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EXAMINING THE IMPACT OF CLIMATE CHANGE ON RURAL LIVELIHOODS AND FOOD SECURITY: EVIDENCE FROM SANYATI DISTRICT IN MASHONALAND WEST, ZIMBABWE.

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ABSTRACT

Climate change is an unbearable reality because climate has changed, is changing and will continue to change. As of now, the global village is just beginning to understand the potential magnitude and severity of climate change impacts on food security, not just now but for future generations. Some of the symptoms of climate change include global warming, loss of crops due to over extensive periods of drought, unpredictable rainfall patterns, melting glaciers, displaced populations seeking refuge after floods, or entire villages devastated by the implacable force of cyclones and hurricanes. It is disheartening to note that the poorest, the most vulnerable countries of the world are the hardest hit. In Zimbabwe, just like any other sub-Saharan African country agriculture as the backbone of food security depends almost entirely on rainfall, a situation which may result in it being vulnerable to climate change. This study analyses the impact of climate change induced disasters on rural livelihoods with specific focus on food security, agricultural production and coping mechanisms in semi-arid areas of Zimbabwe. The methods used in this study include focus group

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discussions (FGDs), key informant interviews, household surveys and field observations. Furthermore, the paper also dwelt on issues that interrogate why climatic phenomenon may come to be regarded as a hazard and why some people become vulnerable. Examples are extracted from Sanyati district in Mashonaland West province, North-West Zimbabwe primarily because it is the region that is hard hit by unfavourable weather conditions.

INTRODUCTION

Climate change continues to be an impending major threat to rural livelihoods across the global (Hoffmann, 2011; IPCC, 2007). Therefore, the world is facing multiple challenges in the 21st century. These challenges include poverty, food insecurity, scarcity of water and most importantly new and complex challenges emerging due to global warming and climate change (Jama and Pizarro, 2008). The most crucial issue for small-holder farmers in arid and semi- arid regions of Zimbabwe is rainfall (Manyeruke, 2013; Nelson, 2009)). It is estimated that only about 37% of the country receives adequate rainfall for rain fed agriculture (DFID, 2009). This makes water a far greater constraint to agricultural productivity than land. Changing rainfall patterns, and increases in frequency of droughts and floods have always adversely affected yields of rain fed crops and livestock productivity in the country. Projections of future climate change impacts place Southern Africa's agriculture sector at the forefront of climate change vulnerability with potential negative impacts on revenue from dry land farming (Kurukulasuriya and Mendelsohn 2006; Mano and Nhemachena, 2007). Agricultural production in many areas will likely be hard hit, with yields declining by 20-50% by 2050 according to IPCC estimates (IPCC, 2007). Africa is one of the most vulnerable continents to climate change, a situation that is aggravated by the interaction of multiple stresses, occurring at various levels (IPCC, 2007; Maunder and Tembo, 2006). This is partly due to low adaptive capacity and higher reliance on natural resources, such as agricultural land, forests and water which are very sensitive to changes affecting the environment. Some countries in Africa already face semi-arid conditions that make agricultural production challenging, and climate change will likely reduce the length of growing seasons as well as force large areas of

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marginal agricultural potential out of production (Dercon, 2002; Everson and Gollin, 2003). For instance food production assessment indicates that domestic food production has already declined by 10% in several of the sub-Saharan countries (Dicko et al., 2005). Ecosystems, land use and livelihoods of local communities are among the aspects influenced by climate change and variability (Mano and Nhemachena, 2007).

REVIEW OF LITERATURE

In most African countries agricultural production depends almost entirely on rain water, a situation that makes Africa particularly vulnerable to climate change. Increased droughts negatively affect food availability, as it happened in the horn of Africa and southern Africa during the 1980s and 1990s (Chikonzi et al 2013I, PCC, 2007; Serigne et al. 2006). Many regions are likely to be adversely affected by climate change (IPCC,2007; Mano and Nhemachena, 2007) , including the mixed arid – semi arid systems in the Sahel and the rangelands in parts of eastern Africa, the coastal regions of eastern Africa, and many of the drier zones of southern Africa (ZimVac, 2009; DFID, 2009). Thus Zimbabwe with more than one – third of its land area in the semi- arid environment faces the risks of negative impacts associated with climate change (Magadza, 2000). Given the poverty level and high dependence on agriculture and natural resources, the country may be quite vulnerable to future climatic changes (Dube, 2008, Dube et al 2014).

