Acknowledgement
This review was undertaken under the auspices of the AfricaInteract project funded by the International Development Research Centre (IDRC).

About AfricaInteract: AfricaInteract is a platform enabling research-to-policy dialogue for adaptation to climate change among a broad range of African stakeholders in sub-Saharan Africa. These include civil society, researchers, policy-makers, donors, and the private sector working on adaptation to climate change in the agriculture and health sectors as well as urban areas with water and gender as cross cutting issues. The overall objective of AfricaInteract is to develop a platform for the effective and efficient transfer of information to policy makers, with the ultimate aim of enhancing the resilience of vulnerable populations. AfricaInteract is funded by the International Development Research Centre (IDRC) and coordinated by the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) under the auspices of the Forum for Agricultural Research in Africa (FARA). The regional focus of AfricaInteract is based on the Regional Economic Communities in the four sub regions of sub-Saharan Africa. focal organizations coordinating regional activities are as follows: the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA) – East Africa; Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) – Southern Africa; Commission des Forêts d’Afrique Centrale (COMIFAC) – Central Africa; and Energie-Environnement et Development (Enda) – West Africa.

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Enabling research-to-policy dialogue for adaptation to climate change in Africa

Research and Policies for Climate Change Adaptation in Southern Africa Agriculture

SUMMARY

Paul Mapfumo, Abdulai Jalloh and Sepo Hachigonta
Paul Mapfumo\textsuperscript{1}, Abdulai Jalloh\textsuperscript{2} and Sepo Hachigonta\textsuperscript{3}

\textsuperscript{1}Professor, Department of Soil Science & Agricultural Engineering; and Soil Fertility Consortium for Southern Africa (SOFECSA) Regional Coordinator, University of Zimbabwe, P.O. Box MP167, Mt Pleasat, Harare, Zimbabwe

\textsuperscript{2}Programme Manager, Natural Resources Management Programme, Conseil Ouest et Centre Africain pour la Recherche et le Développement Agricoles/West and Central African Council for Agricultural Research and Development (CORAF/WECARD), 7 Avenue Bourguiba, BP 48, cp 18523 Dakar, Senegal

\textsuperscript{3}Climate Change Programme Manager, Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), 141 Cresswell Street, Weavind Park 0184, Pretoria, South Africa; Postal address: Private Bag X813, Silverton 0127, Pretoria, South Africa

Acronyms and Abbreviations

\textbf{ACT} \hspace{1cm} African Conservation Tillage Network

\textbf{ASARECA} \hspace{1cm} Association for Strengthening Agricultural Research in Eastern and Central Africa

\textbf{ASWAp} \hspace{1cm} Agriculture Sector Wide Approach of the Government of Malawi

\textbf{CA} \hspace{1cm} Conservation Agriculture

\textbf{CAADP} \hspace{1cm} Comprehensive Africa Agriculture Development Programme

\textbf{CCAA} \hspace{1cm} Climate Change Adaptation in Africa

\textbf{COMESA} \hspace{1cm} Common Market for Eastern and Southern Africa

\textbf{DFID} \hspace{1cm} Department for International Development

\textbf{FANRPAN} \hspace{1cm} Food, Agriculture and Natural Resources Policy Analysis Network

\textbf{FAO} \hspace{1cm} Food and Agriculture Organization of the United Nations

\textbf{GDP} \hspace{1cm} Gross domestic product

\textbf{GEF} \hspace{1cm} Global Environment Facility

\textbf{HIV/AIDS} \hspace{1cm} Human immunodeficiency virus / acquired immunodeficiency syndrome

\textbf{IDRC} \hspace{1cm} International Development Research Centre

\textbf{IIED} \hspace{1cm} International Institute for Environment and Development

\textbf{ISFM} \hspace{1cm} Integrated Soil Fertility Management

\textbf{NAPA} \hspace{1cm} National Adaptation Programme of Action

\textbf{NEPAD} \hspace{1cm} New Partnership for Africa’s Development

\textbf{NGO} \hspace{1cm} Non-governmental organisation

\textbf{PAR} \hspace{1cm} Participatory action research

\textbf{SADC} \hspace{1cm} Southern African Development Community

\textbf{SOFECSA} \hspace{1cm} Soil Fertility Consortium for Southern Africa

\textbf{UNDP} \hspace{1cm} United Nations Development Programme

\textbf{UNFCCC} \hspace{1cm} United Nations Framework Convention on Climate Change

\textbf{WWF} \hspace{1cm} World Wide Fund for Nature

\textbf{ZERO} \hspace{1cm} Zimbabwe Regional Environment Organization

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1. **Introduction**

This document is a summary of a review of research and policies on climate change adaptation in the agricultural sector in Southern Africa that was commissioned under the Africalnteract project. The project is funded by the International Development Research Centre (IDRC) and coordinated by the West and Central African Council for Agricultural Research and Development (CORAF/WECARD). This review was conducted with a specific focus on Malawi, South Africa and Zimbabwe.

