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Publisher: Cogent OA

Journal: *Cogent Food & Agriculture*

DOI: <http://dx.doi.org/10.1080/23311932.2018.1477541>



Stakeholder Perceptions of the Impact of Reforms on the Performance and Sustainability of the Cotton Sector in Ghana and Burkina Faso: A Tale of Two Countries

Yaw Agyeman Boafo^{1*}, Boubacar Siddighi Balde², Osamu Saito³, Alexandros Gasparatos², Rodolfo Damlam⁴, Nadia Ouedraogo⁵, Emmanuel Chamba⁶, Zida P. Moussa⁷

¹ Centre for Climate Change and Sustainability Studies, University of Ghana, Legon, Accra, Ghana

² Integrated Research System for Sustainability Science, the University of Tokyo, Tokyo, Japan

³ Institute for the Advanced Study of Sustainability, United Nations University, Tokyo, Japan

⁴ Graduate School of Frontier Sciences, University of Tokyo, Kashiwa, Japan

⁵ United Nations Economic Commission for Africa, Macroeconomic Policy Division, Ethiopia

⁶ CSIR-Savanna Agriculture Research Institute, Nyankpala, Tamale, Ghana

⁷ Ministry of Agriculture and Water Management, Ouagadougou, Burkina Faso

*Corresponding author email: yboafo@gmail.com

Abstract

This study investigates the outcomes that reforms had on the performance of the cotton sector in Ghana and Burkina Faso. These structural and policy reforms aimed at promoting competition and enhancing productivity, largely under pressure from external donor agencies. The study draws on in-depth semi-structured interviews with stakeholders involved in different aspects of cotton value chains in the two countries. In particular, it elicits the perception of the stakeholder of how reforms affected six domains (input credit systems, price determination and profit distribution, extension services, research and development, institutional and regulatory systems, and food security) related to the performance of the sector. This is complemented with the analysis of policy documents and annual cotton production pre- and post-reform. Results indicate that reforms in Ghana and Burkina Faso took different structural and policy directions, and subsequently, generated different outcomes to the six performance domains. Stakeholders in Ghana perceived predominantly negative outcomes, whereas Burkinabe stakeholders perceived both negative and positive outcomes. Regarding price determination for instance, Ghanaian respondents mentioned the lack of transparency in the seasonal price-setting system and decline in government revenue and farmer profit as direct outcomes of reform actions, while Burkinabe respondents cited guaranteed minimum price, high profit-sharing among farmers, and the favorable price incentives as some positive outcomes of the reforms. The empirical information outlined in this study can be used to identify positive and negative lessons relevant to stakeholders in the public and private sector to help sustain the cotton sector in different parts of sub-Saharan Africa.

Keywords: domains, extension services, food security, input credit, liberalization, sub-Saharan Africa

1. Introduction

Smallholder agriculture is perhaps the most significant socio-economic activity in sub-Saharan Africa (SSA) and is responsible for the livelihoods of hundreds of millions of households (FAO, 2014; AGRA, 2017). As an major industrial crop, cotton (*Gossypium hirsutum L.*) has played a prominent role in the national economy and rural livelihoods of various African countries for more than a century (Tschirley et al., 2010). Even before the colonization of the continent, households and communities cultivated cotton in smallholder settings using simple hand tools and animal traction on mixed cropping systems (Goreux, 2003). The system of cotton production changed significantly during the colonial period, with much of the cotton being grown on plantations to satisfy the needs of colonial governments (Kriger, 2006). After colonial rule ended, many newly independent SSA countries identified cotton as a critical crop to drive and boost socio-economic development, investing huge amounts of financial and human capital, and developing infrastructure to facilitate its production (Delpeuch & Leblois, 2014). In several countries, the cotton sector operated as monopolies, and by providing free inputs catalyzed the development of well-organized cotton production and marketing systems that incentivized many farmers to get involved in cotton cultivation (Kaminski et al., 2011).

Presently, cotton production is an important source of foreign exchange earnings and a major contributor to the gross domestic product (GDP) of multiple SSA countries including Burkina Faso, Mali, Benin, Zambia, Uganda, Zimbabwe, and Chad (Baffes, 2007; Kaminski et al., 2009; USDA, 2016). For millions of rural households, cotton cultivation remains an important source of livelihoods and sustained cash income, thus making it a vital crop in rural development and poverty alleviation strategies (Hussein, 2008). Studies across West Africa have also identified cotton cultivation as crucial in enabling smallholder farmers to enhance their food security (Solidaridad, 2016). For example involvement in cotton production can improve access to fertilizers through the credit schemes of cotton companies, and on several occasions serves as the sole entry crop for inorganic fertilizers into farming systems (Graaf de et al., 2011; Ripoche et al., 2015). However, other studies have contended that cotton competes with food crop production, thus increasing vulnerability and food insecurity, and causes loss of soil fertility and deforestation (Lele et al., 1990; Moseley et al., 2010).

The performance of the cotton sector and its contribution to the economies varies between SSA sub-region. The cotton sectors in countries of West and Central Africa have shown continued growth for many years, while countries in East and Southern Africa growth has been lower (Basset, 2001; Boughton et al., 2003). Overall, the continent's share of world cotton exports continues to rise, albeit still slowly (FAOSTAT, 2016).

Generally, cotton production in SSA consists mainly of small farmers that cultivate cotton under rain-fed conditions in small land holdings (up to 1-2 hectares), and is largely input-intensive (Kaminski, 2007; Abbott, 2013). The inability of rural farmers to access credit and purchase the necessary inputs has required strong government intervention through the establishment of state monopolies to regulate and control all sectors of production, especially following the colonial rule (Delpeuch & Leblois, 2014).

However in the early 1980s due to a series of crises in public monopolies in the cotton sector due to both local and external shocks (i.e., political instabilities, decline in global cotton price), several producing countries in SSA, including those in West Africa, were forced to initiate reform programs (Peltzer & Röttger, 2013). These were often under the pressure and direction of international donors such as the World Bank and International Monetary Fund (IMF) (Berg, 1981). In Ghana and Burkina Faso, these reforms were expected to enhance the competitiveness of the sector, with market liberalization as a means of increasing the relative prices of agricultural products being one fundamental action (Fosu et al., 1997; Abbott, 2013). The approach to (and the timeline of) reforms in the cotton sector has varied between SSA countries, although most countries faced international pressure as part of the Structural Adjustment Programme of the 1980s (Delpeuch & Vandeplas, 2013).

Although these reforms have boosted the performance of the cotton sector in some countries, other countries have seen only a modest improvement (or even a stagnation and continuing decline) due to various human and natural factors (Akiyama et al., 2003; Goreux & Macrae, 2003). For example, in East and Southern Africa, some countries such as Tanzania, Uganda, Zambia and Zimbabwe that followed the reform agenda in the mid-1990s enjoyed varied outcomes (Poulton & Maro, 2009; Poulton & Tschirley, 2009). In West Africa, Francophone countries such as Burkina Faso, Benin, Mali, and Chad, which initiated reforms in the mid-1990s, have often been cited as good examples of reforms improving the overall performance of the cotton sector (Vitale, 2018). Burkina Faso and Mali, for instance, have

emerged as two of the most progressive and proactive countries in SSA, with regard to the use of biotechnology in the cotton sector (Vitale, 2018) and using cotton as an effective strategy to reduce poverty in areas of cotton production. In contrast, Anglophone countries such as Ghana and Nigeria initiated reforms in the 1980s that had the opposite effect, leading to the stagnation or even collapse of the cotton sector (Baffes, 2007; Delpuech & Vandeplas, 2012).

However, the apparent success of reform programs in some countries of Western Africa such as Burkina Faso and Mali may have masked key challenges that can be overlooked. Understanding how reforms unfolded in different countries of the region and the perceptions of relevant stakeholders about their impact, can offer valuable lessons related to the strengths, weaknesses, opportunities, and threats of the cotton sector across SSA.

This study aims to investigate the perceptions of multiple stakeholders in Ghana and Burkina Faso regarding the impact of government-led reforms within the cotton sector on its performance and sustainability. We focus on these two countries as the reforms had radically different outcomes, with Burkina Faso considered a success story and Ghana a failure (see above). In this study, stakeholders are defined as individuals, groups, or organizations that can influence or be affected by a decision or policy within the sector (Tschirley et al., 2010). Following Tschirley et al. (2010) work, domains of performance and sustainability in this study include (a) input credit systems, (b) pricing determination and profit distribution, (c) extension services, (d) research and development, (e) institutional and regulatory systems, and (f) food security. By eliciting and understanding the perceptions of different stakeholders across these six domains, we seek to answer three main questions:

- (1) What has been the nature and scope of reforms of the cotton sector in Ghana and Burkina Faso?
- (2) How do the relevant stakeholders perceive the impact of reforms on the overall productivity and performance of the cotton sector in the two countries?
- (3) Do stakeholders' perceptions of performance agree with secondary data about the sector's productivity in the two countries?

Section 2 presents an overview of the nature and scope of cotton sector reforms in Ghana and Burkina Faso. Section 3 outlines the methodology and research design for the collection

and analysis of primary and secondary data (including the expert interview process and participants). Section 4 presents the main stakeholder perceptions across the six domains introduced above, as elicited through the expert interviews. Section 5 synthesizes the elicited perceptions, and discusses their practical implications and the limitations of this study.

2. Cotton sector reforms in Ghana and Burkina Faso

2.1 Background

For the purpose of this paper, the definition of reforms follows Tschirley et al. (2010), who understood reforms as deliberately chosen changes in the fundamental organization of a sector, and the related changes in the “rules of the game” under which stakeholders operate. The cotton sector has traditionally been managed in several countries of SSA (including Ghana and Burkina Faso), by vertically integrated, state-supported cotton companies (Theriault & Serra, 2014). These companies have largely operated under an input credit system by supplying under contract cotton farmers with production inputs such as cottonseeds, chemical fertilizers, pesticides, and plowing services on credit; and then the farmers then sell their cotton to the same company for a guaranteed price (Theriault & Serra, 2014). This model has more recently given way to more competitive market-based models and hybrid systems in an effort to improve the sector’s productivity and performance (Teft, 2004; Tschirley et al., 2010). Ensuring a fair, balanced, and stable pricing system is key for sustaining and ensuring that cotton can contribute to poverty eradication (IMF, 2003).

Governments in both Ghana and Burkina Faso faced similar pressures to reform their cotton sectors from the World Bank, generally as part of the Structural Adjustment Programmes of the 1980s (Peltzer & Röttger, 2013; Vitale, 2018). This was followed with recurring financial crises among cotton companies in the 1990s (Kaminski et al., 2011). Ghana initiated its policy and structural reforms in the mid-1980s and Burkina Faso in the early 1990s (**Table 1**). The main structural and policy reforms in both countries were instituted under the direction of the World Bank and IMF, with the main rationale being that the liberalization of the cotton sector would improve its competitiveness (Oxfam, 2007).

Figures 1-2 use data from the online databases of the Food and Agriculture Organisation (FAOSTAT) and the International Cotton Advisory Committee (ICAC) to highlight key patterns in the cotton sector for the two countries before, during and after the

reforms. Overall key indicators such as cotton area harvested (in hectares), production quantity (in tons), yield (in tons/hectare), and market share (percentage) show clear variation over time.

<<Add Figure 1>>

Figure 1. Key cotton production trends for Ghana and Burkina Faso: (a) area harvested, (b) production quantity, (c) yield. Sources: FAOSTAT (2016), ICAC (2016).

In Ghana, there was a steady decline in the area harvested from the mid-1970s through the 1980s, and a marginal increase in the sector's growth in the mid-1990s (**Figure 1a**). Area harvested in Burkina Faso increased progressively after the reforms of the 1990s (**Figure 1a**). Seed cotton production in Ghana increased minimally after the implementation of reforms in 1985, peaking at 38,000 tons in 1999, but could not be sustained, declining to around 2,500 tons in 2005 (**Figure 1b**) (MOFA, 2013). This corresponds positively with area harvested during the same period. The sector in Burkina Faso, on the other hand, enjoyed progressive growth after the implementation of reform programs (**Figure 1b**), with substantial growth in seed cotton production, especially in 1994 (54.34 %), 1997 (69.33 %), 2001 (85.86 %), and 2008 (90.98 %) (See **Figure S2 in Supplementary Electronic Material**). Both countries witnessed an increase in yield, corresponding directly to the area harvested, over the study period (**Figure 1c**).

However, the market share differed significantly for the two countries, the market share of Burkina Faso being higher than that of Ghana, despite some variation over time (**Figure 2**). For example, in 2008, the cotton production of Burkina Faso accounted for 38.2% of the West Africa's total, and 18.0% of SSA. In 2014, the regional share of Burkina Faso fell to 32.7%, but its continental share increased to 18.8%. In contrast, the market share of Ghana in West Africa has been consistently very low (less than 1%) and stagnant, with no recognizable increase in growth even after reforms in the sector. Ghana's low market share can be attributed to deep-rooted challenges and constraints of cotton production including lack of credit, inadequate education and extension services, poor quality seed, late inputs deliver, inadequate labor (ICAC, 2008; MOFA, 2013) (see Section 4-5).

<<Add Figure 2>>

Figure 2. Market share of cotton production in Ghana and Burkina Faso: (a) percentage share of production in SSA; (b) percentage share of production in West Africa. Sources: FAOSTAT (2016), ICAC (2016).

2.2 Cotton sector reforms in Ghana

The first stages of reforms involved in 1986 the replacement of the parastatal Cotton Development Board (CDB), which had been established in 1968, with the Ghana Cotton Company Limited (GCCL) (**Table 1**). This action paved way for the deregulation of the sector, ushering in a competitive market-based model. The cotton sector subsequently became an attractive investment option for many private companies, and by the 1996–1997 season, more than 12 companies had entered the market. The attractiveness of the sector during this period is attributed to the ease of entry facilitated by the availability of funding from the Agriculture Development Bank (ADB), and the favorable world lint prices between 1992 and 1997 (MOFA, 2013).

Under the new competitive market-based model, the cotton sector in Ghana experienced a period of boom followed by a period of rapid decline. The boom period occurred between the 1985–1986 and 1996–1997 seasons, when production rose from 956 to 24,953 tons (**Figure 1b**). This was largely due to increases in area harvested, from 409 ha to 28,712 ha, and the yields increasing from 504 kg/ha to 870 kg/ha (**Figure 1c**). This boom was fuelled by the availability of a local market (i.e. local textile companies that purchased cotton at prices between US\$1,620 and \$2,000 per ton), and direct government financial assistance in the form of cotton bonds that drastically reduced the interest burden on the companies. The subsequent period of decline spanned from the 1996–1997 to the 2010–2011 season. According to Ghana's Ministry for Food and Agriculture (MOFA), this decline had three principal causes: (i) loss of the local market for lint due to the liberalization of the economy and the subsequent influx of cheap textile products, (ii) high cost of inputs in the open market, and (iii) high interest charged by banks to the companies entering the world export market at a time when prices were falling. These forces had highly unfavorable impacts to

most companies, with many of them eventually divesting from the cotton sector (MOFA, 2013).

