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## GEOGRAPHY | RESEARCH ARTICLE

# The impact of disaster risks on economic sustainability of cotton supply chains: Evidence from Chiredzi District, Zimbabwe

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**Abstract:** This study seeks to establish the impact of disaster risks on economic performance of seed cotton supply chains in Chiredzi district of Zimbabwe. Reliable primary data were collected through structured questionnaires which were personally administered to cotton farmers by these researchers. In-depth interviews were also conducted with cotton merchants to buttress the results of the structured questionnaires. Given the ordered nature of the dependent variable, economic sustainability, the study employs ordinary least and ordered regression models which check for robustness. Findings indicate that disaster risks have a significant influence on economic unsustainability of seed cotton supply chains in Zimbabwe. Results of conducted interviews show that disaster risks have negatively affected the quality of cotton and cotton products. In addition, thousands of workers lost their jobs and resulted in some cotton supply chain players winding up their businesses.

**Subjects:** Economics; Environmental Economics; Industry & Industrial Studies

**Keywords:** economic sustainability; cotton; disaster risks; supply chains; Zimbabwe

**JEL codes:** Developing country; Economic development; growth, innovation; least developed countries

### 1. Introduction

Developing and developed countries continue to face new and emerging hazards that magnify disaster risks with devastating effects (United Nations Office for Disaster Risk Reduction, 2013). Due to interdependence of world economies, countries are vulnerable to disasters irrespective of their geographical location (Reddy, Anbumozhi, & Singh, 2016). Consequent to these natural or man-made events, there have been disruptions in supply chain systems which affect viability and lead to closure of many enterprises. Disaster risks, particularly droughts, cyclones, wildfires, animal diseases and floods, bring devastating impacts on agricultural operations and agricultural supply chains negatively affecting business performance by undermining environmental, economic and

### PUBLIC INTEREST STATEMENT

The agricultural sector in both developed and developing countries faces many natural and man-made disasters disrupting agricultural operations and agricultural supply chains, affecting business performance by undermining environmental, economic and social sustainability. Scholars in previous research studies have overlooked an association between disaster risks and the economic sustainability of the cotton wool industries in developing countries, which has triggered this study. Therefore, the objective of this research study is to assess the effects of disaster risks on the economic sustainability in the cotton supply chains in Chiredzi district of Zimbabwe. Primary data were collected through questionnaires and interviews. The research study findings indicate that disaster risks have a significant influence on economic unsustainability of seed cotton supply chains in Zimbabwe.

social sustainability. Economic sustainability is the ultimate goal as focus on social and environmental issues is pertinent to economic sustainability (Frontstream, 2013). Economic sustainability comprises food security, poverty reduction, economic viability and economic risk management (Food and Agriculture Organization, 2015). This study focuses on the impact of disaster risks on economic sustainability in agriculture, particularly cotton production in Zimbabwe.

Agriculture contributes significantly to the economic prosperity of both developed and developing countries (Macatta, 2016). Agricultural output and productivity contribute to overall economic development of developing countries more than industrial output. In the history of Zimbabwe, agriculture is an anchor industry of the economy contributing about 13.1% of the gross domestic product (GDP) (Anseeuw, Kapuya, & Saruchera, 2012) and 22.8% of the foreign currency earnings and almost 23% of employment. Furthermore, it is a source of livelihood for about three-quarters of the country's population (Reserve Bank of Zimbabwe (RBZ), 2006). Cotton is Zimbabwe's second most important cash crop after tobacco, constituting 12.5% of agricultural GDP and contributing to 22% of agricultural exports (World Bank, 2010). In the country, cotton is grown by thousands of smallholder farmers, making it a critical source of income for rural communities in cotton-producing regions. Furthermore, there is a strong local demand for cottonseed as a major raw material in edible oil and stock feed production. Cotton production is linked to other sectors of the economy, such as equipment manufacturers, food processors and transporters, creating crucial cotton supply chains (Dandago, 2005). However, in the last decade, cotton has faced threat from disaster risks plaguing the country.