The review responds to growing need for development of climate change adaptation response strategies and policies in sub-Saharan Africa. Global scientific enquiries have revealed unequivocal evidence that the world’s climate is changing and presenting new challenges to all spheres of development, as well as threatening the sustainability of human livelihood systems (World Bank 2009; IPCC 2007a). Most of the changes in climate have been attributed to anthropogenic factors related to industrialization and high external input agricultural systems that characterize most of the world’s developed nations. Reports of the Intergovernmental Panel on Climate Change (IPCC 2007a; IPCC 2001) elaborate that while climate change is a global phenomenon, its effects and impacts will be unevenly distributed across the world’s geographical regions, ecosystems and communities.
Communities in Southern Africa have been developing strategies and mechanisms for coping with frequent droughts, seasonal crop failure and perennial challenges of food insecurity, which are often associated with declining soil fertility. Most of the communities fall back on natural resource pools during cropping seasons (Woittiez et al. 2013), yet emerging evidence from the IPCC suggest dwindling opportunities for communities to rely on these resource regimes as water resources are projected to decline (IPCC 2007b). In Southern Africa, climate change impacts are exerting additional pressures on diminishing natural resource base for most communities, and demanding adaptation solutions to sustain agricultural productivity and developing new income opportunities for the young and growing populations. This may require new forms of production technologies and institutions as the size and quality of land and environmental resources decline.

**Guiding questions**
The review was guided by the following six major questions
i) What is the role of climate change challenges in the context of the multiple challenges and opportunities facing the agriculture sector in the region?
ii) What is the current state of knowledge on adaptation to climate change in the agricultural sector in the region?
iii) What is the current state of knowledge on whether and how research findings are integrated in agriculture sector policies in the region?
iv) What are the major gaps in research on adaptation to climate change in the agricultural sector?
v) What is needed to ensure that research findings are better integrated into the agriculture sector policies?
vi) What is the current state of knowledge on the stakeholders involved with research and policy on adaptation to climate change in the agricultural sector in the region, and how stakeholder involvement could be improved?

**Definition of Key Concepts**

**Vulnerability**: Vulnerability is the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC 2007a).

**Adaptation to Climate Change**: Adaptation is defined as ‘an adjustment in natural or human systems in response to actual or anticipated climatic stimuli or their effects, which moderates harm or exploits opportunities to cope with the consequences’ (IPCC 2007a:).

**Adaptive Capacity**: The ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages or take advantage of opportunities to cope with the consequences, defines what has been termed ‘adaptive capacity’ (IPCC 2001).

**Resilience**: Resilience is defined as the ability of a social or ecological system to absorb disturbance, caused by climate change while retaining the same basic structure and ways of functioning, the capacity for self-organisation and the capacity to adapt to stress and change (IPCC 2007a). Walker et al. (2004) defined resilience as ‘the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks’.
**Agriculture Sector:** Agriculture is defined as the science, art or practice of cultivating the soil, producing crops and raising livestock, and in varying degrees the preparation and marketing of the resulting products.\(^1\) However, in the context of African livelihood systems, this review adopts an inclusive definition of agriculture that embraces fisheries and forestry.

**Climate Smart Agriculture:** Climate Smart Agriculture is defined as agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals (FAO 2010). The concept encompasses improved practices along agricultural value chains, appropriate institutions and policy, adequate financing and investment.

2. **Overview of the Southern Africa Agriculture Sector**

**Key facts for the agricultural sector in Southern Africa**

Agriculture is the economic backbone for most countries in Southern Africa, except South Africa, Botswana and Namibia.\(^2\) The agriculture sector will continue to underpin major economic activities for countries such as Malawi and Zimbabwe, providing for food security, national employment and foreign exchange earnings. Analysis by the Southern African Development Community (SADC) reveal that agriculture is the primary source of subsistence and income for 61 percent (more than 140m people) of the region’s population. The major concern is the relatively low and variable growth rates of the region’s agriculture sector, which has averaged 2.6 percent (Chilonda et al. 2007), against a rising human population and the risks associated with climate change and variability.

The current growth rate for agriculture is below the minimum target of 6 percent set by the New Partnership for Africa’s Development (NEPAD’s) Comprehensive Africa Agriculture Development Programme (CAADP) (AU/NEPAD 2003). Poor performance of the agriculture sector in Southern Africa has been attributed to (i) under-investment in agriculture by national governments (often below 10 percent of national annual budgets); (ii) lack of farmer access to production inputs, particularly seed and fertilizer; (iii) lack of access to output markets; and (iv) low levels of development and dissemination of agricultural technologies (e.g. Chilonda et al. 2007).