To address the decline, the government of Ghana introduced in 2000–2001 a zoning concept, under which the delineated cotton-growing areas were assigned to selected companies. This initiative was led by the Ministry of Food and Agriculture in conjunction with the Cotton Development Project 1 (CDP 1), and with the support of Agence Française de Développement (AFD), the French international development agency. Through this initiative three companies (i.e. *Olam*, *Wienco*, *Armajaro* and their partners) received government concessions to produce cotton in three zones: Upper West, North Central, and Southern North, respectively (MOFA, 2013). However, even after this policy intervention, some small-scale private companies that survived the bust of the sector, such as Intercontinental Farms and Plantation Development Ltd., continued their operations. However, despite some initial positive effects, the zoning could not prevent further decline, as by 2010 cotton production had dropped to a very low level of 2,500 Mt of seed (MOFA, 2013).

In 2011, the government of Ghana, through the Ministry of Food and Agriculture and the Ministry for Trade and Industry, and with donor support from the World Bank, embarked on an effort to revive Ghana's cotton sector. This effort was dubbed the “White Gold Campaign” and was expected to benefit about 100,000 farmers.

2.3 Cotton sector reforms in Burkina Faso

In Burkina Faso, reforms were first considered in 1991 but faced strong opposition and suspicion from local and international stakeholders (Kaminski & Bambio, 2009). With little structural change in the existing system, the reforms took a rather gradual approach. Some form of privatization was initiated in 1992 through the Burkinabe Textile Fibers Company (SOFITEX), which is the main government parastatal in the sector (**Table 1**). In 1998, the government reduced its stake in the cotton company by transferring 30% of its shares to a producer organization [National Union of Cotton Producers of Burkina Faso (UNPCB)], and 34% to Développement des Agro-Industries du Sud (DAGRIS). The state retains a 35% stake in SOFITEX, and private citizens hold the remaining 1%.

The second step of the reforms came in 1999 with the formation of a 12-member committee to coordinate the functions of SOFITEX and UNPCB. This included activities

such as the determination of farmgate prices, selling prices of inputs, and management of the overall research and development program. The committee consisted of seven producers, three SOFITEX representatives, and two government representatives (Baffes, 2007).

The third step involved limited liberalization in 2004 to ease the monopoly of SOFITEX over the national cotton sector. In a similar fashion as Ghana (Section 2.2), the country was subdivided into three zones of cotton cultivation (SP-CPSA, 2004):

- The western zone, operated by SOFITEX;
- The central zone, operated by Burkina Faso entrepreneurs under the name Faso Coton;
- The eastern zone, operated by DAGRIS under the title of SOCOMA (Cotton Company of the Gourma).

In 2006, an umbrella organization (Cotton Inter-Professional Association [AICB]) was created to coordinate the actions of all three cotton companies (Baffes, 2007).

According to Baffes (2007), the reform process in Burkina Faso reflected the view that the free-riding risks of the cotton sector are high, especially with regard to the provision of inputs (and hence credit recovery) and research and extension services. Burkina Faso's cotton market is presently structured into three regional monopsonies, with a main state-owned company that accounts for about 90% of cotton purchases and two private firms responsible for the remainder 10% of cotton purchases. During the decade that reforms occurred, cotton output in Burkina Faso increased nearly fourfold, from 64,000 tons in 1995 to almost 300,000 tons in 2005 (**Figure 1b**). Currently, cotton is one of the backbones of the Burkina Faso economy (Vitale et al., 2018).

Table 1 Timeline of major events related to cotton sector reforms in Ghana and Burkina Faso

Year	Reform actions
<i>Ghana</i>	
1985–1986	Deregulation of the cotton sector. CDB transformed into GCCL, with the government retaining 30% of shares. Supply of free inputs to farmers is maintained, but compensated by lower cottonseed prices.
1989	Proliferation of companies participating in the cotton industry.
1995	Government sells its 30% share in GCCL. Free input supply to farmers changes into input credit. Price-setting mechanism in put place. Diversion of inputs becomes a big problem.
1997–1998	Cotton Development Project 1 (CDP 1) is launched with financial support from AFD. Evolution of the Cotton Growers' Association.
1999–2000	Unprecedented malpractices in the cotton sector, including poaching of farmers and adulteration of product.
2000	ADB ceases financing of cotton companies, due to their high accumulated debt. Several companies begin to exit the cotton sector.
2000–2002	MOFA introduces a zoning policy to address malpractices in the cotton industry.
2004–2005	ADB takes control of GCCL through a debt-equity swap. GCCL is liquidated and ceases its operation.
2010–2011	Launch of cotton sector revival policy (“White Gold” campaign).
2016	Formal inauguration of the board of Cotton Development Authority to carefully examine the challenges of the cotton sector.
<i>Burkina Faso</i>	
1992–1993	SOFITEX (the national cotton parastatal company) commits formally to allow representatives of cotton producers participate in the reform debate. The government commits not to interfere with the management of SOFITEX and establishes a plan (Contrat-Plan) to streamline the accumulated debts of cotton producers and the parastatal.
1994	Amendment of laws pertaining to the establishment of farmer groups.
1996–1999	Free membership is introduced in the formation of local cotton farmer groups. The <i>groupements villageois</i> (village groupings) are replaced by market-oriented organizations (<i>groupements de producteurs de coton</i>) at the subvillage level, through the implementation of new local governance rules.
1996–2001	Establishment of the national cotton union (National Union of Cotton Producers of Burkina Faso, UNPCB) with support of the AFD, the Burkinabé government, and SOFITEX. UNPCB is based on membership of local groups and their integration into regional unions.
1998	Signing of the <i>Accord interprofessionnel</i> between SOFITEX, the government, UNPCB, donors, and a financial consortium (Caisse Nationale du Crédit Agricole; Banque Internationale pour le Commerce, l'Industrie, et l'Agriculture; Banque Internationale du Burkina). This replaces the Contrat-Plan and defines the reallocation of responsibilities within the cotton sector.
1999	Partial withdrawal of the government from the sector through the partial privatization of SOFITEX. Half of the government's share in SOFITEX is transferred to UNPCB.
2000–2006	UNPCB progressively assumed responsibilities from SOFITEX and the government. This includes economic activities such as provision of input credit, management assistance to cotton grower groups, participation in quality grading, financial management and price bargaining. Downsizes of government support to research and extension services.
2002–2006	New players enter the cotton sector. These include private input providers, new regional private cotton monopsonies (e.g. SOCOMA, Faso Coton), and private transport providers.
2004–2006	Establishment of interprofessional association (AICB) through the cooperation of cotton farmers, banks, private stakeholders, the government, and research institutes. Establishment of the association of cotton firms (APROCOB) to interact with UNPCB.
2006–2008	Changes in the price-setting mechanism to reflect better world prices. Development of new smoothing fund managed by an independent organization in 2008.
2008	Total cultivated area under Bt cotton reaches 8,000 ha.
2009	Total cultivated area under Bt cotton increases to nearly 120,000 ha.
2016	Burkina Faso decides to halt the production of Bt cotton because its short fiber hurts its reputation and reduces revenue. AICB (ANPROCOB and UNPCB) instructs farmers to cultivate only conventional cottonseeds from July 2016 onward.

Source: Ghana (Ministry of Food and Agriculture and Ministry of Trade and Industry, 2011), Burkina Faso (Kaminski, et al. 2009).

3. Methodology

3.1 Research approach

As outlined above, this study examines the impact of structural, institutional, and policy reforms on the performance of the cotton sector in Ghana and Burkina Faso (**Figure 3**). The outcomes of the reforms in the cotton sectors of the two countries have been radically different, with the sector flourishing in Burkina Faso and practically collapsing in Ghana (Section 2). A comparative analysis of the experiences of the two countries can offer useful information about the effects of reforms in industrial crop systems. A series of factors can facilitate the comparative analysis between Ghana and Burkina Faso.

First, both countries have a long tradition of cotton production through smallholder-based models. Second, the two countries share a common border with their cotton production areas being located in similar agro-ecological zones (Sudan savanna and Guinea savanna). Actually, their cotton production areas are adjacent and have similar climatic conditions that are well suited for cotton cultivation (Section 3.2). Third, the two countries underwent similar reform trajectories at roughly the same period (Section 2). They faced similar external pressures from donors and pricing regimes from the international cotton markets. Fourth, while in both countries cotton production was an important element of rural livelihoods, there is extreme variation post-reform in the contribution of cotton to their national economies in terms of GDP and foreign exchange earnings.

3.2 Study area description

The cotton production zone in Ghana is predominately in the Guinea and Sudan savanna agro-ecological zones, which lie in three administrative regions: Northern, Upper West, and Upper East. These three regions cover approximately 41% of Ghana (Songsore, 2011). Cotton is cultivated to a lesser extent in a few communities in the transitional agro-ecological zones, within the Kintampo and Atebubu areas of the Brong Ahafo region (Asinyo et al., 2015). Agriculture is the main livelihood activity for the predominantly rural population in the cotton-growing area relies of the country. Seasonal food insecurity is a major constraint to livelihood improvement in the three northern regions of Ghana (World Food Programme, 2009). Rainfall is unimodal and highly irregular in the cotton production

zones, with mean annual rainfall ranging between 1,000-1,100 mm. Cotton production is almost entirely performed under rain-fed conditions, and undertaken through outgrower schemes. In such schemes, under contractual arrangements private cotton companies provide access to inputs (e.g. seeds, fertilisers) and offer markets for smallholder farmers. Family labor is extensively used, with usually larger households adopting cotton production due to its labor intensiveness (Lam et al., 2017). Simple farm implements such as hoes, axes, and donkey-drawn plows are the main tools used for cultivation. Tractor services for land preparation were previously offered to farmers, but this has ceased in recent years. The average farm size is 1-2 ha, with farmers rotating major staple food crops including maize, sorghum, millet, and legumes (e.g. Lam et al., 2017).

Cotton production in Burkina Faso takes place mainly in the Sudanian and Sudano-Guinean agro-ecological zones. The Sudanian zone was the traditional base of cotton production during the French colonial period, but production spread to the Sudano-Guinean zone to the south in the last three decades (Bassett, 2001). The average annual rainfall is 600-800 mm in the Sudanian zone, and 800-1,100 mm in the Sudano-Guinean zone. The average cotton producer farms about 3.8 ha of cotton in Burkina Faso (Baquedano et al., 2010), which is typically produced in a three-year rotation with cotton grown in the first year, followed by successive years of a cereal crop such as maize, sorghum, or millet (Vitale et al., 2011).

In Burkina Faso, our fieldwork was conducted in three cotton regions (Bobo-Dioulasso, Houde, and Ouagadougou). The first two regions belong to the SOFITEX area and the third is within the FASO COTON zone. In terms of cotton production, the region of Bobo-Dioulasso, although it consists only of Houet province, ranks first, providing 18% to 20% of SOFITEX's production and representing 16% of the national total (Vitale et al., 2011). Bobo-Dioulasso is located in the heart of the old cotton basin, and its administrative center is quite close to SOFITEX's headquarters. The Houde region provides 18% of SOFITEX's production of SOFITEX and 16% of the national total. This region houses the site where SOFITEX conducts seed multiplication for cotton producers. This site, created in 1958, is commonly called "*Boni farm*" and is used by the National Institute of Environment and Agricultural Research (INERA) cotton program for carrying out research and trials on cotton varieties, crop rotation, organic fertilizers, and other projects. Ouagadougou belongs to the central region of the country, which is within the FASO COTON cotton zone. This region represents about 5% of the area where cotton is grown in Burkina Faso.

<<Add Figure 3>>

Figure 3. Map of Western Africa showing Ghana and Burkina Faso and cotton production zones, prepared by Martiwi Diah Setiawati and Yaw Agyeman Boafa (2016).

3.3 Data collection

Primary data was collected through in-depth semi-structured interviews with key stakeholders in cotton value chains in the two countries. Stakeholders were grouped into four main categories: (a) private sector (i.e. cotton companies), (b) government ministries and agencies, (c) research and development institutions and non-governmental organizations (NGOs), and (d) farmers and farmer groups. Stakeholders were selected after an initial literature review and institutional analysis of the cotton sector in the two countries (**Table 2**). Easily identifiable stakeholders were purposely sampled at the onset of the study (Overton & van Diermen, 2003), and a snowball sampling technique was used to reach out to other relevant cotton sector stakeholders (Creswell, 2014).

The interviews elicited stakeholders' perceptions and knowledge about the nature and scope of the reforms in the cotton sector, and their perceived impact on the industry's performance and sustainability. Perception questions were asked in relation to the following six domains: (a) input credit systems, (b) pricing determination and profit distribution, (c) extension services, (d) research and development, (e) institutional and regulatory system, and (f) food security.

Data collection in Ghana was undertaken in November-December 2015 and April-May 2016. Data collection in Burkina Faso was undertaken in February-March 2016. All interviews were conducted face-to-face at locations selected by each respondent. All interviews were audio-recorded after receiving consent from each participant. In total 33 participants were interviewed in Ghana and 13 in Burkina Faso (**Table 2**). Due to the lack of cotton farmers' associations in Ghana, we conducted interviews with 10 individual cotton farmers in four active cotton-growing communities (Bullu, Zini, Chum, and Gwollu), all located in the Sissala West district of the Upper West region.

Secondary data was collected from official government policy and regulatory documents, and reports produced by agencies and organizations involved with the cotton

sector. Annual national cotton production and performance data for both countries was obtained from the database of the Food and Agriculture Organization Statistics Division (FAOSTAT), and validated with data from the International Cotton Advisory Committee (ICAC) (see Section 2.1).

3.4 Data analysis

Each interview was transcribed verbatim for further analysis following an inductive content analysis approach. The thematic analysis of interview transcripts allowed for the elicitation of the opinions and viewpoints of the various interviewed stakeholders. We elicited stakeholder perceptions for each of the six domains outlined in Section 3.3, using appropriate code words. To classify and analyse the transcripts of each interview we used the NVIVO qualitative data analysis computer software (version 11), developed by QSR International.

Table 2. Details of the stakeholders interviewed for the study

Stakeholder category	Country	Organisation	Abbreviation	Number of interviewees	Role in cotton sector
Cotton companies	Ghana	Plantation Development Ltd.	PDL	3	Private cotton company with over 25 years of experience in cotton production in the Upper West region of Ghana. Works with rural cotton farmers through contracts (outgrower model).
		Intercontinental Farms Ltd.	IFL	3	Private cotton company operating in the Northern region of Ghana. Provides inputs to cotton outgrowers.
	Burkina Faso	Wienco Ghana (Ghana Cotton Company Ltd.)*	WC/GCCL	2	Private company that specializes in importing and distributing fertilizers and agrochemicals. Took over the facilities and management of Ghana Cotton Company Ltd (GCCL) following its liquidation from the government.
		Burkinabe Textile Fibers Company	SOFITEX	1	Private cotton company that originates from CFDT, a French company that developed textile fibers. CFDT's mission was to promote the development of cotton production in French-speaking Africa and Madagascar through <ul style="list-style-type: none"> • Purchase, transport, and gin seed cotton; • Market cotton fiber and seed; • Supply agricultural inputs to farmers; • Promote the production of cotton and other associated crops through technical support, services, and financing of research and development; • Promote directly textile fibers.
		Faso Coton	FC	1	Private cotton company that focuses its operations in central Burkina Faso under the zoning agreement. Supplies inputs and advice to producers, and purchases, collects, and gins seed cotton.
Government ministries and agencies	Ghana	Ministry of Food and Agriculture	MOFA	6	Lead agency and focal point for the government of Ghana, responsible for developing and executing policies and strategies for the agriculture sector within the context of a coordinated national socio-economic growth and development agenda.
		Ministry of Trade and Industry	MTI	2	Lead policy advisor to Ghana's government on trade, industrial, and private sector development, with responsibility for the formulation and implementation of policies for the promotion, growth, and development of domestic and international trade.
		Sissala West District Assembly	SWDA	1	Second-level administrative subdivision in Ghana. Oversees social, economic, political, environmental, and cultural issues for communities within its specified region.
		Sissala East District Assembly	SEDA	2	
		Ministry of Agriculture and Water Management	MAAH	4	A main government body that defines agricultural policies and develops the necessary infrastructure to support the agriculture sector.
		Ministry of Commerce and Industry Permanent Secretary for monitoring the	MCIA	1	Lead advisor to the Burkinabe government on trade and industrial development. Guarantor of the regulatory framework, legislative, and fiscal.