Agriculture is the main source of employment and livelihood for more than two thirds of the Zimbabwean population, and the most important economic sector in terms of food production. However, according to Kurukulasuriya and Mendelsohn (2006) most of the agricultural production is rain-fed, a situation which makes it more vulnerable to climate change and variability. The impacts of climate in agriculture include decreased production of different crops mainly associated with recurrent droughts, floods, increasing crop pest and diseases and shift of growing seasons (Wheeler and Van Braum 2013;Mano and Nhemachena, 2007; Manyeruke, 2013). For instance, the severe droughts of 1991-1992 and 2011-2012 which hit most parts of the country led to acute food shortages, food insecurity, water scarcity, hunger and acute shortage of hydropower. Climate change scenarios across multiple general circulation models show increases in the country's average mean temperature. Predictions show that the mean daily temperature will rise by 3- 5 degrees Celsius throughout the country and the mean annual temperature will rise by 2-4 degrees Celsius (Hoffmann, 2011; ZimVac, 2009). In most parts of the country rains are increasingly declining and cycles are detrimentally changing. Already the frequency and intensity of extreme weather events such as drought and floods have increased affecting climate sensitive sectors such as agriculture (Maunder and Tembo, 2006, Rademache-Schulz et al 2013). The sectors potentially

impacted by climate change among others include agriculture, forestry, wildlife, water resources, wetlands and livestock, human health, energy, industry and transport (Jama and Pizarro, 2008).

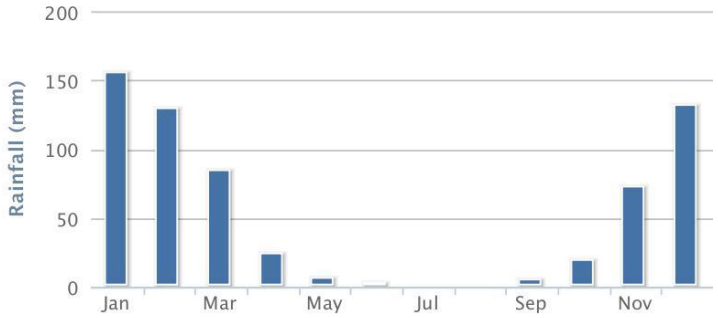

Fig1: Average Monthly Rainfall for Zimbabwe from 1990-2012, Source World Bank.

Livestock in Sanyati district is at risk with animals dying alongside deteriorating pasture condition and drying water sources (Manyeruke, 2013). It is in this context that this study was conducted to establish the climate change impacts in various sectors and agro-ecosystems and determine how vulnerable local communities are coping and/or adapting to associated risks. The main objective of this study was to examine and assess the impacts of climate change and variability on rural livelihoods with particular focus on water resources, agricultural production, food security and existing adaptive capacities in the semi- arid areas of Zimbabwe.

METHODOLOGY
THE STUDY AREA

The study was carried in Muzvezve Ward 5, in Sanyati district located in Mashonaland West province in the semi- arid zone of Zimbabwe. The district was selected mainly because of late, it has been experiencing food insecurity as result of the adverse effects of climate change. Sanyati district lies between 6 ° 7°NW covering an area of 4.832.98km² that is about 32% of the entire Mashonaland West province. It lies within the semi-arid areas of Zimbabwe where frequent food shortages due to uncertainty of rainfall are a constant feature of late (ZimVac, 2009). Thus, the area provides an opportunity to study impacts associated with community livelihoods .Climatically, Sanyati district has a unimodal rainfall range, which spans from November to April. The long-term mean annual rainfall is 624mm with a standard deviation of 179mm (Hoffmann, 2011). Temperatures vary according to altitude, the annual mean, maximum and minimum monthly temperatures in the District are 28°C (November) and 19°C (in June) respectively. The 2012 population and housing census show that Sanyati district had a total population of 112.897 people with a growth rate of 1.9% (Manyeruke, 2013).