Farming systems in Southern Africa can be divided into two types, namely smallholder and commercial. Southern Africa is dominated by rain-fed maize mixed farming systems (Dixon et al. 2001), where the dominant maize-based cropping systems strongly interact with livestock systems, particularly cattle. Rain-fed maize occupies 50-90 percent of cropped farmlands in one year in Zimbabwe and Malawi, and is often mono-cropped. Besides maize, other major staple crops in the region are cereals: sorghum, millets and to a limited extent upland rice grown in wetlands and coastal zones of major lakes (e.g. Lake Malawi) and the sea (e.g. in Mozambique). The main complementary crops to the staple cereals include grain legumes such as groundnut, cowpea, Bambara groundnut and beans, as well as root and tuber crops that include cassava and sweet potato. Major cash crops grown in the region include tobacco, cotton, soybean, paprika, wheat, tea, sugarcane and a variety of high value horticultural crops such as grapes and flowers. Over the past decade, there has been increased production of tobacco, soybean and cotton by smallholder farmers in Zimbabwe and tobacco and soybean in Malawi.

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\(^1\) [www.merriam-webster.com/dictionary/agriculture](http://www.merriam-webster.com/dictionary/agriculture)

\(^2\) [www.sadc.int/about-sadc/overview/sadc-facts-figures](http://www.sadc.int/about-sadc/overview/sadc-facts-figures)
Extensive crop-livestock systems characterized by sorghum and millet production are often confined to the drier agro-ecologies, while pastoral systems are absent in the region. Livestock also provide services such as draught power, milk and manure for cropping, as well as acting as stores of wealth (Rukuni et al. 2006; Cousins 1997).

**Climate change challenges in Southern Africa**

IPCC projected that Southern Africa will experience longer dry seasons and increased rainfall uncertainty (IPCC 2007a), and this will demand adaptation measures. The IPCC data shows temperature increases of 0.1-1°C between 1970 and 2004 in Southern Africa countries, especially, southeast lowveld areas of Zimbabwe and southern and the coastal parts of central Mozambique. During the same period, corresponding temperature increases in the rest of Zimbabwe, Malawi and many parts of Zambia, Botswana and Namibia averaged between 1 and 2°C. IPCC projections (IPCC 2007b; 2001) suggest that Southern Africa will suffer negative impacts in three main areas: i) influence on freshwater resources in lakes and dams; ii) breakdown in resilience of dominant ecosystems; and iii) influence on productivity patterns of food, fibre and forest products.

Southern Africa falls within the regions where a decrease of 10-30 percent in water availability and runoff from rivers is anticipated by the middle of the 21st century. This is likely to increase water scarcity in a region already suffering severe water stress for both agriculture and domestic use. Increased frequency of droughts coupled with warmer temperatures and climate-induced floods are force major changes in land use patterns with a high likelihood of over-exploitation of resources drawn from major natural ecosystems (e.g. Campbell 1996).

IPCC projections suggest that there will be decreases in growing season length and an expansion of semi-arid and arid zones in Southern Africa. Localized increases in temperature of 1-2°C are projected to result in decreased crop productivity, significantly increasing the risk of hunger in many communities (IPCC 2007a). Southern Africa is therefore one of the regions where yields from rain-fed agriculture could be reduced by up to 50 percent by 2020, potentially heightening food insecurity and malnutrition. The agricultural sector in Southern Africa still suffers from lack of access to appropriate information, knowledge and technologies by different farmers and this may greatly limit the scope for climate change adaptation.

### 3. Research on Climate Change Adaptation in Southern Africa Agriculture

#### 3.1 Vulnerability and adaptation of crop farming systems in the region

Downscaled models for South Africa projected temperature increases of 2-3°C, particularly in the interior of the country (Johnston et al. 2012). In Zimbabwe, Unganai (1996) found an increasing trend in mean maximum temperatures of 0.1°C per 10 year period between 1933 and 1993, with an overall increase of up to 0.8°C. However, localized temperatures in areas such as the capital Harare increased by up to 1.2°C over the same period, suggesting uneven distribution of warming. Mugabe et al. (2012) used four downscaled Global Circulation Models (GCMs) derived from IPCC and predicted a 1.5-2°C increase in annual maximum temperatures for the period up to 2050 in most of the country, based on
two of the models (CSIRO and MIROC). Climatic data from Malawi showed that mean and maximum air temperatures increased by 2.3 and 2 percent respectively between 1970 and 2002, and projections up to 2050 also suggest increased warming. Observed and projected increases in air temperatures have been linked to a significant decrease in rainfall in Southern Africa. Unganai (1996) analysed long-term rainfall patterns between 1900 and 1993 and concluded that there was a 10 percent decline in rainfall over the period.

Several studies have revealed that a combination of increased rainfall variability and increasing ambient air temperatures cause significant declines in the yields of major staple crops, particularly maize (Dixon et al. 2003; Kiker 2002; Phillips et al. 1998; Makadho 1996). Most of the regional studies have used simulation modelling to evaluate the potential effects of projected rainfall variability on production of major crops, particularly the staple maize that has a strong bearing on food security. In South Africa, each 1 percent decline in rainfall is predicted to cause a 1.1 percent decline in maize and a 0.5 percent decline in winter wheat production (Bilgnaut et al. 2009). Gbetibouo and Hassan (2005) also predicted reduced yields for a variety of crops including maize, wheat, sorghum, sugarcane, groundnut, sunflower and soybean due to increased rainfall variability and warmer ambient temperatures.