	Burkina Faso	liberalized cotton sector (SP/SFCL)] Ministry of Environment, Green Economy and Climate Change (Department of Legal Affairs and Litigation)	(SP/SFCL) MEEVCC (DLAL)	1	Technical structure whose essential role is to enlighten the decision makers. Responsible for legal aspects. Develops laws and environmental regulations
		Ministry of Education and Scientific Research (National Biosafety Agency)	ANB	1	Regulatory structure on the safe use of modern biotechnology (GMOs and their by-products). Evaluates whether GMOs should be approved for commercialization or experimentation at research institutions. Examines safety measures and conducts inspections.
Research institutions and NGOs	Ghana	CSIR-Savanna Agriculture Research Institute	SARI	2	One of the 13 research institutes of the Council for Scientific and Industrial Research (CSIR). Mandated to provide small-scale farmers of northern Ghana (Northern, Upper West, and Upper East regions) with appropriate innovation and technology to increase their food production base with a sustainable production system. Also, charged with the development of appropriate cropping systems and varieties of crops such as maize, groundnut, bambara, cotton, and vegetable crops, with a focus on northern Ghana.
		German International Cooperation	GIZ	2	Closely cooperating with the Aid by Trade Foundation under the “Cotton Made in Africa” initiative, which helps people to help themselves through trade, improving the social, economic, and ecological living conditions of smallholder cotton farmers and their families in SSA.
	Burkina Faso	National Institute of Environment and Agricultural Research	INERA	2	Main institute in charge of agricultural and environmental research. Focuses on varietal improvement, farming techniques, and management of natural resources, as well as making recommendations in agro-socio-economics
Farmers and Farmers Association	Ghana	Lead cotton farmers in Bullu and Gwollu villages	Farmers	10	Rural smallholder households in the Sissala East and Sissala West Districts of Upper West region of Ghana.
	Burkina Faso	Inter-professional Cotton Association of Burkina	AICB	1	Sets purchase price of seed cotton and input selling price. Approves programs and budget for cotton research. Manages smoothing fund, cotton inputs funds, etc.
	Burkina Faso	National Union of Cotton Producers in Burkina	UNPCB	1	Distribution of inputs. Management of short- and medium-term loans. Marketing of seed cotton. Other related activities such as management of membership fees and social activities.

4. Results

4.1. Perceived impact on input credit systems

The input credit system is an important element of cotton value chains (Section 2.1). Its efficiency can be measured through the availability, quality, and quantity of inputs, and is integral to the expansion and sustainability of the cotton sector. **Figure 4** provides a summary of the impact that reforms had on the input credit system, as perceived by the respondents from Ghana and Burkina Faso (see also Table S1 in Supplementary Electronic Material for some direct quotes).

<<Add Figure 4>>

Figure 4. Stakeholder perceptions of reform impact on input credit systems.

Overall, perceptions across the two countries varied considerably. Ghanaian stakeholders mentioned several issues that in their opinion have negatively affected input credit systems and as an extent the performance of the sector such as (a) inadequate inputs for farmers, (b) limited capital to buy inputs, and (c) expensive and rising costs of production inputs (**Figure 4**). In contrast, Burkina Faso stakeholders discussed a mix of positive and negative. Some of the direct and indirect impacts of the reform programs since the mid-1990s include the (a) well regulated and efficient inputs supply chain, (b) commercialization of Bt cotton (Bollgard II[®]), (c) existence of state subsidy, and (e) high costs of Bt cotton, among others (**Figure 4**). The high costs of inputs and the limited value addition to cotton on the local market are the two main negative impacts of cotton sector reforms that have been common to both countries (**Figure 4**).

4.2 Perceived impact on price determination and profit distribution

As discussed in Section 1-2, cotton production provides a critical source of income and revenue for citizens and governments in SSA. Ensuring a fair, balanced, and stable pricing system in the cotton production system is a key element to sustain the sector and enable it to contribute to poverty eradication (Section 2). **Figure 5** summarizes stakeholder responses regarding the impact of reforms on price determination and profit distribution in the cotton sector of the two countries (see also Table S2 in Supplementary Electronic Material for some direct quotes).

<<Add Figure 5>>

Figure 5. Stakeholder perceptions of reform impacts on price determination and profit distribution.

Stakeholders in Ghana brought up mainly negative outcomes of reforms related to the low price for cottonseed, lack of transparency in the seasonal price-setting system, and the decline in government revenue due to low export (**Figure 5**). Stakeholders in Burkina Faso emphasized reform outcomes such as a guaranteed minimum price for farmers, high profit sharing among farmers, and favorable price incentives for farmers (**Figure 5**). Delays in paying farmers and the negative effect of the low world market were common negative reform outcomes discussed across in both countries (**Figure 5**).

4.3 Perceived impact on extension services

Figure 6 presents summarises stakeholder perceptions as to the impact of reforms on extension services in the cotton sector (see also **Table S3 in Supplementary Electronic Material for some direct quotes**). Ghana stakeholders perceived mostly negative outcomes from the implementation of reforms such as the corrupt field agents of private companies, the conflicting extension policies of cotton companies, and lack of farmer voice in extension services (**Figure 6**). In Burkina Faso, on the other hand, stakeholders perceived more positive than negative impacts. Among the main outcomes cited were the development of better-quality extension services, regular training and support services, a good transport/logistic system, and on the negative side aging extension agents (**Figure 6**). The limited government investment in extension services was one of the common elements discussed by stakeholders in both countries (**Figure 6**).

<<Add Figure 6>>

Figure 6. Stakeholder perceptions of reform impacts on extension services

4.4 Perceived impact on research and development

Our survey of stakeholders in Ghana and Burkina Faso found variations at the country level about the outcomes of reforms on research and development (**Figure 7**) (see also **Table S4** in Supplementary Electronic Material for some direct quotes). Respondents in Ghana mentioned issues such as a lack of concerted government effort in research and development,

delay in commercialization of Bt cotton, and lack of funds for the cotton research program as key outcomes of the reforms (**Figure 7**). In Burkina Faso, stakeholders emphasized how the improvement of research programs in the broader agriculture sector has trickled down to the cotton sector (**Figure 7**). Cooperation between local and foreign research institutes on agronomic issues, eradication of pests and diseases (e.g. boll weevil), consultation with producers on research issues, and dedicated funds for research and development were all mentioned as positive outcomes of reforms in for research and development in Burkina Faso's cotton sector (**Figure 7**).

<<Add Figure 7>>

Figure 7. Stakeholder perceptions of reform impacts on research and development

4.5 Perceived impact on institutional and regulatory systems

Improving the productivity and overall performance of the cotton sector requires a coordinated, participatory, integrated, and collaborative regulatory system across the value chain. **Figure 8** summarizes the main issues raised by stakeholders in Ghana and Burkina Faso with regard to the impact of reforms on institutional and regulatory systems (see also **Table S5 in Supplementary Electronic Material** for some direct quotes). According to respondents in Ghana, reform programs contributed to the weakening and collapse of the existing institutional framework for cotton sector management (**Figure 8**). The lack of cooperative groups, corruption at the management level, politicization of entry licensing for private companies, and failure of zoning policy were among the negative highlighted outcomes of reforms (**Figure 8**). On the other hand, in Burkina Faso, interviewees discussed mainly positive outcomes of reforms such as the high level of capital investment, the development of efficient market-based cooperatives and a powerful cotton producer association, and the careful involvement of the central government in managing the sector (**Figure 8**).

<<Add Figure 8>>

Figure 8. Stakeholder perceptions of reform impacts on institutional and regulatory systems

4.6 Perceived impact on food security

Figure 9 summarizes stakeholder perceptions regarding the impact of cotton sector reforms on food security in the two countries (see also Table S6 in Supplementary Electronic Material for some direct quotes). Respondents in both countries brought up positive outcomes such as agronomic spillover that enhanced cereal production and the availability of extra income from cotton sales to buy food crops (**Figure 9**). However, in Ghana, interviewees discussed some negative outcomes of the reforms such as the displacement of food crops to marginal lands, the intensification of food crop production (e.g. maize, millet), and yield reductions for food crops such as maize (**Figure 9**). Respondents in Burkina Faso reported some positive outcomes such as using the inputs of cotton companies to improve cereal productivity (**Figure 9**). Some respondents also emphasized that crop rotation practices allow cereals with superficial roots to benefit from the backward effects of the fertilizer used for cotton production, which results in greater food crop yields compared to non-cotton-producing areas.

<<Add Figure 9>>

Figure 9. Stakeholder perceptions of reform impacts on food security.

5. Discussion

5.1 Synthesis of stakeholders perception of reform impacts on national cotton sectors

Generally, our study suggests that the elicited stakeholder perceptions (Section 4) reflect quite well the actual performance of the cotton sector in Ghana and Burkina Faso following the implementation of reform programs (Section 2.2-2.3). The multiple stakeholders consulted concretely discussed key linkages between reforms and performance, and shared both the main positive and negative outcomes on the six study domains (Section 2.1, 3.3), based on their experience and knowledge.

In both Ghana and Burkina Faso, the liberalization of the cotton sector to pave way for private-sector investment was the first step toward halting the declining productivity and stagnating yields, and formed the key driver of structural and policy reforms (Goreux, 2004). Our results suggest that Ghanaian stakeholders perceived that the reform had largely negative impacts across the six domains that were considered as proxies for the performance of the cotton sector (i.e. input credit systems, price and profit determination, extension services,

research and development, institutional and regulatory systems, and food security). Interviewees in Burkina Faso, on the other hand, viewed the reforms as having had both positive and negative impacts across these six domains and as an extent on the performance and sustainability of the sector (Vitale et al. 2011).

Dorward et al. (2004) discussed the sustainability of input credit schemes for cotton sector productivity in SSA, which has been one of the prominent domains in our stakeholder interviews (Section 4.1). In Burkina Faso, before the reforms the factors of production were provided to farmers, initially free of charge and subsequently in the form of credit, under public monopolies (Kaminski et al., 2009b).

Our survey results in Ghana revealed that the input credit system in the cotton sector has been inefficient and collapsed rapidly since the sector's liberalization, as has also been outlined in other studies (Howard et al., 2012; Asinyo et al., 2015). Many farmers left the cotton sector due to lack of access to sufficient agricultural inputs after liberalization in Ghana (Delpuech & Vandeplas, 2012). Stakeholders in Ghana openly criticized the dysfunctional credit system as a major reason for the declining performance of the sector. For example, interviews in the four cotton-producing communities in the Sissala West district found that farmers blamed cotton companies and extension workers for not providing them with adequate inputs. On the other hand, officials of the cotton companies accused the farmers of reducing both the planted cotton area and diverting inputs from cotton production to cereal production. However, there was a consistent perception between cotton company officials that farmers consider cotton as a secondary crop and not their main livelihood activity.

According to stakeholders in Burkina Faso, the reform programs have had both negative and positive outcomes for the input credit system (**Figure 4**) (**Table S1**). Most of them agreed that although the central government reduced its participation in the provision of input services for the cotton sector since the 1990s, it still plays a key role in collaboration with the private sector. This seems to ensure a better access to agricultural inputs on credit and enable farmers to make repayments effectively. These stakeholder perceptions are consistent with insights reported in other studies across Francophone countries in West Africa (e.g. Kaminski, 2007; Baquedano et al., 2010). However, it should be mentioned that access to credit remains a key constraint for the adoption of cotton in the country (Porgo et al., 2018).

Considering that producer price-setting mechanisms were one of the key objectives of reform actions in the cotton sector (Section 2), it was anticipated that producers, especially farmers, would enjoy high cottonseed prices (Baffes, 2005; 2007; Goreux, 2004). Available information across SSA shows that producer prices are commonly determined at the beginning of the crop season based on an agreed-upon formula (Tschirley et al. 2009).

Stakeholders in Ghana highlighted that the reforms had negative impacts on the price-setting system. For example, all interviewed stakeholders acknowledged that price-fixing committees have failed at different times, partly because not all stakeholders are properly consulted, which results in high price competition (**Figure 5**). Almost all interviewees across stakeholder groups asserted that even though a floor price is usually announced before the start of the farming season, it is not consistently observed as private companies offer different prices to farmers. The overall decline in the sector's profitability in Ghana and the fact that the farmers suffer the most serious consequences was a common theme in most interviews. The majority of Ghanaian stakeholders emphasized the need for a functioning inter-professional body to coordinate seed cotton pricing in Ghana.

On the contrary, stakeholders in Burkina Faso appraised positively the reform outcomes on price setting and profit determination mechanisms. All stakeholders commented that the improved institutional and policy framework has enabled producers to enjoy a larger share of the profit from cotton production. Cotton farmers exert through the UNPCB strong influence on cotton pricing, which is determined at the beginning of the farming season (World Bank, 2004) (see also **Table S2 in Supplementary Electronic Material**). However, stakeholders in both countries discussed the delays in paying farmers and the negative effect of low world market prices on profits as challenges to be expected in the face of regular fluctuations in the global cotton market (see also Basset 2014).

Cotton is considered a very demanding crop in terms of labour and inputs when compared to other widely grown crops in SSA such as maize (Poulton et al. 2004). As a result, there is a need for regular and specialized advisory and extension services to ensure high productivity. Following the liberalization of the cotton sector, private companies would be expected to provide the needed extension and advisory services to farmers. However, our interviews in Ghana described a generally negative trend in the provision of such services

from the private sector (**Figure 6**) (see also **Table S3 in Supplementary Electronic Material**). According to most interviewees, although government-led agricultural extension activities were limited even before the implementation of reform programs, the extension services in the cotton sector deteriorated further after liberalization. The lack of coordination and the low capacity of private companies to offer effectively such services, have led to poor and contradictory extension to cotton farmers in Ghana (MOFA, 2013). Respondents from small-scale cotton companies and the Ministry of Food and Agriculture pointed that dishonest extension workers have engaged in malicious practices on their own or in conjunction with farmers. Such practices include the sale of cottonseeds (instead of giving it at no charge to the smallholder farmers), under-reporting of supply, and inaccurate weighing.

In contrast, respondents in Burkina Faso identified both positive and negative impacts on extension services due to reforms. Most of the respondents viewed the reform of extension services as contributing to increasing production efficiency across the different cotton-growing regions. The successful commercial introduction of Bt cotton in 2008 was regularly cited as a positive outcome at the onset by interviewees. However the same stakeholders also highlighted their disappointment with the lack of adequate information on the actual impacts of Bt cotton prior to its full-scale introduction, which led the government to suspend the Bollgard II variety at the beginning of the 2016-2017 agricultural season (Sanou et al. 2018) (see also **Table S3 in Supplementary Electronic Material**). The concern of the social, economic and ecological impacts of adopting genetically modified cotton expressed by respondents has been in line with many other studies in different parts of the world (e.g. Bennet et al. 2006; Subramanian and Qaim, 2009; Arza and Vazquez, 2013; Fisher et al. 2015).

