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The Impact of Climate Change on Agricultural Risks Among Cotton Farmers in the Mutoko District of Zimbabwe

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ABSTRACT

Scientists and policymakers are concerned about the effects of climate change on agricultural productivity and the well-being of farmers around the world. Alterations in the amount of precipitation and temperature have a direct influence on crop yields, although a rise in the prevalence of diseases and pests has a secondary but nevertheless important influence. The degree to which farmers believe climate change poses a threat to their agricultural operations is a decisive factor in determining whether or not they will make adjustments to their practices. This study assesses the impact of climate change on agricultural risks among cotton farmers in rural Zimbabwe. Thirteen (13) cotton farmers and employees of a company that buys and sells cotton were interviewed using a qualitative methodology. The study found that the cotton-growing industry has significantly incurred losses due to both the effects of climate change and the broader economic downturn. Several reasons related to Zimbabwe's economic collapse have contributed to the problem facing the nation's rural cotton farmers.

INTRODUCTION

Scientists and policymakers are concerned about the impact that climate change has on agricultural productivity around the world (Dinar & Mendelsohn, 2011; Adebayo et al., 2013). Changes in the amount of precipitation and temperature have a direct impact on crop yields, whereas an increase in the prevalence of diseases and pests has an indirect impact (Mendelsohn et al., 2006; Chapagain et al., 2019). The extent of the detrimental effect that climate change will have on the industry's ability to turn a profit will be directly proportional to the degree to which farmers will be able to adapt their farming methods in response to shifting patterns of precipitation and temperature (Di Falco et al., 2011). The degree to which farmers perceive that climate change poses a threat to their agricultural operations is the deciding element in determining whether or not they will make improvements to their methods in response to the issue.

The theory of planned behavior proposed by Ajzen (1991) asserts that an individual's subjective beliefs serve as the informational foundation upon which an individual's attitudes and intents are created, and from which behavior is enacted. This is because an individual's subjective beliefs are based on the individual's experiences and observations of the world around them. Therefore, to understand the process of adaptation, it is necessary to do in-depth research on how people perceive dangers and make meaning of them (Mugambiwa, 2021). When policymakers and outreach experts have a greater understanding of how people interpret various dangers, they are better able to correct the mistaken subjective judgments that individuals make about hazards (Arbuckle et al., 2013). Previous studies have revealed that the degree to which farmers are concerned about the threats posed by climate change varies substantially from one another. In recent years, there has been a proliferation of research into the perspectives that farmers have on climate change, including what they believe causes

it, what they worry about, how they feel about the risks involved, and how likely they are to make adjustments in response to it (Mugambiwa, 2021).

If farmers are made aware of the reality of climate change, there is a greater chance that they will take steps to adapt to the phenomenon and decrease its effects (Mugambiwa, 2021). This is due to how farmers perceive the risks brought by climate change has a significant impact on the adaptation choices they make (Esham & Garforth, 2013). The farmers' previous experiences play a significant role in shaping both their perceptions of the threats posed by climate change and their motivation to adapt to these changes. According to the findings of the research conducted by Diggs (1991), farmers in North Dakota who have been affected by drought are more likely to believe in long-term climate change. Diggs also found that the number of years spent farming was inversely related to a person's propensity of believing that droughts are becoming more frequent and severe. Niles et al. (2013) found that when farmers perceive a decline in water supplies, their concerns about future water availability and climate change grow, as do their plans to adopt mitigation and adaptation strategies. This was found to be the case regardless of whether or not the farmers experienced a decline in water supplies (Niles et al., 2013).

The effects of climate change are particularly obvious in parts of the world with lower incomes, although they are experienced globally (IPCC, 2013). Nhamo (2009) asserts that the concept of climate change was not recognized as a problem affecting the environment until the turn of the century. However, our understanding of climate change has advanced to the point that its potential implications on future development are now widely appreciated. This indicates that our understanding has reached a tipping point. This demonstrates that temperature changes have negative effects on the evolution of societies in spheres other than the environment, such as the social, economic, and political spheres. Smallholder farmers are particularly vulnerable to the effects of climate change because of the role it plays in reducing agricultural productivity and having a negative impact on livelihood systems that are dependent on the weather (Ngigi, 2009; Brzoska & Frohlich, 2016; Chandra et al., 2017).