Lobell et al. (2011) used a data set of more than 20,000 historical maize trials in combination with daily weather data and showed that for each degree day spent above 30°C final maize yield was reduced by 1 percent under optimal rain-fed conditions, and by 1.7 percent under drought conditions. Furthermore, maize yields are projected to decline by up to 20 percent in the next 50 years in Malawi (Ibrahim and Alex 2008; Lobell et al. 2008), and by 10-57 percent by 2080 in Zimbabwe (Fischer et al. 2005; Lobell et al. 2008) mainly due to increased rainfall variability.

Using the IMPACT global model for food and agriculture, the area suitable for maize production in South Africa was projected to decline by 25 percent between 2010 and 2050, raising concern that the country could become a net importer of maize if no management measures are taken. The model, however, showed that sugarcane was the most resilient crop that showed potential for increased yield across large areas in the country. Similar work in Malawi using DSSAT showed that most of the central and northern regions of the country will witness 5-25 percent increase in maize yields in the period to 2050, while the southern region will have large areas facing threats of a 5-25 percent yield decline (Saka et al. 2012). The model projected doubling of cotton production due to increased yields, although land shortage is expected to limit expansion in cotton production area (Saka et al. 2012). Using the CERES-Maize mode in earlier studies, Makadho (1996) concluded that maize production would become an unacceptably riskier agricultural activity for most smallholder farmers in Zimbabwe mainly due high ambient temperatures triggering moisture stress during grain filling. These findings suggest new challenges in managing cropping systems in the future, and have bearings on potential adaptation options to reduce vulnerability of the cropping sub-sector in agriculture.

This discussion demonstrates the value of modelling in informing future options for climate change adaptation in agriculture, and reveals the glaring knowledge gaps arising from lack of field data on how farmers’ current decision-making process may influence the projected outcomes. Studies by Tadross et al. (2005) provide insights into how improved understanding of climatic factors controlling critical seasonal rainfall events such as onset and cessation could improve targeting of adaptation options.
3.2 Status of scientific evidence for implications of climate change on livestock

The livestock sub-sector will be specifically affected by climate change through effects of changing rainfall patterns and seasonality on feed and fodder production; increase in temperature; reduced water availability; frequent catastrophic events (e.g. severe droughts); changing patterns and distribution of disease; and increased market volatility. Effects of increased temperatures on water demand by livestock are well known. In cattle, for instance, the water intake needed for each kilogram of dry matter intake increases from about 3kg at 10°C ambient temperature, to 5kg at 30°C, and to about 10kg at 35°C (NRC 1981). In Southern Africa, the contribution of groundwater to extensive grazing systems will probably become even more important in the future in the face of climate change.

Climate change may impact negatively on livestock reproduction. Research findings indicate a decline in livestock productivity with rise in ambient temperature and increased frequency of droughts predicted for Southern Africa by the IPCC models (IPCC 2007b). There are also projections that global warming will alter heat exchange between animals and their environments, potentially jeopardizing animal feed intake, growth, reproduction, maintenance and longevity (ILRI 2009). Modeling studies further suggest reduction in animal performance due to decreased forage digestibility. One of the major influences of climate change on livestock systems in Southern Africa is associated with changes in epidemiology of vector-borne and non-vector-borne livestock diseases as habitats for these organisms change.

Options for building adaptive capacity of livestock systems are those rooted in local knowledge systems and institutions and operational at different scales (e.g. field, farm, community, national) to address interactions among the multiple factors regulating food security, environmental services and livelihoods. According to Thornton et al. (2008), farmers require secure land rights, strong local institutions and functioning local legal systems. Five broad areas around which adaptive capacity can be strengthened in livestock systems were suggested by ILRI (2009), and can be modified on the basis of related studies (Brown et al. 2012; IUCN 2010; Government of Zimbabwe/UNDP/GEF 2009; Herrero et al. 2009; Thornton et al. 2009; Chilonda et al. 2007): These areas are (i) Supporting adaptation actions at the local level(ii) Reducing risks in livestock production systems(iii) Institutional adaptation(iv) Technological adaptation and (v) Promoting participatory action research and co-learning processes in the livestock production systems.

3.3 Vulnerability and adaptation of fisheries in Southern Africa

Global perspectives based on IPCC projections are that anticipated climate change and variability impacts on fisheries will include falling productivity, species migration and localised extinctions (IPCC 2007a). Southern Africa has large stretches of coastal waters, mainly in Mozambique, Namibia and South Africa, while other countries such as Botswana, Malawi, Zambia and Zimbabwe are landlocked, but with sizable communities that draw livelihoods from fishing activities on inland freshwater lakes, dams and rivers.

A predicted decline in rainfall in Southern Africa against increased temperatures, rise in evaporation rates and increased demand for irrigation water is expected to decrease runoff by 10-30 percent (IPCC 2007a), resulting in decline in fish stocks. In South Africa, there are indications of damaged coral reefs
due to rising water temperatures and ocean acidification (Nicholls et al. 2007). When sea temperatures exceed long-term summer averages by 1°C, coral reefs suffer ‘bleaching’, rejecting the colourful algae with which they normally have a symbiotic relationship, resulting in loss of colour, greater exposure to disease and often death (Nicholls et al. 2007).