Consequent to the role of cotton in the economy, this study, therefore, seeks to establish the relationship between disaster risks and economic performance of cotton supply chain and establish the significance of the relationship. The next section of this article reviews the literature on global disasters risks and the impact of these on cotton supply chains. The other sections focus on the research methodology used by these researchers before the presentation, analysis and discussion of results.

## 2. Literature review

### 2.1. Disaster risks in global cotton industry

The world is exposed to an increasing number of disaster risks, both natural and man-made (Roh, Pettit, & Beresford, 2008). Most of the natural disaster risks have been attributed to climate change. Climate change is attributed to human activities which change the global atmosphere resulting in variability in climate over a period of time (United Nations, 1992). As climate change continues to hit the global world, there have been frequent and severe droughts, storms, floods and other disasters, resulting in increased damage to the agricultural sectors, especially in developing countries (FAO, 2015). In many Asian countries, particularly Pakistan, cotton ginning was affected by 2010 and 2011 floods and storms resulting in cotton imports surge. The floods hit cotton farmers by washing away their crops, affecting the livelihood of many Pakistan cotton farmers and workers in the textile industry. Demand for seed cotton and cotton products has continued to surge and for that reason, this industry has remained an important element in the economic development of both developing and developed countries. In the same manner, the 2017 flooding in Gujarat, India, affected tens of thousands cotton farmers by damaging their crop as extra moisture led to pest attacks in these areas (Sewa International, 2017). There is increased threat from environmental experts for the development of more sustainable cotton cultivation and production to reduce the overall environmental impact (Bessarabova, 2013). Even though cotton is grown on 2.5% of the world's agricultural land, it consumes 16% and 6.8% of all the insecticides and herbicides used worldwide, respectively, making it a very pesticide-intensive crop. Intensive use of fertilizers and pesticides pollutes the land, while at the same time poses health risks for farmers and workers, which make it economically and environmentally unsustainable (C & A, 2015). The overuse of chemical fertilizers and pesticides causes soil degradation, reducing its nutrient and water retention capacity. As a consequence, farmers face declining yields and have to increase production inputs for better yields. The problem is further

worsened by the resistance of some pests to pesticides. Small-scale farmers are obliged to borrow from banks or cotton buyers, to pay for the increasing costs of farm input. However, a farmer's income from cotton is lower than the production cost in most cases, because of poor cotton yields and low market prices. The industry is known for problems such as child labor and health risks emanating from chemical use (Bessarabova, 2013). Diarra, Barbier, Zongo, and Yacouba (2017) sought to evaluate the impact of climate change on cottonseed production in Burkina Faso. Results of the study showed that climate change has significantly reduced the yield of cotton. They further concluded that increases in global temperature were harmful to cotton production in Burkina Faso. Diarra et al. (2017) also highlighted that cotton yields are positively related to the price of cotton. Unreliable rainfall has also adversely affected cotton yields in Kenya (Gitonga et al., 2010). Furthermore, high input costs which are related to weeding, spraying and harvesting contributed to lower gross profit margins in Kenya (Gitonga et al., 2010). Disaster risks disrupt the supply chain, thereby affecting business performance and undermining organizational competitiveness and economic sustainability of a country (Madu and Christian, 2014). This study seeks to establish the impact of disaster risks on the performance of Zimbabwe's cotton industry.

## **2.2. Global cotton supply chain**

A supply chain refers to a logistics network consisting of firms and business activities that bring products or services to satisfy customer request (Chopra & Meindl, 2007). Cotton has a complex supply chain that stretches from input suppliers, farmers, traders, ginning factories, spinning mills, textile companies and oil processors (WWF-India and YES Bank, 2012). The supply chain is global, spanning from developing countries, where most of the cotton is grown, to developed countries where raw cotton is processed into finished products. Global supply chain networks are exposed to a number of risks, ranging from supply delays, supply disruption, price fluctuations, demand fluctuations, to exchange-rate fluctuations that may occur at any stage of the flow of seed cotton products (Sendil, 2015). However, it is disruptions due to disasters at the production level that can bring the most significant impact on the whole cotton supply chain. The Indian cotton supply chain is known to be disrupted by lack of irrigation facilities, lack of infrastructure, government cotton policy interventions and competition from other fibers among other factors (WWF-India and YES Bank, 2012). Similarly, in the Zimbabwean scenario, cotton supply chains have experienced disaster risks which are influenced by environmental, economic, political and legal factors.

