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Climate Risk and smallholder farmers in Zimbabwe: a case study of Chivi District

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ABSTRACT: *Smallholder farmers in Zimbabwe and indeed most parts of Sub-Saharan Africa face a significant number of shocks which are both climate and non-climate related. These include drought, animal diseases, floods, and market shocks such as increase in input prices as well as the death and illness of family members. The severities of these shocks vary according to family resource endowments and agro-ecological region. Using Chivi district as a case study, the study used drought as the key climate risk in the investigation of the impact of climate variability on agricultural production on small holder farmers in Zimbabwe. The study revealed that climate change (draught) has a significant impact on small holder livelihoods. All households suffered decline in crop yield, consumption, death of livestock and food insecurity.*

Keywords: *Climate change, climate risk, draught, smallholder farmers*

I. BACKGROUND

Zimbabwe's economy is agro-based and climate change may negatively affect agricultural production systems (Gumbo, 2006). Yields from rain fed agriculture may be reduced as a direct consequence of such scenarios as low rainfall. Zimbabwe is divided into five agro-ecological regions based mainly on the quantity of rainfall and the type of agricultural production they can support. The distribution of rainfall ranges from more than 710 mm in region I to less than 450 mm in region V (Vincent & Thomas, 1960). Most smallholder farmers are located in region III and IV where rainfall is unreliable as a result of low humidity levels and the output realized from agriculture may be low to sustain families' right through the year until the following season (Mano & Nhemachena, 2007).This implies that smallholder farmers livelihoods are threatened by food insecurity and high poverty levels are a likely consequence. Droughts characterize southern Africa and farmers in Zimbabwe have been experiencing drought once every two to three years (Mazvimavi, et al, 2007).The occurrence of drought has negatively affected smallholder farmers' crop and livestock production systems and income generating activities.

II. LITERATURE REVIEW CLIMATE RISK

Climate variability is known to cause the occurrence of extreme events such as droughts and floods. Region IV in general receives low rainfall and so the occurrence of droughts will mean that the rainfall received in a season will be less to enable crop production that will yield good harvests (Reynolds, 2004). Zimbabwe has been experiencing droughts every ten years since 1982 and the incidence of occurrence has actually increased in the 21st Century where almost every season has been characterised by dry spells. Drought has been defined by FAO as a reduction in rainfall supply compared with a specified average condition over some specified period (FAO, 2004).This reduction will have an implication on all the activities that require rain water as a source such as crop and livestock production. Droughts affected the country in 1982, 1991/92, 2001/2002 and 2007. Table 3 shows the top ten natural risks in Zimbabwe for the period 1980 to 2010, where drought is the dominant climatic risk in terms of the number of people affected.

Table 1: Top 10 Natural Disasters in Zimbabwe: 1982 to 2010 sorted by numbers of total affected people

Disaster	Year	Total People Affected
Drought	2001	6000000
Drought	1991	5000000
Drought	2007	2100000
Drought	2010	1680000
Drought	1982	700000
Epidemic	1996	500000
Flood	2000	266000
Epidemic	2008	98349
Drought	1998	55000
Flood	2001	30000

Source: adapted from: The OFDA/CRED International Disaster Database (OFDA/CRED, 2012)

III. IMPACT OF CLIMATE RISK

The occurrence of drought has had implications on the wider economies in SSA; Zimbabwe as many people were laid off their employment, reduced crop yields, unsustainable marginal land for livestock. These have all resulted in the erosion of income sources for the region at large. (FAO, 2004) . Access to income determines the livelihood for households and as such if agricultural production systems are affected by drought, most smallholder farmers may fail to sustain themselves. The economy of the country is dependent on agriculture and many industries are based on this, the failure of production may force them to cut down staff. Smallholder farmers who are reliant on income from off-farm activities will adversely suffer. In a study to assess the perceived impact of climate variability on smallholder farmers conducted in Zambia's Monze and Sinazongwe districts and Zimbabwe's Lupane and Lower Gwelo Districts, it was noted that droughts result in food insecurity, increase in poverty and and the incidence of the manifestation of human diseases (Mubaya, et al 2010).