Options for strengthening adaptive capacity of communities dependent on fisheries hinge on principles of participatory action learning and research that inform processes of community-based natural resources management and farmers’ growing livelihood demands. Promotion of cross-boundary cooperation and flexibility of regional fishing agreements to cope with declining stocks, as well as integration of fisheries and aquaculture into national policies on climate change, food security and water management (Brander 2007), can also provide a conducive environment for building adaptive capacity in fishery systems.

4. Sector Policies for Climate Change Adaptation in Southern Africa

Agriculture

In Southern Africa, national policies on climate change adaptation are informed by international and regional conventions and discourse on climate change, particularly those derived from UNFCCC, NEPAD and SADC.

4.1 Climate change considerations in regional agriculture sector policies and strategies

All countries in Southern Africa are members of the African Union and SADC. Malawi, South Africa and Zimbabwe are therefore all signatories to major regional treaties and protocols that guide economic development to safeguard natural resources and the environment for the benefit of the region’s diverse populations. One of the African Union’s major development initiatives is NEPAD (AU/NEPAD 2003), and all the countries subscribe to its programmes. Particularly relevant to the regional agriculture sector is CAADP, which implicitly embraces climate change issues under its strategic Pillars 1 and 3.3

SADC has developed a Regional Agricultural Policy (RAP) (SADC 2012) which seeks to harmonise policy for agriculture and natural resources and strengthen the interventions guided by the SADC Regional Indicative Strategic Development Plan (RISDP) of 2003. One of the major areas of focus for the RAP is to reduce vulnerability in its broad sense. The policy specifically identifies the regional agriculture sector as vulnerable to climate change and variability, and recognises the critical need for adaptation. These regional protocols and policy strategies offer opportunities to broaden the scope for climate change adaptation and draw on integration of major adaptation processes that may be required at the trans-border and regional scales.

The Common Market for Eastern and Southern Africa (COMESA), to which Malawi and Zimbabwe, but not South Africa, are members, is a regional organisation with a principal focus on agricultural development as a means for achieving economic growth, industrial development, agricultural trade and employment creation. In 2002, COMESA approved an Agricultural Policy aimed at harmonising national

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3 www.nepad-caadp.net
policies of member states towards a COMESA Free Trade Area FTA. Subsequently, the COMESA Nairobi Declaration of 2004 on Expanding Opportunities for Agricultural Production, Enhanced Regional Food Security, Increased Regional Trade and Expanded Agro-Exports through Research, Value Addition and Trade Facilitation was a milestone of regional integration. The COMESA policy initiatives may offer conducive policy environments for broad-based climate change adaptation and disaster risk reduction interventions in the region.

4.2 Climate change considerations in national agriculture sector policies and strategies


South Africa provides some of the major contrasts in agricultural policies and strategies on climate change adaptation, because of the relatively low contribution of agriculture to national GDP and therefore a different focus on major pathways to economic development. The key guiding policies and strategies for agriculture in South Africa are contained in the Integrated Growth and Development Plan 2012 (Government of South Africa 2012). This policy addresses the critical challenges of climate change, and clearly embraces the need for substantial public and private investments in irrigation; support of crop varieties and animal breeds that are tolerant to heat, water and low soil fertility stresses; and to build roads and marketing infrastructure to improve small farmers’ access to critical inputs and output markets. The policy framework also dovetails well with the Comprehensive Rural Development Programme (CRDP) of the Department of Rural Development and Land Reform (DRDLR). The CRDP focuses on three main pillars, namely land reform, agrarian transformation and rural development (Government of South Africa 2009). The CRDP addresses several critical developmental issues that focus on reducing vulnerabilities of the socially diverse rural communities, and is therefore relevant for enhancing climate change adaptation processes.

In Zimbabwe, the agriculture sector policies and strategies are provided for in the Comprehensive Agriculture Policy Framework 2012-2032 (Government of Zimbabwe 2012a). This policy framework addresses new challenges and opportunities in the agricultural sector, in line with the national macro-economic policy outlined in the Zimbabwe Medium Term Plan 2011-2015. Surprisingly, the policy framework is silent on climate change, and does place any emphasis on specific challenges related to rainfall variability, increasing temperatures and frequent droughts and occasional floods affecting the sector. Climate change is only mentioned under crop diversification, with a specific focus on breeding of drought tolerant crops, apparently offering a limited scope for adaptation. Zimbabwe’s National Water and National Irrigation Policies are being formulated and offer opportunities for addressing some of the deficiencies on climate change adaptation in the new agricultural sector policy document.
4.3 Agriculture considerations in climate change policies and strategies

The development of climate change policies and strategies by national governments in Southern Africa is essentially work in progress, as awareness and understanding of processes is still gathering momentum, courtesy of the UNFCCC processes. Malawi and South Africa have already completed development of their climate change response policies and strategies. The national strategy for Zimbabwe is under preparation. A National Climate Change Office has been established under the Ministry of Environment and Natural Resources. A national inter-ministerial taskforce on climate change was also formed. The Government of Malawi, through the Environmental Affairs Department of the Ministry Of Environment and Climate Change Management, launched its National Climate Change Policy in 2012 (Government of Malawi 2012) with the objective to ‘reduce vulnerabilities and promote community and ecosystem resilience to the impacts of climate change’. Climate change adaption is ranked first out of eight key priority areas.

