain is not possible for smallholders. Neilson emphasises here that ‘“context matters” and that the interaction between regional institutional settings and value chain structures is paramount for shaping livelihood outcomes and upgrading possibilities’ (ibid.: pp. 297, 298). Neilson extended the concept of social upgrading to make it applicable to smallholder farmers in developing countries ‘who are integrated within the supply chain of a lead firm for a particular commodity’ and who are ‘selling their produce to a dominant lead firm under captive value chain relationships’ (ibid.: p. 298). He also sees parallels between firms and agricultural smallholders in regard to exploitation.

Neilson adds that in the case of livelihood upgrading and from the perspective of smallholders, ‘downgrading within a chain is […] a reasonably common strategy’(ibid.: p. 300), including to ‘switch production to less processed products and low-quality goods’ (ibid). For example, in cases where the outcomes of economic upgrading might result in benefits for the smallholders concerning ‘increased potential earnings’, it could at the same time lead to ‘increased livelihood vulnerability at the household level’ (ibid), resulting in the choice of security instead of economic upgrading.

2.4 Upgrading in primary production

Peter Gibbon extended the concept of economic upgrading from firm-level upgrading of processed commodities to upgrading of unprocessed commodities in the agricultural sector. This concept of *upgrading in primary production* illustrates how actors in agricultural commodity chains try to capture higher margins for unprocessed commodities in developing countries. This could be accomplished by ‘moving up the quality grade ladder, increasing volumes and reliability of supply [or] securing more remunerative contracts through forward sales and becoming active in hedging risk via utilizing futures and options instruments’ (Gibbon 2001: pp. 352, 353).

Gibbon also mentions that in developing countries, dominated by smallholders involved in primary production, there is a need ‘for public action’ (Gibbon 2001: p. 353) to accomplish the aim of economic upgrading. This often takes the ‘form [of] parastatal or state-supported cooperative systems combining measures to establish and maintain export quality’ (ibid.). They thereby contribute to guaranteeing a constant quality as a supplier in export and at the same time guarantee a fixed price for the smallholder farmers. This organisation of smallholders under parastatal and state-supported cooperatives is necessary as international traders and buyers of raw materials are often less willing to contract with private suppliers. The latter often cannot guarantee a constant quality and quantity of raw materials. The parastatals in return are thereby also responsible for guaranteeing local market regulation and coordinating exports.

One of the key differences of economic upgrading in producer- and buyer-driven chains as opposed to upgrading primary production in trader-driven chains is that there is no possibility to externalise ‘lower-profit functions’ (Gibbon 2001: p. 352)

upstream. ‘Capturing higher margins for unprocessed commodities’ could be achieved by increasing the quality, volume and ‘reliability of supply’ and ‘securing more remunerative contracts through forward sales and becoming active in hedging risk via utilizing futures and options instruments’ (Gibbon, 2001: p. 352). But Gibbon also brings in critique here. Market liberalisation in many countries in Sub-Saharan Africa made future sales often not possible, and due to market saturation quality, premia have decreased while discounts on certain raw materials have increased.

He also mentions the problem of ‘catching-up with leading producers’ (Gibbon, 2001: p. 353) since an overproduction of certain products might lead to deflation in prices because, in contrast to other parts in GVCs, there is no possibility of learning effects through the alteration of processes or products themselves or the possibility for downstream or upstream externalisation. Therefore, another form of upgrading that Gibbon suggests is the ‘production of new forms […] of unprocessed raw materials’ (ibid). Here he enumerates the possibility of ‘gene-manipulated food crops’, which should lead to saving on inputs like pesticides, fertilisers, and human labour power. He refers to it as a technical assisted form of ‘producing superior grades of existing commodity forms’ (ibid.). Economic upgrading by introducing GM cotton was also one aim of introducing Bt cotton in South Africa and Burkina Faso.

2.5 Synopsis

Theory on GVC and GPN builds the framework for analysing the case studies within this thesis. Not only the firms as actors, who are central in cotton sectors in Burkina Faso and South Africa, but also the institutional context and non-firm actors can be examined and analysed within these frameworks. Theory on GPN will contribute to analysing the role of the states of Burkina Faso and South Africa when it came to regulating the introduction of and production with GMOs.

The concept of *upgrading in primary production* in *trader-driven chains*, suggested by Gibbon (2001), assists in proving to what extent international traders in South Africa and Burkina Faso were involved in the introduction of Bt cotton but also how they contributed to abandoning Bt cotton in Burkina Faso. The concepts of *livelihood upgrading (*Neilson 2019*)* and *environmental up- and downgrading* (De Marchi et al. 2019: p. 219 ff) assist in understanding what happened socially, environmentally and

economically following the introduction of Bt cotton. They are used to identify the role of different actors involved in the introduction and how it impacted power relations.

Further, the position of a new actor, the biotech corporation Monsanto, will be located within these chains/networks. In these case studies Monsanto will be considered as a lead firm based on the power it has on price formulation of inputs, like seeds, pesticides and fertiliser, on cotton as an end product in the form of raw cotton, specifically cotton lint. But they also transform the demand of inputs additionally applied to seeds. Furthermore, the entrance of Monsanto as a lead firm influenced the national cotton production per se.

3. Methods

To assess the economic, social and environmental impact the introduction of GM cotton had in Burkina Faso and South Africa, I drew on a lot of data published in literature on these cases. Additionally, to gather data I conducted *semi-structured online interviews* with scholars, activists and different actors involved in the cotton value chain. Further, I used Statista (statista.com, accessed July 2021) on the global sector, FAOSTAT (fao.org, accessed July 2021) on the Burkinabe cotton sector and data provided by Cotton SA (cottonsa.org.za, accessed November 2022) on the South African cotton sector. For South Africa, this was the growing year 1997/98, and in Burkina Faso it was 2007/08. Also, the CPB (2000), the Burkinabe biotech law *loi 005* (2006) and the South African *GMO (1997) act*, and different newspaper articles were useful sources that contributed to the results of my research.

3.1 Trade and industry data

Trade and industry data was used from FAOSTAT, Statista, Cotton SA and International Service for the Acquisition of Agri-Biotech Applications (ISAAA). I used FAOSTAT for data on land conversion, alterations in cotton production and input use for Burkina Faso. For the South African context, I used data provided by Cotton SA. For data on GM crops production on a global scale I could additionally draw back on data provided by Statista and ISAAA (2021).

For assessing the environmental and livelihood impact Bt cotton had, the interviews and texts published were not sufficient. I also had to draw on data provided by FAO for Burkina Faso and Cotton SA for South Africa. In Burkina Faso cotton is a major crop; therefore, parameters like land conversion and alterations in fertiliser and pesticide use also made conclusions on the environmental impact possible. In South Africa data provided by Cotton SA on the increase and decrease of the number of cotton producers contributed to better understanding how producing with Bt and HT cotton influenced the livelihood decisions of smallholder cotton producers. Further, the development of the world cotton price over the course of time that my research examines contributed to the decision of producers for whether cotton is produced or not.

3.2 Text and document analysis

The supranational CPB, the Burkinabe biotech law *Loi 005/2006* and the *South African GMO Act (1997)* were analysed by a structured content analysis (Mayring 2014: p. 548). This method uses categories developed inductively, based on the theoretical background. After that, categories that emerged from theory are applied to documents and texts deductively (Mayring 2015: p.61). While the CPB served as a model law, the national biosafety laws were enacted as an equivalent on a national level. The latter two are the base for accessing the potential role of nation-states and the impact they potentially had and still have on different actors in the value chain. This deductive method uses categories emerging from the theory on GVC/GPN and covers topics like socio-economic considerations, environmental protection, safety, assessment and public participation. A search for documents in these categories was performed, and data relevant for analysis was coded, resulting in tendencies toward a more precautionary or more biotech-liberal or laissez-faire approach that the states decided to amend. In addition, the analysis of the interviews that were conducted and newspaper articles contributed to assessing whether the laws enacted were practically obeyed and how the respective governments positioned themselves within the cotton GVCs/GPNs and thereby contributed to powershifts resulting from the introduction of GM cotton in the country contexts.

3.3 Semi-structured interviews

For all interviews conducted I utilised online semi-structured interviews in the sense of a *Leitfadeninterview*. This form of interview was aimed mostly at gaining different perspectives on the controversial topic of introducing GM cotton in these two different country contexts. It was designed for the very diversified actors along and outside of the cotton value chain by attaching it to the different backgrounds of interviewees. It contributed to making very diversified perceptions on and conflict of interest and purpose of introducing Bt cotton clearer to me. Further, it contributed to contextualising the events by simultaneously generating new data (Dannecker and Vossemer 2014: p. 154).

A semi-structured interview was most suitable for investigating my research questions because for this form of interview a questionnaire and thematic framing are fixed, and the interview is structured by a guideline. Although there are

questions prepared in advance and a guideline, which the interview tries to follow, the interviewer adjusts the guideline to suit the context of the interviewee. It tries to explore the reality and perception of interviewees. Through its characteristic of being semi-structured, and therefore aiming at asking similar questions to all interview partners, it makes the data collected better evaluable (ibid.). Due to very different backgrounds, a *Leitfadeninterview* that was adapted to the different contexts of my interview partners was most suitable for collecting qualitative data.

The questions for the interview and the categories for analysing both emerged from the research questions. It contained questions covering the thematic areas of positive and negative social, environmental and economic impact that Bt cotton had in South Africa and Burkina Faso. Also, the expectations that different actors had before the introduction were relevant. In the case of Burkina Faso, the questionnaire also covered inquiries on annual protests of farmers and protests against Bt cotton in particular but also the abandonment and actors involved in the abandonment. Further, it asked for the role of government in the introduction and in the abandonment in the case of Burkina Faso. In both country contexts liberalisation of cotton sectors was the baseline.

The semi-structured interviews I decided to do were with scholars who did fieldwork and research in Burkina Faso (interview 1, 2, 3) and with activists who might have been involved in the process of abandoning Bt cotton in 2016 (interview 4). Additionally, one representative of a trader (interview 5) and different representatives and employees of actors involved in the South African cotton value chain were interviewed (interview 6, 7, 8, 9), along with one representative of an independent South African research institution doing research on the social and environmental impact of GM crops on smallholders all over Africa (interview 10). Regarding the Burkinabe context, one of the researchers accompanied the introduction of Bt cotton in Burkina Faso, and the other did research when Bt cotton was already abandoned. Another one was a French researcher and agroeconomist from CIRAD doing research on and within the Burkinabe cotton sector. The Burkinabe NGO, of which one representative was interviewed, is not simply opposed to biotechnology in agriculture but to industrial agriculture using artificial fertilisers and pesticides in general. They are advocating for agroecology, resulting in sustainable agriculture.

To gain the perspective of farmers I had to draw on interviews with scholars and different actors involved in the value chain in both country contexts. These include the interviews with scholars who did fieldwork in Burkina Faso. All scholars were in contact with locals and partly living in communities during their time in Burkina Faso. They had knowledge of the farmers' perception of Bt cotton and the impact it had on farmers. Its social and economic effect on different groups of farmers differed in regard to income, household size, cultivated land and gender. Four interviews were conducted with employees in firms involved in the South African cotton sector and industry. The semi-structured interviews took between 30 and 80 minutes. All of them were recorded with consent and later transcribed.

As there were protests against Bt cotton and around cotton pricing in Burkina Faso, I tried to reach out to local organisations involved in these protests. For the interviews with the activists, I used the option of a written interview, which by the time of writing this thesis was unfortunately not answered.

3.4 Analysis of interviews

To make the data collected by the interviews accessible, I coded the interviews by codes that emerged from my research questions by first-level coding. Secondly, I looked at which additional codes and themes came up in the interviews and did a second round of coding (Saldana 2009, Bazeley 2013). From this set of codes, themes and categories emerged. This assisted in extracting the data and made it accessible to answer my research question. As a next step I made a table to compare which topics and answers were named by more than one interview partner or mentioned in the literature examined. I thereby divided them into different categories, which are the main topics my analysis covers.

3.5 Limitations of methods

It was not possible to approach farmers in Burkina Faso and South Africa, which I would have considered most suitable to answering my research questions. Due to the limits of capacity, financially and time wise, but also because of the Covid-19 pandemic, travelling there and doing ethnographic fieldwork in Burkina Faso was not possible. Also, the language barrier was a big hurdle to reach out to people but also to conduct interviews in the Burkinabe context. When I tried to reach out to organisations on social media involved in the 'protests against Monsanto' (CPNN

2015), Copagen Burkina Faso, an organisation involved in these protests, did not answer my request. This might be due to me approaching them in English. Also, I had difficulties in setting up an oral interview with *Terre de Vie*. Although my potential interview partner agreed to answer my written questions, he unfortunately had not answered them by the time of writing this thesis.

The topics not sufficiently addressed by the interview partners in order to answer all of my research questions were the topics concerning the environmental impact Bt cotton had in Burkina Faso and South Africa. On the one hand, this was owed to the fact that the scholars' focus of research did not cover the environmental issues arising from the introduction of Bt cotton. Their research was more concerned with the economic and social impact it had on different groups of farmers. This resulted in only speculations but not evidence. On the other hand, this also resulted from the lack of data provided by governments and the governmental and Monsanto's dismissal of exploring these impacts on the environment. Further, in both cases there is a lack of independent research that considers the environmental impact.

For the South African context assessing the perspective of farmers was also not possible. This was owed to the very closed value chain and all communication running via Cotton SA. When I reached out to farmers' unions or even gins, all referred to contacting Cotton SA. Although the latter offered to provide data on the inputs used, including data on pesticides and fertilisers, they had not sent it by the time of writing this thesis. Otherwise, data on inputs is not accessible, and data provided by the FAO is not needed due to the small size of the sector. Another major shortcoming is the bias of my interview partners for this context. They are all employed and participating actors in the cotton value chain in South Africa, except one, resulting in a strong tendency toward evaluating GM cotton in South Africa very positively during our talks.

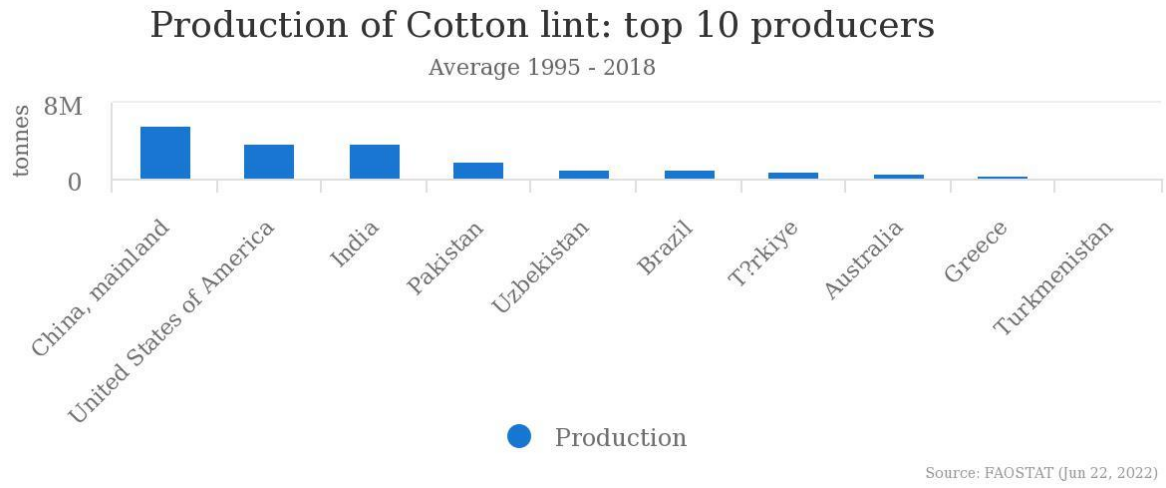
For both country contexts actors critical to GM crops did not have any recent data they could draw on. There was no assessment done by the government, the data simply was not publicly accessible, or the sector was not big enough to re-evaluate the impact GM cotton had.

4. Cotton on a global scale

Cotton is grown in over 100 countries worldwide and, therefore, provides the livelihood for millions of people. Cotton growing takes up to 2.5% of all arable land and thereby results in cotton being ‘one of the world’s most significant crops in terms of surface area, after food grains and soybeans’ (Gray and Moseley 2008, p. 10). The average top cotton-growing countries of 1995–2018 were China, India, the US, Pakistan, Brazil and Uzbekistan (Figure 1) (FAOSTAT 2022). The main cotton producer, China, is not even listed under the top 5 cotton lint exporters for the examined timeframe (Figure 2) (FAOSTAT 2022).

Figure 1 - Exports of top 5 exporters of cotton lint (1995–2018)

Figure 2 - Export quantity cotton lint (1995–2018)



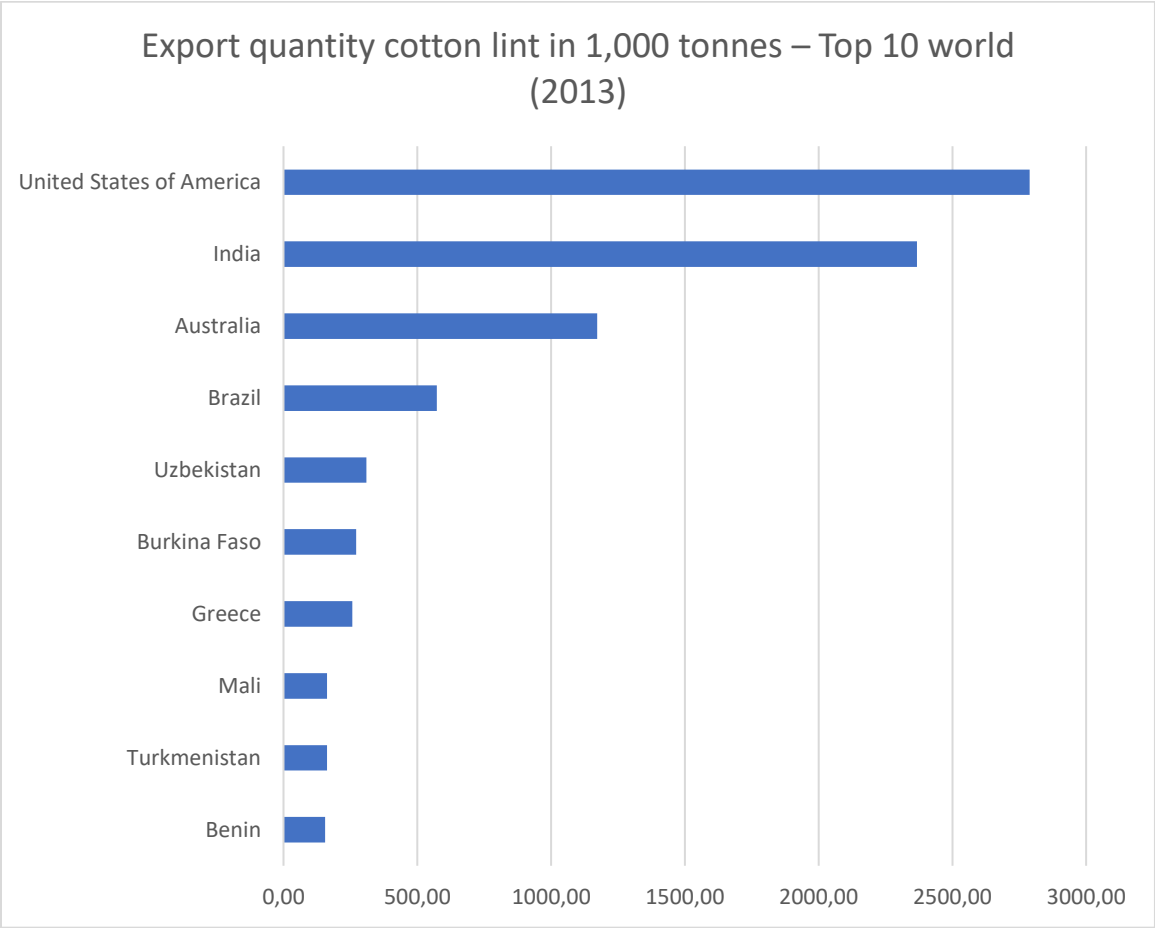
The production of cotton and cotton lint seems to be split between the Global North and Global South at first glance. But the main processers and growers relying on cotton growing to secure their livelihood without subsidies are in the Global South. The fact that the US is one of the top producers worldwide is owed to a heavily subsidised cotton sector (Bassett 2008: p.50). This highly integrated sector results for cotton producers in the US in independence from world market prices and a guaranteed survival of the sector. However, these subsidies lead to depressing the price by ‘dumping […] surpluses on the world market’ (ibid.: p. 37). Therefore, they hinder the possibility of equal participation and trade for all other actors, specifically a fair price paid to producers in the Global South where cotton production is not subsidised.

