

## Managing climate related stresses in southern Africa's agricultural sector

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### Abstract

Southern Africa is expected to experience further increases in temperature and declining rainfall patterns as well as increased frequency of extreme climate events (such as droughts and floods) as a result of climate change. These changes are predicted to have differential impacts on agricultural productivity and food security and other economic sectors across spatial and temporal scales. Changes in climate are expected to be detrimental to main sources of livelihoods (e.g. agricultural activities, water and natural products) for most poor smallholder farmers who have limited capacity to adapt. The adverse effects of climate change on agricultural and other livelihood sources threaten efforts and progress made in improving food security, poverty reduction and other programmes aimed at attaining the Millennium Development Goals in the region. It is therefore necessary to find ways of helping farmers adapt to reduce these negative effects from climate related stresses. Providing alternative adaptation options for farmers will make significant contributions in improving agricultural productivity and food security as well as help reduce poverty in the region. This paper discusses alternative ways that farmers can use to help reduce the adverse impacts from stresses due to changes in climate. The study is based on synthesis of secondary information from various studies on climate change in the region. Some of the important ways to help farmers adapt to climate change include: promoting diversification of livelihood options, enhancing innovations in farming systems, building social networks to help build capacity of communities to work together and capitalize on indigenous knowledge systems as well as improving accessibility to resources such as credit, inputs, and information (seasonal climate forecasts, agricultural production and management practices). National policies also need to support research and

development that prepares the appropriate technologies to help farmers adapt to climate related stresses such as drying and increased warming.

**Key words:** *climate stresses, farmer adaptation, agriculture*

### 1 Introduction

Southern Africa is expected to experience further increases in temperature and declining rainfall patterns as well as increased frequency of extreme climate events (such as droughts and floods) as a result of climate change (Nhemachena, 2008). Rainfall patterns show a declining trend of summer rainfall (about 20%) from 1950-1999 and high frequency of droughts and this is predicted to intensify in the 21<sup>st</sup> century (Mitchell and Tanner, 2006; IRIN, 2006). Predictions for 2050 by the US National Center for Atmospheric Research show that the declining trend in rainfall is set to continue and the region is expected to be 10-20 percent drier than the previous 50 years (Mitchell and Tanner, 2006). New research indicates that climate change could force drought-prone areas of southern Africa to abandon agriculture in the next 50 years. The predicted changes in climate will be detrimental to regional food and water security among other issues such as biodiversity loss and health related issues (IRIN, 2006).

The key issues facing southern Africa with respect to climate change are its impacts on livelihoods, and the ability to reduce poverty and provide food and water security (IUCN, 2002, DFID, 2006). Climate change is expected to affect food and water resources which are critical resources for livelihoods of many people in southern Africa, where much of the population relies on local systems for food and water. Impacts of climate change on food and water resources will have devastating implications for development and livelihoods and are expected to worsen

the challenges posed by climate change on development such as on poverty eradication (de Wit and Stankiewicz, 2006, IISD, 2007).

The livelihoods of local communities that heavily rely on food, water and other natural resources are most threatened by impacts of climate (Nhemachena, 2008). These local communities are usually poor and they are unlikely to be able to respond to the direct and indirect effects of climate change because of limited financial, human and institutional capacity (Mitchell and Tanner, 2006). There is a need to strengthen capacity and the effectiveness of management in the region as a way of helping to reduce the impacts of and to adapt to climate change related stresses through providing strategic advice on ecological, social and economic issues to policy makers (IUCN, 2002).

In addition, current and predicted changes in temperature, precipitation, runoff and climate variability leads to greater food and water stress. High levels of food and water stress will further worsen the vulnerability of the poor in three main ways: (a) increased insecurity of livelihoods (due to depleted access to natural resources that include water as well as other social, financial and physical assets); (b) increased health risks (vulnerability of food and water resources have serious implications for health, for example floods are associated with spread of diseases such as malaria, dysentery etc) and (c) constrained economic opportunities (short and long-term impacts of droughts) (TERI, 2006). Climate change, by adversely affecting food and water resources, threatens progress and efforts made in poverty reduction and achievement of the Millennium Development Goals (MDG<sub>s</sub>).