In addition to causing extensive crop failures, chronic dry spells are resulting in livestock deaths, which is detrimental to longer-term agricultural development as livestock production is a key livelihood activity in Zimbabwe's communal areas and animals are difficult and expensive to replace (FAO, 2008).With the above conditions at stake, one should be in a position to assess that smallholder farmers will be at greater risk as a consequence of livestock death. This study by FAO indicated the longer term agricultural development yet it should be considered that climate variability has got immediate effects on the household which in this case requires sustainability. Smallholder farmers may not be able to replace livestock because they need money to purchase them and their income sources are constrained by the nature of their activities such as crop farming which is also under threat from climate shocks. A study by Gandure and Drimie (2011) in Chivi revealed that, livestock, including small stock and poultry, are an important source of livelihood and income. Households use savings to buy livestock and use income from livestock to pay school and medical fees and to buy food. This reveals the importance of livestock as a livelihood source and the reason why smallholder farmers are more vulnerable to climate variability. Climate change affects the distribution of tsetse flies which carry sleeping sickness and the cattle disease, *nagana*, and the tick-borne livestock disease called East coast fever, or corridor disease (Hulme & Sheard, 1999). Smallholder farmers will face a greater challenge as a result of these diseases because they have low resource and income endowments and may not be able to take the necessary actions against the infestation of these diseases. Livestock are a source of draught power, meat and a source of income to sustain livelihoods, hence livestock diseases have resulted in most smallholder farmers losing cattle and are forced to kill or dispose them to keep pace with the conditions.

Drought results in food insecurity, and this has brought with it exacerbated poverty levels amongst rural households in the region and this has been of a different magnitude amongst different households with smallholder farmers not being spared by poverty. Climate shocks such as drought and floods can cause grave setbacks in nutritional status as food availability declines, prices rise and employment opportunities shrink (UNDP, 2008). Smallholder farmers affected by drought may have the least capacity to respond and may not be in a position to cope with the gravity of the situation caused by droughts and floods. Employment opportunities are a central concern for smallholder farmers in Chivi because most households have to engage in off-farm activities to boost their agriculture income generating activities. With the wider economic scope of Zimbabwe which is based on agricultural production, it is clear that the destruction caused by climate variability will trigger imbalances in the whole economy. This may affect agro-based industries which offer employment to a remarkable number of people and hence their livelihoods will be at risk due to economic shocks.

The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life" (WHO, 1996). Climate variability

scenarios such as droughts and floods provide a challenge to food access and availability. Food crop yields will be reduced as crops are destroyed by floods or fail to mature as a result of dry spells. Access to food is a challenge to smallholder farmers and with food shortages they end up consuming anything which may put their nutritional status at risk. Particularly, decline in the production of rain fed crops such as maize and beans harmed both people's diet and their purchasing power during the 2003-2004 farming season in Kenya when there was a total failure of rains (UNDP, 2008). This often results in setbacks in health because food insecurity is closely linked to malnutrition especially in children. The study will check on the same results in Zimbabwe's communal lands and will go further to assess other climate related risks affecting smallholder farmers residing in ecologically fragile regions.

Crop pests and livestock diseases are also known risks faced by smallholder farmers in Zimbabwe. Zimbabwe has been experiencing more frequent naturally-induced disasters, such as droughts, floods and pest infestations (FAO, 2008). Pests affect the production of crops and the incidence of their occurrence is increased by climatic conditions. Resources that sustain their livelihoods are largely agriculture based and so climate variations such as increased or reduced rainfall or high temperatures provide good conditions for pests and crops to thrive. These result in reduced yields especially for maize which is the widely produced crop and staple food in the country at large and regions in particular.The possible increases in pest and disease infestations may bring about greater use of chemical pesticides to control them, a situation that may enhance production costs and also increase environmental problems associated with agrochemical use (Kandji et al, 2006). Consideration should be made that smallholder farmers may not afford to purchase chemical pesticides due to their low income levels and it should be investigated whether those resident in Chivi suffer risk from crop pests. Little data is available on how pests affect them and this study may address this. Climate change and variability contribute towards the increase in the likelihood of occurrence of these risks and smallholder farmers by virtue of being directly involved in agricultural activities will suffer greater risk and shock.