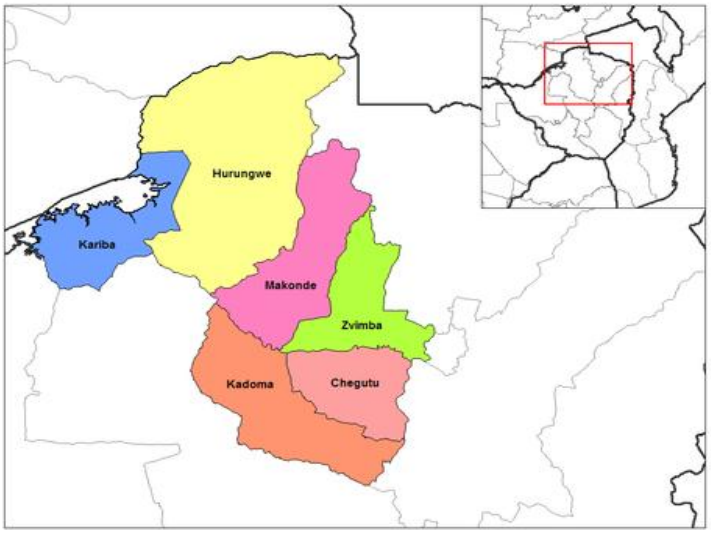

Fig2: Map Showing the Study Area, Kadoma Sanyati District.

DATA COLLECTION AND ANALYSIS

In this study different methods and techniques were used to collect qualitative data from both primary and secondary sources. Secondary data were obtained from reviews of both published and unpublished literature from various sources. Results from these reviews have been used to support various aspects related to the study. Primary data sources included structured and semi-structured interviews for households and key informants respectively, participatory assessments and physical observation.

Participatory methods included focus group discussions and key informant interviews at village level and district level. This was aimed at capturing the diversity of livelihood activities that reflect adaptive capacity and extent of community vulnerability to climate change. The participatory methods were used to establish among others the perceptions of climate change and its influence on food security, existing adaptive capacities and extent of vulnerability of local communities to climate change (Chambers and Gordon, 1992). The focus group discussion comprised of 12-15 people representing various livelihoods and age groups in each village and key informants were drawn from district officials, extension workers and elderly people in the respective villages. Physical observations were also made in the field to capture and crosscheck issues raised in the focus group discussions and key informant interviews, such as crop production and food situation in respective areas.

Household interviews were conducted using structured questionnaires to complement the more qualitative information from participatory assessment and from documentary sources. A sample of 5% of the village households was randomly selected for interviews with equitable representation from all sub-villages in the respective village. A total of 12 households were selected, including 51.5% and 49.5% male and female respondents respectively. The age of respondents ranged between 19 and 80 years. Qualitative data analysis was done through triangulation of narratives from focus group discussion, key informant interview and evidence from field observations. The summaries of the narrations are used in the discussion in subsequent sections.

RESULTS AND DISCUSSION

Implications of Climate Change on Rural Livelihoods

While climate change is a global phenomenon, people will be differently affected by its local impacts. Among other impacts, changing temperature and precipitation patterns will have a profound impact on the natural resource base world -wide, and on the income and livelihoods of people that depend on these resources (IPCC. 2007). In Zimbabwe the agricultural sector is central to sustainable development and food security, as it is the mainstay of over 75% of the population, accounting for 45% of the GDP, and is vital for ensuring food security and alleviating rural poverty (ZimVac, 2009; Mano and Nhemachena, 2007). Thus assessing vulnerability of agriculture to climate change and planning adaptation interventions is crucial for sustaining rural livelihoods. Agriculture, including both crop and livestock production, is the major livelihood activity in the studied villages, other activities being trading various commodities, such as crops and petty businesses. This section focuses more on the agriculture, which is the major source of livelihoods for most people of the study-area.

Implications of Climate Change on Agriculture and Food Security

Agricultural productivity was reported to have declined in both study areas, mainly due to natural factors such as drought and strong winds, and in some instances also due to floods as was the case during El Nino events. The implications of climate change was assessed in terms of crop productivity trends for both food and cash crops, changes in types of crops they produced, farming systems, and patterns in agricultural related activities, incidences of crop pests and diseases.

