4 Climate change and the threat to food production in Southern Africa

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Climate change and its impact

Climate change in Southern Africa is having an impact on life and livelihoods, and farmers are struggling to cope with its impact. Both, floods and droughts have increased in frequency and intensity and the onset of the rainy season has shifted and has become less predictable. In 2017, the Southern African Development Community (SADC) published a handbook entitled *Climate Risk and Vulnerability* (Davis-Reddy and Vincent, 2017) with up-to-date climatic analysis and projections for Southern Africa, which is used extensively in the following section.

Average land-surface temperature has increased across Africa over the last decennia, particularly since the 1970s, and is continuing today (Figure 4.1). The subtropical Southern African region is among the most affected with a trend of 0.4 °C per decade. The rate of change in temperature over Africa is more than twice the global estimate (Osborn and Jones, 2014).

Trends in rainfall for Southern Africa are masked by the high variability and the lack of observational data in the region. The data for 1900 to 2014 (Harris et al., 2013), represented in Figure 4.2, show this high variability with some clear drought periods. The 2000s were wetter for most of the region except for the countries along the southwestern coast of Africa and the eastern coastline of Tanzania.

Trends in extreme events summarized in Figure 4.3, are difficult to discern. However, the number of hot extremes have increased and the number of cold extremes have decreased, as they have globally (Stocker et al., 2013). Evidence suggests that the frequency of dry spells as well as daily rainfall intensity has increased (New et al., 2006). There is some evidence to suggest that droughts have become more intense and widespread over Southern Africa (Masih et al., 2014; New et al., 2006). The projected increase in temperature is expected to lead to more frequent droughts, particularly during periods of reduced rainfall (Engelbrecht et al., 2015; Shongwe et al., 2011; Stocker et al., 2013). The frequency of high fire danger days is projected to increase across Southern Africa which is consistent with the increases in heat-wave days (Engelbrecht et al., 2015).

Climate change is expected to alter the magnitude, timing and distribution of storms that produce flood events (Engelbrecht et al., 2013; Stocker et al., 2013).

Figure 4.1 Mean annual temperature anomaly (°C) over Southern Africa from 1901 to 2014 with respect to the long-term average climatology 1961–1990; based on the gridded CRUTEMv4 data set; red represents a positive anomaly and yellow a negative temperature anomaly

Source: Davis-Reddy and Vincent, 2017

CRU TS 3.23: Rainfall over Southern Africa

Figure 4.2 Mean annual rainfall anomaly (mm) over Southern Africa from 1901 to 2014 with respect to the long-term average climatology 1961–1990; based on the gridded CRU TS 3.23 data set; red represents positive anomaly and blue a negative anomaly in temperature

Source: Davis-Reddy and Vincent, 2017

Number of events (1980-2016)

Figure 4.3 Number of recorded climate-related events over Southern Africa since 1980 (Source: EM-DAT CRED, 2016); “wildfires” refers to any uncontrolled and nonprescribed burning of plants in a natural setting; “storms” to tropical, extratropical and convective storm events; “floods” to riverine, flash and coastal flood events

Source: Davis-Reddy and Vincent, 2017

Tropical cyclones used to be rare in Southern Africa and of low intensity (Fitchett, 2018). The ocean temperature of the South Indian Ocean is creeping up, enhancing the intensity of cyclones. Moreover, the cyclone activity has moved southward where they are more likely to make landfall. Since 1994, category 5 storms in the South Indian Ocean have become more frequent and their frequency is likely to keep increasing. Most of this can be ascribed to an increase in sea surface temperature as a result of global warming. The greatest threat is to the northern half of Madagascar, Mozambique and to the islands of Reunion and Mauritius.

The SADC report (Davis-Reddy and Vincent, 2017) summarizes the climate projections for Southern Africa based on the CORDEX effort using over a dozen different Global Circulation Models with different downscaling approaches and two key development trajectories (RCPs). If greenhouse gases emissions continue to rise unmitigated, central Southern Africa will experience drier summers in the future. Parts of Tanzania and northern Mozambique will possibly be wetter. Winter rainfall in the Western Cape of South Africa is likely to decline in the future. Projections on rainfall tend to deviate among GCM projections and thus remain somewhat uncertain. The projections uniformly predict that the 21st century will see continued increases in temperatures, somewhat less in the coastal regions.

The record of extreme events over the past 35 years in Southern Africa are summarized in Figure 4.3. Drought events were a regular occurrence whereas extreme temperatures occurred episodically. The frequency of floods and storms has increased drastically as have wildfires to some extent. The capacity to cope with these events in the region are limited, and the population is indeed highly vulnerable.

Climate change and agriculture

Agriculture in Southern Africa has limited adaptive capacity to the hazards of climate change due to endemic poverty and restricted capital and technology access and poor infrastructure greatly enhancing its vulnerability (Hachigonta et al., 2013; Parry, 2007). Climate change is also having a dramatic impact on food and nutrition security in most of sub-Saharan Africa (NOAA, 2007). The projected increase in rainfall variability, temperature and extreme events for the region will exacerbate the vulnerability of the predominantly rainfed systems on which food supply depends. Knox et al. (2012) conducted a meta-analysis of climate change on the yield of eight major crops in Africa and projected mean yield losses of 17% (wheat), 5% (maize), 15% (sorghum) and 10% (millet) for Africa by mid-century. Dinesh et al. (2015) suggest that the area suitable for maize production could decline by 20 to 40% relative to the period from 1970 to 2000. Maize is particularly sensitive to temperature, losing 1% for each growing day spent at a temperature above 30°C (Lobell et al., 2011). Wheat has an even lower temperature threshold value (Adhikari et al., 2015).