The impact of reforms on research and development within the cotton sector has varied widely in the two countries according to stakeholder perceptions (**Figure 7**) (see **Table S4 in Supplementary Electronic Material**). All interviewed stakeholders in Ghana agreed that the performance of research and development activities within the national cotton sector has been unimpressive for several years. Interviewees from CSIR-SARI and MOFA highlighted that research and development in the sector has suffered, as the government has been the sole sponsor of research (but also unable to provide sufficient financial support), amidst the lack of meaningful contribution from cotton companies. The interviewed farmers

were quick to blame the lack of research programs as the main reason for the delay in introducing improved cotton varieties.

Again, contrary to the situation in Ghana, stakeholder interviews in Burkina Faso pointed that research and development activities had improved significantly after the reforms (**Figure 7**) (see also **Table S4 in Supplementary Electronic Material**). Most stakeholders highlighted the sustained government budget allocation for research, coupled with external financial assistance (e.g. from the French Agricultural Research Institute- CIRAD), as having played a key role in the introduction of new and improved varieties, and in dealing effectively with pests and diseases. Interviews with researchers from INERA, the main agricultural research agency in Burkina Faso, emphasized that the integrative nature of the sector offers opportunities to all stakeholders (e.g. cotton companies, farmers, government agencies, international researchers) to participate in decision-making, which has been critical in maintaining effective research and development programs in the country (see also Poulton & Tschirley, 2009).

There have been high levels of stakeholder dissatisfaction in Ghana regarding the impact of reforms on institutional and regulatory systems (**Figure 8**) (see **Table S5 in Supplementary Electronic Material**), especially among individual farmers and private cotton companies. Most of these interviewees believed that the reforms had resulted in dysfunctional institutional structures, which contributed to the subsequent overall weakening of the sector. Stakeholders also raised multiple concerns about the politicization of the cotton sector by different governments, which caused an institutional vacuum for the sector. Multiple stakeholders cited the withdrawal of the government's 30% stake in the industry following the collapse of the Ghana Cotton Company Limited (GCCL), and more recently, the "White Gold" campaign (see Section 2.2), as examples of the poor institutional and regulatory systems in the cotton sector. Another example of weak institutional and regulatory processes brought up by different stakeholders, was the zoning policy initiated by MOFA in conjunction with CDP 1, which had no legal support, and hence, could not be properly implemented (MOFA, 2013). Farmers expressed great concern about their lack of knowledge about the White Gold campaign, even though they are supposed to be the key stakeholders in the cotton sector (Section 2.2).

Stakeholder interviews in Burkina Faso disclosed that a functioning institutional and regulatory system has been one of the most significant outputs of the cotton reforms (**Figure 8**) (see **Table S5 in Supplementary Electronic Material**). Interviewees indicated that reform had a positive impact in both strengthening the association of cotton producers as well as the overall regulatory framework of the sector. Multiple stakeholders expressed that the careful and gradual implementation of reform programs had strengthened the involvement of cotton farmers in decision-making, as they are recognized to be the key stakeholders in the sector. Most interviewed stakeholders in Burkina Faso also indicated that the current regulatory framework facilitated an integrated decision-making structure, allowing the effective participation of all actors involved in the cotton sector. Some interviewees from UNPCB, however, mentioned that some failures in the current institutional and regulatory framework are to be blamed for the abandonment of Bt cotton, even after several years of field trials and its subsequent authorization of commercial production by the National Biosafety Agency (Dowd-Uribe, 2014).

Cotton is an industrial crop that can interact with food security in several ways (Fortucci, 2002; Wiggins et al., 2015; Solidaridad, 2016). At the household level, cotton production can generate income that can be used to buy basic foodstuff and other goods, having a direct positive contribution to food access. On the other hand, cotton production can divert land within farms from food crop production to cotton production, possibly reducing the availability of food. Involvement in cotton production can increase access to agricultural inputs, allowing for the intensification of food crop production and having positive overall effects in food availability (e.g. Theriault & Tschirley, 2014). Understanding the combined effects of such multiple factors is important when assessing the local food security outcomes of industrial crop production, including cotton (Wiggins et al., 2015).

Stakeholder interviews in Ghana and Burkina Faso identified that the agronomic spillover from cotton production had positive local food security outcomes through enhancing and intensifying cereal production (**Figure 9, Table S6 in Supplementary Electronic Material**) (Theriault & Tschirley, 2014). At the same time, interviews suggest that the extra income from cotton sales could be used to buy staple crops, contributing significantly to sustaining food security in rural households (see Lam et al., 2017).

5.2 Linking stakeholder perceptions and national-level production data

In terms of its socioeconomic importance and poverty alleviation potential, cotton production remains a key agricultural activity and rural development strategy for several countries in SSA. This is despite the many challenges that the sector has faced in different parts of the continent across its value chain over the past half-century (Poulton & Tschirley, 2009). The analysis of national-level cotton productivity data for the study countries (**Figures 1-2, Figure S1-S3 in Supplementary Electronic Material**) appear consistent with stakeholder perceptions on the performance of their cotton sector after the implementation of the reforms.

The national production data indicate that the performance of the cotton sector in Burkina Faso began to improve significantly after reforms were implemented, as highlighted by the continuous growth in area harvested, quantity produced, yield, and market share since the mid-1990s (**Figures 1-2, Figure S1-S3 in Supplementary Electronic Material**). Other studies have also documented the improved performance of the Burkina Faso cotton sector after reforms were implemented (e.g. Bennett et al., 2006; World Bank, 2006; Kaminski et al., 2009b; Vitale, 2018). In Ghana, the cotton sector, apart from the two short-term booms of 1986 and 2011 (with annual growth rates of 306% and 185% respectively), the sector seems to have been on a terminal decline since its liberalization in 1985 (Asinyo et al., 2015) (see **Figures 1-2; Figure S1-S3 in Supplementary Electronic Material**).

In a nutshell, while Burkina Faso succeeded in achieving the fundamental goal of achieving a strong and robust cotton output through targeted reforms (as shown by the consistent growth since the reforms), the same thing cannot be said for Ghana. All of the six performance domains explored in this study (Section 4), appear to have been negatively impacted after liberalization. In fact, the current state of that Ghanaian cotton sector can best be described as one of stagnation and vulnerability.

Our analysis suggest that the decline of Ghana's cotton sector started at the onset of the reforms in 1985, and can be possibly explained as the combined effect of local (country-level) and external factors. Local-scale factors include the lack of a suitable policy environment, poor organization of the sector, lack of capital/investments, lack of professionalism among some stakeholders, and the absence of a dynamic cotton farmers' association and/or cotton farmers' cooperatives (MOFA, 2013). These have been

complemented by agronomic constraints such as the inability to develop new improved cotton varieties, the availability of quality inputs, the prevalence of pests and diseases, poor soil quality, and the escalating effects of climate change (e.g. shortage of rainfall) in northern Ghana (Asinyo et al., 2015; Howard et al., 2011). Fluctuating global lint prices have further contributed to poor local market conditions, which have affected most SSA cotton-producing countries (Theriault et al., 2013), thereby making the sector unattractive for farmers in Ghana. Farmers interviewed in four cotton-growing communities indicated that pricing is the key driver of their participation in producing cotton in addition to staples like maize and yams, and that falling cotton prices are worsening their poverty and food insecurity conditions (See **Table S2 in Supplementary Electronic Material**).

On the other hand, Burkina Faso is considered as a success story of reforms in the cotton sector, considering the substantial productivity increases and the improvement of the overall performance of its cotton sector (Kaminski et al., 2009b; Vitale et al., 2011; Delpuech & Vandeplass, 2013; Abbott, 2013; Vitale, 2018). All these studies highlight that the Burkina Faso cotton sector reform model is unique when compared to other experiences in SSA, in that it has generated strong returns for a large number of producers in the country. Kaminski et al., (2009a) underscored the gradual reform approach that was adopted by the Burkinabe government, with its strong focus on reinforcing its institutional and regulatory framework, thus ensuring effective market coordination along the cotton production value chain. Specifically, some of the factors that have been critical in improving the sector's performance over the last two decades include the establishment of a national cotton union, the reallocation of responsibilities, and the involvement of cotton producers in decision-making (e.g., on shareholding and price-setting mechanisms) (Kaminski et al., 2009a; Vitale, 2018; Sanou et al. 2018).

5.3 Study limitations

The participants selected for this study were identified through an extensive institutional analysis, and subsequent snowballing during the initial interviews with key players in the sector. While the interviewed stakeholders were deemed as the most appropriate and qualified due to their deep knowledge of the sector (and participation in various capacities), the findings of the study must be interpreted with caution. First, the survey might not have captured the views of all relevant stakeholder groups due to practical

challenges. For example, some identified respondents working for government agencies were not accessible for interviews during the data collection period. Moreover, despite our instructions at the beginning of the interviews, the views of the interviewed stakeholders might reflect their personal opinions and not necessarily those of their organizations. Second, the stakeholder perception analysis method employed in this study relies entirely on the subjective examination of perceptions of reform impacts. Thus, some of the results could be vulnerable to one-sided and biased responses on certain issues.

6. Conclusion and practical implications

The present study highlights the impact of reform actions in Ghana and Burkina Faso's cotton sector by drawing on stakeholders' opinions and national cotton production data. Our results, consistent with previous studies, suggest that the cotton reforms in Ghana and Burkina Faso, although starting from similar points, took different directions, and subsequently, generated sharply different outcomes. Reforms appear to have significantly improved the performance of the cotton sector in Burkina Faso, whilst the situation in Ghana has been radically different. Stakeholder interviews in Ghana and Burkina Faso identified that the reforms had a mix of positive and negative outcomes on each of the six domains examined in this study, as summarized below:

- (1) *Input-credit system*: Stakeholders in Ghana asserted the inefficiency and near collapse of the system after the sector's liberalization, which prompted many farmers to exit cotton production. In Burkina Faso, stakeholders perceived that farmers had improved access to inputs and flexible repayment schemes even after the role of the central government in the sector became minimal following the reforms in the 1990s.
- (2) *Pricing determination and profit distribution*: Stakeholders from Ghana opined that the price-fixing mechanism failed woefully, as the prices negotiations were not inclusive, resulting in high price competition and low prices paid to farmers. Respondents from Burkina Faso, on the other hand, indicated that a direct outcome of the reforms in the country was an inclusive, well-functioning and trusted price-setting system, which was a key reason in improving the performance of the sector.
- (3) *Extension services*: Interviewees from Ghana perceived that extension and advisory services have deteriorated further after the liberalization of the sector, due to poor

coordination between the main actors in the sector (i.e. government, companies, farmers), and the low capacity of private enterprises to provide effectively such services. In Burkina Faso, stakeholder expressed that the quality of extension services was not affected from reforms, contributing positively to increased production efficiency across the different cotton-growing regions. Ageing extension agents, however, were considered a major challenge presently facing the sector in the country.

- (4) *Research and development*: According to Ghanaian stakeholders, cotton-related research and development has been a low priority from both the public and private sector (including cotton companies). The lack of investment in research and development has been a major contributor to the failure to introduce new and diversify current cotton varieties. Stakeholders in Burkina Faso highlighted that a sustained government budget allocation for research, coupled with external financial and technical assistance, has played a major role in the introduction of high yielding, pest- and disease-resistant cotton varieties (including some Bt cotton varieties such as Bolgard II).
- (5) *Institutional and regulatory systems*: Interviewees from Ghana perceived that the terminal decline of the national cotton sector has been partly due to the weak regulatory framework and frequent partisan politicization during the implementation of the reform measures. In Burkina Faso, respondents appeared more satisfied with the institutional and regulatory systems of the sector emanating from the reform process, although inherent challenges were highlighted.
- (6) *Food security*: In both countries, stakeholders highlighted both positive and negative implications of reforms of the cotton sector on food security. For instance, positive spillover from cotton production was mentioned as an example of benefits from reform actions. On the other hand, the shift of local farmers shift from food crops to cotton was identified as a possible risk, due to land and labour diversion from food crop production.

Considering the contrasting outcomes of reforms in Ghana and Burkina Faso, there are some lessons that can be learned in order to revitalize, improve and sustain the overall

performance of the sector. Overall cotton production and productivity increased in Burkina Faso following the reforms, whereas the sector witnessed a terminal decline in Ghana. However, the reforms of the cotton sector in Burkina Faso cannot be considered as a complete success, as for example, several challenges were highlighted including institutional and marketing bottlenecks, and inadequate extension services. Still, the government of Ghana could learn from some of the experiences of Burkina Faso's approach to reforms, in its attempt at revitalizing the Ghanaian cotton sector.

Acknowledgments

The authors thank various stakeholders and individuals involved in the cotton sector in Ghana and Burkina Faso who provided valuable advice and information during this study.

Funding

We acknowledge the financial support of the Japan Science and Technology Agency (JST) for the Belmont Forum project FICESSA.

Ethical Standards

Informed consent was obtained from all stakeholder organizations and individual participants included in this study.

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This study was conducted as part of the Food Security Impacts of Industrial Crop Expansion in Sub-Saharan Africa project (FICESSA). FICESSA is a 3-year interdisciplinary project that aims to provide clear empirical evidence of how a variety of industrial crops [sugarcane, jatropha, cotton, tobacco), ranging from low-value crops (jatropha) to high-value crops (tobacco)] compete for land with food crops in Sub-Saharan Africa, and the mechanisms through which this competition can affect food security, whether in a positive or a negative way. The project also undertakes studies at multiple spatial scales using various analytical tools to study past dynamics and explore future scenarios. FICESSA includes comprehensive case studies of different operational industrial crop projects in Ghana, Malawi, Mozambique and Swaziland. FICESSA also undertakes scoping surveys in Burkina Faso, Guinea and Ethiopia that focus on institutional issues related to industrial crop production and its linkages with food security.

For millions of rural households in Sub-Saharan Africa (SSA), cotton cultivation is an important source of livelihoods. Cotton is an integral element of some national economies and a vital element of poverty alleviation strategies. The cotton sector underwent policy and structural reforms in the early 1980s in several parts of SSA. Ghana and Burkina Faso have been two of the countries that reformed drastically their cotton sectors, but with very different results. Interviews with multiple stakeholders involved in the cotton sector in the two countries suggest that the reforms had indeed very different outcomes that have deeply influenced the performance of the sector. While Burkina Faso is considered a success story considering the good performance of the sector following the reforms, there are several challenges that remain. It is important to learn from the divergent reform experiences/outcomes of the two countries to inform future reforms in other SSA countries.