## **2.3. Environmental risks to cotton supply chain in Zimbabwe**

Gwimbi (2009) noted that climate change in Zimbabwe and the world over has influenced the recurrence of droughts leaving cotton farmers highly vulnerable. These recurring droughts have been a perennial problem for Zimbabwe cotton sector, resulting in a drop in cotton production. The incessant rains that accompanied Cyclone Eline caused waterlogging and leaching of soil nutrients (Ministry of Agriculture, 2000). Consequently, the continuous wet conditions thus caused poor cotton lint quality among other destruction of crops. Furthermore, Zimbabwe cotton suffers contamination showing the extent of the quality control problem currently experienced by the sector (Poulton & Hanyani-Mlambo, 2008). For this reason, seed cotton contaminated by water, sand or fuel and other foreign matter is rejected by cotton merchants. Apart from environmental hazards, Zimbabwe is also exposed to economic risks.

## **2.4. Economic risks in cotton supply chains in Zimbabwe**

Farmers in Zimbabwe are battling high input costs that have rendered farming an unviable business as the prices of their commodities remain stagnant or have plummeted. Input production costs are too high compared to those of neighboring countries. The minimum production cost per hectare of seed cotton is around US\$150 compared to US\$70 in Zambia and less than US\$100 in Mozambique and Malawi (Buka, 2016). Kwa (2001) posits that as costs of production increase and world cotton market prices fall, farmers face a cost-price squeeze and consequently, only well-to-do farmers survive. Fertilizer takes the biggest share of input costs. Consequently, many smallholder cotton producers in Zimbabwe are hurt most as they regularly apply inorganic fertilizer to their cotton due to poor soils in the communal areas (Poulton &

Hanyani-Mlambo, 2008). The high input costs have affected seed cotton and lint quality as the profit growers obtain from pursuing a “high input, high quality” strategy are not high enough (Poulton & Hanyani-Mlambo, 2008). New contracting companies which have not established close links with the main input suppliers and have no experience in sourcing these inputs offer more stringent package of inputs to the farmers than the established companies (Poulton & Hanyani-Mlambo, 2008). In Zimbabwe, there are no subsidies unlike in other major cotton-producing countries, and this distorts international market trade prices (Buka, 2016). Zimbabwe abandoned this policy to supply lint needs at subsidized prices when the cotton sector was liberalized (Poulton & Hanyani-Mlambo, 2008). The subsidies offered to producers by major cotton-producing countries are either on the cost of inputs to the farmer or on the government-guaranteed minimum producer price where the government pays the difference between the producer price and the guaranteed producer price. The Zimbabwe cotton industry is operating below full capacity, with most of firms operating at below 30% capacity (Buka, 2016). This is because of obsolete machinery and equipment as well as lack of affordable capital. Musara, Zivenge, Chagwiza, Chimvuramahwe, and Dube (2011) posit that most people shun agriculture and in particular cotton farming especially the youth who prefer to take up white-collar jobs. Consequently, aging farmers who are less willing to adopt agricultural technologies in dynamic economic environments dominate the industry. Musara et al. (2011) further point out that educated people have also shunned agriculture for white-collar jobs or other projects that have quick returns. In addition to environment and economic risks, Zimbabwe has political and legal risks affecting its cotton supply chains.

### **2.5. Political and legal risks in cotton supply chains in Zimbabwe**

Zimbabwe’s seed cotton industry faces increasing global competition, especially from subsidized cotton farmers in the United States and India who have also become more competitive with biotechnology. In addition to this, these major cotton-producing countries provide minimum support prices to their farmers. Though Zimbabwe has three farmers’ unions representing farmers in general, the cotton sector still has no organized association for cotton growers such as that existing in other countries (Buka, 2016).