The Malawi National Adaptation Programme of Action (NAPA) of 2006 (Government of Malawi 2006), was developed as part of the UNFCCC process, and emphasized five priority adaptation options. In South Africa, the National Climate Change Response Strategy was developed in 2004, to ‘support the policies and principles laid out in the Government White Paper on Integrated Pollution and Waste Management, as well as other national policies including those relating to energy, agriculture and water’ (Government of South Africa 2004). The strategy recognises the vulnerability of the agricultural sector, including rangelands, forests, fisheries and crop-livestock systems.

5. Research Gaps in Climate Change Adaptation and Sector Policies in Southern Africa Agriculture

Several research and policy gaps are evident in Southern Africa. Filling these gaps could enhance climate change adaptation processes in Southern Africa. These gaps occur due to critical lack of empirical research and development studies/interventions on climate change adaptation.

- **Building empirical evidence of climate change impacts and application of adaptation options**: The current body of knowledge in Southern Africa is too scanty to inform the formulation of comprehensive climate change policies and implementation plans. The intricate nature of economic, governance/political, technical and socio-cultural factors determining vulnerability and adaptive capacities of households, communities and institutions make climate change adaptation one of the most complex subjects of development research in the region.

- **Harmonization of concepts, methods and tools for vulnerability assessment**: Although vulnerability assessment studies have been conducted, it remains unclear if different methods are necessary for understanding climate change. The concept of vulnerability in the context of climate change is clearly defined in IPCC reports but different conclusions about climate change have been made
based on different concepts. This has implications for how policy formulation processes are subsequently influenced.

- **Identifying critical variables for improving quality of seasonal forecasts and early warning systems:** Most national policies and strategies on climate change adaptation emphasize the importance of seasonal weather forecasting and early warning systems, but there is no clarity on critical variables to be monitored, and the requirements for matching instrumentation and associated expertise at the national and regional levels to improve the quality of forecasting data.

- **Lack of data and empirical studies to inform budgetary processes for adaptation:** There was limited evidence on quantification of the costs of climate adaptation adaptation processes for specific communities. Operationalization of adaptation action plans is therefore challenging, and may be constrained by poor justification of actions and budgets.

- **Understanding micro-level impacts of climate change and variability in agriculture systems:** Climate change and variability impacts in agriculture have been based on factors regulating biophysical (physical, chemical and biological) and socio-ecological (interactions) processes. One of the impacts of climate change may be alteration of these regular processes (e.g. soil processes, biodiversity, hydrological cycles, and human systems behaviour). Specialist process research is therefore required to understand micro-level impacts of climate change and variability in agricultural production systems. For example, revisiting current understanding of:
  - Dimensions of crop-soil-water interaction patterns to enhance efficiency of resource use and targeting; increasing efficiencies in use of available nutrient and water resources in crop and livestock production systems to be a major determinant of adaptation options in Southern Africa where production is constrained by poor fertility soils and water scarcity.
  - Emerging patterns and causes of post-harvest losses in crop production systems.
  - Patterns in response of local and introduced livestock types and breeds at different scales.
  - Disease surveillance in livestock systems.
  - Emerging patterns in agro-biodiversity such as climate change and variability impacts on pollinators, soil processes crop-pest and crop-disease interactions.
  - Options for designing efficient forestry and fisheries management systems to reduce over-exploitation and post-harvest losses.

- **Role of institutions in fostering and maintaining resilience:** Families and communities in Southern Africa survive in marginal environments because strong institutions support extended family lifestyles and vibrant rural-urban inter-connections. The dynamics of social collaborations (and conflicts) in response to climate change and variability effects have received limited attention, yet they underpin cross-generational survival strategies for the majority of people in the region. Effective climate change adaptation options are rooted in indigenous knowledge systems built on local practices. Comprehensive research on these issues will generate key development insights that can inform policy formulation of cross cutting policies, especially those related to gender and HIV/AIDs.

- **Critical analysis of resource use efficiencies and trade-offs for current and alternative adaptation options:** Institutional mechanisms regulating interactions between cropping, livestock and natural resources (including wildlife, forestry and fisheries) management schemes within rural communities and between rural and urban/peri-urban communities need to be evaluated. Deeper understanding is required of how climate change and variability may enhance or upset some of the traditional sources of resilience for diverse farming communities.