4.1 Key actors in global cotton production networks

The cotton commodity chain in general contains various participants, like ‘actors involved in the production, marketing, trading and processing of cotton, including seed research institutions, input suppliers, cotton farmers, ginners, local traders and exporters’ (Staritz and Tröster 2014: p. 12) who are often organised in a national context. There are also actors like ‘international traders […] spinners, weavers, knitters, and apparel manufacturers’ (ibid.) involved, from different geographical locations. The cotton plant has a high demand in input, which include ‘seeds, pesticides and fertilizers’(ibid.); therefore, there are also providers of inputs participating in the cotton commodity chain (ibid.).

On a national level, in countries where the sector is vertically integrated, the companies responsible for marketing, trading and processing, but also the seed research institutions and suppliers of input, are at least parastatal. This is the case in the cotton-growing countries of West Africa, like Burkina Faso, which was under the top ten cotton exporters in 2013 (see Figure 3 - FAO June 2022, own statistic). Statal involvement in the value chain via parastatal institutions is, therefore, one key argument for expanding the concept of a ‘simple chain’ to a network. Furthermore, the state is also involved in the whole production process by regulating it via laws and regulations. It thereby has the power to regulate the whole sector and the influence international biotech corporations can have on a whole industry on a national level.

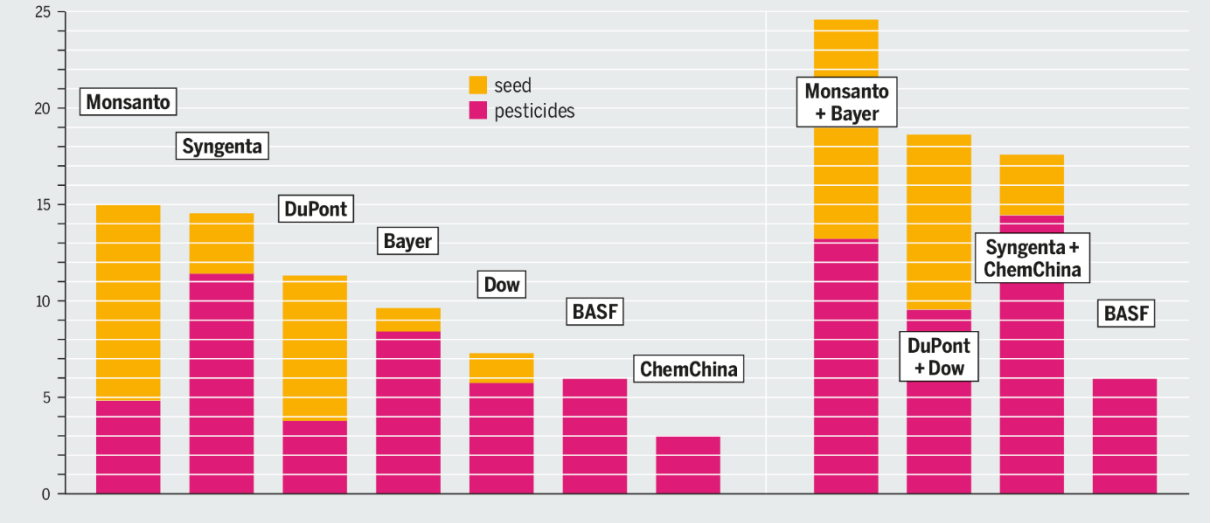
Figure 3 - Top 10 exporters of cotton lint worldwide – in 1,000 t (2013)



Source: FAOSTAT, own figure

Other important actors are input suppliers on a national and international level. These include suppliers of seeds like multinational seed companies, if seeds are not resused from previous seasons. These include international seed suppliers like Monsanto, which was bought by Bayer in 2018, Syngenta and DowDuPont. All of the latter seed suppliers enlisted ‘originally come from the chemical industry’ (Figure 4, eu.boell.org 2017). This results in the same big agribusinesses providing pesticides and insecticides via national retailers or holding patent rights on pesticides that are produced in a national context. This again includes Bayer, who merged with Monsanto; Syngenta, who merged with ChemChina; DuPont, who merged with Dow; and BASF (Figure 4, eu.boell.org 2017, accessed July 2023), which at the time of writing this thesis is also already engaged in the international seed business (interview 7 and 9). Figure 4, on the right side, shows mergers in the seed and chemical industries that already happened.

Figure 4 - Concentration of world's biggest agrochemical companies – 2014 vs planned 2017



Source: eu.boell.org, Bartz/Stockmar,

Large-scale production of cotton, monocultures and 'improved varieties' (Gray 2014: p. 14) led to alterations in national cotton sectors concerning the inputs used. The vulnerability to insect pests, like bollworms, resulted from cultivation in monocultures and often led to big yield losses. This infestation further led to an increase of used inputs like pesticides. Although they protect the plant, they are often dangerous to human health. Also, major insect pests, like bollworms, became resistant to certain pesticides, and therefore, other chemicals that are more toxic to human health were introduced in the late 1990s in Sub-Saharan Africa. These highly toxic chemicals – endosulfan organochlorine pesticides – were already banned in many countries (Gray 2014: p. 16). As one possible solution, GM cotton was introduced. It should protect the yields from losses and provide a demanded and constant quantity of cotton to traders, while at the same time decreasing the amount of toxic pesticides used. This introduction of GM cotton affected all actors along the chain to a certain extent on a national and international level.

4.2 The introduction of GM traits – Bt vs HT cotton

'So it's the traits that give you […] very specific characteristics which you can use in a broader management system which basically you call farming to benefit in some way.' (interview 6)

Fighting world hunger is one key argument of GM technology proponents in the case of food crops like soy or corn. The crops improve by adding features like an enhanced nutritional score or higher drought resistance (Traoré 2016, Wambugu 2016). Also they argue for a need for greater stress tolerance to conquer changes coming along with climatic alterations (Ayushi et al. 2016). A great amount of GM soybeans, canola, corn and cotton traits also have the characteristic of herbicide tolerance; this should lead to 'more efficient herbicide use and/or safer herbicide use' (Nelson 2001: p. 7) and resistance to pests by inserting the 'free-living soil bacteria Bacillus thuringiensis into the host plant' (ACB 2005: p. 15). These crops are then referred to as *Bt crops*. Other desired characteristics are quality improvements that delay ripening, better quality oil, and also higher productivity, which was mostly aimed for in corn and rice (ibid.).

The main purpose of introducing GM cotton was to fight bollworms, a pest to which the cotton plant is very susceptible. Farmers in the US, where it was developed, were plagued by this insect pest and lost big amounts of their yields prior to introducing GM cotton traits. In 2001, all cotton planted globally used 20% of all insecticides 'applied to all crops globally' (James 2002: vi). By inserting the genetic material of *Bacillus thurengiensis* (Bt), a soil bacterium, in the cotton plants, it aimed to kill different forms of bollworm already in the larvae stage. The first trait cultivated was *Coker 312* in the US (Nelson 2001). This trait is already obsolete and was replaced by much higher yielding traits that express the Bt gene thousandfold (ibid.).

Monsanto introduced more advanced traits like *bollgard* and *bollgard II*, followed by stacked traits, which can be used with the herbicides *Roundup Ready* and *Roundup Ready Flex* (RR flex) that contain *glyphosate* (Raphael 2019). Glyphosate and the respective GM cotton varieties were owned by Monsanto until Monsanto was bought by Bayer in 2018 (Bayer 2018). *RR* traits express a tolerance to glyphosate. The latter is a broad-spectrum herbicide that aims at killing weeds but leaves the cotton plant unharmed because the *RR gene* expresses in the plant. The stacked gene varieties available express tolerance to insects by expressing the *Bt* gene and at the same time are tolerant to glyphosate in the early stages of production by expressing the *RR* gene (ACB 2015: p.15, interview 9).

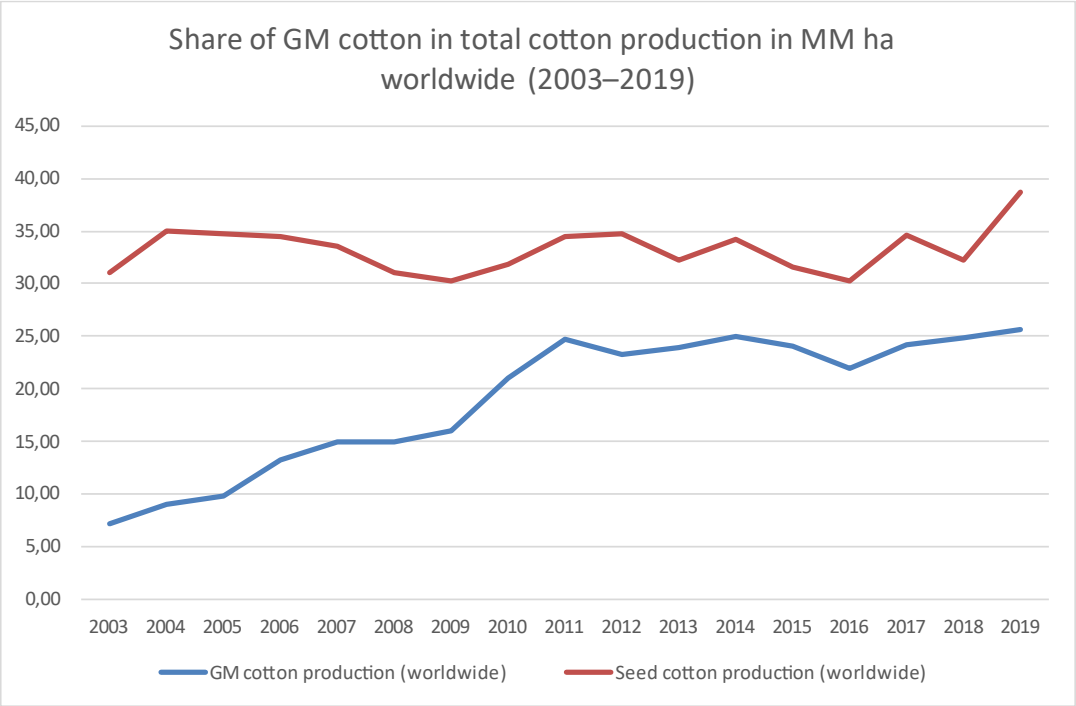
Fighting pest pressure (Bt) and weeds (HT) that are hard to handle on cotton is the main purpose for the introduction of GM cotton. Possible positive side effects in years

of high pest pressure served for justifying the introduction in the Global South. These are poverty alleviation and closing the ‘yield gap’ (Hillocks 2009: p.312). The latter is the main argument when countries of the Global South are compared to countries like Australia and the US. This ‘gap’ should be closed by fully exploring the potential of cotton production in Sub-Saharan Africa. But this is just a side effect if the traits, e.g. the Bt traits, owned by Monsanto express their insect resistance in years when pest pressure is high, and yield losses are, therefore, not as big as if they would be produced with conventional cotton (Falck-Zepeda, Traxler, Nelson 2001). Proponents argue that it has already been applied in the US, China, India and Brazil and, therefore, count it as a success (Falck-Zepeda et al. 2001; Bennett et al. 2004; Frisvold et al., 2006; Hillocks 2009; Marinho 2014). The Bt technology thereby serves as a kind of insurance, minimising yield losses in seasons with high bollworm infestation. When bollworm pest pressure is low, there ought to be no yield gap between conventionally cultivated cotton and Bt cotton (interview 6).

One major critique is the risk of pest resistance and the emergence of secondary pests, which was already observed in countries like India and South Africa where Bt cotton was introduced earlier (interview 1,2, 9). This keeps the costs for inputs high but at the same time leads to an increase in pesticide use again to fight the secondary pests. This results in much higher costs for cotton producers in total, which according to opponents of GM cotton led in countries like India to waves of suicides of small-scale farmers (Thomas and Tavernier 2017).

Even though the ratio of GM to conventional cotton stayed constant over the last ten years, GM cotton increased its market share since it was introduced in the 1990s until the 2010s, accounting for more than two-thirds of world cotton production (see Figure 4) (ISAAA 2021, FAOSTAT 2021). To regulate this ever-growing amount of global trade with GM cotton and products in total, the Cartagena Protocol was adopted in 2000.

Figure 5 - Share of GM cotton in total cotton production in MM ha worldwide (2003–2019)



Sources: FAOSTAT, ISAAA, Statista

4.3 Regulating GMOs globally – The Cartagena Protocol

The Cartagena Protocol on Biosafety (CPB 2000) is a regulatory framework established following the UN convention on biological diversity (bch.cbd.int, accessed July 2022). It is concerned with the movement of Living Modified Organisms (LMOs)[1] between countries and was established in 2003 as a supplement to the Convention on Biological Diversity (CBD). It refers to the precautionary approach of principle 15 in the Rio Declaration on Environment and Development (UN 1992), which states that

> in order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. [But] where there are threats of serious or irreversible damage, lack of full scientific certainty shall

[1] Seeds of GM cotton can be considered as LMO; the end product of cotton lint in the agricultural value chain in contrast is not, owed to the fact that lint per se has no potential of transferring its gene-material to any other organism. The term of LMO will in the following be used synonymously with GMO. (for further information see CPB 2000, https://bch.cbd.int/protocol/)

> not be used as a reason for postponing cost-effective measures to prevent environmental degradation. (UN 1992: p. 3)

It is an internationally binding law and ‘the main international instrument for addressing biodiversity issues’ (CPB 2000: p. 1). It should guarantee for the states that sign it and establish national laws in line with the protocol a safe handling of products of biotechnology. Further, it should contribute to ‘the conservation of biological diversity, the sustainable use of natural resources and the fair and equitable sharing of benefits deriving from the use of genetic resources’ (ibid.). Although possible positive effects of modern biotechnology and biotech’s ‘promotion of human well-being’ (ibid.) are emphasised, it aims at protection from possible threats to human health and the environment that might come along with the application of modern biotechnology.

Issues covered by the protocol are, amongst others, its ‘scope’, including ‘transboundary movement, transit, handling’ and use of LMOs. LMOs are further defined as ‘living organisms that possess a novel combination of genetic material obtained through the use of modern biotechnology’ (ibid.: p. 4). Considering the case studies in this thesis, the regulatory framework of the CPB covers the cotton seeds used for cultivating cotton, but the CPB does not regulate the handling of processed cotton lint. Topics that are covered by the CPB and relevant for the analysis are ‘intentional introduction in to the environment’ (article 7, CPB: p. 6) and the handling of LMOs used ‘for direct use as food or feed, or for processing’ (article 11, CPB: p. 8), which applies for cotton both in the case of seed and unprocessed cotton. ‘Risk assessment’ (article 15, CBP: p.11) and ‘risk management’ (article 16, CBP: p. 12) are relevant articles to this thesis and will be examined and compared in depth to the national laws. Similarly, ‘unintentional transboundary movements and emergency measures’ (article 17, CBP: p.13), ‘public awareness and participation’ (article 23, CBP: p. 18), ‘non-parties’ (article 24, CBP: p. 18), ‘socio-economic considerations’ (article 26, CBP: p. 19) and annex II and III (CBP: p. 27–30) are relevant articles to examine national and international political and institutional frameworks built to regulate the handling of GMOs and will be further analysed below in the analysis section.

It was signed by different countries in different years. Burkina Faso and South Africa also signed it and adapted their national biosafety regulations in alignment with the CPB. In Burkina Faso it was entered into force in August 2003, in South Africa in November 2003 (ibid.). When taking a closer look at the protocol, one of the main weaknesses is the term of ‘parties’. States like Burkina Faso and South Africa decided to sign it and are thereby considered as parties that must stick to the protocol. Internationally acting biotech firms like Monsanto have a vague status when it comes to the question of in what regard they have to obey this law, considering the fact that countries like the US, where Monsanto is located, have not signed the protocol up to the present day (bch.cbd.int, access July 2022). National laws like the Burkinabe *Loi 005/2006* and the *South African GMO Act (1997)* might, therefore, regulate the responsibilities of different actors entering their national agricultural sectors and value chains in a different manner than the CPB.