For fear of competition threat from cheap clothing imports, the Zimbabwe Cotton Marketers Association has been lobbying the Government of Zimbabwe to introduce controls on imports that have negatively affected performance in the industry (Buka, 2016). In response, the government of Zimbabwe enacted Statutory Instrument (SI) 142/2009 in 2009 under the Agricultural Marketing Authority Act 26/2004. Under this SI, every contractor is registered and is obliged to provide all inputs to farmers that they contract and protect them from losing the contracted cotton to other buyers through side marketing (Government of Zimbabwe, 2017). Since the introduction of this regulation, the number of contractors has dwindled from 25 contractors in the 2008/2009 season to 12 contractors in the 2009/2010 season, consequently reducing the area planted (Esterhuizen, 2010). The government has also been undermining its own legislation to benefit their preferred buyers. Muza (2013) also highlighted a case where the Cotton Ginners Association of Zimbabwe (CGAZ) accused Sino-Zimbabwe Holdings of involving political heavyweights such as ruling Zimbabwe African National Union People’s Fund (ZANU PF) ministers and party youths to buy the cotton from farmers contracted by members of the CGAZ.

In order to protect local industries from imports, SI 64 of 2016 was introduced. SI 64 regulates commercial importation of products that can be manufactured locally by requiring a permit for them to be imported into Zimbabwe (Government of Zimbabwe, 2017). The list includes woven fabrics of cotton among a number of items. These import restrictions were meant to protect infant cotton industries so that they grow and compete with foreign firms (Dumbu & Karonga, 2013). The ban of importation of second-hand clothing is difficult to enforce as Zimbabwe has porous borders with neighboring countries, which are also flooded with cheap imports of these goods (Buka, 2016). Government of Zimbabwe mobilized resources for an input loan scheme (Command Agriculture) for the 2016/2017 agriculture season, targeting farmers’ programs, which include

Cotton Input Scheme among other programs (Government of Zimbabwe, 2017). The intention was to increase yields for the 2016/2017 agricultural season.

Research has shown that disasters have a negative impact on the agricultural sector in general. However, it remains unclear how exactly these disaster risks influence the survival of cotton industry in Zimbabwe. Owing to the important role of cotton in the economy, success of cotton industry in Zimbabwe will consequently boost the economy as well as catalyze industrial development. This study is concerned with filling the current knowledge gap on the magnitude and significance of impact of disaster risks on the seed cotton sector and its subsectors in Chiredzi district, Zimbabwe.

### 3. Conceptual development and hypotheses

Literature reviewed in disaster risks in the cotton industry leads these researchers to a conceptual framework. Figure 1 shows the disaster risk conceptual framework with variables that guide this study.

The conceptual framework in Figure 1 presents disaster risks which are categorized as environmental, economic and political and legal risks which impact on economic sustainability. The dependent variable is economic unsustainability that is categorized into low production levels, poor quality, firm closures and job losses. Therefore, this study attempts to investigate a relationship between the disaster risks and economic sustainability in the cotton supply chains in Zimbabwe. Consequently, the following hypothesis was established for this article:

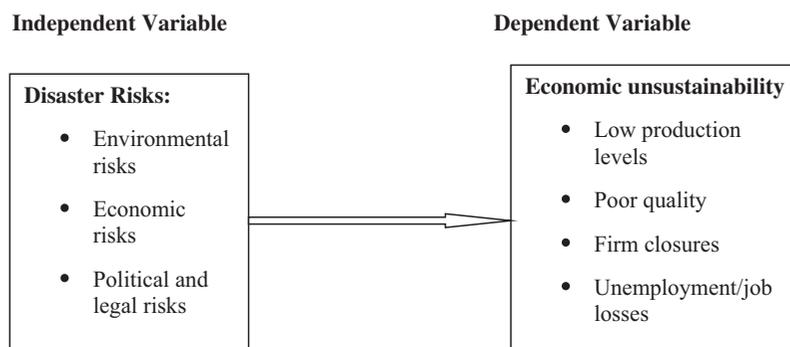
*Hypothesis: The higher the chances of disaster risks occurring, the more economic unsustainability is experienced in cotton supply chains in Zimbabwe.*

Economic sustainability of cotton supply chains index is obtained by summing four Likert items of production levels, quality of cotton and cotton products, level of employment and the growth of firms in cotton supply chains.