Africa is susceptible to the dangers that climate change poses (UNFCCC, 2007). This is because the continent is home to regions with climates that show some of the largest seasonal fluctuations found anywhere in the globe. This indicates that floods and droughts can occur in the same area at the same time, which is not always the case (IPCC, 2007; Lindsey & LuAnn, 2021). Due to the unpredictable weather patterns that result in bad crops, farmers in rural areas confront significant challenges in their efforts to maintain their level of life and provide for their families. It is anticipated that desertification will continue to be a significant risk in arid and semi-arid regions, and it is also anticipated that food and water scarcity, as well as floods, would worsen throughout most parts of Africa (Christensen et al. 2007; Laube et al, 2012; Hsiang, 2016; Gomez, 2015).

There are a variety of elements that contribute to the severity of the effects of climate change in Africa. Alterations to the global climate pose a risk of having repercussions for human cultures in a myriad of different ways. Between the years 1906 and 2005, the surface of the Earth experienced exceptionally rapid warming (IPCC, 2007). Based on studies of temperatures in air and oceans all around the world, the International Panel on Climate Change has concluded that a warming trend may be observed in the climate (IPCC, 2007). Numerous academics have postulated a broad spectrum of possible outcomes as a result of this transition, with many predicting that the move will have negative effects on African countries. Hassan (2010) conducted research into the effects of climate change on agriculture in eleven African countries and discovered that it was damaging to crop yield. However, the negative effects were not as significant for crop production that was sustained through irrigation. Hassan (2010) concluded that rising global temperatures pose a risk to the production of livestock. This shows that climate change affects a variety of forms of production, such as agricultural output and animal husbandry.

Oseni and Bebe (2010) conducted a study that analyzed the techniques that Kenyan farmers employ to strengthen their resilience and reduce their susceptibility to environmental hazards. According to the findings of the study, vulnerable pastoral communities in the dry plains of Kenya that engage in methods of livestock production could be

at risk of experiencing catastrophic effects as a result of climate change. Molua (2008) conducted a study that was quite similar to this one and looked at the effects of climate change on agriculture in Cameroon. According to the findings of the study, an increase in temperature of 3.5% and an increase in precipitation of 4.5 percent would be detrimental to agriculture in Cameroon if there were no irrigation facilities available. This would result in some temperature changes that would add up to approximately 46.7% in output value. It was anticipated that the loss would have repercussions that would be felt throughout the economy to a significant degree.

In addition, Mugambiwa and Tirivangasi (2017: 1) suggest that "...there are a number of potential repercussions that climate change could have on agriculture." A direct consequence of this is the destruction of crops and livestock. Agriculture practices as well as the kinds of livestock that can be managed in various climates may be affected. This illustrates that low-income populations are particularly susceptible to the effects of climate change, which affect not just their capacity to acquire clean drinking water, but also their health and the security of their food supply. The research conducted by Gbetibouo (2006) in the Limpopo province of South Africa revealed that there was a large difference in rainfall from one year to the next and that around half of the farmers who were questioned had altered their practices in response to climate change.

Researchers have demonstrated that climate change can be caused by either an increase or a decrease in rainfall, with severe drought being the consequence of either scenario. Mukherjee et al. (2018) assert that drought is a severe weather situation that develops gradually and poses a high level of risk. There are various societal and economic repercussions of drought, some of which include an increased danger of wildfires, decreased availability of water, agricultural and livestock losses, higher food prices, and indirect effects on health. Mukherjee et al. (2018) add to this evidence by showing that a lack of water due to inadequate water management can also be a cause of drought. This adds to the body of evidence that has already been accumulated. Instead of climate change being to blame, the issue is the inefficient use of locally available resources. Some people believe that climate change is the fundamental reason for the current water crisis, which is characterized by a shortage of precipitation, soil moisture, lake and stream water, and other forms of water. This shows that although there are many causes of drought, the inadequate management of water resources, which was previously highlighted, is considered to be a relatively minor and inconsequential cause (Sukckala et al., 2016; Dorj et al., 2021). This firmly identifies climate change as the fundamental cause of drought, which in turn motivates research into the phenomenon's underlying causes.