Smallholder farmers who sell their produce will be unable to do so due to reduced output which may not be enough to cater for the households' food requirements. They expect income from the sell of produce and this implies that for that season they will not have an income base to sustain themselves. The impact on different farmer groups needs to be established because some receive additional income from other sources such as remittances and performing labour which is not the same situation amongst all smallholder farmer households.

IV. DATA AND METHODOLOGY

The primary data used in this study was adapted from the FAC survey carried out in Chivi district and utilised stratified random sampling in which the sampling frame is divided into various strata or groups before selecting the sample (Alston & Bowles, 2009). Chivi district is located in agro-ecological regions IV and V and is a low rainfall area which is subject to frequent seasonal droughts (Dave et al, 2010). The high incidence of drought means that the agricultural practices in the area are at risk. Maize, sorghum, and groundnuts are grown under dry land conditions and provide the food and income base in the district (ZIMVAC, 2005).

All the wards in these districts were classified into three clusters according to proximity to Chivi Centre (nearer, middle and far remote ward). One ward was randomly selected from each cluster to give us 3 wards in the district. In each ward, 2 villages were randomly selected from village lists that were obtained from the village leadership. From selected villages, lists of smallholder farmers were obtained from village heads and these were stratified by gender of the household head as well as wealth status of the household. Households were put into three wealth categories of poor, medium and rich. The three categories were created in consultation with the local heads and the extension staff (AGRITEX). The wealth status of smallholder farmers highlighted the aspect of different resource endowments which highlighted the economic aspect of the study.
Using a questionnaire, the survey gathered information on the household demographics, risks and shocks affecting households, climate risk and management, household decision making and maize-Crop harvest details.

Analytical Approach

The study followed the risk chain analysis framework outlined by Heitzmann et al (2002) to enable the analysis of climate risks, impact and management amongst smallholder farmer households of Chivi. This follows the notion that all households are vulnerable to risks (Holzmann & Jørgensen, 2000) and vulnerability has been defined as the forward-looking state of expected outcomes, which are in themselves determined by the assets of a household, the correlation, frequency and timing and severity of shocks and by the risk management instruments applied (Heitzmann et al, 2002). Climate risks will potentially affect the welfare of households if they are realized, and in this study, interest was on those risks that are likely to cause negative impacts to the household such as drought which results in food insecurity and difficulty in securing livelihoods.

Data Presentation and analysis

Household Characteristics

In the study, the author purposively sampled both male and female headed households to capture the gender differentiated implications of climate variability (Table 1). This entailed a gender analysis of the socio-economic impact of climate change and variability on smallholder farmers. The results also show that on average the female headed households have more experience in farming with 34 years against the experience of male headed households who have 25 years (table 1). The male heads on the other hand have generally spent more years in school with an average of 8 years whilst the female have 5 years. In terms of age the female headed households average 58 years against their male counterparts who average 52 years.

Table 1: Household characterization: mean difference by gender

	Gender of Head	n	Mean	Min	Max
Farming Experience	**Male**	**54**	**24.81**	**4**	**60**
	Female	**54**	**34.59**	**2**	**71**
Age	**Male**	**54**	**51.69**	**25**	**95**
	Female	**54**	**58.65**	**25**	**93**
Education	**Male**	**54**	**8.02**	**0**	**11**
	Female	**54**	**5.17**	**0**	**11**