Furthermore, changes in climate are expected to have differential impacts on agricultural productivity and food security and other sectors (water, health, biodiversity) across spatial and temporal scales. The impacts of climate change on agriculture in southern Africa will have serious implications for national policies aimed at improving food security and reducing poverty in the region. Empirical results from country studies based on the Global Environmental Facility/World Bank/

CEIPA funded African climate study indicate that agriculture in southern Africa is very sensitive to climate change. Benhin (2006) in South Africa; Mano and Nhemachena (2007) in Zimbabwe and Jain (2007) in Zambia showed that increased warming and drying in these countries will have negative impacts on net farm revenues. This is expected to adversely affect livelihoods of many smallholder farmers who rely on agricultural activities for livelihoods. It is therefore necessary to find ways of helping farmers adapt to reduce these negative effects from climate related stresses.

In auditing climate related stresses in southern Africa's agricultural sectors, it is important to highlight that approaches used to date mainly cover two perspectives. One approach considers the strategic climate change needs analytical framework (SCCNAF). These relate to the broader and climate change framework, institutional and policy set-up. This lays the groundwork for conducive implementation of climate change stress related managing, mitigation and coping mechanisms and systems. The second approach considers the practical climate change needs analytical framework dimension (PCCNAF). This highlights the individual and community adaptation, mitigation measures and coping mechanisms and systems employed in living daily through the struggles consequent to climate change impacts. This paper suggests a third approach, which is termed the climate change special needs analytical framework (CCSNAF). This relates to the impacts of climate change stresses on special needs groups in the community and society, such as vulnerable sections like women, the youth, child-headed households, widows, orphans, the aged and the disabled. It is the argument of this paper that using the tripartite framework of analysis as advanced, will yield a better preparedness and enhanced ability to respond to climate change stress impacts in the agricultural sector, governments, stakeholders, small-holders, civil society and farmers in southern Africa.

The paper presents a briefing of the main challenges of climate change related stresses and discusses ways that can help

communities, especially smallholder farming communities, best respond and adapt to changes in climate. Providing alternative adaptation options for farmers will make significant contributions in improving agricultural productivity and food security as well as help reduce poverty in the region. The objective is therefore to identify ways of helping farmers adapt to reduce these negative effects from climate related stresses.

## **2 Approach of the study**

The study is based on syntheses of secondary information from various studies on climate change in the region and elsewhere in the developing world.

## **3 Results and discussion**

Adaptations are adjustments or interventions, which take place in order to manage the losses or take advantage of the opportunities presented by a changing climate (IPCC, 2001). Adaptation is the process of improving society's ability to cope with changes in climatic conditions across time scales, from short-term (e.g. seasonal to annual) to the long-term (e.g. decades to centuries). The IPCC (2001) defines adaptive capacity as the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The goal of an adaptation measure should then be to increase the capacity of a system to survive external shock or change.

Micro-level analysis of adaptation focuses on tactical decisions farmers and local communities make in response to seasonal variations in climatic, economic and other factors. These tactical decisions are influenced by a number of socio-economic factors that include household characteristics, household resource endowments, access to information (seasonal and long-term climate changes and agricultural production) and availability of formal institutions (input and output markets) for smoothening consumption. Farm-level decision making occurs over a very short time period usually influenced by

seasonal climatic variations, local agricultural cycle, and other socio-economic factors.

Some of these strategies discussed in this paper include: crop management practices; strengthening local capacity; innovative approaches to water management and use in agriculture; accessibility to climate and agricultural information and addressing perceived barriers to adaptation.