Respondents were asked during household interviews about the types of crops they produced. The study findings show that a diverse set of crops is grown in the studied district. However, in Sanyati crop production was reported to be declining. The respondents were also asked to indicate whether there are crops that had been abandoned. The reasons advanced for changes in types of crops produced varied between places. However, it

appeared that the major cause for a decline in production of maize was drought. Other crops that were reported to have been affected by drought conditions include millet, beans, cowpeas and groundnuts. Discussions with extension workers in the area confirmed the observations from the local farmers. Untimely supply of drought tolerant crop seeds was mentioned as a factor for some farmers abandoning crops that cannot perform well under conditions of changing climate.

The decline in the production of crops such as cowpeas and groundnuts was also reported to be associated with drought and diseases. Scientific research seems to support local people's concern about the shortening of the growing season in parts of central Zimbabwe, in which Sanyati district is a part (ZimVac, 2009). It is argued that warmer temperatures lead to accelerated phenology, shortening the growing season which consequently reduce potential crop yield (Magadza, 2000; Maunder and Tembo, 2006). Thus warmer temperatures in combination with reduced rainfall lead to declining yields.

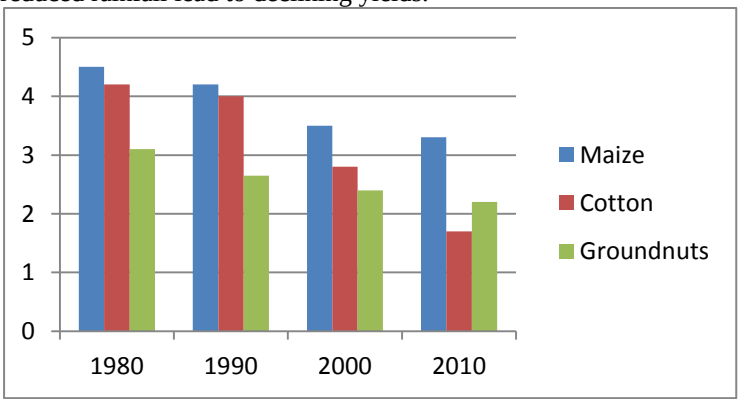

Fig3: Agricultural Production of Selected Crops

Another type of change recorded for Muzvezve was the shift from growing cotton to sunflower and millet due to drought and increased incidences of crop pests and diseases. The high prices of agro-chemicals and low prices for the crop at the market have forced some farmers to shift to other crops. It was further reported in Sanyati Rural district that millet production has increased due to favourable climatic conditions for this crop and the availability of ready markets as indicated by about 3% of the respondents.

As noted in the previous discussion, almost all households are involved in crop production as their main source of livelihood. This suggests that when such activities are impacted by climate change, it may have serious consequence on household food security and general livelihoods. Thus involvement in other economic activities besides agriculture strengthens the household adaptive capacity when agriculture is negatively affected. Such activities complement each other in supporting household livelihoods.

Since agriculture in Zimbabwe is predominantly rain-fed, it is anticipated that a decrease in agro-diversity compounded by climate change will have severe consequences on food security as it usually is insurance in events of drought and pest attacks (Manyeruke, 2013, Sandstrom and Juhola 2016). Climate change results in increased water scarcity, reduced river flows and water storage, which seriously affect crop production, especially of irrigated crops.

Impact of Climate Change on Livestock Production

Livestock production is one of the production systems that are potentially vulnerable to climate change. Respondents in this study indicated that due to low rainfall, pastures have decreased significantly leading to low livestock production.

"We are receiving low rainfall nowadays and our cattle's and goats no longer have good grass. Their growth is slow comparing other years" Mr Takawira a farmer in Muzvezve area.

In addition, since rainfall seasons have increasingly being unpredictable, pastures have become inadequate as compared to previous years. This has lead to a decrease in livestock production. It was asserted that because of the unfavourable pasture conditions the livestock do not have sufficient food to feed on; they are generally weak and may not breed as efficiently as would do under favourable conditions. Generally, shortage of pastures due to changing climate may result in competition for available land, causing conflict and insecurity.