Because many types of drought can occasionally occur at the same time or in fast succession and are interrelated, it is not always simple to distinguish one type of drought from another (Jessoe, 2018; Mukherjee et al., 2018; Nyahunda & Tirivangasi, 2020). According to the underlying cause, droughts can be broken down into three different categories: meteorological, agricultural, and hydrological. Some of the most noticeable effects of meteorological drought are on soil moisture, which can lead to agricultural drought, and then on to water storage deficiencies, which can lead to a hydrological drought that lasts for extended periods. Both of these effects can be traced back to the lack of precipitation (Mukherjee et al., 2018; Nyahunda & Tirivangasi, 2021; Sahoo & Sreeja, 2017). This serves to demonstrate that despite their seemingly dissimilar labels, all droughts are fundamentally the same phenomenon, with comparable causes and effects.

Understanding the specific characteristics of drought is important in light of the ramifications that climate change may have. As a result of climate change, the environment is being subjected to a variety of stresses and shocks, which are having a variety of effects (Mugambiwa & Tirivangasi, 2017; Alfonso & Laruan, 2020). Flooding and drought can be caused, respectively, by an abnormally high amount of precipitation or an abnormally low amount of precipitation at the expected period. Mukherjee et al. (2018) assert that droughts are characterized by a number of interrelated characteristics, some of which are severity, duration, peak intensity, and frequency with which they occur. There is a large degree of variability in the consequences of drought that can be attributed to any one of these causes.

As a result of climate change the consequences of drought are anticipated to become more severe in the foreseeable future, as various researchers have demonstrated (Mugambiwa & Tirivangasi, 2017). It is essential to keep in mind that droughts have always been a common occurrence in every region of the world and that the increased likelihood of them occurring as a result of climate change is likely to cause even more damage to the ecosystem, which will, in turn, cause much more harm to flora and fauna. Smallholder farmers will also experience the consequences of the disaster because they do not possess the resources necessary to set up irrigation equipment. Berlemann & Steinhardt (2017) contend that to quantify a drought, a number of different drought indices have been developed. It is impossible to place an adequate amount of emphasis on the devastation that drought has wreaked in many parts of the world over the past several decades.

MATERIALS AND METHODS

All cotton producers and organizations engaged in the buying and selling of cotton, such as the Cotton Company of Zimbabwe, made up the study's population. Purposive sampling was used to select thirteen (13) participants for in-depth interviews. Purposive sampling is a method in which sample units are chosen for having specific qualities that aid in exploring and comprehending the study's aims and objectives (Bryman, 2012). During the process of data collection, the questions that were asked were partially determined by the demographic features of the respondents. These variables included age, length of time living in the area, and occupation (cotton farmer). Interviews were conducted in the participants' homesteads. We analyzed the data by making use of the tools provided by Thematic Content Analysis (TCA) as prescribed by Braun and Clarke (2006). TCA is a technique for organizing data by locating recurrent themes and trends. We were able to detect trends and patterns by analyzing the data that we had obtained, and then we proceeded to code and categorize these findings to investigate the impact that climate change has had on agricultural risks faced by cotton farmers in rural Zimbabwe.

RESULTS AND DISCUSSION

Climate change poses a significant threat to local farmers because agriculture is the main source of income in the region and farmers rely heavily on rainfall for their crops. A failure to materialize would have a devastating effect on the subsistence economy, which relies heavily on agriculture. Many participants in this study stressed the multiplicity of threats that climate change represents to their economic security. Changes in temperature, erratic rainfall patterns, and water shortages were cited as the most significant implications of climate change on cotton farmers.