Table 1 Timeline of major events related to cotton sector reforms in Ghana and Burkina Faso

Year	Reform actions
<i>Ghana</i>	
1985–1986	Deregulation of the cotton sector. CDB transformed into GCCL, with the government retaining 30% of shares. Supply of free inputs to farmers is maintained, but compensated by lower cotton seed prices.
1989	Proliferation of companies participating in the cotton industry.
1995	Government sells its 30% share in GCCL. Free input supply to farmers changes into input credit. Price-setting mechanism in put place. Diversion of inputs becomes a big problem.
1997–1998	Cotton Development Project 1 (CDP 1) is launched with financial support from AFD. Evolution of the Cotton Growers' Association.
1999–2000	Unprecedented malpractices in the cotton sector, including poaching of farmers and adulteration of product.
2000	ADB ceases financing of cotton companies, due to their high accumulated debt. Several companies begin to exit the cotton sector.
2000–2002	MOFA introduces a zoning policy to address malpractices in the cotton industry.
2004–2005	ADB takes control of GCCL through a debt-equity swap. GCCL is liquidated and ceases its operation.
2010–2011	Launch of cotton sector revival policy (“White Gold” campaign).
2016	Formal inauguration of the board of Cotton Development Authority to carefully examine the challenges of the cotton sector.
<i>Burkina Faso</i>	
1992–1993	SOFITEX (the national cotton parastatal company) commits formally to allow representatives of cotton producers participate in the reform debate. The government commits not to interfere with the management of SOFITEX and establishes a plan (Contrat-Plan) to streamline the accumulated debts of cotton producers and the parastatal.
1994	Amendment of laws pertaining to the establishment of farmer groups.
1996–1999	Free membership is introduced in the formation of local cotton farmer groups. The <i>groupements villageois</i> (village groupings) are replaced by market-oriented organizations (<i>groupements de producteurs de coton</i>) at the subvillage level, through the implementation of new local governance rules.
1996–2001	Establishment of the national cotton union (National Union of Cotton Producers of Burkina Faso, UNPCB) with support of the AFD, the Burkinabé government, and SOFITEX. UNPCB is based on membership of local groups and their integration into regional unions.
1998	Signing of the <i>Accord interprofessionnel</i> between SOFITEX, the government, UNPCB, donors, and a financial consortium (Caisse Nationale du Crédit Agricole; Banque Internationale pour le Commerce, l'Industrie, et l'Agriculture; Banque Internationale du Burkina). This replaces the Contrat-Plan and defines the reallocation of responsibilities within the cotton sector.
1999	Partial withdrawal of the government from the sector through the partial privatization of SOFITEX. Half of the government's share in SOFITEX is transferred to UNPCB.
2000–2006	UNPCB progressively assumed responsibilities from SOFITEX and the government. This includes economic activities such as provision of input credit, management assistance to cotton grower groups, participation in quality grading, financial management and price bargaining. Downsizes of government support to research and extension services.
2002–2006	New players enter the cotton sector. These include private input providers, new regional private cotton monopsonies (e.g. SOCOMA, Faso Coton), and private transport providers.
2004–2006	Establishment of interprofessional association (AICB) through the cooperation of cotton farmers, banks, private stakeholders, the government, and research institutes. Establishment of the association of cotton firms (APROCOB) to interact with UNPCB.
2006–2008	Changes in the price-setting mechanism to reflect better world prices. Development of new smoothing fund managed by an independent organization in 2008.
2008	Total cultivated area under Bt cotton reaches 8,000 ha.
2009	Total cultivated area under Bt cotton increases to nearly 120,000 ha.
2016	Burkina Faso decides to halt the production of Bt cotton because its short fiber hurts its reputation and reduces revenue. AICB (ANPROCOB and UNPCB) instructs farmers to cultivate only conventional cotton seeds from July 2016 onward.

Source: Ghana (Ministry of Food and Agriculture and Ministry of Trade and Industry, 2011), Burkina Faso (Kaminski, et al. 2009).

Table 2. Details of the stakeholders interviewed for the study

Stakeholder category	Country	Organisation	Abbreviation	Number of interviewees	Role in cotton sector
Cotton companies	Ghana	Plantation Development Ltd.	PDL	3	Private cotton company with over 25 years of experience in cotton production in the Upper West region of Ghana. Works with rural cotton farmers through contracts (outgrower model).
		Intercontinental Farms Ltd.	IFL	3	Private cotton company operating in the Northern region of Ghana. Provides inputs to cotton outgrowers.
		Wienco Ghana (Ghana Cotton Company Ltd.)*	WC/GCCL	2	Private company that specializes in importing and distributing fertilizers and agrochemicals. Took over the facilities and management of Ghana Cotton Company Ltd (GCCL) following its liquidation from the government.
	Burkina Faso	Burkinabe Textile Fibers Company	SOFITEX	1	Private cotton company that originates from CFDT, a French company that developed textile fibers. CFDT's mission was to promote the development of cotton production in French-speaking Africa and Madagascar through <ul style="list-style-type: none"> • Purchase, transport, and gin seed cotton; • Market cotton fiber and seed; • Supply agricultural inputs to farmers; • Promote the production of cotton and other associated crops through technical support, services, and financing of research and development; • Promote directly textile fibers.
		Faso Coton	FC	1	Private cotton company that focuses its operations in central Burkina Faso under the zoning agreement. Supplies inputs and advice to producers, and purchases, collects, and gins seed cotton.
		Ministry of Food and			Lead agency and focal point for the government of

Government ministries and agencies	Ghana	Agriculture	MOFA	6	Ghana, responsible for developing and executing policies and strategies for the agriculture sector within the context of a coordinated national socio-economic growth and development agenda.
		Ministry of Trade and Industry	MTI	2	Lead policy advisor to Ghana's government on trade, industrial, and private sector development, with responsibility for the formulation and implementation of policies for the promotion, growth, and development of domestic and international trade.
		Sissala West District Assembly	SWDA	1	Second-level administrative subdivision in Ghana. Oversees social, economic, political, environmental, and cultural issues for communities within its specified region.
		Sissala East District Assembly	SEDA	2	
	Burkina Faso	Ministry of Agriculture and Water Management	MAAH	4	A main government body that defines agricultural policies and develops the necessary infrastructure to support the agriculture sector.
		Ministry of Commerce and Industry [Permanent Secretary for monitoring the liberalized cotton sector (SP/SFCL)]	MCIA (SP/SFCL)	1	Lead advisor to the Burkinabe government on trade and industrial development. Guarantor of the regulatory framework, legislative, and fiscal.
		Ministry of Environment, Green Economy and Climate Change (Department of Legal Affairs and Litigation)	MEEVCC (DLAL)	1	Technical structure whose essential role is to enlighten the decision makers. Responsible for legal aspects. Develops laws and environmental regulations
		Ministry of Education and Scientific Research (National Biosafety Agency)	ANB	1	Regulatory structure on the safe use of modern biotechnology (GMOs and their by-products). Evaluates whether GMOs should be approved for commercialization or experimentation at research institutions. Examines safety measures and conducts inspections.
					One of the 13 research institutes of the Council for Scientific and Industrial Research (CSIR). Mandated to provide small-scale farmers of northern Ghana (Northern, Upper West, and Upper East regions)
	Research institutions and NGOs	Ghana	CSIR-Savanna Agriculture Research Institute	SARI	2

					with appropriate innovation and technology to increase their food production base with a sustainable production system. Also, charged with the development of appropriate cropping systems and varieties of crops such as maize, groundnut, bambara, cotton, and vegetable crops, with a focus on northern Ghana.
		German International Cooperation	GIZ	2	Closely cooperating with the Aid by Trade Foundation under the “Cotton Made in Africa” initiative, which helps people to help themselves through trade, improving the social, economic, and ecological living conditions of smallholder cotton farmers and their families in SSA.
	Burkina Faso	National Institute of Environment and Agricultural Research	INERA	2	Main institute in charge of agricultural and environmental research. Focuses on varietal improvement, farming techniques, and management of natural resources, as well as making recommendations in agro-socio-economics
Farmers and Farmers Association	Ghana	Lead cotton farmers in Bullu and Gwollu villages	Farmers	10	Rural smallholder households in the Sissala East and Sissala West Districts of Upper West region of Ghana.
	Burkina Faso	Inter-professional Cotton Association of Burkina	AICB	1	Sets purchase price of seed cotton and input selling price. Approves programs and budget for cotton research. Manages smoothing fund, cotton inputs funds, etc.
		National Union of Cotton Producers in Burkina	UNPCB	1	Distribution of inputs. Management of short- and medium-term loans. Marketing of seed cotton. Other related activities such as management of membership fees and social activities.