5. Bt cotton in South Africa and Burkina Faso

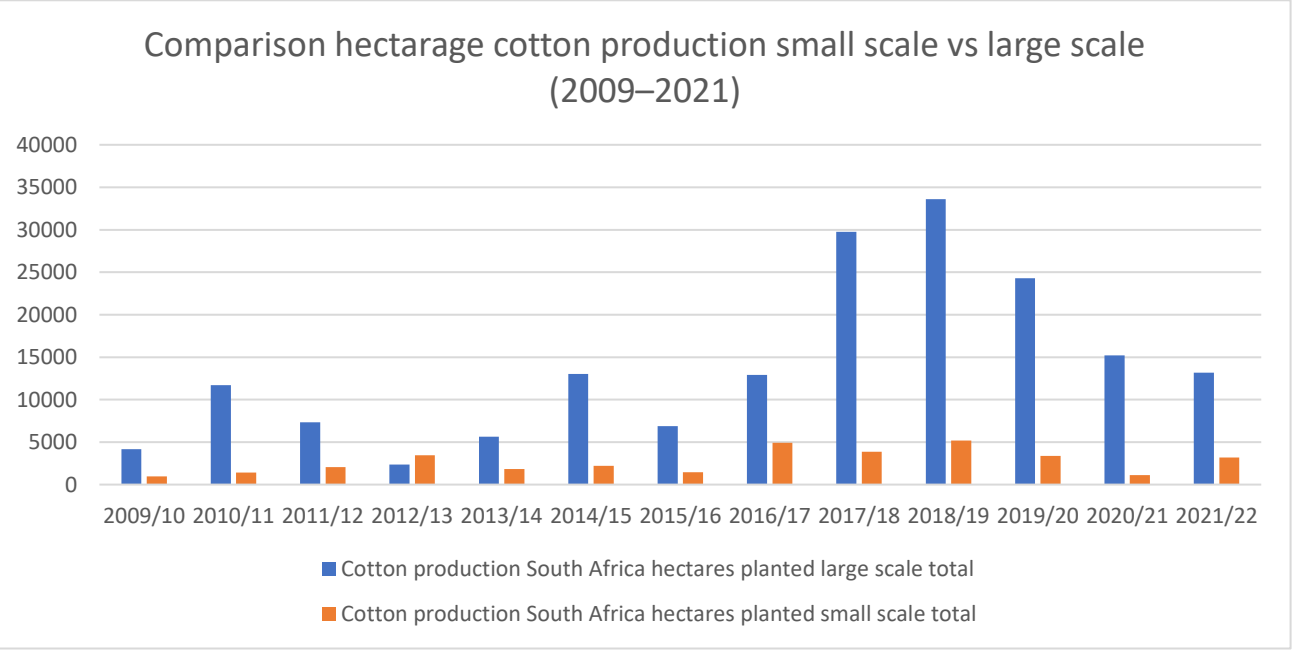
Biotech giants like Monsanto pushed to settle down in African countries since 1996 when field trials started in South Africa with Monsanto's *Bollgard* (Traoré 2016). This trait was soon replaced by *Bollgard II*, which 'contains two different insect-control genes' that both aimed at keeping the GM cotton crops from being affected by bollworms, one of the main pests that cotton is plagued by in this area (Vitale 2018: p. 12). Introduction of these traits in the area should have led to a reduction in sprayings of toxic pesticides on cotton crops. On the one hand, there were the expectations of health benefits by spraying fewer toxic chemicals, which are often not applied correctly and used without protective gear. On the other hand, it also should contribute to saving money because less inputs in total are needed, while increasing yields at the same time. There was the promise of Monsanto that through implementing Bt cotton governments and small-scale farmers benefit by increasing the yields and also by saving on inputs, although there is an additional technology fee that must be paid to patent holders in contrast to conventional seeds (interview 9, Gray 2014).

In the most cited studies researching the economic impact that Bt cotton had (SA: Gouse, Kirsten, Jenkins 2002, Ismael et al. 2002, Bennett, Ismael, Morse and Shankar 2004, Morse, Bennett, Ismael 2004; Witt, Patel, Schnurr 2006, BF: Hèma, Omer, Somé, Traoré, Greenplate and Abdennadher 2009, Vitale, Vognan and Vitale 2020, Vitale 2018, Vitale and Greenplate 2014) similarities concerning the actors analysed can be identified. These studies focused predominantly on small-scale farmers and confirmed a positive economic impact of Bt cotton. Especially the technology is considered as beneficial for smallholders in years with high pest pressure (SA: Fok, Gouse, Hofs, Kirsten 2007). There was a positive impact on farm income identified on the small scale as well as on the large scale, for both irrigated and rain fed, resulting from a higher yield and less costs for inputs in total including pesticide, although costs for seeds are much higher (Gouse et al. 2002). Despite a strong dominance of smallholder farmers in Burkina Faso, in contrast to South Africa, the overall evaluation of the studies' outcomes were similar (Vitale 2014, Pertry, Sanou, Speelman, Ingelbrecht 2017).

5.1 The South African cotton sector

In general, the South African agricultural sector, in contrast to other African countries, is not dependent on cotton as an export crop and is not a net exporter of cotton in total. Therefore, South Africa is not economically dependent on cotton production, and cotton can be considered as a small crop compared to other crops, like maize, in South Africa. Small-scale cotton producers are some of the main actors in the cotton value chain. Around 10% of cotton producers cultivated large scale, according to James (2002), who counted 400 of 4,000 cotton producers as large-scale farmers in 2001. Although a majority of cotton producers are small scale, the majority of cotton is produced by large-scale producers. This is also visible in a comparison of hectarages of cotton cultivated by small-scale to large-scale farmers cultivating cotton in South Africa from 2009 onward (see Figure 5) (Cotton SA, own statistic). Even though the difference fluctuates there is a strong tendency toward a much bigger area of cotton cultivated by large-scale farmers than by small-scale farmers.

Figure 6 - Comparison ha cotton production small scale vs large scale South Africa (2009–2021)



Sources: cottonsa.org.za, own statistic

The South African cotton and textiles industry crucially changed in 1997 when the Cotton Board under the marketing of the *Agricultural products act, 1996*, was dissolved. The whole value chain downstream of production was now organised

under Cotton SA, which can be considered as an agribusiness, going along with Bernstein's definition of a vertical integration and organisation of a whole sector under corporate activity. Further, the liberalisation led to the closing of textile mills and a further marginalisation of the cotton sector in total (interview 8). All steps and actors along the value chain from producing over packing, to ginning, spinning, grading of cotton and export, which is relevant during this thesis, are organised and run through the channel of this organisation. They provide the public infrastructure, support the cotton industry, are responsible for 'raising awareness of critical issues, providing information necessary for decision-making, and facilitating cooperation on matters of shared interest'. They claim to 'provide valuable information that is timely and relevant to all sectors of the cotton industry in assessing market conditions and is the official source of statistics on production, trade, consumption stocks and prices' (Cotton SA). For this service of organisation, the different actors organised under Cotton SA have to pay a levy to them (ibid.).

While it is possible to access a wide range of data via Cotton SA's homepage on yields, hectarage and farmers, imports, and exports, all additional information, like on inputs used, and exact information on where cotton is cultivated, is hard to find. This is owed to a very tight and narrow organisation under Cotton SA. It is difficult to get access to individual role-players organised under Cotton SA, like ginners or farmers, and thereby to gather more data on inputs used because they again refer to Cotton SA for information (personal experience, interview 10). The prices the cotton producers receive are oriented on world market prices, and fluctuations are directly transferred to producers, also regarding input prices. South African cotton is sold via Cotton SA to international traders, and it thereby functions as an agent for cotton exports (interview 5).

The small size of a sector, all organised under Cotton SA, up to the present led to a monopolisation in seed supply by one company, Mahyco (Maharashtra Hybrid Seed Company)[2]. The latter incorporated in India with Monsanto. There it developed and introduced Bt cotton seeds. After 2015, the Indian seed company expanded to African countries (economictimes.indiatimes.com, 2015). Further, there is also a national seed authority, Sansor (South African National Seed Organisation), who

[2] Mahyco is the cotton company; the trait is now owned by Bayer, who is the patent holder and receives the technology fee. Producers pay it when they buy cotton seeds. It also has to be admitted that Monsanto owns 26% of Mahyco, besides the 50:50 joint venture in sub-licence of GM seeds in India (acbio.org.za, 2014).

oversees quality control, being thereby directly subordinate to seed companies, and counts them as their ‘bosses’ (interview 5). Before the dominance of Mahyco in cotton seed supply in South Africa, there were also big seed companies like Carnia and Sensako, which were bought by Monsanto in 1999 and 2000.

5.1.1 Introduction of Bt cotton and development of use in South Africa

Up to the present day all cotton planted in South Africa has been genetically modified. Almost all cultivars contain the Bt gene, but all are herbicide tolerant in the form of tolerance to glyphosate (Cotton SA 2022, interview 9). While first experiments with GM cotton started already in the early 1990s, Monsanto’s Bt cotton was introduced for commercial production only in the 1997/98 growing season (FAO 2022). It was the first African country to adopt production with Bt cotton and, even on a global scale, it was one of the early adopters. More precisely, it adopted Monsanto’s insect-resistant cotton variety *bollgard*.

It was released in South Africa in 1997. *Bollgard* was followed in 2000 by a *RoundupReady* (RR) trait that expresses tolerance to glyphosate. In 2003 *bollgard II* was released in South Africa, containing an additional insect control gene, following its predecessor *bollgard*. In 2005 a stacked variety entered South Africa’s cotton market. It contained the insect control gene of *bollgard* but also tolerance to glyphosate of the *RR* variety (Department of Agriculture, forestry and fisheries, Republic of South Africa, 2021).

Due to the fact that the *RR* and stacked varieties are only to be used with glyphosate, produced by Monsanto, the South African case and cotton value chain cannot be analysed isolated from the agrochemical value chain and alterations resulting from the introduction of Bt cotton and its followers that also influenced the cotton value chain and production network in a strong manner. They are, due to an obligation to use the Monsanto/Bayer herbicide glyphosate (Bayer 2020: p.11), strongly interrelated with one another. The contractual binding of producers to use Monsanto/Bayer products in the whole production process influenced cotton producers regarding the type and intervals of herbicides they used and applied.

One reason for Monsanto tying cotton producers contractually to their product and not generics was basically owed to the fact that Monsanto’s patent on glyphosate ran out in South Africa in 2000, and the herbicide market was flooded with generics from

China (ACB 2015: p. 6). So, the result was '[i]f growers want to use glyphosate, they must agree only to use Roundup herbicide on Monsanto crops' (ACB 2005: p. 8) by signing a 'licensing agreement' (ibid.) that obliged them to use only *Roundup* in combination with the seeds. In most cases, especially in the case of the Makhathini flats, the inputs, including seeds, fertilisers and pesticides that also include insecticides, were and are still sold in a technology package that is prepared in the right quantities per product for application on all different sizes of farms (interview 8). And although producers might use any glyphosate product on their crops, they are constrained to use *Roundup* because if any problems in the production process occur, they would 'forfeit their claims for compensation if there are problems with the seed' (ACB, 2017: p.21), referring to resistance of pests or weeds in cotton crops.

Another strongly interrelated value chain is the seed value chain. Since the introduction of Bt cotton, it had a strong influence on cotton producers and thereby the cotton value chain. While it was the same with cotton as with other crops, that seeds of previous seasons were spared for planting in the following season, this was made impossible by the introduction of patented seeds for production, like Bt seeds. Cotton producers by contract agreed to use the seed containing Monsanto/Bayer 'gene technologies for planting a commercial crop only in a single season' (ACB 2005: p. 8, Bayer 2020: p. 5) and guarantee not to save their seeds from previous seasons for replanting. The result is that cotton growers must buy new seeds every season. This results in multiplying the costs by already higher seed costs that must be paid every year.

As the example of South Africa shows, costs for Bt seeds are twice as much as non-Bt seeds (Bt: 785 rand, RoundUp Ready: 365 rand, stacked variety: 1,150 rand), and costs for GM seeds in general are three times as much as for conventional seeds (Schnurr 2019: p. 76). Slightly divergently, Fok et al. (2007: p. 8) suggest an increased share of costs for seeds in total input costs of 70% to 80% (from 40% to 60% before).

5.1.2 Showcase: Makhathini flats

Different governmental 'development projects' were initiated of which one aimed at 'uplifting' (interview 9) small-scale famers by showing that GM cotton could have a positive economic impact on poorer farmers. One of these projects was initiated to

‘increase production [and] increase yields’, which should have resulted in ‘poverty reduction’ (interview 10) in the area of the Makhathini flats. Some of the major reasons for why GM seeds were used were simply that the ‘government was not opposed to GMOs’ (interview 8), that the whole topic of GM cotton cultivation was discussed less controversially back in the 1990s (interview 6), and in addition Bt cotton was perceived as ‘the best seed available on the market’ (interview 6). These latter statements could be challenged due to the fact that they are coming from actors within an industry that is now using GM cotton varieties 100% of the time. The role of the South African government is, therefore, crucial. It has to be recognised that it facilitated GM cotton and thereby contributed to South Africa’s cotton farmers’ experience in the Makhathini flats being a widely cited and popular example of a positive impact that Bt cotton can have on smallholder farmers.

The often-cited example of small-scale farmers growing GM cotton in the Makhathini flats evolved to one of the most popular success stories regarding a positive effect on yields, reduction in pesticide use, labour input and gross margins on smallholder farmers. These are some of the main arguments that explain the high adoption rate (Table 1) (Bennett 2004, Ismael et al. 2002 after James 2002) of Bt cotton in the first years after introduction (James 2002; Bennett, Morse and Ismael 2004, Thirtle et al. 2003).

Table 1 - Adoption rate of Bt cotton in the Makhathini flats (1998–2001)

Table 67. Area of Bt Cotton and Number of Bt Cotton Farmers in the Makhathini Flats, South Africa 1998-1999 to 2000-2001

	Bt Hectares	No. of Small Farmers	Adoption % Bt
1998-1999	80	75	10
1999-2000	752	411	40
2000-2001	1,864	1,184	60
2001-2002	5,670	2,976	92

Source: Bennett, 2002 and Ismael et al., 2002a.

Source: Bennett, 2002 and Ismael et al., 2002a after James 2002

Thus, there is critique on these evaluations, considering the outcomes of the studies being narrow and misleading. The institutional context and its impact on the overall outcome was left out. This crucial aspect was not considered in the analysis of Bt

cotton's impact on small-scale farmers after the first years following introduction (Witt, Patel, Schnurr and Witt, 2006, p: 497).

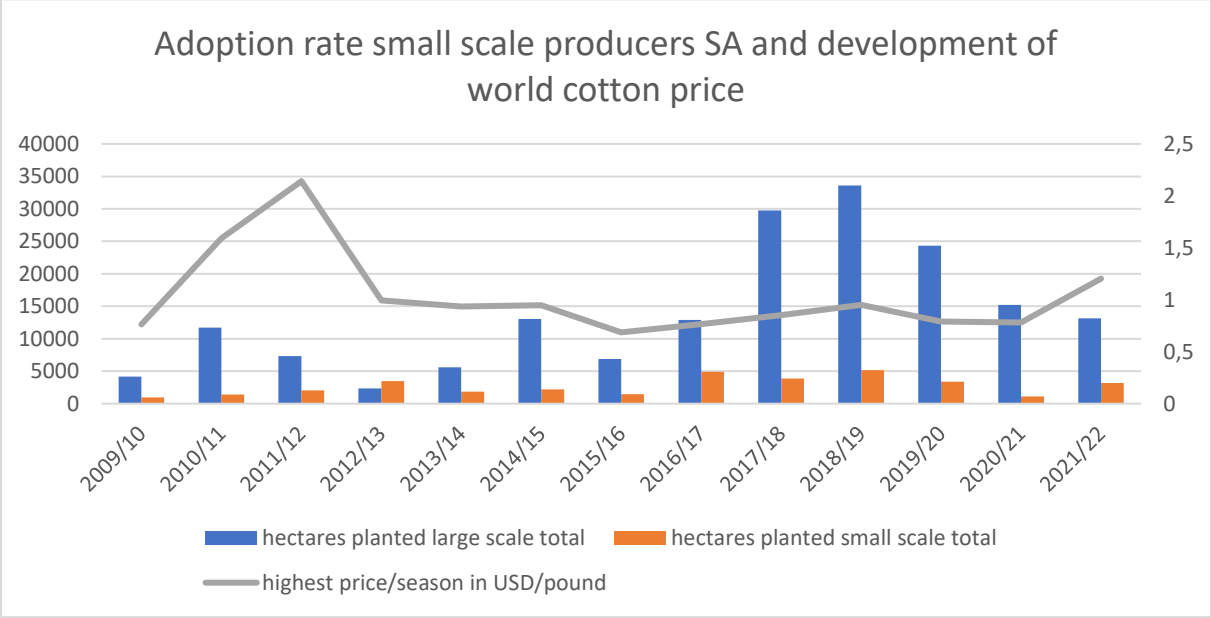
The institutional setting in the region changed over time. This also influenced supply of farmers with inputs. In the case study of Bt cotton in the Makhathini flats, first the cotton company Vunisa had a monopoly in providing the farmers with inputs, seeds and pesticides, and at the same time provided credits to make inputs available. Further, Vunisa had a monopsony in buying the cotton from farmers, they reduced the revenue of the producers by deducting the credit directly (Witt et al. 2006, Schnurr 2019). This was the basis for enabling cotton production to smallholder farmers and decisively contributed to an overall positive evaluation of Bt cotton after the first years following introduction. But the institutional setting changed.

In 2002 another cotton company entered the region. By first buying the cotton from producers, they disrupted the input-output providing and buying system established by Vunisa. This further led to the bankruptcy of Vunisa, leading to a monopoly of the new company. MCC (Makhathini Cotton Company), in contrast to Vunisa, did not provide the cotton farmers directly with inputs. But as long as MCC operated in the area, Bt cotton was still grown. This was owed to different factors, amongst others, the impossibility for poorer farmers to decide on conventional cotton. Since 2007, when 'MCC closed up', the production of Bt cotton also 'stagnated'. MCC's gin was bought by the 'department of agriculture and Fisheries', which aimed to 'locate the entire cotton value chain in this area' (Schnurr 2019: p. 77).

5.1.3 Regulating GMOs in South Africa

While producers and the whole industry were protected before, they became vulnerable to global fluctuations in prices, affecting producers and other actors in the value chain directly. The result was that survival of and within the textile and cotton industry became difficult (interview 8). Fluctuations in world cotton price, price for inputs and the possibility of rentability of cotton production in South Africa reflects directly in smallholders deciding whether they plant cotton or not in South Africa (Figure 8) owed to the transference of price directly to producers.

Figure 7 - Acreage produced under smallholders vs world cotton price (2009–2021)



Sources: Cotton SA, macrotrends.net

When it comes to a regulatory framework for handling of products of biotechnology, South Africa had already established a committee in the 1970s. SAGENE (South African Committee for Genetic Experimentation) was designed 'to ensure compatibility with rapidly changing standards coming out of the United States' (Schnurr 2019: p. 42) and should have guaranteed a safe handling of products of modern biotechnology. Thereby, 'SAGENE played a decisive role in awareness raising and training throughout the 1980s' (ibid.). It also 'emerged as the clearinghouse for the slew of experiments on genetic modification that followed in the 1990s' (ibid.) when field trials with GM seed varieties where inquired about and thereafter started. The GMO Act passed in 1997 and was aligned with the standards of the Cartagena Protocol in 2006 (ibid.: p. 42). It followed the regulation under the agricultural pest Act 36 of 1983 (gov.za, interview 6).

With the GMO Act 'two regulatory bodies' were established, the 'Executive Council' and the 'Advisory Council'. They should have, as one of their core activities, monitored GM technology so that it 'presented no unacceptable levels of risk to human health or the environment' (ibid.: p. 43). To complete the framework, 'a complementary arm of the South African regulatory framework, the National Biotechnology Strategy, was enacted in 2001' for 'bolstering secondary

considerations such as capacity building, legal complexities, and funding' (ibid.: p. 43). Schnurr remarks here that the 'South African regulatory system was the first of its kind and positioned the country as a "biotechnology leader in Africa"' (ibid.). Its 'pioneering regulations [were] viewed as progressive and enabling by biotech boosters' (ibid.). The strength of the governance framework was the 'division of risk assessment (Advisory Council) and risk management (the Executive Council)' (ibid.).