Source: Household Survey data

n= number of households

The study was composed of 36 households within differentiated wealth classes, the poor, middle and rich classes (Table 2). The average age of the household heads is 55.17 years, with the mean amongst the poor being 49.97 years, middle 55.36 years and rich 60.17 years. This may be attributed to resource endowments that determine access to healthy standard of living characterized by unrestricted access to health facilities and food and nutrition balanced diet, hence a higher average within the rich and lower years within the poor who may not have attained assets. The Middle class have generally spent more years in school with an average of 7 years with the poor and rich having lesser averages of 6.3 years. The poor had the least years of farming experience with 23.56 years, the middle and rich class had higher years of 31.42 and 34.14 years respectively. The middle and rich classes as a result of better access to income and resources such as agricultural inputs are always involved in production every season. On the other hand the poor have less farmer experience as factors such as lack of inputs, limited land and poor rains, and farmers may go for some seasons without meaningful production.

Table 2: Household characterization: mean difference by wealth class.

	Wealth Class	N	Mean	Min	Max
Farming Experience	**Poor**	**36**	**23.56**	**2**	**60**
	Middle	**36**	**31.42**	**5**	**71**
	Rich	**36**	**34.14**	**5**	**59**
Age	**Poor**	**36**	**49.97**	**25**	**87**
	Middle	**36**	**55.36**	**25**	**93**
	Rich	**36**	**60.17**	**26**	**95**
Education	**Poor**	**36**	**6.33**	**0**	**11**
	Middle	**36**	**7.14**	**0**	**11**
	Rich	**36**	**6.31**	**0**	**11**

Source: Household survey data

Impact of drought on agricultural production and livelihoods

Drought as earlier noted is the climate risk with an adverse impact affecting the households of Chivi during the period 2006- 2010. The droughts could have been more pronounced given that Zimbabwe during this period experienced a severe crisis characterized by poor harvests, shortage of cash, inputs and basic commodities. Follow up questions were made on the impact of drought and related drought management strategies. In the study drought was taken as the reference risk because it was reported by many households. Coping with the drought was thus difficult for the smallholder farmers of Chivi. This shows that drought as evidence of climate variability is becoming common as it characterized all the years. The results resonate with Mazvimavi, et al (2007) who noted that droughts characterize southern Africa and farmers in Zimbabwe have been experiencing drought once every two to three years.

Effect of Drought on male and female headed households

Table 3 illustrates the outcome of drought on the male and female households. The decline in crop yield was the greatest effect on all households as shown by the high frequencies of 43.8% and 57% amongst the male and female households respectively. However, the male headed households reported a higher frequency of

40% with regards to food insecurity and shortage whilst the female households had 29.1%. Women had a lesser impact of food insecurity because they usually receive food aid and participate in food for work to supplement the household food status. The death of livestock was cited by 11.3% of the male headed households against 6.3% of the female headed. Most male headed households own more livestock as it is believed to be a symbol of wealth in society. Moreover, men have better access to income since they take up a variety of jobs and hence can purchase livestock for their households. In the event of drought, they may lose the livestock to death and thus cannot sale them to secure income for food that may guarantee them food security in the household.

Table 3: Outcome of drought (% by gender and wealth class)

Outcome of Shock	Gender		Wealth Class		
	Male %	Female %	Poor %	Middle %	Rich %
Loss of assets	1.3	-	1.9	-	-
Decline in Crop yield	43.8	57	40.7	52.6	58.3
Death of Livestock	11.3	6.3	5.6	10.5	10.4
Decline in Consumption	3.8	3.8	3.7	5.3	2.1
Food insecurity and shortage	40	29.1	46.3	31.6	25
Loss of Income	-	3.8	1.9	-	4.2