Warmer temperatures lead to vegetation drying faster and drinking water becomes scarce much faster after the end of the rainy seasons. Furthermore, livestock forage productivity and palatability may decline as plant composition changes due to increased temperature and reduced rainfall. In addition, livestock diseases become more frequent with climatic extremes. As such livestock forage amount and quality may decline as rangeland plant composition changes due to temperature, rainfall and CO2 concentrations. Climate projections indicate that droughts impact faster and may have more severe consequences on livestock, wildlife and people. One of the possible risks is that livestock and human diseases will be more frequent with climatic extremes. Already human diseases such as malaria and cholera have become more prevalent in several parts of Zimbabwe and Southern Africa, for example in the Zambezi river basin and Sanyati district (Jama and Pizarro, 2008; Hoffmann, 2011; Manyeruke, 2013).

Community-Based Coping Strategies to Impacts of Climate Change

In response to changing climate, communities in the studied villages in Muzvezve resettlement areas in Sanyati district have developed multiple strategies to adapt to changing environmental conditions. For instance, adaptation to drought conditions is achieved through various methods, including the growing of drought tolerant and fast maturing crop varieties, buying food, increasing wetlands cultivation and livestock keeping, and

where feasible, water harvesting, buying supplementary foods, practicing mixed cropping and increased emphasis on small stocks (Scoones, 1998, Makate et al, 2016). Household with limited livelihood assets were seen to be more vulnerable to the impacts of climate change, especially on food security, because of limited adaptive capacities.

"I used to grow cotton but now l grow millet. The crop does not require a lot of rainfall". Mr Mutsinye a farmer in Muzvezve Village

Need for Drought Tolerant Crop Varieties

Cultivation of drought and or pest tolerant crops varieties is one of the local adaptation strategies to the impacts of climate change, especially those associated with unreliable and unpredictable rains like the one frequently experienced in Sanyati district. About 50% of the respondents considered growing of drought tolerant crop varieties as an important mechanism especially for addressing droughty conditions. This point to a long experience with drought conditions to the extent that nearly all community members understand the importance of drought tolerant crops or crop varieties. As such most farmers have tried to adapt by planting several varieties of sorghum and other drought tolerant crops such as sweet potatoes and green beans. On the contrary, in several instances rainfall was reported to have been received in amounts above average, and communities had to adapt to such eventuality. However, a few individuals reported to have no adaptation mechanisms for excessive rainfall. On the other hand, this may reflect the fact that in many instances excessive rainfall is not always viewed by the local communities as a major problem as compared to droughts.

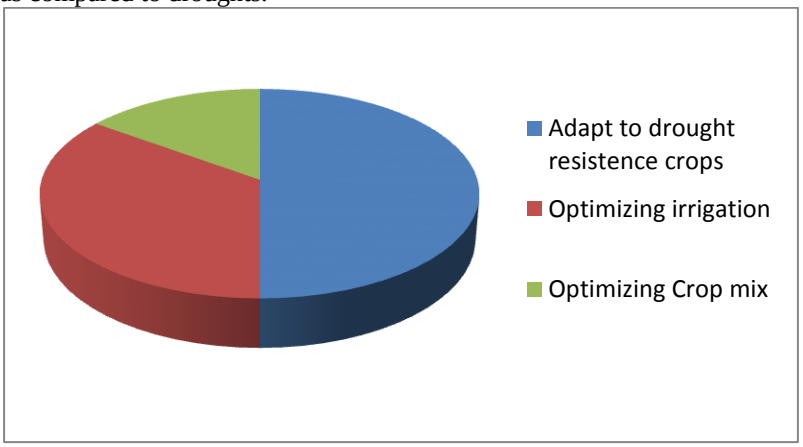

Figure 4: Responses to adaptation methods

Emphasis on Crop Diversification

Several climate change coping and adaptation strategies have been identified in Sanyati district, including crop diversification. The study argues that diversification and adaptive strategies such as water harvesting for small-scale irrigation, integration of livestock and crop production, and