One of the main critiques of this regulatory framework is the 'lack of public participation' when it was created but also that the 'governance structure privileged the interests of those actors who created it' (ibid.), favouring industry interests instead of protecting consumers (interview 10). Nevertheless, the regulatory framework implemented in South Africa served as a model for other African countries following the South African pathway of introducing GM varieties, like Burkina Faso.

5.2 The cotton sector in Burkina Faso

Agriculture is 'one of the key drivers of economic growth in Burkina Faso' (Vitale 2018: p.2). Within this agricultural landscape, cotton is Burkina Faso's most economically important crop. One big difference of West African cotton growing countries, like Burkina Faso, to other cotton-growing countries is the big number of small-scale farmers who rely on cotton growing to secure their livelihood. Cotton grown for subsistence agricultural use is only marginal; mainly it is cultivated for commercial use. It is the country's most important export crop and makes up to 60% of the country's export profits. The income gained through cotton cultivation contributes to securing the livelihoods of about three million people in Burkina Faso (Vitale 2018). These estimated 350,000 cotton-growing farmers export 99% of their cotton to the world market (Staritz 2018, Bassett 2008). One advantage cotton has in contrast to other cash crops, like palm oil and rubber, is the 'quick return on investment, which makes it more suitable for small farmers, than tree crops cultivated in plantations' (Gray 2008: p. 12).

The structure of Burkina Faso's cotton sector today has its origins in the end of the French colonial period in the late 1950s and early 1960s. 'Parastatal cotton companies [still] play key governance roles' in the 'West African cotton commodity chain' (Bassett 2008: p. 39). One key characteristic of the Burkinabe cotton sector is the contract farming, where small-scale farmers procure their inputs on credit. After

independence, a monopsony in the cotton sector was established. The only buyer of cotton, the cotton company Sofitex, provided the cotton farmers with inputs on credit. This monopsony tied the farmers strongly to the cotton company and at the same time enabled a credit system for the farmers to buy the inputs like seeds, fertilisers, and pesticides at the beginning of the season. The loans are paid back in the harvest season; they receive 95% of the negotiated price and fewer inputs plus an eventual premium (Staritz 2018).

The parastatal cotton company Sofitex was not just responsible for inputs and money loaning but also ‘varietal research and development, input delivery, extension services, village-level marketing, transportation, ginning, and selling cotton fibre on world markets’ (Bassett 2008: p. 40). Through its special characteristic of being the only buyer of cotton and provider of inputs, Sofitex had and still has much power regarding the cotton price setting but also influence on input prices (Bassett 2008).

Although there was the attempt of the World Bank and IMF to liberalise the cotton sector in Burkina Faso in the late 1990s, there is still a strong influence of the state perceptible in the cotton sector. Owed to structural adjustment programs, the government of Burkina Faso was forced to split the parastatal cotton company and sold three gins to private investors. The cotton-growing zones were split and assigned to the respective cotton companies. Private investors were thereby enabled to buy from producers in these areas. After liberalisation of the Burkinabe cotton sector in 2004, Sofitex still held 82% of cotton-growing zones. The remaining 18% were split between the companies SOCOMA and Faso Coton. Besides big international cotton traders, the former French Company for the Development of Textile Fibres (CFDT), a fertiliser company, and private investors hold shares of these private companies. Also, the Burkinabe farmers’ union, UNPCB, is a shareholder (10% and 20%) of these companies (Bassett 2008).

Still, the cotton companies Sofitex, Socoma, and Faso Coton are some of the main actors in the Burkinabe cotton value chain. They are responsible for formation of prices, input provision, loans for producers and guaranteeing a market for Burkinabe cotton producers. Each cotton company has a region, which it provides with loans and inputs. In return the producers must sell their cotton to their respective company. The farmers’ union UNPCB is involved in the pricing negotiations. The outcome of these negotiations is a ‘nationwide pricing’ and a ‘guaranteed market’, which

‘provides security to producers who can obtain credit from cotton companies as long as they sell them their crop’ (Bassett 2008: p. 42). The prices are negotiated in advance by an interprofessional committee, the Inter-professional Association of Cotton Producers of Burkina Faso (AICB), this consists of government, cotton companies, and farmers (Staritz 2018: p. 826). Although the UNPCB is involved in the pricing negotiations around the fixing of cotton prices for the season, there are annual protests accompanying this event (Engels 2021).

According to Bettina Engels (2021), these peasant protests are an indirect result of structural adjustment programs and liberalisation of the cotton sector. She analysed protests in 2011 in Burkina Faso. A big number of small-scale farmers perceived UNPCB as a prolonged arm of the government that in general serves the needs of better-off, bigger-scale farmers. These resulted in protests from the early 2000s on and had a peak in 2011 that included destroyed cotton fields and people being imprisoned and killed.

One major issue was poor-quality input and low prices they received for their cotton. Further, they complained about corruption regarding the cotton classification, and payment often was delayed (Dowd-Uribe 2014). Even though a lot of farmers would prefer growing other crops than cotton, they are tied to cotton growing because it guarantees them access to a guaranteed market, credit, and inputs, which they would have no access to if they decided on other crops (Engels 2021, Dowd-Uribe 2014).

The poor-quality inputs that were a subject of contention of peasants’ protests in 2011 also included the cotton seeds. By this time, Bt cotton made up 58% of total cotton cultivated in Burkina Faso (Pertry et al. 2016: p. 86). Additionally, bad quality seeds were also much more expensive. This big share of Bt cotton grown also had a strong influence considering the price of inputs. While there are costs around $2/ha for conventional seeds to be paid, the price for Bt cotton is around 30 times higher, at around $60/ha (Dowd-Uribe and Schnurr 2016: p. 5).

5.2.1 Introduction of Bt cotton in Burkina Faso

Globally there was a loss in cotton yields perceived in the 1980s and mid-1990s. But while in other cotton-growing regions of the world like China, Brazil and the US, the yields increased again in the last few decades, in West African countries they

still decreased. Cotton, as a highly sensitive and demanding crop, is very vulnerable ‘to frequent droughts and insect damage, making cotton highly dependent on insecticides’ (Compaorè 2018: p. 29). The use of the latter led to a strong resistance of pests to insecticides (Vitale 2018) and further contributed to an increase in use of much more toxic endosulfans, which already were banned in many countries. They were reintroduced in Burkina Faso in the growing season of 1999–2000 to control bollworm outbreaks (PAN 2009: p. 16). Their use was considered necessary to fight pyrethroid-resistant insects. This reintroduction of endosulfans led to poisonings of peasants in various ways (Gray 2008: p. 16).

One of the main reasons to introduce Bt cotton in Burkina Faso was the prospect of reduction in sprayings of toxic pesticides. Another incentive was the expectation of higher yields, resulting thereby in a higher net income. While there were around six sprayings per season necessary during the cultivation of conventional cotton, there was the promise of reducing these sprayings to one to two sprayings per season by introducing Bt cotton. This should not only have led to savings in costs for pesticide up to $60 million (Pertry 2016: p. 13) but should also have led to health and environmental benefits for farmers and soil.

Field trials with Monsanto’s *Bollgard II* started in 2003. There was backcrossing with the locally grown varieties necessary to further guarantee the quality of the cotton grown in Burkina Faso. Furthermore, a legal framework was established to ‘regulate field testing and commercialization of genetically modified (GM) crops’ (Pertry 2016: p. 85). The result was two of Monsanto’s ‘regional Bollgard II varieties’ authorised by Burkina Faso’s national Biosafety Agency and launched for commercial cultivation in the season 2008/09. The GM seeds were distributed by all three cotton companies (Sofitex, SOCOMA and Faso Coton); the peak in adoption was in 2014, when 70% of all cotton grown in Burkina Faso was Bt cotton (Pertry 2016: p. 86-87).

The first years of cultivating Bt cotton commercially were considered successful by authorities. Therefore, ‘a new authorization for 10 years for *Bollgard II* has been issued in 2013’ (Pertry: p. 86). Despite an alleged successful introduction of Bt cotton, the contract with Monsanto was ended in 2016 due to cotton fibre quality issues (Luna 2019, Dowd-Uribe and Schnurr 2016, interview 3).

Proponents of GM cotton claim the story of Burkina Faso's Bt cotton history to be a success. They argue with an increase in yields, which resulted in an approximately 65% increase in net income compared to conventional cotton. In addition, they argue that production costs equal the costs of conventional cotton, although the costs for the seeds are around 30 times higher. This is owed to the reduction in costs for pesticides (Pertry 2016: p. 87). That makes up to '35 – 45 percent of cotton growers' gross revenues' (Bassett 2008: p. 43) when grown conventionally. Regarding the impacts on environment, the proponents evaluated Bt cotton as positive with positive impacts on biodiversity and insects resulting from spraying fewer pesticides (Pertry 2016: p. 88).

One major weakness of these evaluations is the timeframe it looks at. Often the first years of Bt cotton's introduction are evaluated, while the second half of production with Bt cotton is not included in these calculations (Pertry 2016, interview 3). Another weakness is the overall strong focus on economic outcomes when considering the reality of a complex rural reality. There is not enough differentiation regarding the peasants' land size, income and social status when possible benefits and risks arising from the introduction of Bt cotton are evaluated.

5.2.2 Regulating Bt cotton in Burkina Faso

Cotton world market prices are often transferred directly to producers. In Burkina Faso, producers are protected from a strong volatility in world cotton price through the *fonds de lissage*, initiated by the AICB. The latter was an answer to attempts to liberalise the domestic cotton sector by Bretton Woods Institutions, World Bank and IMF in order to further guarantee producers' survival in the sector, while at the same time avoiding states' involvement. With the introduction of this 'smoothing mechanism' a floor price, resulting from 'medium-term price trends' based on the average price of five years, was created. This average price is not necessarily the 'trend-price', which can be understood as the world market price, but leaves scope to correct it up if the world cotton price goes up (max 1 cent/kg). In times of falling prices or market failure the calculated price can also be corrected down to the 'floor', which is max 5 cents/kg of the calculated price. This tool was mainly introduced to protect the main stakeholders, like producers and cotton companies, in the cotton value chain from losses. The aim was to protect 'against short-term price volatility and the risk of market failure as in 2004 and 2005' and should thereby also provide price

transparency for all stakeholders in the sector (WTO 2008, p 5). Via tender systems the cotton is offered on the market. The highest bidding gets the cotton. The floor price is also dependent on input costs and can develop during the season. The producer should, therefore, still be able to restore their livelihood when prices for inputs rise (Bassett 2008: p. 42, interview 5).

To protect producers from possible risks arising from the production of GMOs, biosafety Loi N° 005-2006 (2006, the following is my own translation) was enacted by the Government of Burkina Faso in accordance with the Cartagena Protocol. It determines the handling of GMOs and its products and defines measures for prevention of ethical risks arising from the use of biotechnical products. It should thereby guarantee safety for the environment and human and animal health and further guarantee biological diversity. Further, it regulates the development, experimentation, production, dissemination and storage of GMOs.

Article 3 of the law includes the establishment of a national agency for biosafety. Public participation is included and should be considered in decision-making processes on GMOs after being fully informed and having given their approval or disapproval on the matters of environmental, human and animal health, ethics and the economy resulting from the introduction of GMOs. The final decision is made, similar to South Africa, by the national authorities. The authority has three bodies. The national biosafety observatory (NBO), an advisory body also responsible for educating and monitoring; the national scientific committee on biosafety (CSNB), responsible for scientific evaluation of biosafety; and the internal scientific committee on biosafety, serving the ministerial departments. All three of them act as advisory bodies.

Chapter two, section one is concerned with safety measures, including a strict monitoring, good laboratory practice, good manufacturing practice and a good distribution practice. In general, awareness for the possible risks inherent in the use, handling or movement of GMOs should be raised. To evaluate these risks, an observation period was determined; the endurance of this period is not further defined. Also, it points at measures to be taken to avoid possible risks but does not define them in detail.

In section two, a risk assessment and its execution by national authorities is defined. It uses guidelines developed by international authorities as guidelines to evaluate the

possible risks. Additionally, an absence of scientific knowledge should not be interpreted as an indicator for the absence of risk, going along with the definition of the precautionary principle (in accordance with the Rio declaration)

In Section 3, Article 18 it is defined that the importer of GMOs is obliged to provide technical and financial support to safely introduce the GMOs according to the law, by appropriate management and risk assessment.

Articles 29 and 30 demand a study assessing possible risks over an undefined time period. It must prove that the GMOs do not pose any risk to human or animal health, biodiversity or environment; contribute to sustainable development; guarantee to not harm socio-economically or environmentally; and not be unethical. Although Article 39 and 50 demand an evaluation and research of possible risks and under supervision of national authorities, Monsanto avoided it at least partly by pointing to studies they did outside the national territory of Burkina Faso (wikileaks).

Regarding the liability, the user is held responsible for any damage caused by the use of GMOs, also if it is of a socio-economic nature.

Despite this, it is often emphasised that the Burkinabe biosafety legislation holds on to the precautionary principle (europarl.europa.eu, accessed November 2022), and measures and timespans to prevent possible risks are not further defined. And although it should in theory provide a framework for in-depth research on the possible impact on environmental, socio-economic and health aspects, accurate definitions are missing. Further, for once-permitted GMOs that caused damage, all costs and risks arising from the caused damage must be borne by the user (Loi 005-2006).

5.2.3 Abandonment of Bt cotton in Burkina Faso

There was a lot of news coverage of anti-GMO lobbyists around protests and the abandonment of Bt cotton in Burkina Faso in 2016 (see Luna 2019, Jishnu 2017, Bavier 2017). There are also annual protests in the cotton sector around the prices the cotton farmers receive for their cotton. In the years when Bt cotton was cultivated in Burkina Faso for commercial cultivation, there were in addition to the protests around prices, protests against Bt cotton. Although anti-GMO activists claim farmers were involved in the abandonment, their protest, in fact, did not contribute to the abandonment of Bt cotton. The only reason why this decision was

made was due to big financial losses on the Burkinabe side, ending in a discontinued contract with Monsanto (interview 1, 2, 3, 4).

This financial loss resulted from cotton quality issues, that were already communicated to Monsanto in 2011/12 (interview 3), nevertheless the contract was renewed in 2013. In the end Monsanto could not fix the quality issues, therefore the IACB, consisting of representatives of the three cotton companies and the farmers' union UNPCB, took the case to court and sued Monsanto over $76 million dollar compensation in 2016 (ibid, Bavier 2017, a). The result was a settlement out of court. The contract was ended, AICB kept 75% (11.3 billion CFA) of royalties, still outstanding to Monsanto, and Monsanto received 25% (3.7 billion CFA). This is compared to the claimed loss of 48 billion CFA, only a marginal share being compensated.

6. Comparative analysis on economic, social and environmental impacts of Bt cotton in South Africa and Burkina Faso

'…there was no objection from the government to allow this, because some countries initially […] did not allow GMO crops to be produced in their countries' (interview 8)

Governments are responsible for establishing a legal framework, but the state is also the primary provider and facilitator when it comes to introducing GM cotton in South Africa and Burkina Faso. The main actors responsible for the introduction in both cases were the state and Monsanto sharing an interest in introducing it in the respective contexts. Without governmental permission the introduction of Monsanto's Bt cotton would have been impossible. Also, they were responsible for establishing a regulatory framework to guarantee the safe use and handling at all stages of production.

Despite the government of Burkina Faso facilitating the introduction of Bt cotton, it also had a tendency toward being a regulator. Still there were state marketing boards that prevented the government of Burkina Faso from being solely a facilitator within this GPN when it comes to the introduction of GM cotton. A failed liberalisation of the cotton sector resulted in further statal involvement in the main cotton company Sofitex. The government thereby still had control in key strategic sectors. The price smoothing mechanism *fonds de lissage*, which was introduced before Bt cotton, also regulated the direct transference of cotton price fluctuations to producers. Both of these aspects finally resulted in the state being directly affected by losses.

6.1 Analysis in South Africa

In South Africa, up to the present, all cotton grown in the small cotton-growing sector is 100% GM. Almost all, except the refuge areas, which make up only 5–10% of cotton cultivated, are stacked varieties. All cotton contains at least an herbicide tolerance, which develops as a tolerance to glyphosate. This results in 100% of cotton cultivated in South Africa containing the RR gene, and 90–95% additionally containing the Bt gene (interview 5, 6, 9). This outcome and dominance

of GM in the cotton sector was influenced by different factors, of which governmental involvement is one of crucial importance.

6.1.1 Governing the South African biotech cotton value chain

The aim of creating ‘healthy competition’ by abolishing monopolies after apartheid in different industries ended in ‘de facto monopolies’ (Bernstein 2013: p. 28). ‘Agribusiness’ was the result of these emerging monopolies, which Bernstein (2013) defines as ‘corporate activity upstream of farming’, including supply of seeds, fertilisers, agrichemicals, and machinery, but also ‘downstream’, including activities like ginning, further processing, marketing and distribution, including the acting as agent for exports in the case of cotton. The aim of diversifying the industry ended in a ‘vertical integration, consolidation of market power, and private regulation’ (ibid.).

In South Africa the government not only facilitated the seeds and provided the farmers with Bt cotton in the context of ‘development projects’ but also provided a legal framework for regulating the production of GM seeds with the *South African GMO Act (1997)*. Although public participation is included in the legislation for introducing new GMOs, critics claim that there is a ‘limited role for public participation and lack of transparency’ (interview 10) in the decision-making process. Also, organisations who regularly write comments on different new approvals feel that taking into account their consideration is only “ticking a box” (ibid.) in the whole decision-making process, instead of considering objections they have on different new traits. The decisions on new approvals or objections to different new traits do come from within the industry, (ibid.). This also emphasises Schnurr’s critique of a ‘limited role for public participation’ and results in a ‘governance structure [that] privileged the interests of those actors who created it’ (Schnurr: p. 43). The regulatory framework for introducing new GM traits still includes a long process and three years of testing prior to approving new traits (interview 9).

Further arguments for the introduction of GM cotton in South Africa were a strong national R&D sector and infrastructure that are now fully externalised to multinational seed and agrichemical corporations. Back in the 1990s the national R&D sector should have been similar to industrialised countries like the US (interview 6). Despite emphasising a strong R&D sector on a national level, the result of 25 years of cultivating GM cotton in combination with liberalisation of the industry is a 100%

dependence on corporate R&D, like that provided by seed and agrichemical multinational corporations Monsanto/Bayer or BASF. This results in dependence of the whole sector and hope for biotech corporations to further invest to apply for new approvals for a minor crop with traits that are better adapted to climatic conditions.

Further, the organiser of the national cotton value chain, Cotton SA, expects that different HT traits will be developed, despite claiming that the current traits ‘don’t have developed resistance’ yet (interview 9). Besides this corporate capturing of the whole value chain there are also impacts on environment and livelihoods that Bt cotton and further stacked trait varieties had on different groups of farmers. These have been researched extensively shortly after introduction, and in the early 2000s.