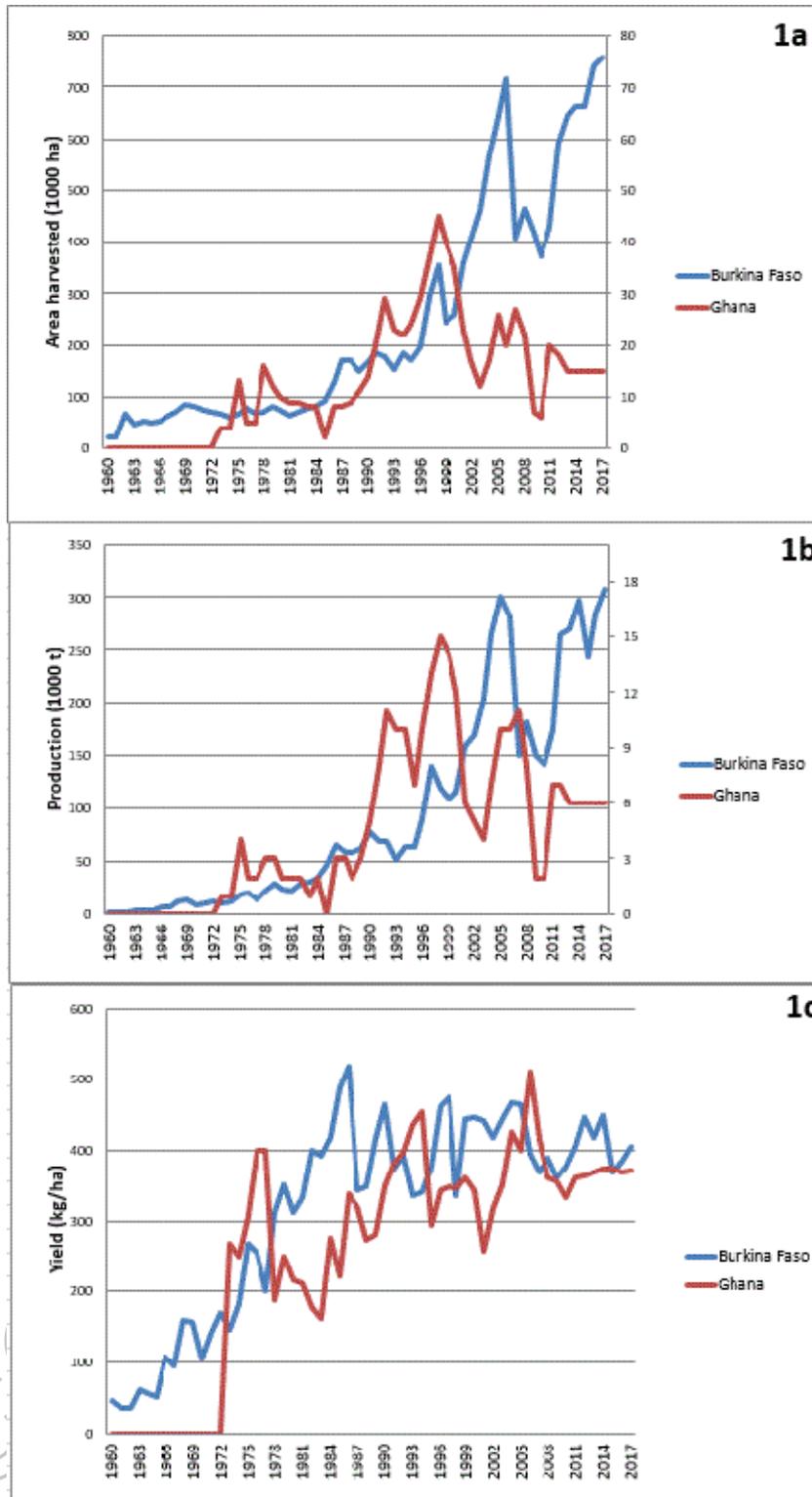


Figure 1

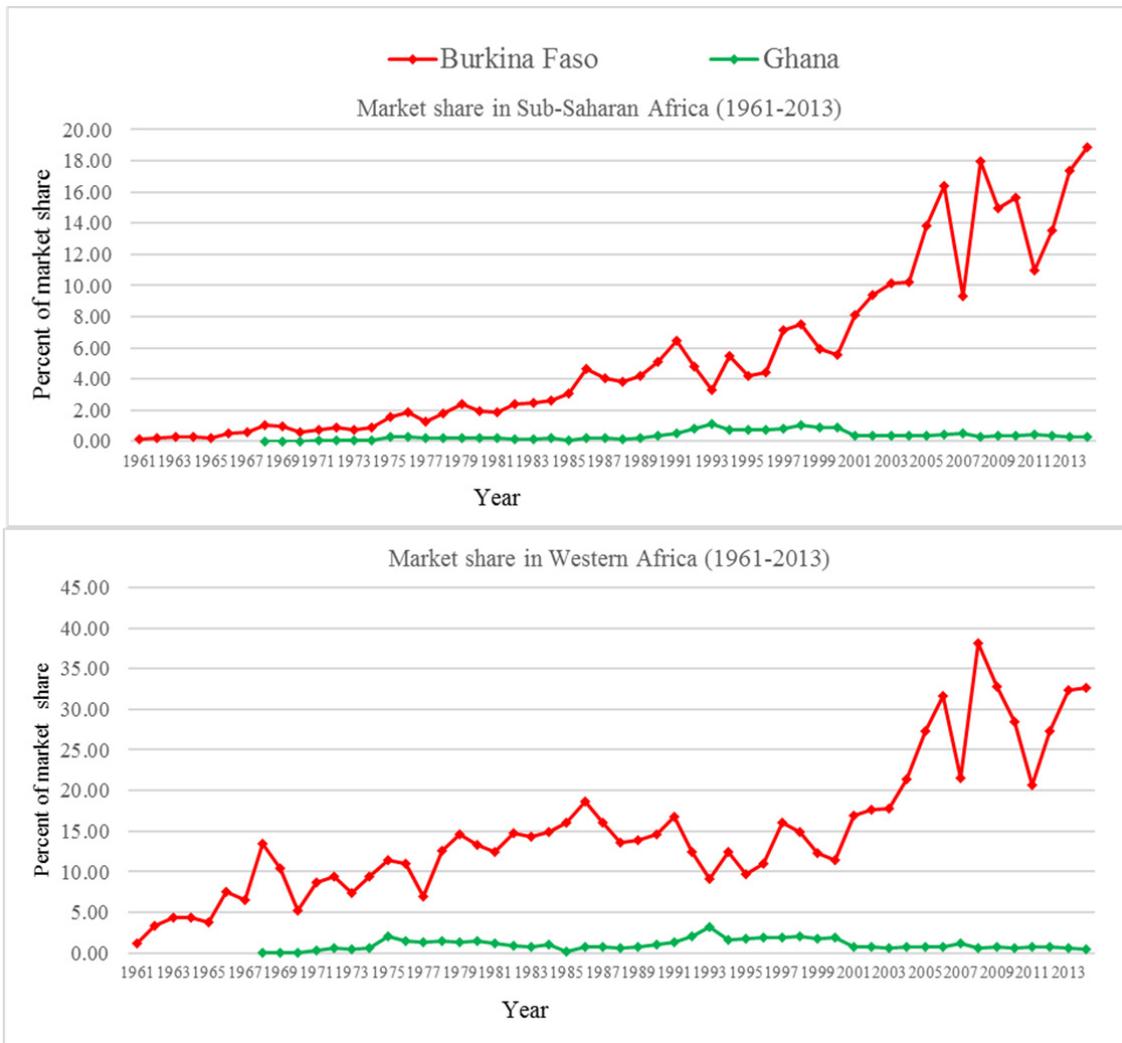


Figure 2

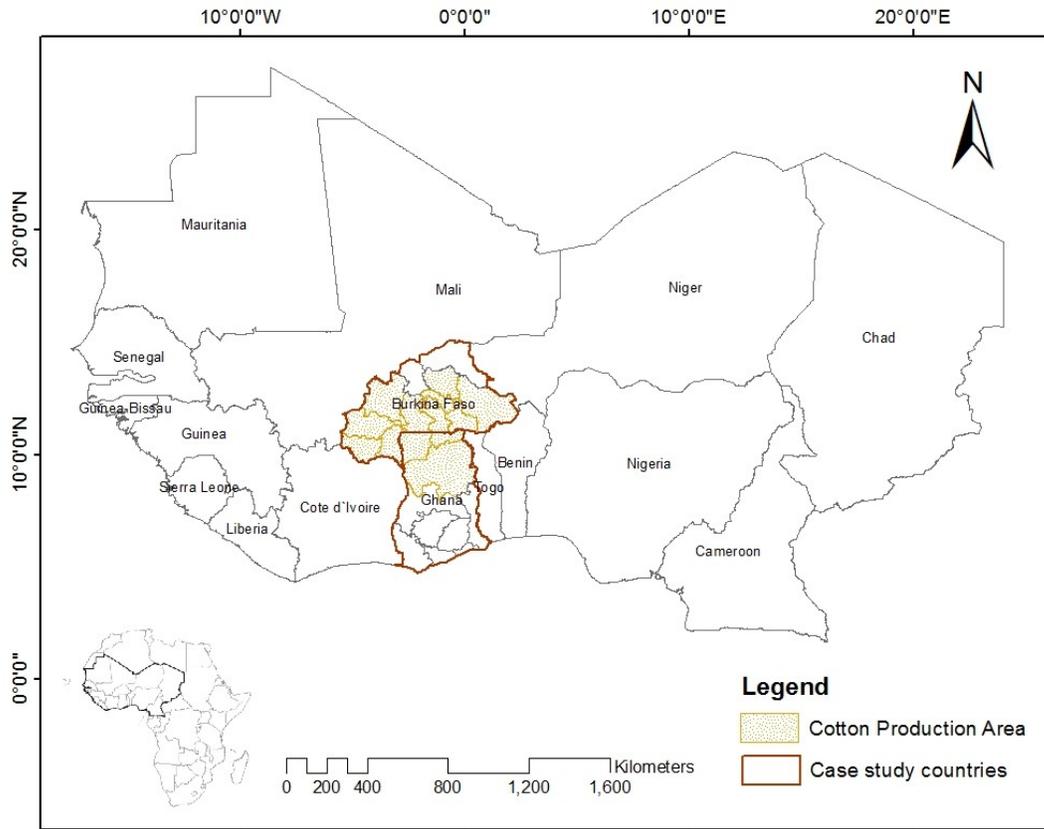
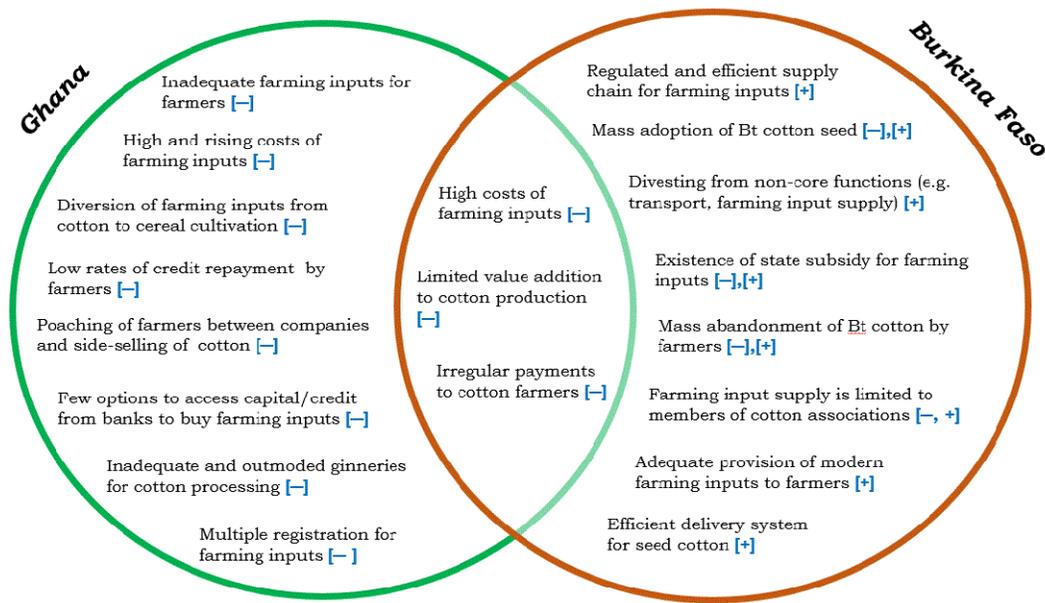
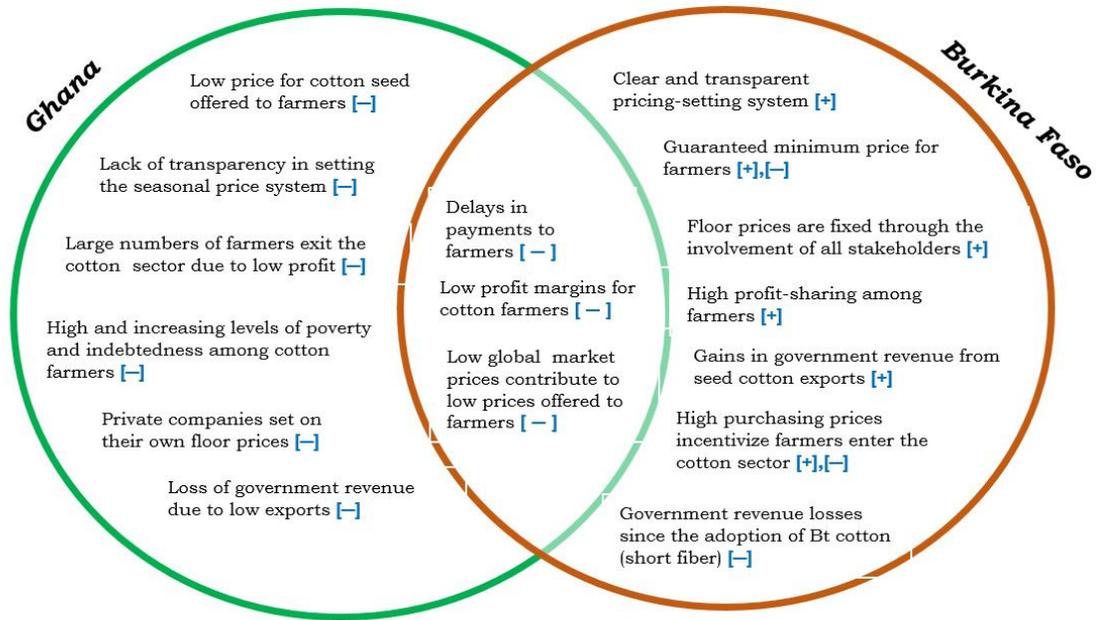


Figure 3



[-] negative impact; [+] positive impact

Figure 4



[-] negative impact; [+] positive impact

Figure 5

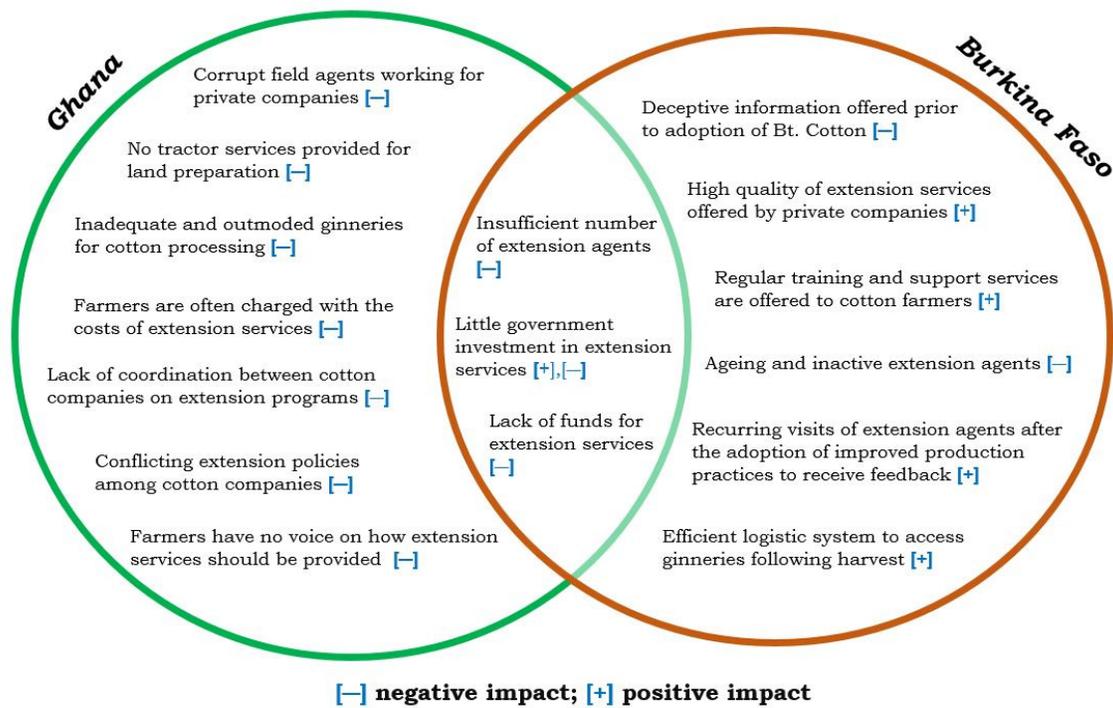
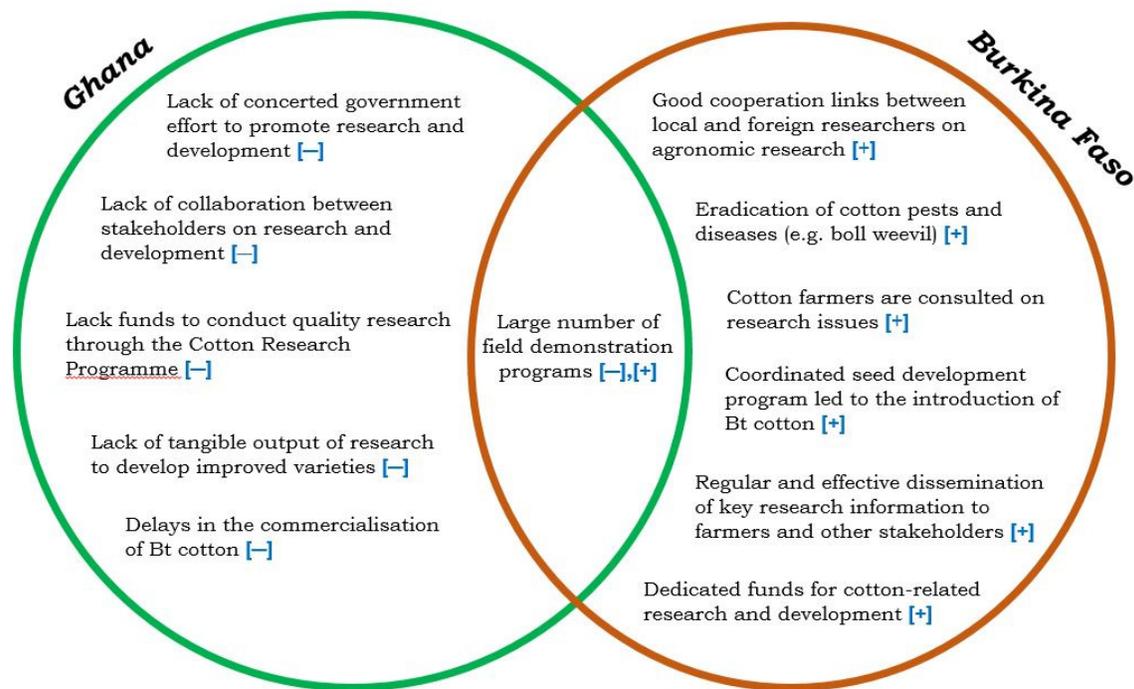


Figure 6



[-] negative impact; [+] positive impact

Figure 7

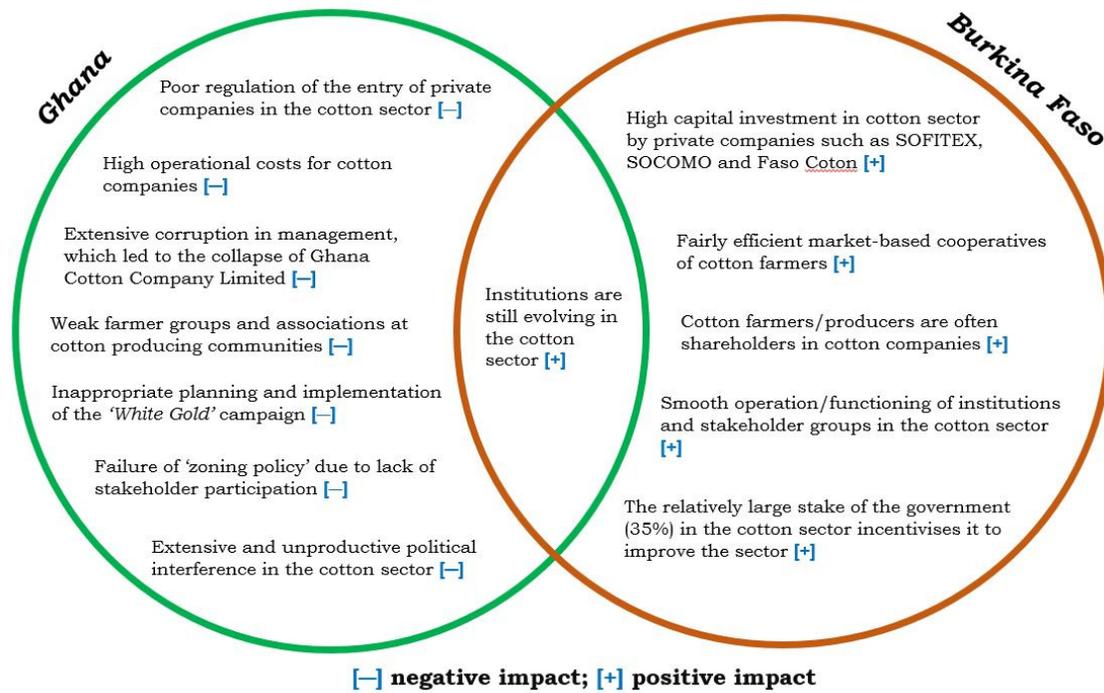


Figure 8

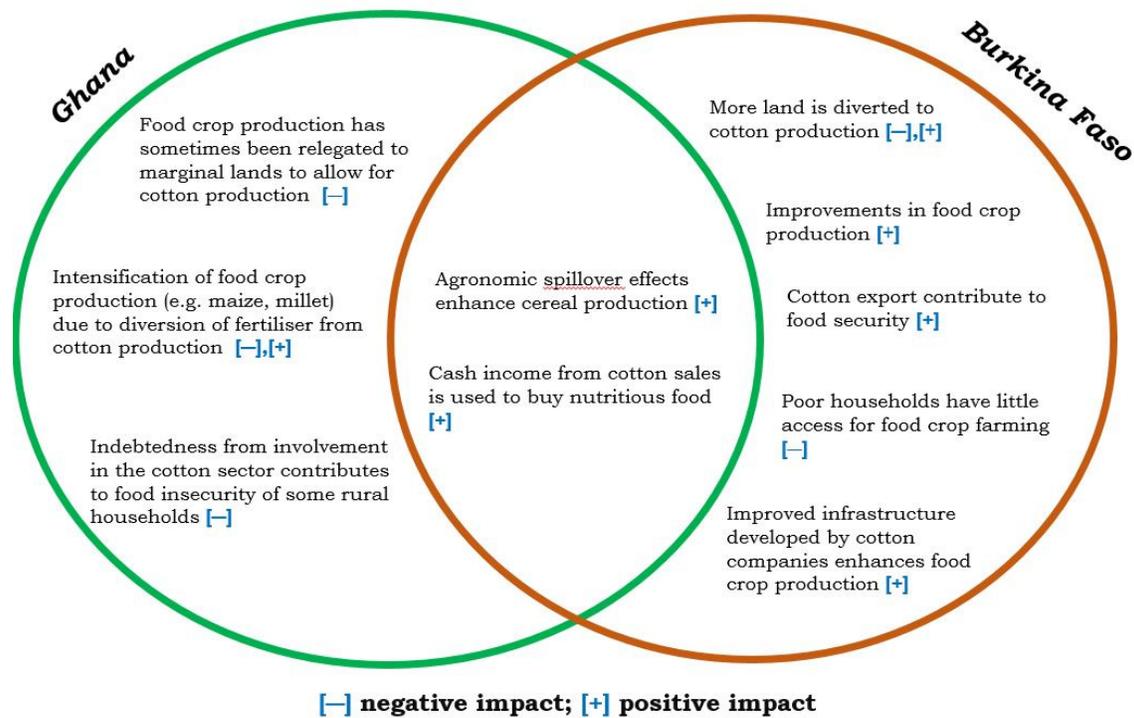


Figure 9

Table S1: Relevant quotes from stakeholder interviews on the perception of the impact of reforms on input credit system statements