non-farm activities are crucial to ensure sustainable livelihoods in a changing climate. In the study areas, 46.7% of the respondents indicated to be entirely engaged in crop cultivation, involving a diversity of crop types. Crops are grown in diverse mixtures, aiming at increasing farm productivity and avoiding the risk of crop failures. Growing crops with different growth requirements ensures that even under stressful environments such as drought, some harvest can be obtained. Such experiences are also reported for other parts of semi-arid Zimbabwe (Nelson, 2009). About 50.5% practiced agro-pastoralism. A small proportion of respondents (6.6%) reported to be involved with agro-forestry. The implication of these findings is that in semi-arid environments livelihoods are diversified by combining crop production and livestock keeping and agro-forestry, as well as various other non-farm activities. Crop diversification and livestock keeping are viewed as risk adverse strategies especially in semi- arid environments (Manyeruke, 2013; Mano and Nhemachena, 2007).

Integration of Livestock in the Farming System

In Sanyati district, as well as other semi- arid environments it is traditional to keep large herds of livestock as a sign of wealth and as a status symbol. It is for these reasons that many famers in such areas invest in livestock whenever they get resources from other economic activities (DFID, 2009; Kurikulasuriya and Mendelsohn, 2006). While such a practice has guaranteed a livelihood for the respective households in Sanyati, in times of crop failure due to unreliable climatic conditions. Local experience and its impact on the availability of pastures and water, many farmers now put more emphasis on small stocks whose fodder and water requirements are smaller, as expressed by 37.5% of the respondents. The small stocks include goats and sheep.

" My child, l keep cattle and goats in numbers so that when hunger hit like what happened in 2008, l sell some of my goats and buy maize" Mr Nyamutova

As a result of climate change, which has made crop production rather unpredictable because of variations in rainfall patterns, many farmers have put more emphasis on livestock keeping instead of crops, as reported by 20.9% of the respondents. Livestock are often sold in times of need. Selling of livestock appeared to be a major means of dealing with food shortages in Sanyati Rural district, and appears to be a coping strategy closely associated with semi-aridity. This practice is also common in other parts of the semi-arid areas in the country (Chambers and Gordon, 1992; Dercon, 2002).

RECOMMENDATIONS

Based on the findings of the research and the literature citied above, the following recommendations offers a way forward for strengthening climate change adaptation strategies to safe guard rural livelihoods. The

recommendations arising from this paper are relevant to Sub-Saharan countries because the whole continent is dealing with similar environmental challenges.

- Government needs to secure technical support and funding for climate change adaptation
- The Ministry of Education should introduce climate change trainings for pupils and teachers at primary and secondary level
- Collection and dissemination of metrological data in rural areas should be improved so that communities will be able to plan their adaption strategies
- Community leaders should be trained in climate change adaptation measures.

CONCLUSIONS

The study has shown that almost all household are involved in agricultural production as their main source of livelihood. This suggests that when agricultural activities are impacted by climate change it may have serious consequences on their households' food security and general livelihoods. Diversification to other economic activities besides agriculture strengthens the household adaptive and coping capacity when agriculture is negatively affected. Such activities complement each other in supporting household livelihoods, which are particularly important in adapting and coping to the changing climate. The observed decline in crop productivity in all the study areas is multifaceted, being partly due to impacts of changing climate and partly due to other non-climatic stress factors such as shortage of land, land tenure issues, low soil fertility and inadequate extension services. Climatic related events such as rainfall coming late, increased temperature and increased incidences of drought have serious impacts on livelihoods and hence rank high among the factors affecting community livelihoods and food security.

REFERENCES

Chambers, R. Gordon, C. (1992). Sustainable Rural Livelihoods: Practical concepts for the 21st Century. IDS Discussion Paper 296, IDS, Brighton, UK.

Chikodzi, D., Murwendo, T., & Simba, F.M. (2013).Climate Change and Variability in Southeast Zimbabwe: Scenarios and Societal Opportunities, *American Journal of Climate Change,*2, 3 .

Dercon, S. (2002). 'Income Risk, Coping Strategies and Safety Nets', World Institute of Development economics Research, Discussion paper NO 2002/22, United Nations University.

DFID. (2009). Draft September 2009 OPR Narrative Report. Protracted Relief Programme phase II. (PRPII), Zimbabwe.