6.1.2 Economic impact of Bt cotton in South Africa

The main focus lies on environmental and social impacts genetic modified cotton had on different groups of farmers, which is also interrelated with economic aspects. There will be identified intersections of environmental, social and economic aspects, which are crucial to understand the overall impact the introduction of GM cotton had on livelihoods and the domestic cotton value chains. At least in the early years and with an intact input-credit system Bt cotton had a positive economic impact on smallholder cotton producers in the Makhathini flats. But as soon as a second gin opened in 2002, the system was disturbed and ended in smallholders not being able to service the credits, they needed for much more expensive GM cotton varieties (see chapter 5.1.2).

6.1.3 Social impact of Bt cotton in South Africa

A major social benefit is the spared time in spraying, due to the use of Bt cotton. These reduced sprayings, which was the main purpose of introducing it, also resulted in a positive economic impact through less pesticide applications (Bennet et al. 2004). Further, it could be used differently (interview 8, 6). The labour time, which is often done by women, could be used differently, for example, in spending it with their children (ibid., Clive 2002).

Another positive aspect is the restoration of the social status. In the context of small-scale farming, pesticides are often applied with knapsacks on farmers’ backs. These pesticides also have a particular smell. Through an overall stop of use of formerly

applied pesticides or exchange of pesticides applied, they also got rid of the typical smell, which resulted in farmers before introduction being ‘looked down’ on (interview 6).

Also, some interview partners emphasised the simplification of cotton farming by ready-made packages including all inputs needed for different farm sizes. During the period of introduction in the Makhathini flats small-scale and subsistence producers were provided with packages that contained besides 5 kg bags of bd seeds and herbicides, also gloves and protective gear suitable for the size of their land (interview 8). This was seen as positive and probably also contributed to a high adoption rate. Cotton production was thus also more profitable and attractive on smaller plots of lands. Cotton seeds were previously sold in big sacks of 25 kg, which contributed to smaller scale farmers often deciding against producing cotton. Prior to Bt cotton’s introduction, ready-made packages were also sold, including smaller sacks of conventional seeds and the respective chemicals. Witt et al. (2006: p. 507) emphasise the absence of availability of conventional seeds in smaller sacks in the Makhathini flats during the period of Bt cotton’s introduction. This in return in combination with several other factors, e.g. availability of credits, has contributed to a high adoption rate in total. Others criticise additionally a lack of choice concerning other inputs included, like herbicides, forcing producers to use certain chemicals and narrowing their possibility to choose (interview 10).

While the marketing strategy of Bt cotton in the Makhathini flats is perceived as one of the major benefits for smaller-scale farmers, it is also one of the most critical aspects. Besides the tying of farmers to certain products and limiting their choice, they were and still are obliged to sign technical user agreements. By signing them, they contractually agree to use the seeds for only a single season (Bayer 2020). The tradition of reusing seeds from previous seasons is thereby made impossible by two aspects. If the seeds were saved, they would breach the contract. But also the seeds would not perform in a second season, considering yields and quality (interview 6) due to being hybrids and not openly pollinated (interview 8).

Additionally, producers have to plant a refuge area to avoid the emergence of insect resistance of target pests to Bt cotton. If the required area is not planted, which needs to be at least 5–10% of total cotton production area, the producers lose all claims if pest resistance emerges. This area of refuge does not contain the Bt gene,

which makes it very susceptible to pests and in years of high pest pressure might result in a loss of the total refuge area planted to pests (interview 6). At the same time, the seed company and its representatives can access the crops any time they want to inspect (Bayer 2020).

Also by signing the agreement they contractually agreed to only use Monsanto/Bayer herbicides in combination with HT crops and stacked varieties, with the result that 'Bayer does not make any representations, warranties or recommendations concerning the use of products manufactured or marketed by other companies' and

> Bayer specifically disclaims all responsibility for the use of these products in crops containing Bayer Technology. All questions and complaints arising from the use of products manufactured or marketed by other companies, or the impact to Bayer Technology from the use of such products, should be directed to those companies. (Bayer 2020)

This results in losing all claims on compensation if the technology does not work out as intended when generic insecticides are used.

One major objection resulting from this closed system of input provision and contractual binding of farmers to certain products is the dependence on 'techno fixes' (interview 10) to conquer agricultural challenges. This critique of 'commercialization of GM' in general also includes rejecting 'research that goes in genetically engineered seeds, because of the implications for smallholder farmers, the environment and other socio-economic implications' (interview 10). This applies also to introducing GM cotton like Bt cotton. These are fixing agricultural problems only for a short term. Due to monopolisation in certain sectors, where lead firms like Bayer/Monsanto have patent rights on seeds and pesticides, the result is limitation of alternatives and possibilities to conquer the challenges of modern agriculture and climate change. Further, a total reliance on technical fixes results in new challenges. A resistance of pests in a cotton sector that is 100% dominated by GM cotton could, vice versa, only be solved again by new gene technology and again combined with other chemicals to fight them (interview 9). In the case of the South African cotton sector, the point of no return, considering limited alternatives, seems to have been passed. Biodiversity is thereby threatened on different levels.

6.1.4 Environmental and health impact of Bt cotton in South Africa

‘What does it cost in the end of the day in non-economic terms, like biodiversity?’ (interview 5)

In the early years of producing with Bt cotton in South Africa a study was done on the difference of toxic load to environment between production with Bt cotton and conventional cotton (Bennett et al. 2004). The toxic load to environment was measured with the *biocide index,* which resulted from ‘the amount of pesticide applied each year, its concentration of active ingredient (a.i.), the toxicity of the ai’, in accordance with the WHO definition, divided through ‘how long the ai remains active in the environment’ (ibid.: p. 666). The lower the index, ‘the lower the value of the Biocide Index the better’ (ibid.: p. 666). The study was done from 1998 to 2001 with the first trait NuCOTN 37-B containing the Bt gene. The result was a reduction in sprayings of pesticides of Bt producers in comparison to producers with non-Bt varieties. There was not only a reduction of sprayings of Bt producers in pesticides for Bt target pests but also a reduction in spraying for non-Bt target pests measured in Bt producers (ibid., 670) (see Table 2). This circumstance according to the authors would have shifted to again using pesticides for non-target pests in Bt producers when they realize that the Bt gene does not protect against all insect pests that cotton is susceptible to.

Table 2 - Biocide Index – Comparison Bt vs non-Bt users (1998–2001)

Table 6. *Application of insecticide active ingredient (ai) applied to non-Bt and Bt cotton over three seasons along with the conversion of ai to Biocide Index (BI)*

	1998/1999			1999/2000			2000/2001		
Insecticide	Non-Bt	Bt	$P<$	Non-Bt	Bt	$P<$	Non-Bt	Bt	$P<$
Monocrotophos ai	0·684 (0·06)	0·314 (0·122)	0·001	1·153 (0·083)	0·942 (0·175)	ns at $P<0·05$	1·7 (0·183)	0·678 (0·113)	0·001
Dimethoate ai	0·131 (0·026)	0·065 (0·048)	ns at $P<0·05$	0·126 (0·035)	0·008 (0·012)	0·001	0 (0)	0 (0)	n/a
Total non-bollworm ai	0·815 (0·068)	0·379 (0·124)	0·001	1·278 (0·091)	0·95 (0·175)	0·05	1·7 (0·183)	0·678 (0·113)	0·001
Cypermethrin ai	0·186 (0·015)	0·093 (0·032)	0·001	0·2 (0·019)	0·004 (0·004)	0·001	0·28 (0·035)	0·067 (0·018)	0·001
Deltamethrin ai	0·006 (0·002)	0·002 (0·002)	ns at $P<0·05$	0 (0·0002)	0 (0)	n/a	0·019 (0·014)	0 (0·0006)	0·01
Fenvalerate ai	0·001 (0·0005)	0 (0·0004)	n/a	0 (0)	0 (0)	n/a	0 (0)	0 (0)	n/a
Endosulfan ai	0·037 (0·014)	0·019 (0·0195)	ns at $P<0·05$	0·101 (0·032)	0 (0)	0·001	0 (0)	0 (0)	n/a
Total bollworm ai	0·23 (0·021)	0·114 (0·037)	0·001	0·301 (0·038)	0·004 (0·004)	0·001	0·299 (0·041)	0·067 (0·018)	0·001
Total insecticide ai (variety)	1·045 (0·082)	0·493 (0·146)	0·001	1·579 (0·109)	0·954 (0·175)	0·001	1·999 (0·198)	0·745 (0·118)	0·001
Total insecticide ai (season)	1·01 (0·08)			1·42 (0·1)			1·38 (0·13)		
% Non-bollworm ai	78·1	77·6		81	100		85	90·7	
% Bollworm ai	21·9	22·4		19	0		15	9·3	
BI (non-bollworm)	21·91 (1·831)	10·15 (3·406)	0·001	34·91 (2·45)	26·54 (4·896)	0·05	47·59 (5·122)	18·98 (3·174)	0·001
BI (bollworm)	5·95 (0·856)	2·98 (1·257)	0·01	9·65 (1·832)	0·09 (0·075)	0·001	5·98 (0·819)	1·34 (0·355)	0·001
BI (total insecticide; variety)	27·86 (2·298)	13·13 (4·008)	0·001	44·56 (3·34)	26·63 (4·895)	0·001	53·57 (5·405)	20·32 (3·266)	0·001
BI (total insecticide; season)	26·86 (2·17)			40·01 (2·88)			37·25 (3·51)		
Sample size	1196	87		329	112		254	245	

Figures are the average and 95 % confidence interval (parentheses). Active ingredient is in kg/ha, while Biocide Index is adjusted per hectare.
n/a = not applicable.

Source: Bennet et al. 2004: p. 672.

Other environmental impacts are saving water (James 2002) and a reduction in poisonings, which arises through less pesticides sprayed but also through different chemicals used. This results in better soil health but also contributes to less costs and a positive health impact for farmers (James 2002).

In general, it is hard to reproduce how the amount of chemicals used on cotton crops changed over the long run as data on detailed input use is not available. But different interview partners involved in the cotton industry in South Africa emphasised that there was a reduction in spraying, of 8–10 per season, more toxic and much more different chemicals, like paratethroids, to none, or limited to 2–3 sprayings per season (interview 9, 5). One interview partner mentioned that one of the big developments in modern agriculture is much more awareness of chemicals and their use in agriculture since the beginning in the 1960s, when everything was used extensively, from fertiliser over herbicides to pesticides. This arises not only from introducing GM crops, but is owed to more research being done in general (interview 5).

While actors involved in the cotton value chain and industry emphasise the positive effects that Bt cotton's introduction had in South Africa, others also point to blank spaces considering the research that has not been done yet. There is, for example,

still an ongoing need to use insecticides against nonlepidopteran pests, the insects Bt cotton is not resistant to (Matthews and Tunstali 2006). However, the use of GM cotton made cotton production easier in general. Therefore, proponents still argue that if the characteristics of the GM traits, e.g. herbicide and insect resistance, were not perceived as beneficial, it would not be on the market still (interview 5). Counting this latter statement as true, we also must consider that a much bigger share of acreage was cultivated by largescale farmers. Even though the majority of farmers planting cotton was small scale in the timeframe that the widely cited research looks at (Gouse, Kirsten, Jenkins 2002, Ismael et al. 2002, Bennett, Ismael, Morse and Shankar 2004, Morse, Bennett, Ismael 2004; Witt, Patel, Schnurr 2006), large-scale farmers finally were responsible for the market outcome of monopolisation of GM cotton in South Africa.

While the example of the Makhathini flats is often used as a prime example of a successful implementation of GM cotton in South Africa and generally worldwide for smaller-scale farmers, there are still many research gaps and blank spaces when considered holistically. These include a very short time frame, the concentration of research on only Bt traits, leaving out herbicide tolerance and its influence in the whole production system but also the infrastructure, including the credit system and importance of governmental funding, prior, but also after, the introduction in the long run.

Further, NGOs and independent research institutions claim that long-term implications on communities and the environment have not yet been evaluated (interview 10). While there were a lot of studies done in the beginning, it seems no one is interested in the long-term impacts. They claim one result of the ‘dominant technologic platform’, which consists at the time of writing this thesis of 100% dominance of GM cotton, i.e. using the technology of Bayer, formerly Monsanto, as ‘structured around large-scale private corporate R&D’, resulting in ‘path dependencies, sunk investments and institutional logics, that are increasingly difficult to change’ (ACB 2017: p.23). They further criticise the general ‘top down approach’ which makes farmers’ innovation nearly impossible due to contractual binding of not reusing seeds, and at the same time missing resources to enable the development of more ‘context appropriate seeds and crop protection methods’ (ibid.: p.24).

Although appropriate research is still missing, at least one interim conclusion can be drawn from this monopoly of GM cotton varieties: There is a loss in biodiversity in regard to a diversified offer of germplasm in cotton seeds.

6.1.5 Research gaps

Despite all literature and research on GM cotton in South Africa being about Bt cotton in the Makhathini flats, I tried to analyse the whole era of GM cotton in South Africa from the late 1990s on. There was research done on the socio-econonomic, health and environmental impacts on a small area in South Africa. One of the major shortcomings is the narrow timeframe of research. The focus lies mostly on short-term effects seen immediately, including higher cross margins, less costs in different spheres (health, inputs, labour), the eradication of pests, better soil health and short-term health benefits for producers.

Further, all research done in the Makhathini flats was done in the early 2000s. Still interview partners claim that ‘for us it works’ (interview 9). But when taking a closer look, not even NGOs are further interested in the prestige project of GM cotton ‘upscaling’ small-scale farmers in Africa (interview 10). Others concluded that cotton is only cultivated on the large scale in South Africa, at the time of doing interviews, which was in spring 2022 (interview 8).

The trait – HT, Bt or stacked – is not the only factor influencing the outcome of a crop in a season. If the rain is not enough, due to high input costs it would not be beneficial for small-scale farmers. Other factors are crop management in general, fertiliser and pesticide use (ACB, 2011). Regardless, figuring out how the introduction of HT cotton and stacked varieties influenced the cotton value chain and how it environmentally and socially impacted different groups of farmers was one of the main purposes of this thesis.

All interview partners confirmed a reduction in sprayings in general when using HT and stacked varieties (interview 8, 9, 6). Additionally, they mentioned a concentration on glyphosate as an herbicide, substituting other herbicides used before like atrazine, acetochlor and triazines (Interview 8). When asked what influence this had socially the answer was simply that weeding, which was often done by hand and is a very time-consuming work but also necessary to guarantee a certain crop outcome, was made much easier for producers. This resulted in spared time but also saved costs

for buying different herbicides. These statements came from within the cotton industry (interview 6, 8, 9).

Considering the question of what environmental impact and impact on the whole cotton and pesticide value chain the extensive use of glyphosate had, there was no data available. Different actors emphasised the positive effect of glyphosate on soil health, compared to different herbicides used before. While some emphasised that still no weed resistance or pest resistance emerged (interview 9, 6), the statements regarding weed resistance are contradictory (interview 8). Others claim that there were problems but blame farmers for not having planted refuge areas in the case of pest resistance. One interview partner promised to send a study done by the respective ministry on the connection of soilhealth and glyphosate (interview 5). Instead, he sent a metastudy done. According to this study, glyphosate can be more quickly mineralised in soils than the previously used herbicides ‘alachlor, atrazine, and metolachlor’ (Lee, Clay and Clay 2014: p.226). The latter were used prior to the introduction of HT crops. Even though the mineralisation is faster, factors like tillage and irrigation influence the possible pollution. While practicing no-tillage agriculture would result in the least disturbance of soil and thereby low chances of transferring glyphosate to non-target areas, irrigation or rain after spraying would contribute to possible run offs to non-target areas and could thereby possibly pollute rivers and ground-water (ibid.).

Actors from within the value chain point at a higher toxicity of formerly used herbicides and emphasise a decrease of toxicity for users by using glyphosate and reducing the total number of sprayings (interview 6, 8), which in total should have led to a decrease of environmental impact in total and positive health effects for producers. However, in 2015 glyphosate was classified as ‘probably carcinogenic to humans (Group 2A)’ by the WHO (2015), while being in the same category with the pesticide diazinon, which is banned in other regions of the world, like the EU (PAN 2006). Scientific evidence on positive environmental impacts of HT traits and stacked varieties is missing. Although there was a study done by the South African government, which according to one interview partner had positive results, with only little glyphosate residues measured in soils, it is not publicly accessible (interview 6). Additionally, a request to SANBI, the South African National Biodiversity Institute, who should have done the study (ACB 2011), did not answer my request. There I

asked for a study on HT crops and its impact on soils, and the possibility of sending it to me. This lack of evidence might partly be owed to the change in position of the responsible researcher for the respective study,

Dr. Lukeshni Chetty, the formerly responsible for the research under SANBI changed employment and became general manager of the South African National Seed Organisation (SANSOR) in October 2012. One interview partner stated that seed companies are the 'bosses' (interview 5) of Sansor. The fact that 100% of cotton planted in South Africa is GM and all cotton cultivated is at least HT could have contributed to the outcome of the study either not being done or not being published.

The fact that all GM cotton traits, approved in 2021, were owned by Bayer, according to a USDA report (2021), draws a picture of a monopoly erected in the cotton industry and seed industry. The respective seed company in charge of the seed provision and reproduction in South Africa is Mayhco, an original Indian company that expanded to South Africa. But the patent holder and the one receiving payment of patent fees for the planted traits is still Bayer. This monopoly resulted from different mergers of national and international seed companies and an approachment by either Bayer or Monsanto that finally resulted in Bayer being the sole patent holder of GM cotton crops on the South African market (see Table 3).

Table 3 - Traits and companies involved in South Africa's 27 approved GE plant events for commercial production

Crop	Traits	BAYER	syngenta	CORTEVA agriscience
Corn	Insect resistance	2	1	
	Herbicide tolerance	1	1	2
	Drought tolerance	1		
	Stacked	3	3	5
Soybeans	Herbicide tolerance	1		
	Stacked	1		
Cotton	Insect resistance	2		
	Herbicide tolerance	2		
	Stacked	2		

Source: USDA (2021) after Department of Agriculture, Land Reform, and Rural Development

Highlighting research gaps and blank spaces does not provide evidence for any positive or negative impacts, neither environmentally, nor socially. But it is noticeable that after 'proving' that Bt cotton 'worked' in the context of smallerholder famers in South Africa, no one was interested in the further progress of the project. GM cotton

production in South Africa is dominated up to the present day by a majority of large-scale farmers, producing with different traits than researched with a personal focus on positive economic short-term effects (ACB 2005: p.22). A similar scenario to what happened in the Makhathini flats, at least in theory, happened in Burkina Faso in the season 2007/08, when Bt cotton was introduced to small-scale farmers. The outcomes of the studies done after introduction considering the positive economic effects were similar, although the final outcome of the project was different, and resulted in a fade out of cotton production with Bt cotton after 2016. After that it was replaced again by conventional cotton.