- **Understanding emerging gender dynamics in the context of climate change adaptation:** Current evidence suggests that changing gender roles in response to impacts of climate change and variability, as well as interventions that yield critical analysis on the direction and magnitude of such
changes and their effects on livelihood systems are required. This may help to inform the discourse on gender and climate change in agriculture. While national policies indicate increasing awareness of gender issues among stakeholders, there is no clear evidence of content. Studies are required to explain how the evolution of local cultures and social values within vulnerable communities are shaped by environmental marginality and socio-political systems. Such studies could provide insights into current value systems as an outcome of climate change adaptation processes.

- **Development of options for commercialisation of smallholder agriculture**: Research programmes should be designed and implemented on options for sustainable agricultural intensification, and on understanding circumstances where intensification shows promise. Outcome of analyses of trade-offs between intensification options are critical in informing future policy formulation. Research should be conducted to provide data and information on climate change and variability effects on production and trade of industrial export crops that include cotton, rice, coffee, cashew and macadamia nuts, tobacco, groundnut, tea, sugarcane and horticultural crops (especially flowers).

- **Development of ‘climate smart agriculture’ systems**: Climate smart agriculture has been conceptualized and applied based on speculative arguments with limited supporting empirical evidence. This is likely to misdirect policy formulation on potentials and limitations of emerging agricultural technologies and their suitability to diverse local contexts. The role ISFM and CA technologies, which been developed and tested under different agro-ecologies in Southern Africa for climate change adaptation, should be studied in sufficient detail to inform policy formulation.

- **Enhancing crop-livestock interactions**: Available evidence suggests that research in Southern Africa has focused more on crops at the expense of other subsectors including livestock, forestry (natural resources) and fisheries. However, with increasing challenges of climate change, livestock production has generally been projected to offer a more favourable adaptation strategy than cropping. A Future policy aimed at increasing productivity and competitiveness of the agricultural production systems must therefore consider the management of crop-livestock interactions as a critical component.

- **Analysing trade-offs between irrigated and rain-fed systems**: While irrigation development is emerging as a major area of focus for national policies and strategies, the potential negative impacts of declining rainfall patterns on agricultural water tend to be ignored in policy formulation. There are no clear indications that due consideration is being given to options for increasing productivity in rain-fed cropping systems.

- **Critical analysis of implications of past research and development intervention programmes on current and possibly future manifestations of vulnerabilities**: Current discourse implies that existing livelihood systems inherently lack resilience, regardless of the differences in community exposures to multiple stress factors other than climate change and variability. However, there is little empirical evidence demonstrating how, and to what extent, past intervention programmes have significantly reduced vulnerabilities of the poor and disadvantaged rural communities. The changing context of development interventions due to climate change may also require governments to revisit some of development policies. Climate change also emphasizes weaknesses in current approaches and methodologies for measuring vulnerability and impact in development (e.g. against the changing context of development interventions and multiple stress factors).

- **Generation of context-specific adaptation options**: There is limited empirical data on which generalisations of potential impacts of climate change in a country can be made to inform local adaptation processes, yet adaptation is well known to be a local phenomenon. This strongly suggests a need to generate site-specific data and empirical evidence that can inform technical interventions and policy formulation at the local level. This emphasizes the importance of engaging local-level decision-makers as important agents of change than national and regional stakeholders.
6. Stakeholders and Opportunities for Collaboration and Funding in Research on Climate Change in Southern Africa Agriculture

Several stakeholders are involved in the planning and implementation of climate change adaptation strategies in all Southern African countries. Stakeholders include government departments, national research institutions and universities, farmer organizations, NGOs and civil society organizations. These stakeholders have been brought together in national platforms facilitated by departments in the ministries of environment (e.g. Climate Change Committee in the Department of Environmental Affairs in Malawi). Intensity of interaction among these stakeholder institutions and organizations have been limited to specific project contexts as current policies do not provide for funding of the platforms. A major missing link has been rural institutions and local level structures of farmer organizations, which are supposed to provide ‘grassroots’ perspective to the discussions on climate change adaptation.

The majority of policy related interventions on climate change adaptation in Southern Africa have been at the research level. However, there has been significant involvement of development partners, NGOs, international research organizations and regional policy networks in many of the research projects, providing leveraging for possible policy advocacy and dialogue processes. However, the total number of completed and ongoing projects for which there is published evidence is highly limited in relation to the magnitude of the problem. Most of the policy-related projects have also focused mainly on awareness raising because of lack of local empirical evidence.

Engagement with various stakeholders at the implementation level suggests that climate change adaptation funding streams are either not commonly known or the mechanisms for accessing the funding are beyond the capacity of institutions and practitioners in the region. However, future funding mechanisms for development and/or analysis of climate change adaptation processes largely remain unclear.

7. Conclusion and Recommendations

7.1 Conclusions

Emerging trends on climate change and variability present a major threat to the predominantly rain-fed agriculture sector in Southern Africa, rendering the livelihoods of the majority of both rural and urban communities vulnerable. Research evidence informs that the pending impacts of climate change and variability will compound these multiple stress factors, creating an extra load of challenges that will not only heighten but change the nature of vulnerabilities for communities in the region. Sources of vulnerability to climate change and variability, particularly for the rural farming communities, are multi-dimensional, and matching adaptation options will require use of integrated approaches to research and development.