Ghana	Burkina Faso
<p><i>“As farmers, we have been witnessing a continual decline in the amount of inputs being given to us to farm cotton. They say the government is not in the position to provide free inputs like fertilizer and pesticides. I have to buy pesticides in addition to the one supplied by PDL because it is often too small. This was not the case 20 years ago, when the government provided fertilizer and pesticides for free”.</i></p> <p>[Cotton Farmer, Bullu Village, Sissala West District]</p>	<p><i>‘The supply of inputs considers the ability of each group to be able to pay the debt (credit). After the assessment of needs and the quantification per items (NPK, urea, insecticides, equipment, etc.), other processes (i.e. counting) required the involvement of cotton companies, the National Union of Cotton Producers (UNPCB), INERA, which is responsible for the quality control’.</i></p> <p>[Official, SOFITEX, Houunde region]</p>
<p><i>Due to low quantity of inputs for farmers, they tended to register with different companies to get more inputs. Inputs especially fertilizer are often used for other crops and this results in low output in cotton”</i></p> <p>[Official, CSIR-SARI, Nyankpala]</p>	<p><i>We cannot control input prices; we have to go to the state to get subsidies. The price of cotton is also a problem when it falls. Up to a certain level, producers are no longer encouraged to produce when the price of cotton falls while the factory produces at fixed costs. In addition, there is a delay of delivering inputs to producers’ due to conditions of roads”.</i></p> <p>[Official, Faso Cotton]</p>
<p><i>“Farmers have been complaining a lot about the inadequacy of fertiliser for the cotton farms. But we have had to reduce because we as cotton companies have limited access to credit” My company always try to give fertilizer and pesticide to farmers at the minimum costs. In the last 12 years, government support to the cotton sector through MoFA has been virtually non-existent. Moreover, everything has been politicised“</i></p> <p>[Official, Plantation Development Limited, Wa].</p>	<p><i>“Since the state is a shareholder, it contributes to the input support, technical support, supervision, and research. The tillage equipment of cotton producers is around 70% today unlike Chad where they estimate 7-15 people around a plow. In these agricultural materials, often the state comes to the aid and some can obtain them by themselves since they make money through ancillary cultures (small millet, beans, etc.).</i></p> <p>[Ex-Official, UNPCB]</p>
<p><i>The truth is, input costs have increased over the years. The fact that farmers have to pay a lot of money for fertilizers means that at the end of the harvest season they barely end up nothing in terms of income and that to me is the main reason the industry is collapsing”.</i> Prior to the 1980s, Ghana’s cotton industry was burgeoning with strong local involvement especially from textile companies</p> <p>[Official Ministry of Food and Agriculture, Sissala East District, Tumu].</p>	<p><i>If you are not a member of a group, you cannot benefit from the advantages linked to the inputs, the marketing, etc. In fact, this is the way cotton companies are demanding to recuperate their inputs and collect the production. Therefore, farmers are obliged to sell their cotton to the cotton companies and the funds allow to recover their credit.</i></p> <p>[Official, Farmers’ organizations and extension services, Ministry of Agriculture]</p>
<p><i>“...Farmers complain about the lack of mechanization services to help them expand their farm area. When GCCL was in operation, they had access to mechanization services but they are not receiving that anymore from the private companies. Thus, many have exited the sector”</i></p> <p>[Official, Sissala West District Assembly, Gwollu]</p>	<p><i>The state since 2008 has pledged to subsidize fertilizer, seeds and agricultural equipment through specific operations so we can give the amounts that the state brings for each year as part of this grant. For example, the state can subsidize 10-15,000 tons of fertilizer, 4,000 tons of seeds in support of small farmers. So, there are seeds, fertilizers, and agricultural equipment as part of the state subsidy, but</i></p>

	<p><i>it should be clarified that this is only a small contribution. Since the 1990s, the input market has been liberalized. Before this period, the Ministry of Agriculture purchased the inputs and distributed them to cotton producers, but since the 1990s, the market is liberalized, meaning that producers organize themselves with private operators and buy their inputs. For the agricultural equipment, it is the private that also controls.</i></p> <p>[Deputy of the Department of inputs and Crop Development, Ministry of Agriculture]</p>
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Table S2: Relevant quotes from stakeholder interviews on the perception of the impact of reforms on price determination and profit distribution statements

Ghana	Burkina Faso
<p><i>'In Ghana, cotton farming is all about pricing. This is what attracts farmers into the cotton production. Farmers like better price but don't like it been tied with the inputs. They have to make it like cocoa price. Even 1 Ghana cedi difference in the price can change a farmer's mind'. So even though Ghana on the international market has become a high earning crop in recent years, local farmers are not enjoying their fair share.'</i></p> <p>[Official, Crop Services Directorate, Ministry of Food and Agriculture]</p>	<p><i>"For each cropping season, the purchase price of cotton grain is determined based on market conditions and tenders. Nevertheless, operationally, there is a specification for fertilizers (urea, NPK,) and a standard specification that is suitable for each company. Apart from prices, there are other conditions (cotton ranking) that must be defined so that actors can respect them. On cotton paid to producers, there are two types of choices that depend on the quality. The cotton of the first choice which is less loaded, contains less debris and less leaves, is clean. The cotton of second choice contains debris and has been beaten by rain, etc. The price gap is determined based these qualities. The price of the first choice varies per campaign (i.e. 110 to 135 CFA per kg). For the second choice, the calculation is made on the basis of the first choice".</i></p> <p>[Official, AICB]</p>
<p><i>"Even though the Ministry of Food and Agriculture, Ministry of Trade and Industry and other collaborating agencies tried hard to setup a mechanism for setting fair prices at the beginning of each farming season with careful consideration of world market prices in consultation with recognized cotton production companies, other mostly small-scale private companies also had their own prices for buying seed cotton depending on their input costs, this resulted in poaching and collapsed of the system"</i></p> <p>[Member, 'White Gold' Campaign, Ministry of Trade and Industry]</p>	<p><i>'Lately, income declines as cotton prices have declined in the world market. When producers' incomes fall, they cannot cope with what the pressure of the period demands. The different problems related to production are inputs, rainfall, agricultural materials, etc.'</i></p> <p>[Ex-Official, UNPCB]</p>

<p><i>“Farmers are not trustworthy. They often registered with more than one cotton company because of price differentials and inputs. At the end of the farming season, they gave their output to the company with the best price even though they took inputs such as fertilizer, pesticides and ploughing from a different company. Moreover, the government refused to involve my company in price setting arrangements and for me I blame that on politicians”</i></p> <p>[Official, Intercontinental Farms, Tamale]</p>	<p><i>“It is independently of our will since we are governed by the laws of the market. There are times when we can produce well, but if world prices are bad, it is a real catastrophe. Actuality the concern is the length of the silk of the GM cotton (Bt), which is short. It is a little short (1-1.5 mm) compared to the local variety. This translates into a financial shortfall of FCFA 10 per kilogram. This year, it seems that the producer talks about 50 FCFA on every kilogram. So, this is current problem, we are seeing how we will find a solution with our partner (Monsanto) who gives the GMO which must work to correct this deficit to enable us to better produce and sell better”.</i></p> <p>[Official, SOFITEX, Houde region]</p>
<p><i>‘Compared to 20 years ago, farmers have been making loses in the production whiles the cotton companies are gaining and making abnormal profit. They buy our produce at low prices and sell it highly in the world market. Farmers in Burkina Faso earn higher than us here in Ghana, even with the same quantity. The situation is very bad, to say the least’.</i></p> <p>[Farmer, Bullu village]</p>	
<p><i>‘It has become difficult for us to cover the costs of inputs in recent years. After deduction of fertilizer, pesticides and tractor services (which is no more in existence), most of us earn nothing. Many farmers are in debt and do not qualify for future credit to plant cotton’</i></p> <p>[Farmer, Gwollu]</p>	

Table S3: Relevant quotes from stakeholder interviews on the perception of the impact of reforms on extension services statements

Ghana	Burkina Faso
<p><i>“Cotton production extension system is not like MoFA system as it is now being done solely by individual cotton companies. However, due to low knowledge base, weak co-operation and unhealthy competition between these companies, conflicting and inadequate services are being provided to cotton farmers. This has been a major challenge as far as the performance of the sector is concerned. SARI has developed a cotton production manual, which could be of help to these companies.</i></p> <p>[Official, Official, CSIR-SARI, Nyankpala]</p>	<p><i>‘Since the reform of the cotton sector in 1996, an advisory support system was put in place. Before this date, agents of the Ministry of Agriculture provided the system. Currently, SOFITEX has its technical staff of cotton and cotton correspondents. They contribute to the increase of production efficiency and coverage of the entire cotton production area. Agents are trained by SOFITEX through external and internal training staff. In turn, they give advice to producers and receive all complaints, manage conflict, help for the operation of these groups on the ground and report information that may be important for the cotton sector to the region levels and to the general direction.</i></p> <p>[Official, SOFITEX, Houde region]</p>

<p><i>“The politicization of the cotton sector in Ghana. Lack of capital for expansion from banks and fluctuating world market prices means that private cotton production companies like PDL is unable to create our own extension services to provide technical support to farmers beyond providing them with inputs. It has become too expensive”.</i></p> <p>[Official, Plantation Development Limited]</p>	<p><i>“As far as cotton is concerned, it is true that from outside people think that cotton is managed by the Ministry of Agriculture, but in reality, the cotton sector is attached to the Ministry of Commerce. In addition, all cotton companies are independent from the Ministry of Agriculture because they have their own staff to supervise and monitor production. They are also linked to research institutions, which support research on varietal issues, etc.”</i></p> <p>[Official, Department of Inputs and Crop Development, Ministry of Agriculture]</p>
<p><i>“When my father was farming cotton about 30 years ago, extension officers were coming regular to teach them how to apply the fertilizer and also to harvest the seed cotton properly and that helped to have higher output. Nowadays, they only provide us with the cottonseed and fertilizer. They hardly provide technical support” For this, this is the major reason for the declining performance of the sector, because we as farmers are ready to grow the cotton despite all the environmental challenges.</i></p> <p>[Farmer, Nyemiti village, Sissala West District].</p>	<p><i>“Cotton companies including SOFITEX are not attached to the Ministry of Agriculture. SOFITEX is a very powerful society since it is practically autonomous. Agents recruited from the Ministry of Agriculture do not supervise cotton producers. After the reform, SOFITEX recruited its own agents, she put her own dispositive, and it is like a state in a state. It has its own staff and comes with significant results”.</i></p> <p>[Official, Direction of Legislation, Regulation and Land Tenure Security, Ministry of Agriculture]</p>
<p><i>“As someone who has been farming cotton for more than 30 years, I have been aware that the extension officers from the cotton companies steal connive with farmers and other agents to steal inputs meant for farmers. Thus, one cannot trust the extension and field supervisors to provide both technical and advisory support to farmers. It’s quite pathetic”</i></p> <p>[Farmer, Bullu village, Sissala West District]</p>	<p><i>“We also have a role of advisory support to producers, a system of supervision on the ground, we advise producers how to produce cotton, give them reliable information. So, an interface staff that bring back the information and vice versa”.</i></p> <p>[Official, Faso Cotton]</p> <p><i>“As for extension services, the difficulty is that the dispositive, the team of extension workers is not sufficient (if I need 40 extension workers to cover my area I can only have 20 for example). However, the result would not be the same if I had the 40 coaches. So there is a problem of availability, a deficit in the coverage of supervision and we also have an aging team”.</i></p> <p>[Official, SOFITEX, Hounde region]</p>

Table S4: Relevant quotes from stakeholder interviews on the perception of the impact of reforms on research and development statements

Ghana	Burkina Faso
<p><i>“The limited research being invested in cotton research in Ghana means that we are not ripping the full benefits. Even though the Cotton Research Programme was instituted, there is no money to fund research into the sector. At the moment, field trials of Bt-cotton (Bacillus thuringiensis) in the three northern regions is yielding positive results, although my major concern is that public awareness and education is low”.</i></p> <p>[Official, CSIR-SARI, Nyankpala]</p>	<p><i>‘For the cotton, the national committee of biosecurity approves on each project (dossier). This committee consists of a number of experts from different specialties. After the evaluation, they examine the safety measures that are required and the enquirer (person or organism who wants to conduct the experiment) has a duty to respect the safety measures. Finally, the ANB conducts monitoring missions and inspections regularly to see if the enquirer who made the request respects different conditions that have been signed”</i></p> <p>[Researcher, ANB]</p>
<p><i>“We farmers are interested in adopting Bt-cotton to improve our yield but the government is saying that they are still conducting tests and experimentations before approving it. This so-called experimentation has been going on for so long. It shows that they are not serious with research on cotton”.</i></p> <p>[Farmer, Bullu]</p>	<p><i>“Cotton brings more than 60% of export earnings. Therefore, cotton is a key sector for the development of Burkina Faso. All production systems are integrated with the cotton sector. When there was a crisis, people began to abandon cotton cultivation, there had been the strategy to adopt Bt cotton and must begin with the first experiment. It was decided not to accept directly seeds from foreign companies. We conducted first experimentation (2003-2006) by introducing the genes in our varieties. Then in 2008 we had the first multiplications and the total cultivated area under Bt cotton was 8,000 hectares. In 2009, it increased nearly by 120,000 hectares”</i></p> <p>[Researcher, INERA Bobo-Dioulasso]</p>
<p><i>‘In Burkina Faso, they do a lot of research and cotton is succeeding because they grow it like cocoa and government is heavily involved. The same cannot be said for Ghana and maybe it is because the Ghana government relies on many crops especially cocoa and has failed to see the importance of cotton over the years. Reforms have actually worsened the situation as things were better in the 1980s”.</i></p> <p>[Official, Plantation Development Limited, Wa)</p>	<p><i>“In 1998, we experienced a serious crisis with the advent of pest groups that resisted to the active substances of chemicals (pesticides) causing the loss of efficiency in cotton production. This problem has mainly attracted the attention of stakeholders in the cotton industry. After several discussions, authorities have explored the Bt cotton option to boost the agriculture sector in general particularly cereals production”.</i></p> <p>[Official, INERA, Cotton Development Program Bobo-Dioulasso]</p>
<p><i>“There has virtually being no research into the cotton sector in Ghana. As far as I am concerned, that has been the case for the agricultural sector in general for many years. Even though I am aware that SARI is doing field trials on Bt-cotton, as an experienced person in the cotton industry, I can say that introducing Bt-cotton is not the solution. In fact, it will only impoverish smallholder farmers and only worsen</i></p>	<p><i>‘For the cultivation of genetically modified cotton, even if the yield is not high, the difference is not very important in terms of yield gain compared to conventional cotton. Monsanto wanted us to increase the area of Bt cotton since it is to their advantage, but cotton companies and producers have some problems with the GMO (short fiber and loss of revenue), we want to reduce the areas occupied by these GMOs (Bt</i></p>