Change in Temperatures

One of the fascinating findings that several participants reported was the variation in temperature as a result of climate change. Participant observations are that temperatures went through a significant range of changes during the course of time. It was formerly thought that hot days would only occur during summer, but now scientists anticipate that the warm weather will continue well into the fall and even into the winter. The month of December marks the beginning of summer in the Southern Hemisphere, and it lasts until March. Around this time of the year, the majority of the area's farmers grow their crops. It is important to keep in mind that Mutoko is in a semi-arid zone, which is already working against it in terms of the potential it has for agriculture. As a result of this and taking into consideration that agriculture serves as the region's primary source of revenue, the effects of climate change will have far-reaching repercussions for the people who reside there. One participant had this to say: … There are many changes that we are currently observing; for instance, temperatures were not as high in the past as they are now. The summers are hotter than they used to be, and our crops frequently suffer when there are less rains, which is normal these days. (Participant 13; Cotton farmer).

Participants in the study contributed evidence suggesting a connection between the recent drop in rainfall and the rising average temperature across the globe. The fact that these two factors, when combined, pose a danger to agricultural production has led some people to believe that smallholder farmers should be extremely concerned about them. According to the remarks made by participants, one of the most significant challenges that smallholder

farmers in the Mutoko district face is severe weather. These findings are consistent with Bakuwa's (2015) study that delved into the public's understanding of global climate change in Malawi. The study found that the vast majority of people in Malawi believe that temperature changes are a result of climate change and that these changes have severe negative effects on farming activities among smallholder farmers. The findings are also in line with the work of Egan and Mullin (2012) and Capstick and Pidgeon (2014), both of which highlight the connection between local weather patterns and the experiences of community members, particularly farmers, in the sense that their activities are significantly impacted due to changes in weather patterns.

Egan and Mullin (2012) and Capstick and Pidgeon (2014) both highlight the connection between local weather patterns and the experiences of community members. One of the participants of this study observed that the combination of insufficient rainfall and extreme heat is a huge source of concern for smallholder farmers and the residents of the local area. This is owing to the fact that the success of their farms has a direct bearing on how well they will be able to provide for themselves throughout the course of their lives. Therefore, one could argue that the impact of hot days, as other scholars might describe it, is having a big influence on people's livelihoods and raising questions about whether or not sustainability can be achieved.

Erratic Rainfall Patterns

Some of the participants mentioned perceive unpredictable rainfall as a result of climate change. Participants have also noticed that rain is less predictable than it used to be. This indicates that people cannot rely on any certain schedule for precipitation. Cotton farmers in the district confront a significant problem in their agricultural endeavors due to the lack of predictability in rainfall. The inability to predict rainfall has implications for agricultural planning. Due to the erratic nature of rainfall, a majority of cotton farmers suffer significant financial losses every year. Sometimes the rains come months after the farmers have sown their seed and other times the rains cease when the crops still require watering. This provides a glimpse into the ways in which cotton farmers are impacted by unpredictable rainfall and the consequential impacts on sustainability.

Here's what some participants had to say; ...we have noticed over the years that the weather is changing, and we have even become accustomed to it. If I recall well, the trend has been that some years we have enough rain while others do not. But compared to now, I can state that when we were younger, the amount of rain we got used to getting was greater than it is now. We never faced many of the difficulties we do now since our plants and crops were always well-fed. Even though the seasons are currently changing, the only thing that is changing in terms of our labor as farmers is the poor rainfall. (Participant 10: Cotton farmer). The patterns of rainfall today and when we were young have significantly changed. The amount of rain we get is insufficient to support crops. (Participant 5: Cotton farmer).

Erratic rainfall comes out as one of the most major changes that participants have noticed, which suggests that it may be a direct influence of global warming. This is crucial because it provides a hint about the kind of change and how the farmers see it, which means that they will be in a better position to develop their adaptation plans as a result. Gbetibouo (2009) found similar findings when he polled 794 smallholder farmers in South Africa's Limpopo River basin about their thoughts on and strategies for dealing with climate change. The findings of the study suggest that one of the problems that have arisen as a result of climate change is a reduction in both the frequency and severity of rainfall. In addition, the research conducted by Noah (2015) in Tanzania revealed that shifting patterns of rainfall are becoming increasingly unpredictable, uneven, and patchy, which presents a substantial challenge for smallholder farmers.