Source: Household Survey Data

Effect of Drought on poor, middle-class and rich households

Table 3 also shows that the decline in crop yield was a common outcome of drought for the households in Chivi. The rich households cited it with 58.3%, middle class 52.6% and the poor 40.7%. The rich feet more impact as they commit a lot of their investments to agricultural production and decline in crop yield has great impact on their income cycle. This also explains why 4.2% within the rich reported the loss of income. The poor had a lower frequency because they usually do not have the required inputs due to low income levels to enable meaningful production and use retained seed repeatedly such that they generally harvest less each season. Crops require moisture for optimal growth and droughts lower yield. The drought impacts on crop production are even worsened because the majority of smallholder farmers have no irrigation facilities to supplement rainfall. Linked to the decline in crop yield is food insecurity and shortage that was noted by a higher proportion of 46.3% amongst the poor. This was attributed again to low income levels, hence less alternatives for food when compared to the rich who had a lesser frequency of 25%. The middle class had 31.6% citing the outcome and for the rich and middle class, the severity may have been less due to their better command over income and resources hence able to channel some towards alternative food sources. Food insecurity is common in drought years as all households were not spared and 3.7% within the poor, 5.3% within the middle-class and 2.1% amongst the rich noted a decline in their consumption levels as they have to keep pace with the reduced yields until the next cropping season. This goes in line with the findings of ZIMVAC, (2009) Rural Livelihoods survey in Zimbabwe where families reduced consumption and rationed meals to cope with food insecurity. Setbacks in the health status of households may be noted to be a reality as food insecurity may increase the levels of malnutrition that are common in children, with poverty setting in and making sustainability of households' livelihoods a great challenge for the smallholder farmers of Chivi.

Impact of Drought on Crop and Livestock Production on Households by wealth class

All the farmers that were interviewed indicated that their crops were affected by drought over the 5year period. However 75.9% of the farmers indicated that their livestock was affected by the droughts. This may be attributed to the lack of information on climate risk management. Furthermore, the households make use of poor management practice such as failure to weed which may exacerbate the effects of drought. To construct the impact classifications, farmers were asked to assess the impact of drought on livestock production using the scale 0-5 where 0 meant no impact, 1-2 implied less impact, 3 moderate impact and 4-5 meant severe impact. For the impact of drought on crop production, the scale 1-5 was utilized with 1-2 as less impact, 3 moderate impact and 4-5 as severe impact. Table 4 shows that all farmers in spite of their wealth class were severely affected by drought as 97.2% severe cases were reported amongst the poor, 91.7% amongst the middle class and 94.4% amongst the rich. The rich on the other hand had a higher proportion of households citing the severity of drought on livestock with 66.7% as they own more livestock than other classes. This is relevant given that the rich had only 2.8% citing the absence of impact on livestock hence showing that very few did not own livestock. The poor class had 50% citing the severe impact of drought on livestock and a higher frequency (22.2%) of those who faced no impact at all showing that those who own livestock are few when compared to the rich and middle class.

Table 4: Impact of Drought on Crop and Livestock Production. (% by wealth class)

	Crop			Livestock			
Wealth Class	**Severe**	**Moderate**	**Less Impact**	**Severe**	**Moderate**	**Less Impact**	**No Impact**
Rich	**94.4**	**5.6**	**-**	**66.7**	**22.2**	**8.3**	**2.8**
Middle	**91.7**	**8.3**	**-**	**47.2**	**30.6**	**16.7**	**5.6**
Poor	**97.2**	**2.8**	**-**	**50.0**	**11.1**	**16.7**	**22.2**

Source: Household Survey Data

Impact of Drought on Crop and Livestock Production by gender

Drought impacts on crop production are severe on all households be it male or female as shown by the 94.4% frequency on the groups against 5.6% who cited the moderate impact of drought (Table 5). On livestock, women reported a severe impact of drought with 61.1% against men's 48.1%. Female headed households because of limited income and less participation in off-farm activities, basically survive on the sale and consumption of farm produce and livestock, as such the death of livestock adversely affects their livelihood. Moderate and less impact was cited by more male headed households with 27.8% and 16.7% respectively. Table 5 also shows that male headed households own more livestock with only 7.4% noting that no impact was perceived on livestock whilst 13.1% was noted amongst the female headed households.