6.2 Analysis in Burkina Faso

Since cotton is a source of livelihood of a majority of people in Burkina Faso, and thereby is the second important export good following gold (see Table 3), the government has an interest in securing this source of livelihood for producers. The Burkinabe government is, despite attempted liberalisation of the cotton sector through IMF and World Bank, still a major shareholder in the main cotton company Sofitex (Bassett 2008). It thereby has an interest in cotton being sold to certain prices on the world market, as its costs and revenues also directly impact the governmental budget.

The French research institute CIRAD and the Burkinabe national research institute INERA were doing research on cotton prior to the introduction of Bt cotton. They were responsible for introducing new cotton varieties adapted to the West African environment and ensured the quality, which achieved higher prices on the world market owed to its superior quality (interview 5).

Table 4 - Export value cotton Burkina Faso (2017–2020)

Product label	Exported value in 2017	Exported value in 2018	Exported value in 2019	Exported value in 2020
All products	2,820,721	3,269,734	3,261,124	4,381,069
Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad . . .	1,809,703	2,147,780	2,271,494	3,574,826
Cotton	372,130	323,634	355,254	265,430

Source: UN Comtrade via trademap.org

6.2.1 Governing the Burkinabe biotech cotton value chain

The government of Burkina Faso under Blaise Compaoré, president of Burkina Faso until October 2014, contributed in a strong manner to introducing Bt cotton in Burkina Faso. To meet demands of Monsanto, requirements for ‘importation and production of transgenic cotton seed varieties’ (Wikileaks) were adjusted to their favour. The proposed ‘one-year authorization’ was increased to a five-year period. Also, Monsanto denied undergoing ‘excessive liability requirements demanded’ and pointed at twelve years studying the ‘nutritional and toxicity analyses’ that ‘provided ample scientific evidence that Bt cotton was safe for both consumers and the environment, and objected to the excessive liability requirements’ (Wikileaks). By changing conditions for Monsanto to enter the national cotton sector, the government facilitated the introduction of Bt cotton in Burkina Faso. This easy access for Monsanto to the domestic cotton production network contributed to changes resulting from it further. Additionally, the government of Burkina Faso was also responsible for building a legal framework to guarantee a safe production with Bt cotton. Loi N° 005-2006 was enacted in accordance with the CPB.

Different groups of farmers, which are represented differently by the UNPCB, respective to their income and farm size (interview 1) welcomed the introduction of Bt cotton. This also included the farmers’ union, who holds shares in cotton companies (SOCOMA: 10%, Faso Coton: 20%, Sofitex: 82%) and, at least in theory, has a voice in decision-making processes within cotton companies regarding major alterations concerning inputs used (Bassett 2008, p,42). It can thereby be assumed that the decision to introduce Bt cotton was welcomed by all actors in the cotton value chain, including farmers, cotton companies, the respective gins and its national and internatioal shareholders (interview 1, 5).

All three Burkinabe cotton companies (Faso Coton, Socoma and Sofitex) distributed Bt seeds during the period of cultivation. One question was whether the farmers could choose between conventional and Bt seeds during this time. They could officially. But if they chose to grow conventional seeds, they didn’t receive inputs on credit. They had to pay needed fertilisers and pesticides in advance (interview 4). This resulted in only higher capitalised farmers being free to choose during this time.

In contrast to the South African context, in Burkina Faso officially only Bt cotton was introduced. The R&D of bollworm-resistant seeds adapted to the Burkinabe context,

at least in theory, was a cooperation between Monsanto and the national research institute INERA. Although Monsanto was the sole provider of knowledge on Bt seeds, it could not capture the agrichemical cotton value chain. Herbicide tolerant traits were not approved and not (officially) planted from the growing period 2008/09 until abandonment. However, later research showed that seeds containing HT and Bt genes were used (Bourgou et al., 2020).

6.2.2 Economic impact of Bt cotton in Burkina Faso

Prior research mainly focused on economic and partly on social impacts that Bt cotton had in Burkina Faso. Impact on livelihoods and the decisions concerning it are influenced inseparably by economic, social and environmental aspects.

One interview partner mentioned that middle- to large-scale farmers in Burkina Faso 'loved it' (interview 1). They were able to increase their acreage, didn't have to spray much and in addition the yields were better if the plant was given all the inputs it needed, like fertilisers in the right amount and time. This was one of the main expectations before adopting Bt cotton and one of the positive aspects that resulted in intensifying production with Bt cotton. It resulted in achieving bigger yields by cultivating the same area. But also extending production and increasing the area cotton is grown on was possible. Two aspects promoted this positive impact. The first was increased productivity through technical innovation. The second was availability of labour power saved by reduced spraying, which then could be used for cultivating more agricultural land. These new prospects of increasing productivity led to two social impacts, which still need to be researched.

Further, cotton growing in Burkina Faso relies on rain for irrigation. This also brings the risk of losing parts of fields owed to dryness or washing off seeds in the early phase of cultivation. This further led to a need for replanting. Bt cotton's introduction was accompanied by a 'unique per-hectare' (Dowd-Uribe and Luna 2020: p. 8) pricing, which officially included a kind of insurance against risks of losses and included a free replanting. In fact, free replanting was only available in the early years of Bt's cultivation. Later, farmers had to prove how their losses emerged and were blamed to be responsible themselves for their losses. This often resulted in an impossibility to receive those 'free' replantings and made producers pay for the

replanting themselves (Dowd-Uribe and Luna, 2020). This procedure was also in accordance with Loi 005-2006 that says that the user must bear the financial risks of planting GM cotton, thereby protecting more industry interests than cotton producers' rights.

While farmers later had to pay for replanting or chose to pay themselves, because the limited time available for replanting pressured them to do so, the risk of falling even higher in debt increased (ibid.). The replanting thereby resulted in much higher costs for producers by doubling the costs for seeds, with the result of even higher input costs for already indebted farmers, while prices they received for their cotton was equal or even less in contrast to conventional cotton (interview 4). Additionally, the number of seeds provided for the first planting was reduced in the future years (Dowd-Uribe and Luna 2020: p. 8-9). The difference in price between conventional and Bt seeds was around 2 dollars/ha for conventional, compared with 60 dollars/ha for Bt seeds (Dowd-Uribe and Schnurr, 2016). This resulted in higher credits to repay to cotton companies in harvest season for often already indebted cotton smallholders. The latter combined with Bt cotton working out as expected, including no higher yields and therefore no higher prices being paid by cotton companies, resulted in even higher debts for cotton growers in total (interview 4).

To sum it up, the main beneficiaries were 'highly capitalized farmers, people who got more secure access to land, who had more availability to labour, who had more just capital in general [they are] going to benefit from this. Because they're going to be able to drop the inputs in, that it needs to achieve those high yields, they are going to be able to attend the labour […] to get those yields' (interview 2). This in contrast results for smaller scale, marginalised or poor farmers who cannot afford to invest in Bt what it needs to attain high yields to probably fall in debt for it.

These occurrences suggest that at least a certain percentage of farmers welcomed the abandonment of Bt cotton in 2016. Although different people claim farmers' involvement and participation in the development of Burkina Faso's cotton sector (see Luna, 2019), the ones profiting the least from Bt cotton's introduction had also the least influence in the decision of abandoning it in 2016.

6.2.3 Social impact of Bt cotton in Burkina Faso

Owed to the fact that spraying is predominantly done by men, this results in male labour being spared. Increasing the area used for cotton cultivation might result in an increase of demand of labour power for weeding and picking, which is predominantly done by women in Burkina Faso. This increase in labour could be done by women in the familiar sphere or by hired labourers on the free market. Familiar labour used for extra weeding and picking would probably result in more unpaid work for women in families. Another possibility is the emergence of new markets for women. They can be hired in collectives and thereby earn money (interview 2).

These are possible outcomes like alterations occurring in the colonial period in cotton-growing West African countries. This resulted in male-dominated households (although cotton growing was previously done by women), growing cotton as cash crops and gendered division of labour resulting from it (Isaacman and Roberts, 1995).

Negative social impact on smaller-scale or less capitalised farmers is one main category emerging when considering the social impact Bt cotton had. Bigger scale producers profited from the introduction. They made up 40–45% of total cotton acreage in 2009 (interview 3). This resulted in a big share of cotton growers not profiting from the introduction, neither economically nor socially.

6.2.4 Environmental impact of Bt cotton in Burkina Faso

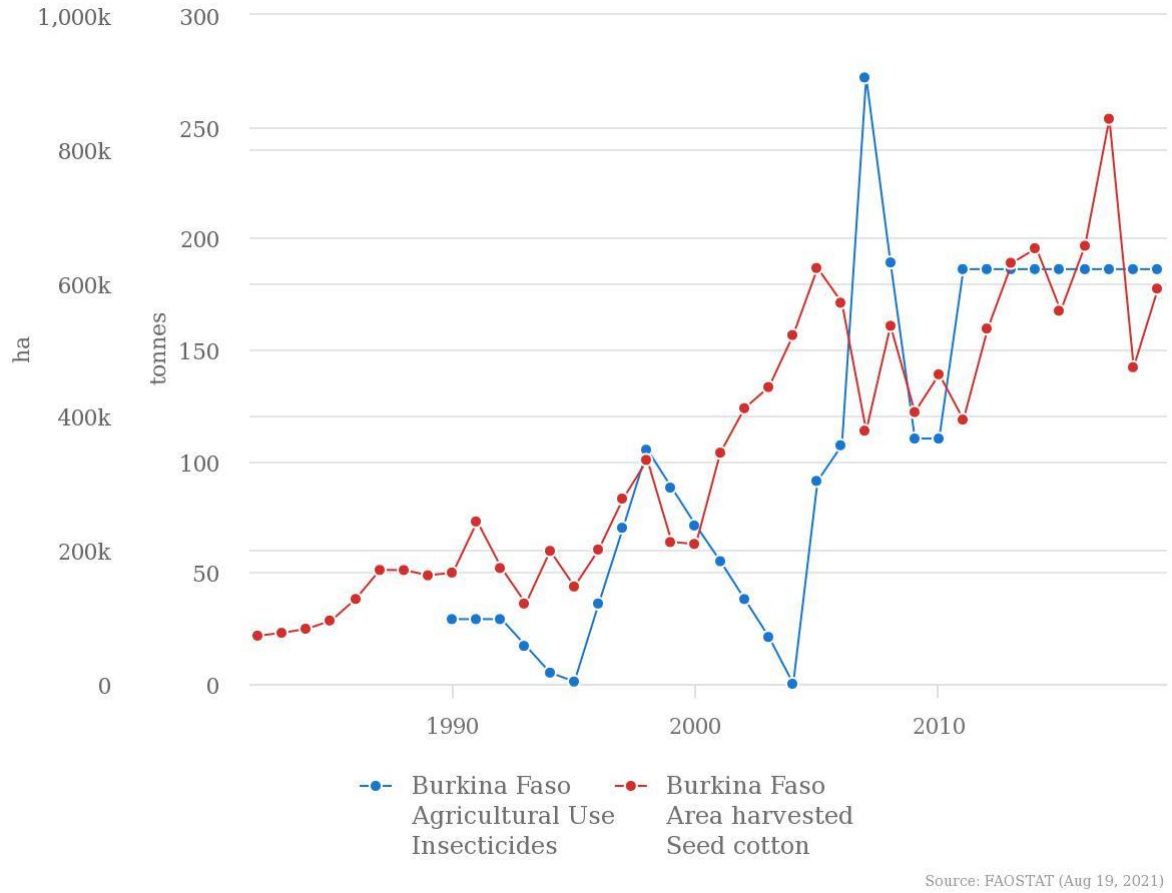
Even though one interview partner stated that a final evaluation regarding the environmental impact is missing (interview 4), it can be concluded that environmental good happened during the time Bt cotton was cultivated. At least in the first years of cultivation, pesticide use did go down. This is stated by scholars doing research on the topic (interview 1, 2), but it is also validated in literature published on the case (Luna, 2019, Pertry 2016, Vitale 2018). This reduction in pesticide sprayings also contributed to less spraying on food crops bordering cotton fields, which further led to health benefits for people growing and consuming these food crops. The pesticides used for cotton crops are not approved to be used on food crops and led thereby to health issues until death for consumers (interview 4). Data provided by the FAO (Vitale 2018) though sheds another light on the issue of pesticide consumption. Pesticide use did decrease after the first year of introduction but went up again after

the 2010 season and stayed constant the following years, independent of Bt cotton's use (see Figure 8). Although not all pesticide used in Burkina Faso was used on cotton crops, a big share of 80% of pesticide is used for cultivating cotton in West African countries like Burkina Faso (Bassett 2008: p. 43). Therefore, this increase cannot be considered as not relatable. Even if pest resistance was not documented while cultivating Bt cotton, the use of pesticide increased again.

Pest resistance is another aspect that must be considered when planting Bt cotton. This already happened in other countries where Bt cotton was grown before (Pertry 2016, interview 2). It had not yet occurred by the time of abandonment but might have probably occurred the following years, owed to producers not planting refuge zones with conventional cotton, which is considered necessary to avoid pest resistance (interview 1, 2). This would have led to an increase in pesticide use again, which is obvious in the case of Burkina Faso after 2010 (see Figure 8).

This could be partly owed to seed contamination of Bt seeds by conventional seeds and vice versa. Also, the quality of seeds provided by Monsanto partly did not express the Bt gene the way it was intended to. One interview partner stated that the timespan of three years for backcrossing of local seeds with American Bt seeds was insufficient to result in quality seeds. Therefore it was unlikely that the result is high quality seed which expresses the Bt gene (Bourgou et al. 2020, interview 3). This resulted in low-quality seeds, charged at a high price, which in addition probably needed extra spraying to guarantee yields.

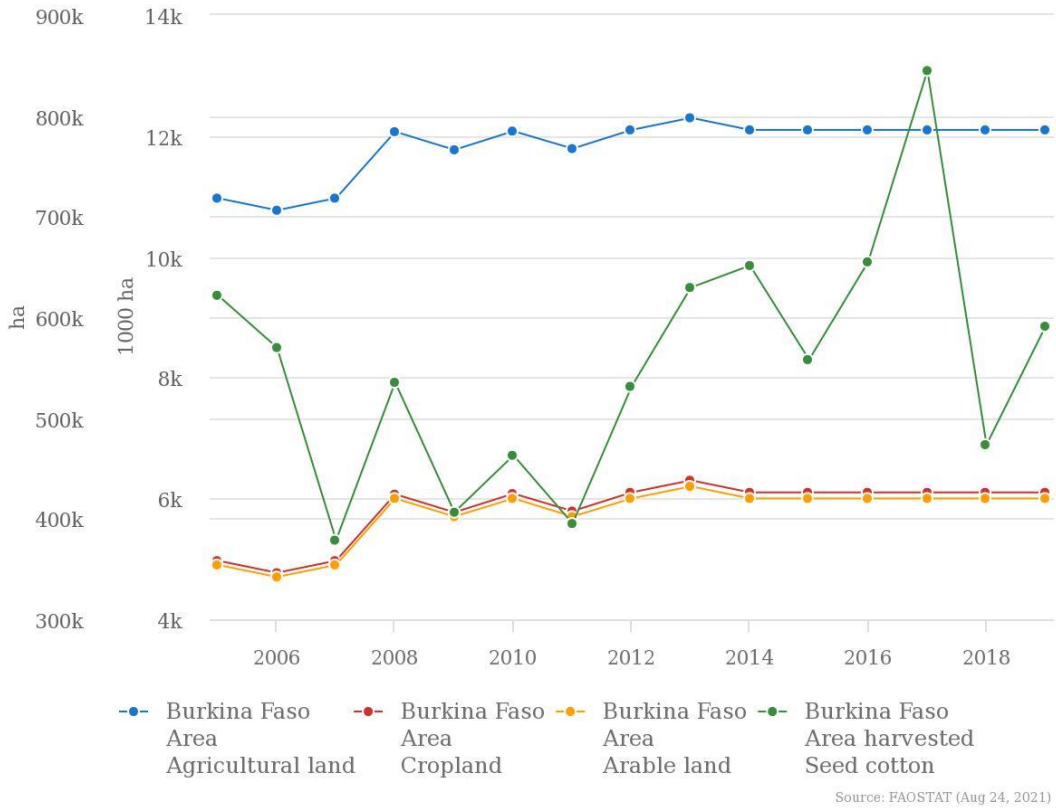
Figure 8 - Burkina Faso – Insecticide use total and seed cotton area harvested



Source: FAOSTAT

Another positive impact concerning social and environmental implications is the conversion of land to cotton crops. The expanded production, which resulted from saving labour power through pesticide reduction, led to land conversion into cotton crops. While land conversion of formerly uncultivated land to increase production would be a negative impact on the environment, conversion of already cultivated land into cotton crops would be considered positive (interview 2) or at least neutral. This seems to be the case for Burkina Faso (see Figure 9). While cotton cultivation did go up, land conversion of formerly uncultivated land seems non-existent for this timeframe (see also Figure 9).

Figure 9 - Burkina Faso – Land conversion and cotton production (2005–2019)



Source: FAOSTAT

While all of the above is based on observations and research, evidence is the result. But there are also several allegations stemming from cotton growers' observations. No research has been done yet to prove those facts. These allegations therefore account for the subcategory of unsubstantiated claims that are not based on evidence but will be expressed in the following section.

6.2.5 Unsubstantiated claims

In this chapter, impacts that are not scientifically validated but nevertheless coincide with the growing of Bt cotton, and associated with it by many farmers, are put here. Some claimed Bt cotton plants were toxic to animals. Farmers in certain regions observed their cattle preferred conventional cotton stonks to Bt stonks (interview 4), others said the cattle were dying because they ate Bt cotton plants (interview 3). However, the latter statement was contextualised differently by the interview partner who peasants reported this to. Dying cattle might also be owed to other factors. Artisanal mining and toxic chemicals used for the mining in this area could have contaminated streams where cattle used to drink water from.

While the environmental impact is independent of income, land size and status of peasants, the social impact shows big differences considering this category. The most social inequalities arise from the difference in farmers' income. While the better-off, bigger-scale farmers not only economically benefitted more, they also were preferred by the institutional system and as a result benefitted most socially from Bt cotton's introduction.

6.2.6 Restoring the previous GPN - a matter of quality and politics

The main actors involved in the suspension were the cotton companies and Monsanto. Owed to Burkina Faso's vertically integrated cotton sector, and the inherent governmental involvement, the latter was also strongly engaged. Quality issues arose from insufficient backcrossing with local cotton varieties and resulted in short fibred cotton. Occurrences on the world market in combination with the change in cotton quality led to two very special situations.

Before the introduction of Bt cotton, Burkinabe cotton was known for its long quality fibres and could therefore achieve higher prices on the world market. The problems with the quality and the short fibre resulting from the cultivation of Bt cotton were known from the beginning on. But additionally in the years of 2011/12 the world market had a high demand in cotton and therefore could not care about quality disguised as quality issues. In the years after, when the situation on the world market normalised, the quality loss got obvious, and lower quality cotton could not be sold for prices usually achieved. The loss in cotton quality thereby resulted in big financial losses for the cotton companies and vice versa the government. After they bought the cotton from producers for an in-advance fixed price, they were not able to sell to the world market anymore without big losses (interview 3).