Water Shortages

Water shortage is portrayed as a significant challenge brought about by climate change. These shortages are a direct result of dams and rivers that, under normal circumstances, would produce an adequate amount of water but have instead run dry. The early drying up of rivers has now become a common occurrence and it is one of the factors that is contributing to water challenges that the region is currently facing. By July, one of the major dams in the district had run dry, forcing the local community

to scramble for water from a nearby dam that were almost completely devoid of water.

One participant had this to say; Due to the severe water deficit brought on by the absence of rain, drinking water and water for domestic animals like cows are now severely insufficient. The fundamental issue is that there is a high demand for water and little supply. As a result, there are too many farmers fighting for a limited amount of water from sources like the Sinyerere Dam, which is necessary for all types of agricultural activity. For instance, the water in the dam is already insufficient when some farmers bring their cows and goats and insert their irrigation pipes. Therefore, by July the dam would be dry, and at the moment we are using a dam from a neighboring hamlet (Matedza dam), which is also drying up as a result of supply being insufficient to meet demand. (Derick: In-depth interview July 2019).

Figure 1. Matedza Dam
Source: Image Taken by Shingirai Mugambiwa

The narratives provided by the participants made it abundantly evident that water shortages are a critical issue. One may make the case that water is the most important component of agriculture on a smaller scale, such as that practiced by cotton farmers in the Mutoko district. As a consequence of this, it is reasonable to presume that water shortages have caused them to suffer severe setbacks in their agricultural endeavors as well as in their way of life in general. Rivers and dams are two of the most prevalent ways in which people who live in this region obtain their supply of domestic and agricultural water. However, only two of the farmers who took part in this research had access to boreholes, hence, it cannot be considered a common water source.

Figure 1 depicts the worrying water levels in one of the major dams in the district as of the beginning of July 2019. Participants in the study report that the reservoir behind the dam has never been brought down to its bare minimum level. Instead, it has only ever dropped to low levels in October or November, but these conditions have never persisted for more than a short time until the next rainy season and replenished the reservoir. The fact that such a diverse range of pursuits is dependent on the water supply from the dam makes the rate at which it is being depleted more alarming. In addition, this study revealed that locals cultivate and maintain vegetable gardens and that the majority of these gardens are constructed close to the dam for ease of access to the water source. To make matters even worse, cotton farmers from the neighboring *Sinyerere* dam, where the dam has totally dried up, have traveled to the *Matedza* Dam (See. figure 1) to create gardens to make use of the water. The fact that some of the farms use irrigation pumps, which demand huge volumes of water, is another example of the pressure that is being placed on the dam. This is one of the primary factors that is

contributing to the dam's water supply being depleted at an alarmingly rapid rate. The drought that is currently affecting the Mutoko district is the culmination of a number of issues that are interconnected with one another. These issues include, but are not limited to, climate change, the drying up of rivers, the depletion of dams, and an increase in the amount of competition for limited water supplies. Mugambiwa (2021) asserts that farmers place high importance on the availability of water, and they believe that modifications to irrigation systems are required in order to cope with water shortages. Since pump syphoning river water quickly depletes water levels and draws substantial quantities of water, as was the case with the *Sinyerere* dam, farmers have placed restrictions on the use of this method as a means of modifying irrigation.

The Major Agricultural Risks in Cotton Farming

Cotton farming in the Mutoko district faces an increased risk of extinction as a direct result of the severe consequences of climate change. Participants have revealed that the lack of rainfall in the surrounding area is making cotton farming increasingly hazardous. According to the narratives provided by participants, a significant number of the region's cotton farmers have suffered consistent financial losses as a result of the poor production of cotton. This is even though cotton farmers receive subsidies from the government, and the crop has lower water requirements in comparison to other crops, such as maize. …given the high temperatures in this area coupled with the lack of sufficient rains, you find that the growing of cotton is not a good investment for farmers anymore. This is because when farmers come to sell their produce they do not receive good returns as they used to in the past. (Participant 3: Key Informant (COTCO)).