### 4. Methodology

This study is based on a survey of seed cotton farmers and merchants from Chiredzi district in Zimbabwe. The researchers chose to follow a pragmatic philosophical worldview as it opened doors to a mixed-methods approach (Creswell, 2014). Consequently, a mixed research method integrating both qualitative and quantitative research was applied in this study to test the hypothesis (Creswell, 2014). It was decided that the strengths of one method would cover up the weaknesses in another by using both methods in this study. Qualitative data were gathered from cotton farmers using questionnaires, while qualitative data were gathered using semistructured interviews with cotton industry authorities (cotton merchants). The interview method is

Figure 1. Conceptual framework for disaster risks.



useful to locate and gather extensive information from a small sample of key informants with relevant knowledge for the objectives of this research (Creswell, 2014; Saunders, Lewis, & Thornhill, 2009). Using a survey system sample size calculator at 90% confidence level and a confidence interval of six (6), 186 cotton farmers of 9,100 farmers from Chiredzi district were purposively recruited to respond to questionnaires. A total of 153 responses were obtained for questionnaires, constituting 82% response rate. The researchers interviewed all the eight cotton merchants since it is not recommended to sample for in-depth interviews (Appendix) for population sizes <50 (Henry, 1999). Chiredzi District was purposively selected for this study because of the frequent occurrence of environmental disasters coupled with a relatively high number of rural populations who depend mostly on cotton for their livelihood.

The researchers devised a questionnaire to measure how economic sustainability in cotton supply chains had been affected by disaster risks. Each question was a 5-point Likert item, with responses ranging from “strongly disagree” to “strongly agree.” Each respondent’s values across questions on economic sustainability were summed to give an aggregate Likert-type scale and then divided by the number of questions combined to get an economic sustainability index. Similarly, a disaster risk index was computed by summing respondent’s values across questions enquiring about disaster risks and then divided by the number of questions combined. The reliability for the questionnaire was tested using Cronbach’s alpha calculated based on four sub-questions relating to economic sustainability section as per Appendix 1. A Cronbach’s alpha of 0.84 was obtained, which is greater than the acceptable guideline of 0.7 for reliability testing acceptance (Ciudad-Gómez & Valverde-Berrocso, 2014). The researchers used member-checking strategy to ensure the validity of in-depth interviews (Creswell, 2014). The researchers conducted follow-up interviews with participants and provided them with the opportunity to comment on the findings.

The respondents participated in the study with full knowledge that it was not punishable to respond in a way they thought and felt about the questions asked (Tedlock, 2005). More so, they were assured of confidentiality in order for them not to be biased in their responses. The study used both descriptive and inferential statistics to analyze the data. Ordinary least squares (OLS) regression techniques were applied to derive inferential statistics. It also employs ordered logit (OLOGIT) and ordered probit (OPROBIT) estimation for robustness check. Data from questionnaires in this study were analyzed and scrutinized using STATA Version 12 and presented in table form in order to come up with meaningful research analysis. Qualitative data collected by in-depth interviews were analyzed using the thematic content analysis and reported in Vignettes to put an impact on the senses of readers.

## 5. Results and discussion

### 5.1. Demographics

This study assesses the impact of disaster risks on economic sustainability in cotton supply chains in Zimbabwe. Demographic data of questionnaire respondents are discussed in terms of age, gender, educational qualification and experience in the cotton industry. Table 1 shows the summary statistics for the background characteristic of respondents relevant to the objectives of this study.

The findings reveal that 65% of the respondents were male and 35% were female. This finding implies that males dominate the cotton industry. Zimstats and UNFPA’s (2016) findings which revealed that 62% of households in rural areas were male-headed support this. Table 1 further displays the age differences of the respondent household heads. The ages of the respondents range from 29 to over 60 years, with the majority of them being over 50 years (59%). Almost a quarter of cotton farmers (25%) are senior members of the community. Musara et al.’s (2011) findings which argue that agriculture is shunned by the youth who prefer white-collar jobs confirm this. This is expected to negatively affect cotton production, as the elderly are less willing to adopt