### **3.1 Crop management practices**

Local level adaptations that can help farmers in southern Africa reduce the impacts of climate change on agricultural production involve two main modifications in the production systems (Nhemachena and Hassan, 2007). The first is increased diversification that involves engaging in production activities that are drought tolerant and or resistant to temperature stresses as well as activities that make efficient use and take full advantage of the prevailing water and temperature conditions, among other factors. Crop diversification serves as an important form of insurance against rainfall variability. Growing a number of different crops in the same plot or in different plots reduces the risk of complete crop failure as different crops are affected differently by climate events (Orindi and Eriksen, 2005; Adger et al, 2003). The second strategy is escaping sensitive growth stages through crop management practices that ensure that critical crop growth stages do not coincide with very harsh climatic conditions in the season such as mid-season droughts. Crop management practices that can be used include modifying the length of the growing period and changing planting and harvesting dates.

In addition, increasing household and food security at the small-holder and community level may require the appropriate development and application of dry harvesting technologies. This can assist in the harvesting, storing and availability of food year-round through seasoning of mangoes, sweet potatoes, tomatoes et cetera.

### 3.2 Innovative approaches to water management and use in agriculture

Climate change is expected to adversely affect water resources through affecting rainfall patterns and distribution, translating into serious impacts for agricultural production and other uses. There is therefore a need to put in place innovative water management techniques for both agricultural use and economic development in the region. Two important water management approaches have been documented in literature: (a) water supply management that involves developing new sources of water and groundwater, promotion of water harvesting and reuse of agricultural drainage; and (b) water demand management that involves incentives (e.g. through policies) and mechanisms (e.g. through institutions) as well as new technologies that promote efficient use of water (such as high-precision irrigation) and soil and water conservation (Innocencio, et al. 2003).

Increasing and managing water supply: Designing and developing infrastructure to store or direct water resources in a basin is an important water supply management strategy. Important supply management approaches include rainwater harvesting, tapping of shallow aquifers and development of wetlands. The major limitations to this approach include constrained amounts of land, water and financial resources as well as social and ecological considerations that must be respected to sustain such developments (Innocencio, et al. 2003). Water harvesting that involves a process of concentrating and conserving rainfall runoff in the field or in storage structures like tanks and ponds offers great potential for managing water supply. Water that is conserved through this approach has potential to make substantial supplementary contributions for water supply, helping to reduce the effects of temporal and spatial variability of rainfall like mid-season droughts and dry spells that are common in many water-stressed regions of southern Africa.

Agricultural yields and reliability of production have been shown to significantly

improve in a number of studies (Ngigi 2002; Rockström et al 2001; Rockström 2001 WFS; 1996 all cited in Innocencio, et al. 2003). Some of the potential contributions of water harvesting techniques in rain-fed areas include: "(a) reduced pressure to invest in conventional water augmentation through large dams and run-of-the-river diversion schemes etc (b) relatively cheap technology easily available to poor farmers and (c) environmental benefits with reduced pressure on groundwater resources" (Innocencio et al. 2003).

Developing and promoting low-cost, labour saving techniques and water harvesting approaches that offer both agricultural and ecological benefits increase community-level use and adoption of such approaches (Innocencio et al. 2003). Examples include using precision agriculture that makes use of site-specific soil, crop and environmental data and contour ploughing and precision land levelling. In addition effective use of rainfall used for crop production increases through combining conservation tillage (e.g. minimum and zero tillage) and precision agriculture and water harvesting (Innocencio et al. 2003).

*Water demand management* is an important water-saving technique that involves designing techniques for increasing economic efficiency of use, improving water quality as well as promoting environmentally sustainable use of water resources. Land and water productivity as well as rural livelihoods can be improved significantly through affordable irrigation technologies and water management practices. Irrigation technologies like micro or drip irrigation that make use of low cost plastic pipes and sprinklers have great potential application in water-stressed southern Africa countries (Innocencio et al. 2003). Experiments and technology in sensor-based irrigation and water irrigation management information systems should continue being explored as typified by current work in that domain at the Scientific & Industrial Research and Development Centre (SIRDC) in Zimbabwe.