Figure 2. Cotton Depot at Nyamuzizi Shopping Centre
Source: Photos taken by Shingirai Mugambiwa

Based on the findings of this study, it has been concluded that the amount of cotton harvested in the Mutoko district is decreasing as a result of climate change. One of the key informants (participant 3), revealed that the amount of cotton that has been stockpiled at the *Nyamuzizi* depot reflects a drop in the amount of cotton that has been produced by farmers. Three years ago, the storage facility would have been completely full by July. However, in 2019, barely half of the facility's capacity had been utilized (See. Figure 2). However, the decrease in cotton production can also be related to a wide range of other variables. Cotton price has fallen as a direct result of the hyperinflation that has been wreaking havoc on the economy of the country. As of today, July 2, 2019, one kilogram of cotton could be purchased for ZW$1.90 (Zimbabwean Dollar), which was equivalent to approximately USD$0.60 (United States Dollar). Since farmers need to make a living off of their sales, the price effectively nullifies any profit that could come from cultivating the crop. As a result of inflation, the money that they get would not even be sufficient to last them one month, in contrast to the roughly twelve months that it would have been sufficient for when the country used the US dollar as its official currency.

One participant had this to say; ...I finally turned to cotton after several failed attempts to grow maize and ground nuts as a result of inadequate rains. The choice was made in light of the fact that cotton farming only requires your labor because Southern Cotton and the Cotton Company of Zimbabwe provide inputs. … So, in previous years,

we were encouraged to grow more cotton because, given that the money was in US dollars, selling it would net us good returns. It is now challenging because the local currency we are using is insufficient and the cost of basic commodities is increasing daily. (Participant 5: Cotton farmer).

The participant's narrative draws attention to a challenge that is encountered by a significant number of cotton growers in the Mutoko district. The cotton-growing business has suffered losses as a result of both the effects of climate change and the general deterioration of the economy. To better understand the current state of the economy in Zimbabwe, a reflection on the country's history would be quite insightful. The current crisis that is plaguing the country's cotton growers was caused by a number of factors that are tied to the economic collapse of Zimbabwe.

The cotton market is vulnerable for a number of different reasons, two of which are hyperinflation and a shortage of output due to climate change. Another crushing blow was initiated by the Zimbabwean government on June 24, 2019, when it restricted the use of foreign currency as legal tender. After 10 years of using a number of different currencies, including the South African rand, the United States dollar, the British pound, and the Botswana pula, a local currency was finally introduced. Following the signing of the Global Political Agreement (GPA) between Morgan Tsvangirai's MDC and Robert Mugabe's ZANU PF, the Government of National Unity (GNU) was established, and the country opened its borders to the investment of foreign capital. The government of national unity came into being in the wake of the disputed national elections that took place on March 29, 2008.

After the introduction of a local currency, the Zimbabwean dollar in 2019, Zimbabwe once again experienced hyperinflation. As a direct result of this, the productivity of farmers suffered severely. Farmers in Zimbabwe face a number of challenges, one of which is that the nation's cotton industry is dominated by a state-owned monopoly Cotton Company of Zimbabwe, which handles all purchasing and sales of cotton. This is contrary to crops such as groundnuts and maize which can be cultivated commercially and sold to private players at a price that is favorable to the farmers. Moreover, with other crops, farmers have the option of keeping the yields for themselves in the event that the price set by the government is unfavorable.

CONCLUSION

This study has revealed that the degree to which cotton farmers are concerned about the threats posed by climate change varies substantially from one farmer to the other. The study was embedded within the theory of planned behavior which emphasizes that an individual's subjective beliefs serve as the informational foundation upon which an individual's attitudes and intents are created, and from which behavior is enacted. In the study, cotton farmers are exposed to a complex set of agricultural risks as a result of hyperinflation and a decrease in yield as a direct result of climate change since cotton yields are directly influenced by shifts in temperature. The degree to which farmers can modify their farming practices in response to shifting patterns of temperature is directly related to the magnitude of the negative impact that climate change has on the ability of the industry to earn a profit. As articulated in the theory of planned behavior, individual cotton farmers' subjective beliefs are based on the individual's experiences and observations of the world around them. Moreover, to understand the process of adaptation, how farmers perceived dangers and make meaning of them was found fundamental. Also, when policymakers and outreach experts have a greater understanding of how people interpret various dangers, they are better able to correct the mistaken subjective judgments that individuals make about hazards.