**Table 1. Demographic data**

Demographic variable	Variable	Frequency	Percentage	SD
Gender	Male	82	64.90	0.500
	Female	71	35.10	0.500
Age	≤29 years	17	12.80	0.315
	≥31 age ≤40	23	10.60	0.359
	≥41 age ≤50	21	18.10	0.345
	≥51 age ≤60	51	33.00	0.473
	Age ≥61	41	25.50	0.444
Level of education	Never been to school	10	06.50	0.193
	Primary education	68	44.40	0.583
	Secondary education	63	41.20	0.473
	Post-secondary education	12	07.80	0.388
Experience in cotton farming	≥0 years ≤5	12	12.80	0.270
	≥6 years ≤10	20	04.30	0.338
	≥11 years ≤15	22	05.30	0.552
	Years ≥16	99	77.70	0.479

innovative agricultural technologies in dynamic economic environments (Musara et al., 2011). The results also revealed that 13% of the respondents were aged below 29 years, 11% were aged between 31 and 40 years, while 18% were aged between 41 and 50 years. There is an increase in farmers below 29 years joining cotton farming than the subsequent age group. This is mainly attributed to command agriculture (Government of Zimbabwe, 2017). The study also reveals that 7% of the respondent household heads have never been to school, while 44% have been to primary level and 41% have attained secondary-level qualification. Only 7.8% have attained post-secondary school qualifications. The lack of educated people on cotton farms is consistent with the earlier finding of Zimstats and UNFPA (2016) who found out that of the adult rural population of Zimbabwe aged 25 years and above, 8.5% have never been to school and only 8.7% had completed tertiary education. The results in Appendix 1 indicate that a majority of respondent farmers (78%) have cultivated cotton for at least 16 years and are therefore considered to be experienced enough in seed cotton farming. This is implied considering that most households have relied on cotton farming for their livelihood since time immemorial. Conversely, 13% of farmers had less than 5 years of experience, 4% between 6 and 10 years, while 5% had 11 to 15 years. The recent increase in the number of farmers cultivating cotton can be attributed to the recent government-assisted input loan scheme code named Command Agriculture (Government of Zimbabwe, 2017).

**5.2. Impact of disaster risks on economic sustainability of cotton supply chains in Zimbabwe**  
 OLS, OLOGIT and OPROBIT estimates obtained from analysis of questionnaires are presented in Table 2.

Disaster risks significantly decreased the economic sustainability in cotton supply chains in Zimbabwe. The beta coefficient of disaster risk index shows a positive relationship to economic unsustainability of seed cotton supply chains. With one unit increase in the disaster risk index, the supply chain economic unsustainability in cotton supply chains increases by 0.917 units holding all other factors constant. The beta coefficient of 0.917\*\*\* in Column 1 of Table 2 reveals that disaster risk index has a statistically significant impact on economic unsustainability of seed cotton supply chains in Zimbabwe at 1% level of significance. In other words, there is a 99% confidence that

**Table 2. OLS, OLOGIT and OPROBIT estimates: impact of disaster risks on economic sustainability of cotton supply chains in Zimbabwe**

Variables	OLS	OLOGIT	OPROBIT
	(1)	(2)	(3)
Risk index	0.917*** (0.132)	4.861*** (0.682)	2.791*** (0.457)
Male	0.238*** (0.0786)	1.434*** (0.365)	0.811*** (0.247)
≥31 age ≤40	-0.0382 (0.147)	0.0337 (0.954)	-0.0294 (0.521)
≥41 age ≤50	-0.0777 (0.175)	-0.200 (0.959)	-0.172 (0.544)
≥51 age ≤60	0.104 (0.145)	0.639 (0.864)	0.355 (0.483)
Age ≥61	0.289*** (0.152)	1.829*** (0.931)	1.025*** (0.517)
Primary education	0.0942 (0.210)	0.635 (1.373)	0.380 (0.685)
Secondary education	0.0803 (0.218)	0.518 (1.393)	0.337 (0.689)
Post-secondary	0.103 (0.235)	0.641 (1.481)	0.376 (0.735)
≥6 years ≤10	0.139 (0.318)	0.673 (1.725)	0.393 (0.864)
≥11 years ≤15	-0.290* (0.170)	-1.192* (1.057)	-1.042* (0.575)
Years ≥16	-0.469** (0.210)	-2.567** (1.237)	-1.429** (0.697)
Constant cut1		17.67*** (4.417)	10.25*** (2.270)
Constant cut2		22.38*** (4.640)	12.80*** (2.411)
Constant	0.306 (0.700)		
Observations	153	153	153
R <sup>2</sup>	0.332	0.2589	0.2602

Robust standard errors in parentheses.