### **3.3 Accessibility to climate and agricultural information**

Information concerning climate change forecasting, adaptation options and other agricultural production activities remains an important factor affecting use of various adaptation measures for most farmers and local communities. Lack of and or limitations in information (seasonal and long-term climate changes and adaptation options) increases high downside risks from failure associated with uptake of new technologies and adaptation measures (Jones, 2003; Kandlinkar and Risbey, 2000). Agricultural and other economic policies need to ensure easy availability and accessibility of useful climate (short and long-term) adaptation options to help in reducing the downside risks of failure that might be associated with new technologies and adaptation measures and help facilitate farmer uptake of adaptation measures.

Availability of better climate and adaptation information helps local communities make comparative decisions among alternative crop management practises and this allows them to better choose strategies that make them cope well with changes in climatic conditions (Baethgen et al, 2003). In addition, utilising long-range seasonal forecasts provides a powerful tool for communities to adapt in a gradual and controlled way to changes in climate (DFID, 2006). Through providing relatively reliable estimates of changes in climate in the seasons to come, there is room for governments and communities to make informed decisions about adaptation strategies. For instance they can make informed management decisions on water resources, food security and crop planting recommendations (DFID, 2006).

Effective climate information needs to be closely linked to both impacts and development needs of the local communities and economies. There is therefore a need to provide climate information that allows decision makers and local communities to respond appropriately to changes in climate. According to the DFID (2006), this requires considerable analysis involving both meteorologists and sectoral specialists and some of the information needed include:

probability and occurrence of days of drought; failure of early rains; rainfall and humidity patterns; availability of water for irrigation; seasonal stream flow forecasts etc.

Failure to implement adaptation options and poor agricultural performances by most farmers have been blamed on lack of information and resources. In southern Africa for example, despite the region having early warning units and meteorological departments in individual countries, lack of access to information remains a major reason for agricultural failure in the region. Adaptation policy measures need to consider how best information concerning adaptive measures, forecasts and production cycles reaches local communities to help them respond to changes in climate. Climate change policy measures regarding information need to put in place information pathways that ensure that important climate change (weather events) information is timely disseminated to local communities.

An important way is to provide the information to women and farmer associations who can then transfer the information to other members of the communities. Adaptation can be significantly improved if women farmers are empowered with the necessary knowledge, information and power to help raise awareness on climate changes, related stresses and the various coping strategies farmers can implement to help reduce the potential negative impacts. Women groups are important in promoting community adaptation programs as women and their associations have the power, strength and endurance that need to be supported in building coping abilities of the local communities.

### **3.4 Strengthening local capacity**

Successful adaptation efforts need to consider strengthening local institutions, active participation and involvement of those at risk, use of sector based approaches and expansion of information, awareness and technical knowledge (IISD, 2007). Building local institutional capacity is key to facilitate and promote adaptation to climate change at the local level as well as promotion of action

research to develop new varieties and cropping patterns to respond to climate risks (IISD, 2007).

Building and strengthening social networks within communities help build the capacity of communities to work together and capitalize on local knowledge systems. Also, through local cooperation communities have the capacity to try new innovations as they are able to spread the risk of new practices and technologies. This has potential for higher uptake of successful innovations. Societies with stronger social institutions are better able to cope with climate changes and disasters.

In addition, successful responses to climate stresses need to involve all stakeholders and feedbacks in designing adaptation strategies and testing options as well as synthesising indigenous knowledge and practices with scientific knowledge into suitable adaptation options. Another important strategy to raise responses to climate related stresses is community mobilisation and raising awareness through local culture ad practices such as dramas and singing about climate change. It is also important to integrate agriculture with other strategies related to income diversification and policy formulation (IISD, 2007).

The important challenge is to identify the poorest members of the community (women, children and the aged etc) and empower them so that they become part of the community development programmes. It is also important to build the capacity of the local communities to be better able to work for their livelihoods, which is more sustainable compared to providing food handouts. It is therefore important for local interventions to work closely with extension workers and local activists, building awareness and creating an enabling environment and providing moral support for cooperation and active participation of the local communities.