REFERENCES

Adebayo, A. A., Mubi, A. M., Zemba, A. A. & Umar, A. S. (2013). Awareness of Climate Change Impacts and Adaptation in Adamawa State, Nigeria. *International Journal of Environment, Ecology, Family and Urban Studies*, 3(1), 11–18.

Ajzen, I., (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes.* 50 (2), 179-211.

Alfonso, G.P. & Laruan, K.A. (2020). Climate change trends, impacts and adaptation of upland farmers in La Trinidad, Benguet, Philippines. *International Journal Agronomy and Agricultural Researches*, 17(1), 1-15.

Arbuckle JG, Morton LW, Hobbs J (2013) Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation. *Climate Change,* 118 (1), 551-563.

Bakuwa, J. (2015). Public understanding of global climate change in Malawi: An investigation of factors influencing perceptions, attitudes and beliefs about global climate change. PhD thesis. Stellenbosch University.

Berlemann, M., & Steinhardt, M.F. (2017). Climate change, natural disasters, and migration-a survey of the empirical evidence. *CESifo Economic Studies*. 63 (4), 353–385.

Braun, V. & Clarke, V., (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3 (1), 77-101.

Bryman, A. (2012). *Social Science Research Methods*, 4th edition, Oxford: Oxford University Press.

Brzoska, M., & Frohlich, C. (2016). Climate change, migration and violent conflict: vulnerabilities, pathways and adaptation strategies. *Migration and Development*. 5 (2), 190–210.

Capstick, S. B. & Pidgeon, N. F. (2014). Public perception of cold weather events as evidence for and against climate change. *Climatic change,* 122 (1), 695-708.

Chandra, A., McNamara, K. E., Dargusch, P., Caspe, A. M. & Dalabajan, D. (2017). Gendered vulnerabilities of smallholder farmers to climate change in conflict-prone areas: A case study from Mindanao, Philippines. *Journal of Rural Studies*, 50, 45–59.

Chapagain, P. S., Ghimire, M. & Shrestha, S. (2019). Status of natural springs in the Melamchi region of the Nepal Himalayas in the context of climate change. *Environment, Development, and Sustainability*, 21(1), 263–280.

Christensen, J., Hewitson, B., Busuioc, A., Chen, A., Gao, X., Held, I., et al. 2007. Regional Climate Projections. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. Averyt, et al. (Eds.), Climate Change (2007): *The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Di Falco, S., Veronesi, M. & Yesuf, M. (2011). Does adaptation to climate change provide food security? A micro-perspective from Ethiopia. *American Journal of Agricultural Economics.*

Diggs, D.M. (1991). Drought Experience and Perception of Climatic Change among Great Plains Farmers. Great Plains Research: *A Journal of Natural and Social Sciences*, 1 (1) 113-132.

Dinar, A & Mendelsohn, R., (2011). *Climate change impacts on African agriculture. Center for Environmental Economics and Policy in Africa*. Centre for Environmental Economics and Policy in Africa, Pretoria (CEEPA).

Dorji, Y., Man Rai, C., & Nidup, T. (2021). Climate Change Awareness among the Teachers of Higher Secondary Schools. *Asian Research Journal of Arts & Social Sciences*, 15(4), 12–22.

Egan, P. J. & Mullin, M. (2012). Turning personal experience into political attitudes: The effect of local weather on Americans' perceptions about global warming. *The Journal of Politics,* 74 (3), 796-809.

Esham, M & Garforth, C. (2013). Agricultural adaptation to climate change: insights from a farming community in Sri Lanka, Mitigation and Adaptation Strategies for Global Change, *Springer*, 18(5), 535-549.

Gbetibouo, G.A. (2006). *Understanding farmers' perceptions and adaptations to climate change and variability. The case of the Limpopo Basin, South Africa.* International Food Policy Research Institute Research Brief, Washington DC., USA.

Gomez, N. (2015). Climate change and adaptation on selected crops in Southern Philippines. *International Journal of Climate Change Strategies and Management*, 7(3), 290–305.