There is evidence of increasing ambient air temperature, increased frequency of droughts and in particular the worsening of rainfall season quality due to poor distribution as well as early and end of
season droughts. Effectively, potential growing areas for the major staple cereals (particularly maize) will be significantly reduced, while water resources for crop and livestock production systems and fisheries will also be reduced. There are already emerging trends of increased dependency on common natural resource pools such as forest, rangelands and fisheries by poorer sections of communities, including women and youth, as crop production continues to fail. Consequently, the required levels of climate change adaptation into the future are beyond the provisions of the available common natural resource pools without significant external (management) interventions.

Furthermore, there is evidence of increasing share value of livestock in the total revenue of the agricultural sector as farmers find cropping riskier with deteriorating quality of cropping seasons. Future climate adaptation policies focusing agricultural interventions in the region will therefore need to address sustainable options for managing crop-livestock interactions. However, availability of feed resources remains a major threat to livestock production.

Major knowledge gaps exist on how local-level changes in climatic factors (e.g. rainfall, temperature, humidity and air circulation patterns) across spatial and temporal scales influence the socio-ecological processes that underpin agricultural production systems. Current research on climate change in the region has tended to focus on assessing trends in major climate variables, farmers’ current coping strategies, knowledge systems and sources of vulnerability, as well as identifying opportunities for adaptation. Detailed studies on the effects of changing climate variables on ecological processes covering crop, livestock and fisheries, including soil-plant-water interactions, plant-insect interactions (e.g. pollinators, pests and disease vectors) and transmission patterns of livestock diseases are critically needed.

Current national climate change policy frameworks require supporting empirical evidence and technical inputs based on field experiences to inform the development of local community relevant climate change adaptation plans. Research to policy dialogue processes have been derived from interventions characterized by participatory action research, co-learning and innovation system approaches involving stakeholders including communities, farmer organizations, policymakers and public and private research and extension. Agricultural policy instruments supporting institutionalization of these approaches will broaden opportunities for development of context-specific climate change adaptation options in the Southern Africa.

**7.2 Recommendations**

The following recommendations are addressed to national governments, regional policymakers and development partners:

i) **Develop national and regional policy frameworks to support transformative change processes that take agriculture beyond current models of smallholder farming systems towards more productive, market oriented and resilient systems:** Implementation strategies driving such policies should embrace participatory action, co-learning and co-innovation approaches and processes that enable communities to self-mobilise, self-organise and intensity their market participation at local, national, regional levels.

ii) **Enhance national and regional capacities for climate change research and development to address critical requirements for data and empirical evidence on sustainable land and natural resources management options:** Strategies and comprehensive research and development action plans should be developed at national and sub-national levels to support development of technical and institutional mechanisms for addressing land degradation and declining soil fertility challenges undermining agricultural production. Formulate clear national policies specifically focused on
supporting farmers and service providers to develop or adopt new and improved technologies.

iii) **Establish institutional mechanisms and technical capacities for bridging current gaps between regional policy formulation and action planning and implementation at the national and sub-national levels:** The development of regional policies should be matched with establishment and/or strengthening of research and development networks/consortia at national and regional levels.

iv) **Develop comprehensive national policy frameworks for promoting agricultural technology development and innovation systems:** Policy frameworks should be informed by current and future projections on the relative importance of different crop and livestock types and cultivars/breeds as changes occur nationally, regionally and globally in food supply patterns and food taste preferences, against changes in costs of production of certain crops and livestock products.

v) **Harmonize climate change policies, strategies, programmes and interventions at national and sub-national (provinces or districts) scales:** This is particularly relevant for the agricultural, environmental and health sectors. National ministries of environment should effectively coordinate climate change policies and climate change adaptation processes linked to activities in the agriculture sector.

vi) **Develop targeted (area/context specific) approaches for decentralising and strengthening decision-making:** This should be coupled to the development of policy frameworks for climate change information dissemination and integrated knowledge management in agricultural systems, including strengthening of early warning systems at all levels to increase capacity and efficiencies in the generation and dissemination of seasonal weather forecast and early warning information, and their interpretation by farmers and extension.

vii) **Enhance financing and resource mobilisation for supporting the agriculture sector (e.g. establishing national policies consistent with the Maputo Declaration):** National governments should commit funds towards infrastructure (e.g. irrigation) capacity development at different levels, from grassroots communities through extension systems to research, including policy analysis. This will enable sustained generation of empirical evidence at scale in the different agricultural sub-sectors. Develop specialist skills necessary to measure impacts of climate change and understand adaptation needs.

viii) **Develop mechanisms to support establishment/strengthening of interactive platforms at community, sub-national (district and province), nationals and regional scales to promote research to policy engagements and dialogue:** To enhance supply of new information and evidence to policymakers, and also to enable policymakers to demand research products and evidence on the missing links.

8. References