One key finding of a study on southern Africa regional spatial development perspective is the need to entrench practical and working collaboration and partnerships covering the full spectrum of technical and non-technical domains (Chakwizira et al,

2008). In this regard, it is important that a much stronger science and technology climate change capacity system be explored. This could take the form of what this papers terms a Southern Africa Climate Change Observatory Network. This will provide a platform for dialogue, knowledge and information exchange by experts, practitioners, civil society and the communities in terms of best practice, learning experiences, shared challenges and even foresight studies. Such a regional body will be replicated at the national (national climate change observatory network), district (district climate observatory network) and local/community level (local climate change observatory network). Such an institution can be housed in the existing SADC agriculture directorate or other working modalities can be instituted. This suggestion is being advanced given the urgent need to tackle climate change in a sustainable manner in southern Africa, if not worldwide.

### **3.5 Addressing other perceived barriers to adaptation**

Resource limitations coupled with household characteristics and poor infrastructure limit the ability of most rural communities to take up adaptation measures in response to changes in climatic conditions. With resource limitations, communities fail to meet transaction costs necessary to acquire the adaptation measures they might want to and at times communities cannot make beneficial use of the available information they might have (Kandlinkar and Risbey, 2000). Possible ways to improve the adaptive capacity of disadvantaged communities require ensuring access to resources, income generation activities, greater equity between genders and social groups and an increase in the capacity of the poor to participate in local politics and actions (IISD, 2006). This in a way entails promoting many activities associated with sustainable development and policies that help reduce resource pressure, improve environmental risk management and increase the welfare of the poorest members of society.

Market access is another important point to consider in farm and community-level adaptation. Farmers with access to markets both input and output, have high chances on taking adaptation measures in response to changes in climatic conditions and other factors. Input markets allow communities to acquire the necessary inputs they might need for their farming and other economic operations such as different seed varieties, fertilisers, and irrigation technologies. On the other end, access to output markets provides communities with positive incentives to produce cash crops and other products for the market that can help improve their resource base and enhance their ability to respond to changes in climatic conditions.

Misplaced information and funding can potentially trap farmers into situations they cannot get out of. An example is a situation whereby a farmer receives an irrigation loan and is trapped into repaying that loan. Even if there are other factors that make irrigation farming unattractive, such as poor output prices, the farmer is trapped, as he/she needs to repay the loan. In this case joint planning and policy making are important to avoid such situations of trapping farmers and communities in situations they will be locked into, making it difficult for them to take other alternatives that come along with time.

Furthermore, rural communities struggle for food, and development and research policies and strategies need to empower rural families in ways that enhance food production. Empowering local communities, commitment and vision of what is to be achieved are important in determining successful uptake of adaptation strategies that aim to improve rural livelihood goals. Also, top-down approaches without analyses of social dynamics in the rural communities won't work and have been shown to create divisions within societies. Experience shows that divisions created due to top-down approaches damage the social capital base which is an important component of household adaptation to external stresses. It is therefore important for interventions to come in ways that build and harmonise social relations and not to create divisions that destroy the social capital base.

Participatory approaches are therefore important as they help build on what the farmers know and have. It is important to give farmers and communities a chance to walk their mind and researchers walk theirs and both sides should find ways of integrating the different lines of thought about how best to deal with the problem. Farmers and communities need not be treated as recipients of aid; what they need are not handouts but instead they want to be empowered to be able to deal with the problems themselves. Farmers and communities need genuine interventions that empower them and provide them with sustainable solutions to their livelihood needs.

#### **4 Conclusions**

The study is based on synthesis of secondary information from various studies on climate change in the region. Some of the important ways to help farmers adapt to climate change include: promoting diversification of livelihood options, enhancing innovations in farming systems, building social networks to help build capacity of communities to work together and capitalize on indigenous knowledge systems as well as improving accessibility to resources such as credit, inputs, and information (seasonal climate forecasts, agricultural production and management practices).

Adaptation efforts need to pay particular attention to management of water and other natural activities, agricultural activities and the sources and generation of energy. Successful adaptation strategies will need to consider improvement of information and methodologies, implementation of concrete adaptation activities, technology transfer and capacity building. National policies also need to support research and development that prepares the appropriate technologies to help farmers adapt to climate related stresses such as drying and increased warming.

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