Hassan, R. (2010). Implications of climate change for agricultural sector performance in Africa: policy challenges and research agenda. *Journal of African Economies*, 19 (1), 77-105.

Hsiang, S., (2016). Climate econometrics. *Annual Review of Resource Economics*. 8, 43–75.

Intergovernmental Panel on Climate Change (ICCP). (2013). Climate Change 2013. *Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge. Cambridge University Press.

Intergovernmental Panel on Climate Change (IPCC). (2007). Synthesis Report. Contribution of Working Groups I II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland.

Jessoe, K., Manning, D., Taylor, & E.J. (2018). Climate change and labour allocation in rural Mexico: evidence from annual fluctuations in weather. *Journal of Economics* (608), 230–261.

Laube, W., Schraven, B. & Awo, M. (2012). Smallholder Adaptation to Climate Change: Dynamics and Limits in Northern Ghana. *Climatic Change*, 111, 753774.

Lindsey, R., & LuAnn, D. (2021). *Climate Change: Global Temperature*. NOAA Climate.gov's Science and Information for a Climate-Smart Nation.

Mendelsohn, R., Dinar, A & Williams, L. (2006). The distributional impact of climate change on rich and poor countries. *Environmental Development and Economics.* 11 (1), 1–20.

Molua, E. L. (2008). Turning up the heat on African agriculture: The impact of climate change on Cameroon's agriculture. *African Journal of Agricultural Resource Economics*, 2 (1), 45 - 64.

Mugambiwa, S. S. (2021). Evoking the epistemology of climate governance through indigenous knowledge systems for sustainable development in rural Zimbabwe. *Jàmbá: Journal of Disaster Risk Studies* 13(1), a1024.

Mugambiwa, S.S. & Tirivangasi, H.M., (2017). 'Climate change: A threat towards achieving "Sustainable Development Goal number two" (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) in South Africa', *Jàmbá: Journal of Disaster Risk Studies,* 9(1).

Mukherjee, N., Zabala, A., Huge, J., Ochieng, J., Blal, N., Esmail, N & Sutherland, W. J. (2018). Comparison of techniques for eliciting views and judgements in decision‐making. *Methods in Ecology and Evolution*, 9 (1), 54-63.

Ngigi, S. N. (2009). Climate Change Adaptation Strategies: Water Resources Management Options for Smallholder Farming Systems in Sub-Saharan Africa. New York: The MDG Centre.

Nhamo, G. (2009). Climate change: Double-edged sword for African trade and development, *International Journal of African Renaissance Studies - Multi-, Inter- and Transdisciplinarity.* 4 (2), 117-139.

Niles, M.T., Lubell, M & Haden, V.R. (2013). Perceptions and responses to climate policy risks among California farmers. Global Environmental Change, 23 (1), 1752-1760.

Noah, N. M. (2015). Living with climate variability and change: lessons from Tanzania. PhD Thesis. University of the Witwatersrand.

Nyahunda, L., & Tirivangasi, H. M. (2020). Barriers to Effective Climate Change Management in Zimbabwe's Rural Communities. African Handbook of Climate Change Adaptation, 1-27.

Nyahunda, L., & Tirivangasi, H. M. (2021). Harnessing of Social Capital as a Determinant for Climate Change Adaptation in Mazungunye Communal Lands in Bikita, Zimbabwe. Scientifica, 2021.

Oseni, S. & Bebe, O. (2010). *Climate change, genetics of adaptation and livestock production in low input systems.* 2nd International Conference: Climate, Sustainability and Development in Semi-arid Regions, August 16-20, 2010, Fortaleza – Ceará, Brazil.

Sahoo, S.N., & Sreeja, P. (2017). Development of Flood Inundation Maps and Quantification of Flood Risk in an Urban Catchment of Brahmaputra River, *ASCEASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering*, 3(1).

Suckalla, N., Fraserb, E. & Forsterc, P. (2016). Reduced migration under climate change: evidence from Malawi using an aspirations and capabilities framework. *Climate and Development*. 8(1), 1-14.

UNFCCC. (2007). *Climate change: impacts, vulnerabilities and adaptation in developing countries*. Bonn, Germany: United Nations Framework Convention on Climate Change.