\*\*\*  $p < 0.01$  (significant at 1%), \*\*  $p < 0.05$  (significant at 5%), \*  $p < 0.1$  (significant at 10%).

disaster risk index has some effect on the economic sustainability of seed cotton supply chains in Zimbabwe. Since there was a significant relationship between the dependent and independent variables at the 0.01 level, the researchers accepted the hypothesis.

Using OLOGIT and OPROBIT regression analysis to test for the robustness of the model, the results did not vary much, suggesting that the model is correctly specified. The OLOGIT and OPROBIT models in Columns 2 and 3 of Table 2, respectively, confirm this. This further shows the robustness of the model. This is in tandem with FAO (2015), which points out that frequent and

severe drought, floods, storms and other disasters result in increased damage to the agricultural sectors.

Findings from interviews conducted with cotton merchants corroborate with the quantitative results, from questionnaires administered to cotton farmers. As a result of disaster risks, seed cotton supply chains have been economically unsustainable. Interviewee respondents revealed that domestic supplies of seed cotton have dwindled due to cyclones and consecutive droughts in the country. This is summarized in one of the respondent's words:

As a result of droughts that are common in this district, both the quality and quantity of cotton harvested have been affected, leaving the country's textile producers struggling as they face lack of raw cotton supply and higher prices for imports. Excessive rains received in year 2017 also affected cotton yields, as it resulted in boll rot. In the face of low cotton yields, the country relies on importing cotton from other countries to fulfil our demand.

These results have similarities with Diarra et al.'s (2017) findings. They concluded that increases in global temperature were harmful to cotton production in Burkina Faso. Gitonga et al. (2010) also concluded that unreliable rainfall has also adversely affected cotton yields in Kenya.

The interviewees confirmed that a number of cotton farmers left production of cotton for other cash crops due to poor prices, significantly reducing seed cotton-planted area. One of the key informants commented that:

Many farmers have surrendered producing cotton and have switched to cultivation of other crops like maize. Other farmers have shifted to small scale mining as it offers them quicker and better livelihoods.

This study also revealed that many cotton-processing companies had closed operations. Some ginning companies exited the cotton industry, while others went under judiciary management. One of the interviewees had this to say:

Many ginning companies in the country have closed and some are faced with closure. I blame our cotton legislative frameworks that are so weak. Although statutory instruments are in place they have failed to address issues of fabric import ban and raw cotton side marketing.

Supporting the above argument, Buka (2016) argues that SIs that ban woven fabric, among other items, are hard to implement as Zimbabwe's borders are porous and hence the country is flooded with cheap imports of these goods. In like manner, Muza (2013) blamed Sino-Zimbabwe Holdings and COTTCO's breach of SI 142/2009 relying on ruling ZANU PF bona fide to buy cotton from farmers contracted by members of the CGAZ. It is a clear case of the state breaching its own legislation for the benefit of preferred buyers.

In the same fashion, disaster risks have affected capacity utilization along cotton supply chains in Zimbabwe. Due to the Zimbabwe land reform program, the hectareage under cotton dwindled.

The land reform programme of year 2000 has also reduced hectareage under cotton given that some large-scale farmers who were growing cotton seed were displaced after being disposed of their land.

Large white commercial farmers who have now been dispossessed of their land previously did the bulk of seed breeding. Following a decline in production of seed cotton on farms, there has been underutilization of ginning capacity.