Also, the issue of quality was taken to Monsanto already in the years 2011/12. One reason why the issue was not fixed was because they did not take the complaints of people in Burkina Faso concerning quality seriously and kind of 'looked down' (interview 1, 3). Another reason might have been that Burkinabe people were not clear enough in demanding the quality issue to be fixed (interview 3). According to one interview partner, these issues with cotton seeds not only included complaints about the quality of cotton, but also the purity was not guaranteed. This was owed to the short duration of backcrossing and could thereby not result in high-quality

GM seeds. He stated that ‘it is not possible for just a period of another three years to actually provide GM seeds which are totally pure’ (interview 3) and thereby stated the impossibility of guaranteed GM seeds that contained both insect control genes at a time. Further he stated that these occurrences were ‘Monsanto’s fault, not mistake’, blaming them of doing the rushed introduction of low-quality Bt seeds knowingly.

Two reasons are responsible for Monsanto’s decision to provide Burkinabe farmers knowingly with low-quality, not fully operating Bt seeds. First, they were calculating that when they can claim successful business in a main cotton-producing West African country like Burkina Faso, other countries will follow the path and start introducing GM cotton as well. Secondly, they were probably not noticing the big quality gap between American and Burkinabe cotton, which concludes in a more technical fault, resulting from a lack of motivation and ignorance (interview 3).

The farmers’ union, UNPCB, who also holds shares in all three cotton companies, was in the beginning opposed to ending the contract. Therefore, one interview partner claims that the contract was interrupted later than usually intended by the cotton companies. The farmers represented by the UNPCB had, at least in the beginning, a mostly positive economic impact. They were not directly affected by the market’s reaction to the loss in quality (interview 3). They had the cotton companies as a buffer and guaranteed sales before. Also, the contract was renewed again for ten years in 2013 (Pertry 2017) but ended prematurely in 2016 (interview 3). Another interview partner claims that although there is a board of representatives at Sofitex, which also holds a chair for members of the UNPCB, they did not really have a say in deciding whether Bt cotton was abandoned or not (interview 1).

Independent of UNPCB being involved in the abandonment or not, the worse-off, indebted, or even just smaller-scale farmers are barely represented by the farmers’ union and thereby could not have participated in the suspension. Although the moratorium of Bt cotton might at least financially relieve them and contribute to lower their debts.

7. Comparison of case studies

In both country contexts previous research resulted in similar findings after the first years of producing with Bt cotton. The outcome of studies is similar. In both cases the adoption rate of smallholder farmers was fast; also yields increased in both cases, costs for inputs decreased and less pesticides needed to be sprayed. Environmental, social and health benefits accompanied economic benefits and resulted in a decrease of social inequality (Bennett 2004). Although the portrayal of the base line for both case studies was represented similarly, their contexts differ widely. By analysing the case studies, I identified parameters that illustrate the difference. This makes a comparison impossible and a difference in final outcomes unavoidable. These determinants further discussed include scale, institutional context, funding, technical aspects, and debtor and size of debts, and will be discussed in detail.

7.1 Scale

Difference in scale within this analysis does not simply refer to farm size or cotton production area, but also refers to cotton as a crop in relation to other crops produced in these countries. Additionally, the relation of smallholders to large scale producers also plays a crucial role for the outcome.

In South Africa most of the cotton is produced large scale, on an area over five ha. In Burkina Faso, cotton is cultivated on plots of land between one and three ha. Cotton as a crop is only a minor crop in South Africa, making up only 1% of all croplands used for GM crops (including corn, soybeans and cotton), which is even less from land used for agricultural production in total.

Further, in Burkina Faso there is a big share of population dependent on cotton production. In 2018 the livelihood of around three million people (Vitale 2018) was secured by around 350,000 smallholder cotton producers, out of a population of around 19.5 million (World Bank, via data.worldbank). In contrast, those dependent on cotton production in South Africa out of a population of 57.5 million in 2018 were only 1,450 farmers, of which 1,300 were smallholders.

South African smallholders cultivated cotton on plots around 2–5 ha (ICAC 2019: p. 4), up in total 5,000 ha (ibid) of 28,000 ha (USDA 2021: p. 5) cotton production area. This is only a very small share of 12,413,000 ha of crop land in South Africa. In contrast in Burkina Faso cotton production occupies around 10–15% of arable land

(ejatalas, 2017) and thereby accounts for around 4% of national GDP (Reuters 2017). This disparity in scale on different levels in domestic cotton sectors reflects in the outcome and contributes to the decision of producing with Bt cotton or not.

7.2 Infrastructure and institutional context

The supply with, and persistence of, a functioning infrastructure is necessary to make Bt/HT cotton a sustainable long-time project. It is thereby partly a direct result of the institutional context within national cotton production networks. South Africa was used as a best practice example to introduce Bt cotton in other African countries that cannot provide a highly technical infrastructure within its cotton sectors. For production of GM cotton the infrastructure throughout the season and after harvesting has to be in place, cotton must be processed as soon as possible in gins, and also the infrastructure for seed supply must be in place.

GM seeds must be treated before they can be planted. The cycle of collecting seeds, treating them right, storing them, doing quality testing and making sure that cotton producers receive high-quality GM cotton seeds again, expressing its genes, is overseen by Sansor in South Africa (interview 7). Owed to the fact that all cotton in South Africa is GM, quality control is much easier. There is no need for attention regarding separation of GM and non-GM seeds in the ginning process.

Mahyco, having a monopoly in cotton seed supply all over South Africa, resulted from the small cotton sector in total. The adaptation to GM of the whole sector made production with GM cotton possible and rentable for large scale producers in an environment rather not suitable for cotton production. But the full adaptation of the whole infrastructure to GM, including the outsourcing of R&D, also made the South African Cotton production network dependent on corporate R&D. The only alternative to the technology applied would be another new technology introduced. This is argued by actors from within the value chain but also independent research institutes (interview 9, 10).

Even though in Burkina Faso there is also a high centralisation in the cotton sector, and split between three cotton companies, not all cotton planted was GM. Lack of care in the ginning process, when it comes to separation of GM and non-GM seeds, also contributed to the outcome that Bt cotton is not grown in Burkina Faso anymore (interview 5). A study by Bourgou et al. (2020) showed that Bt seeds were

contaminated with conventional seeds, not expressing Bt genes and vice versa in the ginning process. This resulted in already lower cotton quality, additionally still needing again treatment with more pesticides. Results were loss owed to a loss in quality in Burkina Faso (Krinninger 2016, ejatlas 2017, Bavier 2017,a).

Finally, producers do not have the freedom to choose whether they plant GM cotton or not, in both contexts. But in South Africa smallholders finding it not profitable for some reasons can still return to other crops as a livelihood strategy. In Burkina Faso an abandonment of Bt cotton was decided by the government because the government of Burkina Faso was directly hugely affected by big losses that occurred. Cotton producers in Burkina Faso still 'wish bt cotton back' (interview 1) because for them a return to conventional cotton also means a return to use more pesticides. Still, for the government of Burkina Faso a return to Bt cotton is not fully precluded yet (interview 4), but new terms must be negotiated before.

The level of statal involvement in the national cotton production network results from the grade of liberalisation of cotton sectors in total. The institutional context contributes in different ways to facilitate GM technology or to abandon it. For the government in Burkina Faso the status quo was not bearable anymore. Obvious huge losses resulting after not even a decade of producing with Bt cotton led to the outcome of abandonment. If they produced further with Bt cotton, the lower grading and price achieved for it on the world market would have also reflected medium-term in the *fonds de lissage* and thereby would have directly affected producers. In South Africa the cotton sector is small with even not enough smallholders being involved to invest in appropriate production methods for small-scale producers. The domestic cotton sector, after more than two decades, is fully adapted to production with GM. To take the step and invest in appropriate cotton production systems for smallholders is too big and to cost intensive as all R&D is already outsourced to biotech corporations like Bayer and BASF. Biotech corporations are already testing new varieties large scale, requesting new approvals soon (interview 9, 8).

7.3 Funding

Not all small-scale producers are necessarily poor, and cotton is also often not the only source of income for cotton producers. But smaller scale and resource-poor

farmers are more often dependent on credits and other funding to finance their inputs because their return on investment of previous seasons is not as big as for larger scale producers. This leads to a general need for and persistence of financial aid for cotton smallholders in SSA, provided through and by respective governments, as actors within national cotton production networks.

Producing with Bt cotton implies high costs for inputs (see Chapter 5.2.2.), including 50% technology fee in seed costs. Either way higher prices for GM seeds result in higher financial risk in advance. Even if other inputs are reduced Bt cotton might be unattractive for already resource poor farmers to buy (ibid.).

Additionally, contributing to the decision whether cotton is planted or not is the world cotton price and additionally the availability of credits, and in what relation the world cotton price is transferred to producers. In South Africa cotton production is not subsidised by the state; therefore small scale cotton producers are dependent on funding and ‘development projects’ initiated by the government (interview 9).

In South Africa most of the cotton is produced by large-scale producers (Cotton SA). Higher in number, but way less producing smaller scale farmers are often dependent on credits, which they often hardly can receive. A title deed is required to receive credits. But they do not possess the land they are producing on. This makes receiving credits difficult (interview 9). Different governmental development projects therefore aim at ‘uplifting’ (interview 9) smaller and resource poor farmers. This leads to an increase of cotton production in certain regions (interview 9). Between 2012 and 2018 a project was initiated, besides others, by the Department of Rural Development and Land Reform (DRDLR) to enhance cotton production by smallholders and to ‘support […] cotton farmers in three provinces to enable sustainable producers of quality cotton’ (ICAC 2019: p.6). In the latter project again 90 million South African Rand (USD 8,3 million) were invested in cotton production for smallholders (ibid.). The introduction of Bt cotton in the 1990s in the Makhathini flats was a similar project. With a functioning credit system (ACB 2011: p.11) and the provision with infrastructure, including a gin (Schnurr 2019), Bt cotton worked out for a certain time in the region (ACB 2005: p.20). But the already small number of 5% of population of the flats producing cotton dropped due to a disruption of the input-credit system. A temporary shutdown of infrastructure and a high technology fee finally contributed to this outcome (interview 9).

Burkina Faso is also not capable of subsidising its farmers. But cotton serves as major cash crop for many producers there. They have a functioning input-credit system to provide different groups of farmers, most of them smaller scale, cultivating 1–3 ha of land, with the inputs and credits needed. The secure input-provision system with a secured market and a division of farmers in co-operatives (GPCs = *groupments des producteurs de coton*), where farmers bail for the payback of the loans of each other, makes receiving inputs easier even for poorer farmers (Dowd-Uribe 2014a: p. 558).

Besides easier availability of credits for inputs, two other incentives contributed to a high adoption rate in the early years of Bt cotton in Burkina Faso. One was the introduction of the *fonds-de lissage* that protects producers from volatility of world cotton prices. Another one was the increase of prices paid to producers in season 2007/2008, when Bt cotton was planted the first time for commercial purpose. The floorprice for cotton was increased from 145 CFA to 155 CFA/kg grade one cotton (USD 0.34 to 0.39) and the government subsidised nitrogen (NPK) and urea fertilisers with USD 15.5 million additionally. The result was a decrease of prices for fertiliser from around USD 47 to USD 29 for NPK and USD 31 for urea (wikileaks), by at the same time making incentives for cotton production by increasing the possible net earnings. These aspects in combination with high expectations resulted in many producers deciding for Bt cotton in the beginning.

7.4 Technical aspects

The South African agricultural sector was described as modern, equal to the US considering infrastructure, size of farms and use of heavy agricultural machinery already back in the 1990s (interview 8, 6). South Africa could in general not be compared to other African countries when it comes to farm sizes and agricultural practices (interview 6). In Burkina Faso, agricultural labour is often still done by hand and with the help of animals; thereby the whole family is involved (interview 1).

Besides the aspect of stage of industrialisation of domestic cotton sectors, the location of R&D is further relevant. This additionally led to different outcomes. Also, traits introduced in general, and the research done on predominant traits planted play a role. Cotton grading and the importance to produce quality cotton for certain

contexts, to achieve higher prices, are technical related aspects responsible for different outcomes and thereby crucial to understand them.

In Burkina Faso it was contractually agreed that GM traits were developed and bred in collaboration of the national research institute INERA, the French CIRAD and Monsanto. This should have led to transferring the demanded characteristics of insect tolerance, provided by Monsanto, to local varieties. Reality of collaboration in R&D though looked different. The time for backcrossing with local varieties was not sufficient. The result was an import of Bt cotton hybrids from the US (interview 3), resulting in lower quality cotton, despite Burkinabe officials objecting to it from the beginning on, fearing a loss in quality as a result (Schnurr, 2019). The importance of quality of cotton, for the survival of a big cotton sector, providing the livelihood for a big share of the population, contributed in Burkina Faso to a return to production with conventional cotton after 2016. This was only possible through an intact national, not fully outsourced, R&D sector and infrastructure.

In South Africa R&D is already outsourced to transnational biotech corporations like Bayer/Monsanto, BASF or Syngenta. The only patent holder receiving technology fee, via cotton companies in South Africa was by the time of writing Bayer. The whole infrastructure is adapted to biotech cotton. All research considering the development of new traits is done, although partly on national territory, under authority of biotech companies like Bayer. The seed companies are the ‘bosses’ (interview 7) of the national seed authority Sansor, which is in the case of South Africa Mahyco. But the patent holder and provider of technology is still Bayer. Research on impact of recently planted traits, which are treated with glyphosate, on smallerholder livelihoods and environment is not available. Although South African authorities have done a study on the impact of glyphosate and GM traits on environment (interview 6) it is not accessible. Further, there was a study planned to be done on the influence of HT crops on environment, in the financial year 2011, according to an ACB (2011) report. But the responsible for this study, Dr. Lukeshni Chetty, changed employment from SANBI (South African National Biodiversity Institute) to general manager of Sansor in October 2012.

There was a study completed about the influence of Bt maize and the toxin expressed on the environment. But a study on HT crops, and the impact the use of glyphosate has, that was planned in 2011, is still outstanding or at least not available.

A request about this study and the results were, till time of writing, not answered by SANBI. Additionally other non-firm actors and non-governmental actors like ACB have also not researched the influence of HT crops on livelihoods and environment. The number of smallholders involved in production with HT cotton is too small; also data on geographical location of production sites with GM crops is not available (interview 10).

7.5 Loss

Despite the claim of economic upgrading of farmers and other actors along the value chain in both country contexts, losses occurred. According to an ACB (2011) report in South Africa in the Makhathini flats, producers' debts increased because of high seed costs. The combination of low world cotton prizes and high seed costs resulted according to this report in 'cumulative debts of all farmers in the area' topping USD 3 million, USD 1322/farmer. Even though this must be seen critically, as ACB in 2005 reported, that cotton smallholders only make up 5% of the population in the flats and their crops only cover 0.7% of the land there. While ACB suggests that there was a decline in cotton production and an increase of debts of farmers, the price for GM seeds could only be one variable contributing to debts of farmers in the Makhathini flats.

A disturbance of the institutional setting, including the supply with credit for inputs, and a drop in world cotton price, are other factors contributing to increased debts of cotton smallholders. Their number in the flats dropped in 2002 from 1,400 out of 5,000 smallholders, to 1,300 cotton smallholders all over South Africa in 2019 (ICAC). This suggests a decline but does not verify a total abandonment of GM cotton by smallholders. The number of small-scale cotton producers goes along with rises and falls of world cotton prices. It is thereby another major factor contributing to the decision whether to cultivate cotton or not. But cotton smallholders are either way considered as marginal (interview 6, 8), and is is not simply a result of introducing GM cotton. A common livelihood strategy in South Africa for smallholders, to avoid a financial risk resulting from the production with GM cotton, like suggested by Neilson, is turning to other crops.

In Burkina Faso the price smoothing mechanism *fonds de lissage* was implemented shortly before Bt cotton was introduced for commercial production. It resulted for

cotton producers in Burkina Faso in not being directly affected by a price drop resulting from a loss in quality, and a resulting low price for their cotton being achieved on the world market. The losses were absorbed by cotton companies, producers were protected by the price smoothing mechanism. But the loss in quality was not communicated to producers (interview 1). Producers was told that production with Bt cotton stopped without reasoning. As a result, they were dissatisfied with a return to conventional cotton. From the point of view of producers, yields were a little higher and they additionally received a higher price for Bt cotton from companies.

By the time of abandonment, Sofitex was still a major actor in the national cotton production network. Losses resulting from a decrease in cotton quality, resulting from production with Bt cotton, affected the government of Burkina Faso directly. This was owed to a part liberalisation of the cotton sector in Burkina Faso and governments' continuous involvement as actor within, by owning a big share of the major cotton company. The final result was by 2016, a loss of 85 million dollars for cotton companies, owed to the inferior cotton quality resulting from production with Bt. 19 million USD were compensated by held back royalties owed to Monsanto; the rest was dropped by Burkina Faso as a 'goodwill gesture' (Bavier 2017).

To that end, it can be concluded that a major factor contributing to the decision to abandon Bt cotton is the size of losses occurring from it, but also who is paying off debts. Even though the true economic impact it has on smallholder producers in contrast, is not crucial for the decision by governments and other monopolised agribusinesses, whether to facilitate GM cotton or not.

7.6 Final note

The choice for producing with GM cotton and a possible payoff for smallholder producers is accompanied by several factors. One is connected to funding of resource poor producers to enable cotton production. Another one is linked to different aspects of scale. Lower mechanisation levels on the producer side often goes along with smaller farm size. This further reflects in agricultural practices. The technisation and industrialisation of the whole sector also reflects in the infrastructure. A thereof resulting monopolisation in inputs like seeds and outsourcing of R&D is one major aspect, contributing to a possible successful adaptation of GM cotton. But if the quality of seeds is not according to expectations, GM cotton cannot

be successful in a country where a big share of population is dependent on cotton production.

Further it must be admitted that climatic conditions in South Africa are not suitable for cotton production at all. This is probably also contributing to a small number of smallholder producers and thereby resulted in a dominance of GM cotton in South Africa. For large scale producers, which are dominant in the domestic cotton sector, bt and ht cotton works out well in regard of benefiting economically from it (interview 6, 10). In this all actors agree. Nevertheless, small scale producers were used as an example for successfully using Bt cotton in the Makhathini flats, serving thereby as showcase and model for other African smallholder dominated countries to introduce it. The adoption rate of the whole country does not reflect a total failure, nor can it be considered as a full success. But the Makhathini flats cannot and should not be used as paradigm for upscaling small holder cotton producers.

8. Conclusion

This thesis has analysed the environmental, social and livelihood impact the introduction of GM cotton had on different groups of farmers and other actors along the South African and Burkinabe cotton value chain, and within its production networks. It used theory on GPN to localise and position the nation-state and its role within production networks (Horner 2017). Further, it used the concept of upgrading in primary production provided by Gibbon (2001) to identify the purpose of introducing GM cotton in both contexts. It drew on the concepts of environmental up-and downgrading (Campling 2019, DeMarchi 2013, 2019) and livelihood up-and downgrading (Neilson 2019) to assess the impact GM cotton's introduction had on different groups of farmers. The analysis methodically built up on online interviews with different experts involved on different steps in the cotton value chain and within the national production networks. Additionally, different data sources and documents were used to show trends and impacts resulting from production with GM cotton in South Africa and Burkina Faso.