Climate change will affect livestock productivity indirectly as well as directly. Climate change will diminish feed resources for livestock through changes in the primary productivity of crops, forages and rangelands. Changes in species composition in rangelands and some managed grasslands will affect the animal species that can graze them (Thornton et al., 2007). Domesticated species perform best at temperatures between 10 and 30°C and they will produce around 3 to 5% less for each 1°C increase above those levels. These temperatures are already exceeded in several regions.

According to Haywood (2015), the biophysical impacts of climate change can have a ripple effect along the whole agricultural value chain which spans input companies, farmers, distributors, agro-processing companies and retailers. The chapters in this book offer many guidelines on how to cope with the multiple stressors associated with climate change. Policymakers ignoring or denying the hazards associated with climate change do so at the peril of their society.

Climate change and biotic stresses

Crop loss will be complicated by a host of factors such as: 1) a decrease in host plant resistance; 2) a reduction in the efficacy of pesticides; 3) shifts in the effectiveness of ecosystem services that naturally regulate pest densities; 4) shifts in strains of fungi responsible for toxin production in postharvest; 5) arrival of alien pest species; and 6) enhanced weed growth and ultimate competition with crops (Muatinte and Van den Berg, 2018; Oerke and Dehne, 2004; Pratt et al., 2017; Tefera, 2012). Increased temperature associated with climate change will likely have a major impact on crop losses due to increased biotic stress (outlined in chapter 5 in this volume) from weeds, insects, fungal pathogens, viruses, nematodes and rodents. These pests cause yield loss at all stages in the production cycle from planting to postharvest with total harvest losses approaching 60% (see chapter 6 in this volume). Yield losses of major staple crops (i.e., maize, rice, wheat and soybean), due to increased insect pests alone will expand by 10 to 25% for each degree of global mean surface warming (Deutsch et al., 2018; Henson et al., 2011).

These pests usually have enhanced development rates even with slight increases in daily temperatures, producing additional generations per cropping season and increased numbers of offspring. In addition, there will be shifts in pest species composition but also an increased spread of invasive pests into new zones with suitable climatic conditions. Furthermore, increased soil temperature, as affected by direct solar heating, will not only increase evapotranspiration but also the density of soil-borne pests in rhizosphere causing root system degradation that will affect water and nutrient uptake (Sikora, 2018).

Smallholder farmers in Africa will be more vulnerable to these consequences of climate change than large family and commercial farmers who have access to management options. Small farmers lack the necessary knowledge of pest biology and integrated management strategies and also face financial constraints (Biber-Freudenberger et al., 2016). Agriculture in Southern Africa, especially

that of smallholders, will need to learn to cope with expected increases in biotic stresses. Therefore, it is of utmost importance that government institutions in the region develop response strategies and improve support to small-scale farmers to avoid crop losses and failures and ensure adequate food production.

Conclusions and recommendations

Climate change is a threat to food security (IPCC, 2019). If farmers are to cope with this threat, it is imperative to better understand the three intertwined food security and climate change challenges, namely 1) ensuring food security; 2) coping with the impact of climate change on agriculture; and 3) mitigating the impact of agriculture on climate change. To properly address these intertwined challenges, the Southern African agri-food system has to become more efficient and resilient at every scale from the farm to the regional food system. (Climate Smart Agriculture Sourcebook, FAO, 2013).

Resilience, the capacity of systems, and communities, to prevent, mitigate or cope with risks or recover from shocks, has various dimensions; biophysical, economic and social, operating at various scales. The manner in which the various dimensions and scales interact is crucial and needs to be better understood.

The current and emerging technologies to enhance agricultural transformation in Southern Africa and create resilient livelihoods are well documented in the various chapters in this book. They were selected for their significant role in traditional farming practices in Southern Africa and farming practices useful for climate change adaptation in agriculture in Southern Africa (IIED, 2011). Priority focus in the scaling up of proven technologies and practices is to reduce the vulnerability of farming in the region. The technologies described in this book as they relate to resilience include crop diversification of cereals and legumes, crop insurance schemes, drought or flood tolerant crop varieties, hazard-proof grain storage facilities, livestock shelters, strategic fodder reserves, bio-security of animal production systems, water reserves to buffer droughts and resilient animal breeding (FAO, 2011). However, traditional knowledge systems should be given due consideration in the technology packages.

Technologies and practices designed to address Disaster Risk Reduction (DRR) and climate change adaptation can be delivered as a coherent package of solutions, scaling up of proven risk reduction practices can be achieved through policies that support their systematic expansion. Climate Smart Disaster Risk Management (CSDRM) is designed to address the need to integrate disaster risk reduction and climate adaptation. There are 12 components of CSDRM comprising three action-oriented pillars (Davis-Reddy and Vincent, 2017) as follows: Pillar 1. Addressing changing disaster risks and uncertainties; Pillar 2. Enhancing adaptive capacity; and Pillar 3. Tackling poverty and vulnerability and their structural causes. Pillar 2 is of particular relevance here, since its key focus is on enhancing adaptive capacity and building resilience. This has policy implications for resource allocation for interventions at institutional and network levels that provide opportunities for learning, knowledge sharing for

solving problems. In this context the factors essential for increasing resilience would include community participation, promoting diversity, acknowledging the importance of social values and structures in planning, preparedness and readiness. (Davies-Reddy and Vincent, 2017)

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