## 6. Conclusions

This study assesses the impact of disaster risks on economic sustainability of cotton supply chains in Zimbabwe. The study offers one major finding. After controlling for demographic variables, the study established a statistically significant positive association of disaster risks and economic unsustainability in cotton supply chains in Zimbabwe. This study has shown that high disaster risks in cotton supply chain significantly lead to economic unsustainability of households and business entities in the supply chain. Precisely, the interviews first revealed that disaster risks have adversely affected the quality of cotton produced. Second, the interviews confirmed a fall in production capacity utilization. Third, a number of cotton farmers and processing plants closed businesses as many opted for alternative investments. Last, consequent to the above, many workers were left unemployed. The study recommends the introduction of agricultural subsidies so that farmers become competitive on the international market. It is further recommended that cotton seeds and lint be processed within the country to generate employment and the much-needed foreign currency. There is need to consistently enforce the legislations that have been put in place to enable a conducive environment for uninterrupted production in cotton supply chain. Joint efforts and collaborative research involving private as well as public sector research institutes would help in finding a quick and sustainable solution for yield development. By working together to enhance the sustainability of cotton production, farmers and businesses can contribute not only to a resilient cotton sector, but also to greater food security, both now and in the future. The researchers could have conducted surveys in all the cotton regions of Zimbabwe, but due to resource constraints, the study was delimited to Chiredzi district. The researchers suggest that, in future, this study should be extended to other parts of the country, including major cities, where most of the clothing industry factories are located.

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### Authors' research interests

The authors' interest areas are in disaster risk management. The focus is in establishing the strategies that may be implemented in reducing the impact of disasters in various industries in developing countries that are the most affected by disasters such as Zimbabwe. The authors are also interested in the possible hindrances that thwart the efforts by governments, NGOs and private sector organizations to reduce the vulnerability of communities to disasters.

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## Appendix 1. Questionnaire with cotton farmers

### Section A: Demographic data

#### 1. Gender

<b>Male</b>	<b>01</b>
Female	02

#### 2. How old are you?

<b>≤29 years</b>	<b>01</b>
≥31 age ≤40	02
≥41 age ≤50	04
≥51 age ≤60	04
Age ≥61	05

#### 3. Level of education

<b>Never been to school</b>	<b>01</b>
Primary education	02
Secondary education	03
Post-secondary (diploma, degree, postgraduate)	04

#### 4. Experience of participation in cotton supply chain

<b>≥0 years ≤5</b>	<b>01</b>
≥6 years ≤10	02
≥11 years ≤15	03
Years ≥16	04

**INSTRUCTIONS:**

From the list of disaster risks in Section B below please rate how strongly you agree or disagree on they affect the supply chain by placing a tick (✓) in the appropriate box.

1 - Strongly disagree (SD); 2 - Disagree (D); 3 - Uncertain (U); 4 - Agree (A); 5 - Strongly agree (SA)

<b>SECTION B: Disaster risks affecting cotton supply chain in your area.</b>	<b>SD</b>	<b>D</b>	<b>U</b>	<b>A</b>	<b>SA</b>
5. Competition from imported cotton products	1	2	3	4	5
6. Laxity in implementing government policies in cotton sector	1	2	3	4	5
7. Droughts	1	2	3	4	5
8. Diseases and pest outbreak	1	2	3	4	5
9. Incessant rains	1	2	3	4	5
10. High production costs	1	2	3	4	5

Indicate how disaster risks in Section B above has impacted on economic sustainability in cotton supply chain.

<b>SECTION C: Impact of disaster risks on economic sustainability in cotton supply chains in Zimbabwe</b>	<b>SD</b>	<b>D</b>	<b>U</b>	<b>A</b>	<b>SA</b>
11. Disasters risks have resulted in job losses in cotton supply chains.	1	2	3	4	5
12. Disasters risks in the cotton supply chain have resulted in dwindling production levels.	1	2	3	4	5
13. The quality of cotton has deteriorated owing to disaster risks experienced in the cotton supply chain.	1	2	3	4	5
14. Disaster risks in cotton supply chain has led to the closure of some processing plants	1	2	3	4	5

## **Appendix 2. Interview guide with cotton merchants**

**Date of interview:**

### **Introduction**

- Researchers introduce themselves and explain the purpose of the interview
- They state the expected duration of the interview.

### **QUESTIONS**

#### **Impact of disaster risks on economic sustainability of cotton supply chains**

1. How is the social and political framework of Zimbabwe affecting economic sustainability of cotton supply chains?
2. How has the economic situation of Zimbabwe affected the economic sustainability of the cotton industry?
3. Has the cotton supply chain in Zimbabwe experienced any environmental disasters?
4. To what extent has environmental disaster impacted on economic unsustainability the cotton industry?



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