The findings suggest that in both cases without contribution of governments as facilitator, Monsanto's Bt cotton could not have been introduced with the purpose to economically upgrade smallholders. This was, besides fighting pest pressure, the aim of production with Bt cotton in both country contexts. However, the exact roles of governments differed, owed to different basic parameters. In South Africa the cotton sector is already very liberalised. In Burkina Faso there is still strong governmental involvement and regulation in the whole cotton industry. This latter also expresses in a market dominance of the parastatal cotton company Sofitex.

While both governments facilitated the production with Bt cotton and supported thereby the provision of smallholders with Monsanto's seeds, the way they funded resource poor smallholders, differed. In South Africa's Makhathini flats, which later served as an example for other African countries, resource-poor smallholders were provided with bt seeds and other inputs. The institutional setting and infrastructure were put in place. This also included a gin. Poorer farmers also were able to receive credits in the context of this *development project*, funded by the government, independent of title deeds and property rights. The result, after first positive evaluated production years, was an increase in debts of already indebted farmers in the region. With the disruption of the institutional setting, poorer farmers could not receive credits

for inputs anymore. The result was a decrease in cotton production, with a choice for other crops.

In Burkina Faso the Burkinabe government, as major shareholder of the main cotton company Sofitex, is involved in the domestic cotton sector and took the role as producer, besides its crucial role as facilitator of Bt cotton (Horner 2017). For the short period of cultivating Bt cotton, for a majority of producers an economic upgrading was achieved. But Bt seeds per se were not exclusively responsible for this positive impact. The *fonds de lissage*, a price smoothing mechanism, including a prior season negotiated floor price for producers, was introduced. Originally it was intended to protect producers from the volatility of world cotton prices. In this special case this floor price also protected producers from a transference of a price decline owed to quality loss. Further lower prices for other inputs like fertilisers were funded by the government, while prices producers received for cotton were increased. These incentives contributed to higher margins when Bt cotton was introduced and contributed to high adoption rates in the early phase of producing with Bt cotton. Further the terms for production of Bt cotton, and the contract were changed to suite Monsanto's terms. Also the government, owed to its role of producer, was finally directly affected by losses occurring from bad cotton quality. This led in Burkina Faso to the abandonment of Bt cotton in 2016.

Early studies claimed a positive social and livelihood impact for cotton producing smallholders in both countries. Spared time in spraying could be used differently. In South Africa through a reduction in sprayings the social status could be restored. Producers got rid of the pesticide smell on clothes. But in both contexts one major critique was the limited choice between conventional and Bt. In Burkina Faso, there was conventional cotton available, but if producers chose to plant it, they could no longer receive credits for other inputs, similar to the development project in the Makhathini Flats, where conventional cotton was only available in bigger bags. Bt seeds were sold in smaller ready-made packages, containing other inputs. This marketing strategy was by some perceived as positive and a simplification in production, but for others as a limited choice concerning their freedom to choose in inputs. Further, the financial burden to plant Bt was high for many poorer producers. This resulted in increased debts of already indebted farmers in South Africa. In Burkina Faso medium-term production would have showed the same results for

poorer farmers. Without the possibility to give Bt plants all inputs necessary because of high costs in total, Bt does also not perform better in regard of high yields.

Finally, the outcome of smallholder production with Bt cotton in both contexts is similar. Production stopped to a certain degree. In Burkina Faso Bt cotton was abandoned in 2016, thereby not being accessible anymore. In South Africa smallholders often chose to produce other crops because the high prices of seeds, including a technology fee, was a financial burden and risk that was too high to invest in Bt seeds. Thereby it underlines Neilson's (2019) argumentation, who emphasises that smallholders within this context cannot be conceptualised as firms; further they do not act like firms. Nevertheless, they are selling their products to lead firms within value chains. As a result, also within the South African context, they choose, despite the potential of higher margins, to produce other crops, due to an increased livelihood vulnerability on household level.

Also, in both contexts, the impact on environment was partly evaluated positive. A reduction in pesticide sprayings was one major result, thereby also resulting in water savings. This reduction in sprayings further had a positive impact on crops bordering cotton fields, with a decrease of contamination of food crops with toxic pesticides, thereby also leading to positive health effects. Another positive impact in the Burkinabe context was that no land conversion of formerly uncultivated land to cotton fields happened. But in Burkina Faso pesticide use did go up again after 2010 and stayed constant since. In South Africa the fact that all cotton planted officially is genetic modified, leads to implications considering biodiversity. Despite the sector being small in total, 100% GM cotton implies a loss in biodiversity per se, leaving no space for alternatives.

Further, in both countries research gaps were identified considering the environmental impact. In Burkina Faso there are claims of producers, concerning impacts on animal health, that are not researched yet. In South Africa, most significantly, after more than two decades of cultivating GM cotton, production shifted from Bt to HT crops, predominantly done by large scale producers. This results in blank spaces concerning the impact on environment and livelihoods, after research was done only on Bt cotton in the first years of production. Neither the government provides data on the impact of herbicide tolerant crops and glyphosate on soil and environment, nor is there research done by independent research institutions. The

effort is big and the sector and involvement of smallholder producers not enough. Additionally, independent research institutions admit having problems localizing areas where GM cotton is planted, due to a hard accessibility of data on geographic locations of GM crops. Further they claim a lack of smallholder involvement to research this era of HT crops in detail.

It can be concluded that in agricultural value chains with a focus on cotton, traders are identified as leadfirms like suggested by Gibbon (2001). But their power to put pressure on actors upstream and within the value chain is bigger if the state is dependent on export earnings for its GDP through sales of cotton. This was the case in Burkina Faso. There is no distinction on the market between genetic modified and conventional cotton per se for prices to be achieved. But in contrast loss in quality does impact prices. This expresses through lower prices received on the world cotton market, transferred to actors further upstream the value chain. Although this often affects producers directly, in the case of Burkina Faso losses were intercepted by the government. In South Africa prices producers receive are tied to world cotton prices. Fluctuation and low prices are transferred to producers directly, with discounts or premium for lower or higher quality. These alterations in prices therefore reflect in adoption rates in general. In contrast higher prices are incentives for small holder farmers to decide for cotton. But all things considered the price is not the sole decision-making basis. The institutional setting and the infrastructure necessary for cotton production, eventual governmental involvement through funding and climatic conditions in the areas play key roles, particularly in South Africa.

Results of this thesis contain theoretical implications contributing to theory on chain and network literature in the sense that biotech corporations like Bayer/Monsanto must be accounted as lead firms when it comes to the analysis of agricultural value chains (Gibbon 2001). This is firstly argued by a global big share of cotton cultivated being GM. It expresses in a strong influence these companies have on price creation for inputs (including technology fee in seeds) cotton producers have to pay. Secondly, they have not only impact on prices for inputs as seeds, but also the domestic cotton industry must adapt to provide quality GM cotton seeds. Treatment of GM seeds is different to conventional seeds prior planting. And seeds cannot and must not be spared for replanting after harvesting. Thirdly the cultivation with HT crops, which is very dominant globally, leads to further implications in the value chain

regarding inputs. Former patentholders of herbicides used on HT crops also produce seeds or at least they are patent holders of the technology for production of seeds, like in the case with Bayer as a patent holder for different GM traits available in South Africa. They at the same time provide herbicides containing glyphosate. Although generics are available, a big share of cotton producers still uses the originals, also resulting from the possibility to lose all claims, if the cotton does not work out as expected when generics are used.

Additionally, actors downstream the global cotton value chain do less take account of how production of cotton impacts livelihoods of producers and influences the environment. The securing of livelihoods and economic upgrading of smallholders is secondary, but intrinsically tied to it, in countries with a domination of smallholder cotton producers. Their focus is like suggested by Gibbon (2001) that a demanded continuous quantity of cotton in best possible or expected quality is provided to traders and further downstream. Vice versa, traders are dependent on retailers as lead firms, as is the case in the apparel industry, where cotton is used extensively.

Considering the social and livelihood impact the outcomes are ambivalent, owed to the different roles nation-states take. While in South Africa the state only acts as facilitator (Horner 2017), low prices are directly transferred to producers. Further producers might choose to grow different crops as a livelihood strategy (Neilson 2019). In Burkina Faso the governmental role of producer and facilitator (Horner 2017) also introduced a price smoothing mechanism, besides other funding, that protected and supported producers. This protected producers from price decline when cotton quality and world market prices were low. But the latter, although profiting from Bt cotton, had to switch to conventional cotton again, without choice.

Environmental upgrading should, according to De Marchi et al. (2019), in total result in more improvements for environment than losses, respectively when it comes to GHG emissions, biodiversity loss and overexploitation of nature. Even though emissions and pollution might be reduced, producing with Bt cotton leads to a loss in biodiversity. Considering the offer in seeds, which is extremely reduced through this monopolisation, a loss in seed diversity is intrinsic. A monopoly of GM cotton in a country with the whole value chain being adapted to it, necessarily leads to a lower level of biodiversity. Further pest resistance or resistance to glyphosate, although not yet officially occurred in South Africa and Burkina Faso, but in other cotton growing

regions of the world would lead to an increase in pesticide use again. The result in these cases is an increase of pesticides used in total (see also Beckie et al. 2014, Lee et al. 2014, Ferreira Mendes 2021).

In the medium-term, despite an abandonment of Bt cotton in Burkina Faso and the low adoption rates in South Africa, an introduction in both contexts can be accounted as successful for biotech leadfirms. The little sector still cultivating in South Africa and the short period in Burkina Faso were sufficient examples for other African countries to adopt Bt cotton, although they refused it before. Even though eastern African countries were well known for their focus on and strength in organic cotton production (interview 5), in 2020 Bt cotton was released in Kenya (Nanteza 2022). Also, in Burkina Faso a return to Bt cotton, after fixing the quality issue, is not precluded. In South Africa different actors from within the value chain hope for a new technology to be brought in soon. Thereby emphasizing the working out of the ‘old’ technology. It is not clear whether weed resistance occurred to glyphosate, but why would there be a need for a new technology then? They hope for biotech corporations to invest in the little sector. New projects are already in the pipeline. BASF as provider of seeds, *LibertyLink* cotton with *Glufosinate* thereby substituting *glyphosate* as herbicide, and *Bollgard III*, are already in the last phase before permission.

On the background of knowledge on the technological pathway African countries take when it comes to cotton production, and a concentration of power in biotech-leadfirms, attention needs to be drawn to blank spaces in the discussed case studies for further research. The case of Burkina Faso seems to be researched a lot. And owed to the circumstance, production with Bt cotton stopped, also the scientific discourse around it trickles away. Allegations of farmers seem not worth rolling up the case again; most of all, everybody involved in cotton production seems to have already talked enough about it (interview 1). In the case of South Africa blank spaces illustrate themselves differently. A whole era of GM cotton cultivation is not researched at all, although portrayed as history of an era of successful GM cotton production, lasting more than two decades. The hard accessibility of certain actors in the value chain, leaves questions in the field on the impact GM cotton, respectively HT cotton and glyphosate, further have on producers, environment, and the whole cotton production network.

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10. Appendix

I Abstract

Monsanto's Bt cotton was introduced in South Africa and Burkina Faso in the late 1990s and early 2000s. Besides fighting pest pressure, fighting poverty was a declared aim of introducing genetically modified (GM) cotton in both countries. As of now in South Africa the whole cotton production network is adapted to production with GM cotton, including varieties tolerant to glyphosate, an herbicide also developed by Monsanto. In Burkina Faso Bt cotton was abandoned through a state decision after eight years of producing with Bt cotton. This thesis analyses the role of states, Monsanto and international traders in the introduction of Bt cotton in South Africa and Burkina Faso, and their role in abandonment in Burkina Faso. Environmental, livelihood and economic impacts of Bt cotton and other GM cotton varieties are aspects of interest for this research. Furthermore, it looks at how Bt cotton has led to alterations in cotton production and cotton sectors in general. The analysis uses theory on global value chains and global production networks. The concepts of upgrading in primary production and environmental and livelihood upgrading were used to assess the impact on smallholders in both contexts. Methodologically, this thesis uses quantitative data provided by different sources, such as FAOSTAT, Statista and national cotton marketing boards. Most importantly, ten semi-structured online interviews with different actors within the national cotton production networks, NGOs and scholars contributed to qualitative data. The findings suggest that the role of the state is crucial for different reasons. It provides the base for a legal framework to make production with GM cotton possible. Furthermore, the state is a facilitator either in providing GM cotton via a parastatal cotton company or through governmental development projects. Moreover, the state and governmental involvement in the cotton sector was also crucial for the decision of abandonment in Burkina Faso. There the state, through strong governmental involvement in the sector, was directly affected by huge losses, that occurred through production with low quality Bt cotton. In South Africa, a very liberalised small sector, allows direct transference of low world cotton prices to producers. Loss of producers and the decision to produce other crops is a result. The environmental and economic impact that Bt cotton had was evaluated as positive in both contexts in the early years. But there are significant blank spaces in both contexts where further research is lacking. In South Africa, where the whole production network is adapted to production with GM cotton, a loss of biodiversity is one negative result, further the small sector is dominated by large scale producers, because production for smaller scale producers is too risky and not rentable. In Burkina Faso, during production with bt cotton the use of pesticide did go up drastically again. Finally, a comparison of case studies shows that different factors like scale, infrastructure and institutional context, funding, technical aspects, and different aspects of loss contributed to an adaptation of the whole sector to GM cotton in South Africa, while Burkina Faso abandoned production with Bt cotton in 2016.

Monsantos Bt-Baumwolle wurde in den späten 1990er und frühen 2000er Jahren in Südafrika und Burkina Faso eingeführt. Neben der Bekämpfung von Schädlingsbefall, war die Bekämpfung von Armut ein erklärtes Ziel der Einführung von genetisch veränderter (GV) Baumwolle in beiden Ländern. In Südafrika ist inzwischen das gesamte Baumwollproduktionsnetzwerk auf die Produktion mit GV-Baumwolle umgestellt, einschließlich Sorten, die gegen Glyphosat, einem ebenfalls von Monsanto entwickelten Herbizid, tolerant sind. In Burkina Faso wurde der Anbau von Bt-Baumwolle aufgrund eines staatlichen Beschlusses nach acht Jahren aufgegeben. Diese Arbeit analysiert die Rolle des Staates, Monsantos und internationaler Händler bei der Einführung von Bt-Baumwolle in Süd Afrika und Burkina Faso, und im Fall von Burkina Faso auch deren Rolle in der Beendigung der Produktion damit. Die Auswirkungen von Bt-Baumwolle und anderen gentechnisch

veränderten Baumwollsorten auf die Umwelt und den Lebensunterhalt, sind neben wirtschaftlichen Aspekten, von Interesse für diese Untersuchung. Außerdem führte GV-Baumwolle zu Veränderungen in der Baumwollproduktion und in den Baumwollsektoren im Allgemeinen. Die Analyse stützt sich auf die Theorie der globalen Wertschöpfungsketten und der globalen Produktionsnetzwerke. Die Konzepte der Aufwertung der Primärproduktion, der ökologischen Aufwertung und der Aufwertung des Lebensunterhalts wurden verwendet, um die Auswirkungen auf Kleinbauern in beiden Kontexten zu bewerten. Methodisch stützt sich diese Arbeit auf quantitative Daten aus verschiedenen Quellen wie FAOSTAT, Statista und nationalen Baumwollmarketingbehörden. Zehn Online-Interviews mit verschiedenen Akteuren:innen innerhalb der nationalen Baumwollproduktionsnetzwerke, NROs und Wissenschaftler:innen trugen zur Erhebung qualitativer Daten bei und ergänzten die Endergebnisse dieser Untersuchung. Die Ergebnisse deuten darauf hin, dass die Rolle des Staates aus verschiedenen Gründen entscheidend ist. Er bietet die Grundlage für einen rechtlichen Rahmen, der den Anbau von GV-Baumwolle ermöglicht. Darüber hinaus unterstützt der Staat die Bereitstellung von gentechnisch veränderter Baumwolle entweder über eine halbstaatliche Baumwollgesellschaft oder durch staatliche Entwicklungsprojekte. Auch die Beteiligung des Staates und der Regierung am Baumwollsektor ist entscheidend für die Entscheidung, den Anbau einzustellen in Burkina Faso. Dort war der Staat durch sein starkes Mitwirken in diesem Sektor unmittelbar von den enormen Verlusten betroffen, die durch den Anbau von Bt-Baumwolle geringer Qualität entstanden. In Südafrika ermöglicht ein stark liberalisierter kleiner Sektor die direkte Weitergabe der niedrigen Weltmarktpreise für Baumwolle an die Erzeuger:innen. Der Verlust von Erzeuger:innen und die daraus resultierende Entscheidung, andere Kulturen anzubauen, ist eine Folge. Die Auswirkungen von Bt-Baumwolle auf die Umwelt und die Wirtschaft werden in den ersten Jahren in beiden Kontexten als positiv bewertet. In beiden Kontexten gibt es jedoch große Lücken, die nicht weiter erforscht wurden. In Südafrika, wo das gesamte Produktionsnetz auf den Anbau von GV-Baumwolle umgestellt wurde, ist der Verlust der biologischen Vielfalt ein negatives Ergebnis, außerdem wird der kleine Sektor von Großproduzent:innen beherrscht, da die Produktion für kleinere Produzent:innen zu riskant und nicht rentabel ist. In Burkina Faso ist der Einsatz von Pestiziden während des Anbaus von Bt-Baumwolle nach den ersten Jahren des Anbaus wieder drastisch angestiegen. Schließlich zeigt ein Vergleich der Fallstudien, dass verschiedene Faktoren wie Größe, Infrastruktur und institutioneller Kontext, Finanzierung, technische Aspekte und verschiedene Aspekte von Verlusten zu einer Anpassung des gesamten Sektors an GV-Baumwolle in Südafrika beigetragen haben, während Burkina Faso 2016 beschlossen hat die Produktion von Bt-Baumwolle einzustellen.

II List of interview partners

Number	Date	Mode and Language	Interview partner
1	26th March 2021	Online - English	Sociologist, Colorado State University, US
2	14th May 2021	Online - English	Professor of International Studies, University of San Francisco, US
3	19th June 2021	Online - English	Agricultural economist, CIRAD, Montpellier
4	17th June 2021	Online - English	FIAN, Burkina Faso
5	2nd March 2022	Online - German	Trader, Switzerland
6	4th March 2022	Online - English	Biosafety South Africa
7	9th March 2022	Online - English	Expert in GM Input provision, South Africa
8	16th March 2022	Online - English	Policy and research manager, SANSOR, South Africa
9	23rd March 2022	Online - English	Cotton SA
10	19th July 2022	Online - English	Researcher, African Centre for Biodiversity, South Africa