Dicko, H., Gruppen, H.,Traore, A,Voragen,J., & Berker, J. (2005). Sorghum Grain as human food in Africa.Relevance of content of starch and Amylase activities, *African Journal of Biotechnology.*

Dube, C. (2008).The impact of Zimbabwe's drought policy on Sontala Rural Community in Matabeleland South Province, Unpublished MSc Thesis, Department of Geology, Geography and Environmental Studies,Stellenbosch University.

Dube, T., Homann-Kee Tui, S., Van Rooyen, A. F., & Rodriguez, D. (2014).*Baseline and Situation Analysis Report: Integrating Crop and Livestock Production for Improved Food Security and Livelihoods in Rural Zimbabwe, Socioeconomics Discussion Series Paper 29.*

Evenson, R.E, & Gollin, D. (eds) (2003).*Crop variety Improvement and its Effects on Productivity:* The Impact of International Agricultural Research, CABI Publication, United Kingdom.

Food Security Assessment. Co-ordinated by the Scientific Industrial Research and Development (SIRDIC) & Food and Nutrition Council (FNC), Harare, Zimbabwe.

Hoffmann, U. (2011).Assuring Food Security in Developing Countries under the Challenges of Climate Change: Key Trade and Development Issues of a Fundamental Transformation of Agriculture.

IPCC. (2007). IPCC 4th Assessment Report - Climate Change 2007. Working Group II on "Impacts, Adaptation and Vulnerability".

Jama, B. & Pizarro, G. (2008). "*Agriculture in Africa: Strategies to improve and sustain smallholder production systems. Reducing the Impact of Poverty on Health and Human Development" Scientific Approaches*, Oxford, Blackwell Publishing.

Kurukulasuriya, P. & Mendelsohn, R. (2006). Crop Selection: Adapting to Climate Change in Africa. CEEPA Discussion Paper No. 26, Centre for Environmental Economics and Policy in Africa, University of Pretoria.

Magadza, C.H.D. (2000). Climate Change Impacts and Human Settlements in Africa: Prospects for Adaptation. *Environmental Monitoring and Assessment* 61(1), 193-205.

Makate, C., Wang, R., Makete, M. & Mango, N. (2016). Crop diversification and livelihoods of smallholder farmers in Zimbabwe: adaptive management for environmental change, *Springerplus*, 5(1): 1135.

Mano, R. and Nhemachena, C. (2007). Assessment of the economic impacts of climate change on agriculture in Zimbabwe: a Ricardian approach. Policy Research Working Paper 4292, Development Research Group, Sustainable Rural and Urban Development Team. The World Bank, 1818 H Street NW, Washington, DC 20433.

Manyeruke, S. (2013). The Effects of Climate Change and Variability on Food Security in Zimbabwe: A Socio-Economic and Political Analysis Charity University of Zimbabwe Department of Politics and Administrative Studies Zimbabwe.

Maunder, N. & Tembo, G. (2006). The Impact of Food Aid on Grain Markets in Southern Africa: *Implications for Tackling Chronic Vulnerability*, Cornell University Press, New York:

Nelson GC. (ed). (2009). Agriculture and Climate Change: An Agenda for Negotiation in Copenhagen, 2020 Focus No. 16

Rademache-Schulz, C., Schraven,B. & Mahama, E. S. (2013). Times matter: Shifting seasonal migration in Northern Ghana in response to rainfall variability and food insecurity, *Climate and Development*, 6:1.

Sandstrom, S. & Juhola, S. (2016). Continue to blame it on the rain? Conceptualization of drought and failure of food systems in the greater horn of Africa, *Environmental Hazard Journal*, 16.

Scoones, I. (1998). Sustainable Rural Livelihoods: A framework for analysis. IDS, Working Paper 72, IDS, Brighton, UK.

Serigne T, *et al*, (2006). Climate Change Climate and Variability in Southern Africa: Impacts and Adaptation in the Agricultural Sector, Word Agroforestry Centre (ICRAF), United Nations Environment Programme (UNEP)

Wheeler, T. & Von Braum. (2013). Climate Change Impact on Global Food Security, Science, 341, Issue 6145, 508-513.

ZimVAC. (2009). Zimbabwe Vulnerability Assessment Committee (ZimVAC) Interim Rural