Table 5: Impact of Drought on Crop and Livestock Production. (% by gender)

	Crop			Livestock			
Sex	**Severe**	**Moderate**	**Less Impact**	**Severe**	**Moderate**	**Less Impact**	**No Impact**
Male	**94.4**	**5.6**	**-**	**48.1**	**27.8**	**16.7**	**7.4**
Female	**94.4**	**5.6**	**-**	**61.1**	**14.8**	**11.1**	**13.0**

Source: Household Survey Data

Food security status of households in Chivi

The occurrence of climate variability as evidenced by drought that has been characteristic of almost each and every season since 2006 has resulted in household food insecurity in Chivi district. Table 6 shows that 98% of male and female headed households were food insecure after the 2010/11 season.

Table 6: Food Security status (% by gender and wealth class)

Gender of Head	**N**	**Food security status**	
		Secure	**Insecure**
Male	**54**	**1.9**	**98.1**
Female	**54**	**1.9**	**98.1**
Wealth Class			
Poor	**36**	**0**	**100**
Middle	**36**	**0**	**100**
Rich	**36**	**5.6**	**94.4**

Source: Household Survey Data

Table 6 further supports this as all the households within the poor and middle classes were deemed to be food insecure. The rich had only 5.6% food secure households and 94.4% were food insecure. This may show that drought has negative implications on smallholder farmer livelihoods as all production systems are affected and crop yield reduces and this also makes them food insecure. Most of the households in Chivi had a negative deviation from the suggested FAO/WFP yearly cereal utilization to render them food insecure.

Food security by Gender

The results show that all the households were food insecure as the mean per-capita maize production for both the male and female headed households were lower than the FAO/WFP suggested cereal utilization of 167kg/capita/year. The male headed households had an average per-capita maize production of 42.44kg which was considerably higher than that of the female led households which averaged 34.86kg (table 7).

Table 7: Per-capita maize production (kg by gender and wealth class)

Gender of Head	N	Maize Production (per-capita)	Min Production	Max Production
Male	**54**	**42.44kg**	**0**	**500**
Female	**54**	**34.86kg**	**0**	**200**
Wealth Class				
Poor	**36**	**24.24kg**	**0**	**150**
Middle	**36**	**29.15kg**	**0**	**100**
Rich	**36**	**62.56kg**	**0**	**500**

Source: Household Survey Data

Food security by Wealth Class

Even though the three classes were food insecure during the 2010/2011 season, the results show that the rich generally produce higher yield during drought periods (table 7). The per-capita maize production averaged 62.56kg which was better than the 24.24kg produced by the poor and 29.15kg produced by the middle class. The poor are thus made vulnerable as a result of the low maize yield they produce and in the face of drought; this vulnerability may be exacerbated much to the negative impact on their livelihoods. The rich because of better command over income and resources are able to find alternatives of inputs and manage their produce by way of irrigation hence be in a position to produce more yield.

V. CONCLUSION AND RECOMMENDATIONS

This study used a risk chain analysis framework to assess climate risks and their impact on smallholder farmers' agro-based livelihoods. Climate variability's impact is being felt and climate change effects will be felt in the long run. Since farmers largely reported on drought as a key climate risk, they all indicated that this risk had an effect on their production and consumption given that the reduction in yield subsequently led to a reduction in household consumption and thus food insecurity. Drought conditions also led to the death of livestock, loss of assets through disposal to sustain their livelihood needs as well as loss of income anticipated from production. Climate change is an external risk that can be conceptualized as component that contributes to household vulnerability and poverty because it affects the welfare of the household. Since farmers largely reported on drought as a key climate risk, they all indicated that this risk had an effect on their production and consumption given that the reduction in yield subsequently led to a reduction in household consumption and thus food insecurity. Drought conditions also led to the death of livestock, loss of assets through disposal to sustain their livelihood needs as well as loss of income anticipated from production. This means that there is need to strengthen the economic status of women through the provision of funding in the form of loans for farm based or off-farm projects, the provision of key inputs such as seed, fertilisers which are favoured by the soil and climatic characteristics present in Chivi and intensive research into farmer agricultural activities in low rainfall areas of the country should be expanded and strengthened. One area that requires maximum attention is the provision of up to date climate and weather information to help smallholder farmers address the plight of climate change and variability.

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