<i>poverty conditions”</i>	<i>cotton) and increase those of conventional cotton”.</i>
[Official, Intercontinental Farms Limited, Tamale].	[Official, AICB]

Table S5: Relevant quotes from stakeholder interviews on the perception of the impact of reforms on institutional and regulatory system

Ghana	Burkina Faso
<p><i>“Although government intentions for liberalizing the cotton sector in Ghana was good, the right structures and management systems were not put in place and this has threatened the very survival of the sector. For instance, the more recent policy of zoning initiated by the Ministry of Food and Agriculture (MoFA) had many shortcomings and resulted in conflicts between cotton companies due to poaching and side-selling of outputs by farmers”.</i></p> <p>[[Official, CSIR-SARI, Nyankpala]</p>	<p><i>Burkina Faso is a successful model in terms of the reform of cotton sector. The association of cotton producers are represented in the management chain. It is an integrated liberalization where producers become shareholders in cotton companies. Furthermore, they belong to the Inter-Professional Association of Cotton of Burkina (AICB) where all questions are settled (fixing the price of cotton grain, inputs, Rebates, etc.). All these questions are decided within this association”.</i></p> <p>[Official, INERA, Bobo-Dioulasso]</p>
<p><i>“I think that because of the inadequate involvement of farmers and farmer groups in decision making, they feel alienated. That explains why many farmers in Northern Ghana are finding cotton cultivation unattractive and are exiting the sector. In Burkina Faso, farmers are the most important stakeholders and have a major say. The same cannot be said for Ghana, unfortunately. The reform policies did nothing to change this”.</i></p> <p>[Official German Development Cooperation, Cotton, Accra, Ghana]</p>	<p><i>“The AICB regroups two professional families in the cotton sector. They are the UNPCB (association of cotton producers) and L'APROCOB (3 cotton companies). Together we manage the cotton sector, defend the interests of its members and the application of the implementation of all instruments that are defined in the Inter-Professional agreement between the two families (UNPCB and APROCOB). Beyond this agreement that links these families, there is the state who initiated the liberalization of the sector and established the legal instrument (protocol agreement between actors). These instruments are such as fixing price, fertilizer purchase, definition of session conditions, seeds, insecticides, etc. The support of the state has evolved according to the conjunctures. This increases with the volume and costs of inputs”.</i></p> <p>[Official, AICB]</p>
<p><i>“There is no transparency in the cotton institutional environment in Ghana and that has been the case over the last 30 years. Politicians have been controlling the sector even though they often have no idea about the workings of the sector in Ghana. They give contracts to their cronies and this to me has been the bane of the cotton sector in Ghana, hence the low productivity.”</i></p> <p>[Official, Intercontinental Farms Limited, Tamale].</p>	<p><i>“The cultivation of cotton enabled producers to be organized and structured into a real sector, the Inter-profession, and so on. This is really important, because in all cotton-producing areas, producers are organized. So, this contributes to their capacity building. Cotton producers have a fairly interesting level not only from a technical point of view, equipment, etc. When we make the typology of our farmers in general, we realize that it is in the cotton producing areas that people have a fairly interesting standard of living because they use mechanization, motorization, and so on.”</i></p> <p>[Official, Department of Inputs and Crop</p>

	Development, Ministry of Agriculture]
	<p><i>'Cotton companies are autonomous in all aspects. It is not the agents recruited by the Ministry of Agriculture who supervise cotton producers. SOFITEX has recruited its own agents, it has put its own dispositive and staff'</i>.</p> <p>[Official, Direction of Legislation, Regulation and Land Tenure Security, Ministry of Agriculture]</p>

Table S6: Relevant quotes from stakeholder interviews on the perception of the impact of reforms on food security

Ghana	Burkina Faso
<p><i>'As far as I am concerned, cotton reforms have improved food security of growing households because farmers use the fertilizer provided to them for cotton to grow other crops like maize to improve yield. More yields of maize mean households can sell some bags to buy other food needs when they find it necessary. They also don't have to worry about food scarcity as it pertained in the early 1980s. This practice though has impacted negatively on seed cotton productivity and my company as well'</i>.</p> <p>[Official, Intercontinental Farms Limited]</p>	<p><i>'In Burkina Faso, the survival of food security depends on cotton production since the technique that producers use on cotton, is also applied to cereals production making them the best producers of cereals too. This is due to the official amount of fertilizer (15-30%) allocated to cotton producers for the production of cereals. In addition, cereals such as sorghum and millet, where one does not need to apply fertilizer, may also benefit on the carry-over effect (rear-effect) of the cotton cultivation during the last season. Furthermore, cotton producers with significant landholding go for livestock'</i></p> <p>[Ex-Official, UNPCB]</p>
<p><i>"Usually, cotton is grown in places where staples like yam, rice does not do well so if farmers grow more cotton they can get enough money to buy food crops to feed the whole family. Serious farmers have told me that the money from cotton has played a key role in helping them feed their family all year round. I don't have empirical evidence to that effect but I believe them"</i>.</p> <p>[Official, Plantation Development Limited]</p>	<p><i>"The cultivation of cotton is the only crop in Burkina Faso allowing producers to obtain fertilizer for cotton as well as for cereals. This system allows cotton producers to obtain more production of maize or sorghum allowing them to achieve the food security. In addition, crop rotation (cotton-cereals) allows cereals to benefit from the carry-over effect and produce more yields. Producers sell the surplus of cereals and this is a positive impact of cotton cultivation on food security. Most cotton producers are well equipped (plows, oxen, etc.), allowing them to cultivate more farms."</i></p> <p>[Official, Faso Coton]</p>
<p><i>'The money I get from cotton is important for my households. When the price for seed cotton is good, we earn a lot of money to buy food that we don't produce here because of poor soils. We are able to buy guinea fowl and goat during festive occasions. The problem is cotton cultivation is now more attractive for us farmers'</i>.</p>	<p><i>"In Burkina Faso, the best producer of cotton is also the best cereal producer. This is an established fact and constitutes technical and scientific findings. It is a fact of the rest of the country and it is done in the field. For us, cotton is an engine to the development of cereal crops. It is the finality of food security in the cotton areas as well as in the whole country. Cotton areas serve as reservoir for the supply of cereals to</i></p>

<p>[Farmer, Gwollu, Sissala West District]</p>	<p><i>deficit areas. In addition, some cotton producers remain a reference due to the diversification (maize production and livestock)”.</i></p> <p>[Official, SOFITEX, Hounde region]</p>
<p><i>“...In recent years, I will say that because the cotton business is not booming, I don't get enough money to buy variety of food especially meat so I can say that my household food security situation has become worse. Personally, I blame this on the cotton companies and government who are cheating us”</i></p> <p>[Cotton farmer, Zini, Sissala West District]</p>	<p><i>“In the cotton-growing areas, bees are no longer encountered as before, whereas beekeeping is a source of income. This is also the case for fish in ponds, rivers, etc. This is also true for toads. So all this fauna is threatened. This is due to the fact that many of the pesticides are used”.</i></p> <p>[Official, Department of inputs and Crop Development and his Deputy, Ministry of Agriculture]</p>

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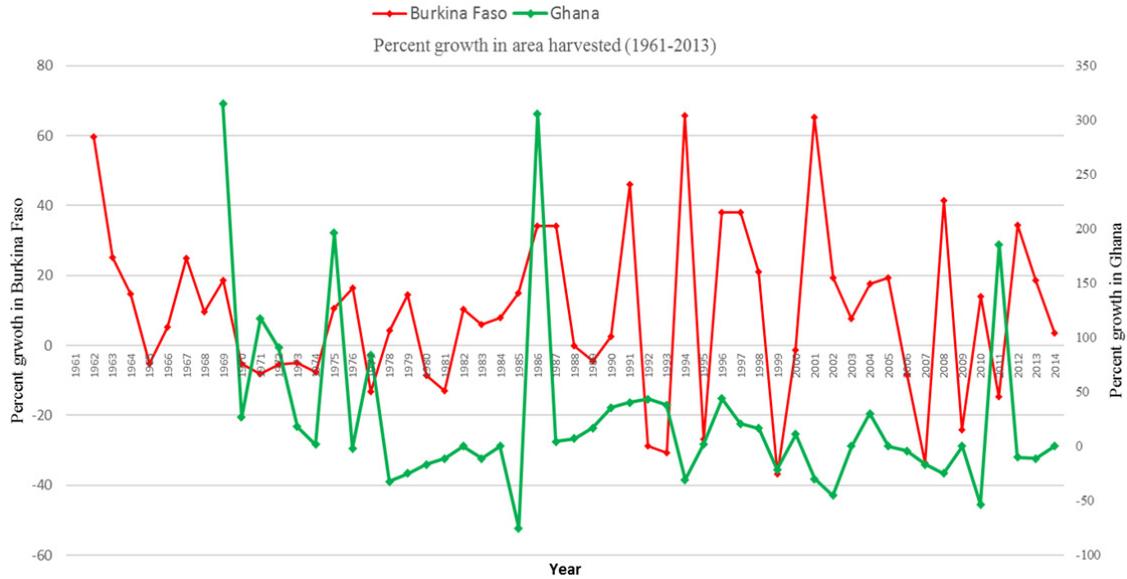


Figure S1: Annual percentage change in cotton area harvested in Ghana and Burkina Faso for the period 1961-2013. Source (FAOSTAT, 2016, ICAC, 2016)

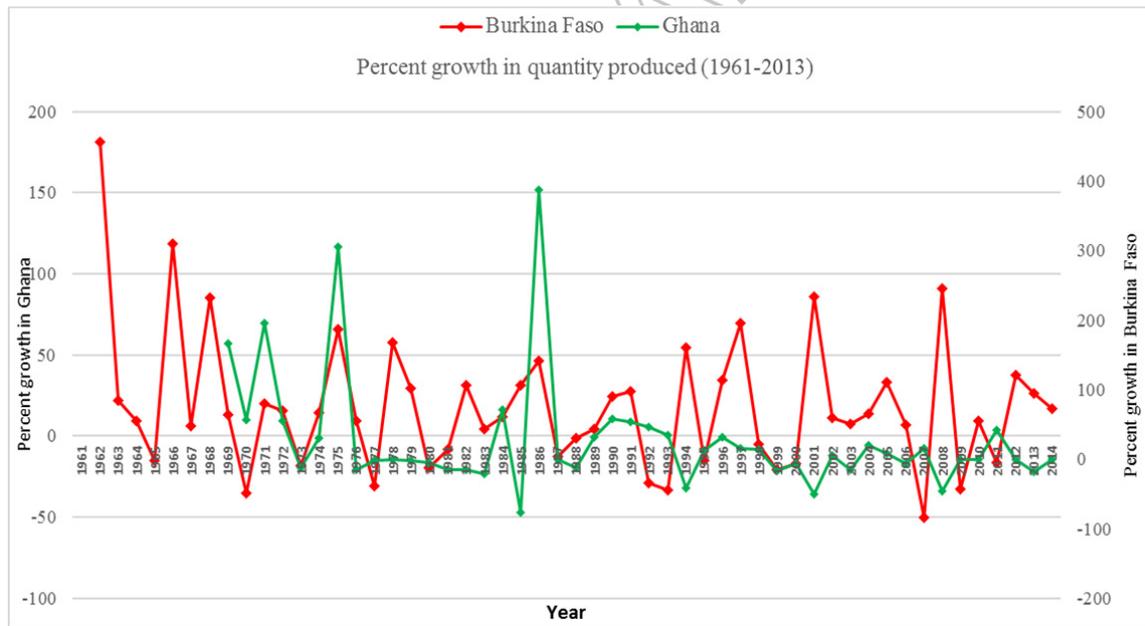


Figure S2: Annual percentage change in cotton production in Ghana and Burkina Faso for the period 1961-2013. Source (FAOSTAT, 2016, ICAC, 2016)

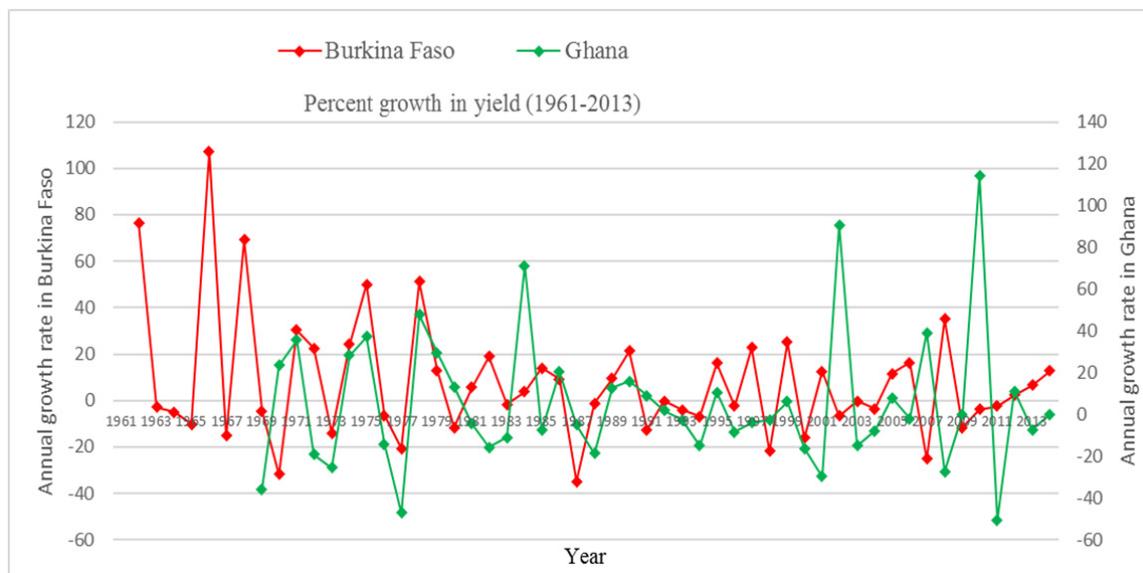


Figure S3: Annual percentage growth in cotton yield in Ghana and Burkina Faso for the period 1961-2013. Source (FAOSTAT, 2016, ICAC, 2016).