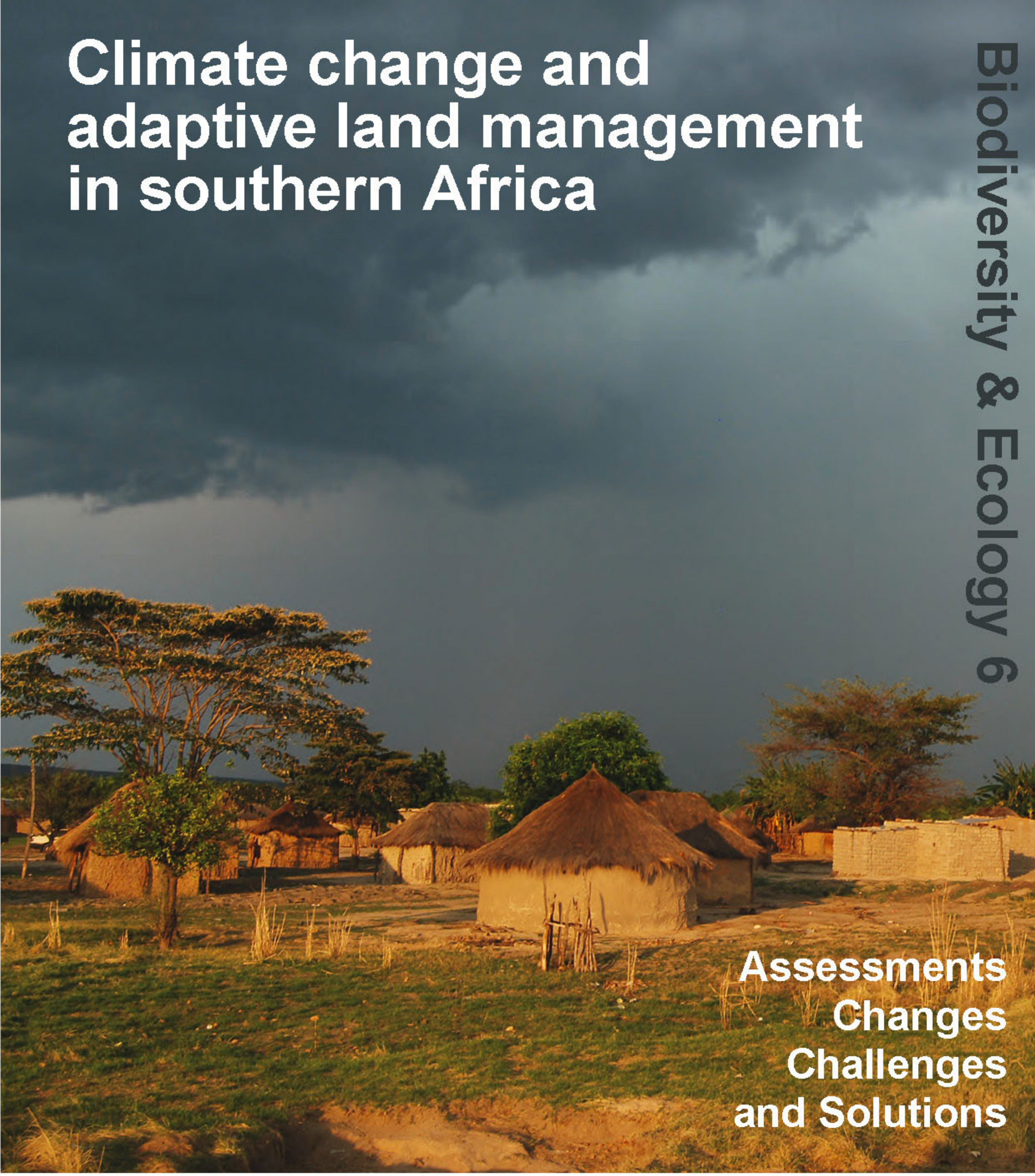
# Climate change and adaptive land management in southern Africa

Biodiversity & Ecology 6



## Assessments Changes Challenges and Solutions

Product of the first research portfolio of

**SASSCAL 2012–2018**

Southern African Science Service Centre for Climate Change and Adaptive Land Management

SPONSORED BY THE

Federal Ministry of Education and Research

Klaus Hess Publishers
Göttingen & Windhoek
www.k-hess-verlag.de

ISBN: 978-3-933117-95-3 (Germany), 978-99916-57-43-1 (Namibia)

Language editing: Will Simonson (Cambridge), and Proofreading Pal
Translation of abstracts to Portuguese: Ana Filipa Guerra Silva Gomes da Piedade
Page desing & layout: Marit Arnold, Klaus A. Hess, Ria Henning-Lohmann
Cover photographs:
front: Thunderstorm approaching a village on the Angolan Central Plateau (Rasmus Revermann)
back: Fire in the miombo woodlands, Zambia (David Parduhn)
Cover Design: Ria Henning-Lohmann

ISSN 1613-9801

Printed in Germany

Suggestion for citations:
Volume:
Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch, J.M., Helmschrot, J. & Jürgens, N. (eds.) (2018) Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions. *Biodiversity & Ecology*, **6**, Klaus Hess Publishers, Göttingen & Windhoek.

Articles (example):
Archer, E., Engelbrecht, F., Hänsler, A., Landman, W., Tadross, M. & Helmschrot, J. (2018) Seasonal prediction and regional climate projections for southern Africa. In: *Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions* (ed. by Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch, J.M., Helmschrot, J. & Jürgens, N.), pp. 14–21, *Biodiversity & Ecology*, **6**, Klaus Hess Publishers, Göttingen & Windhoek.

Corrections brought to our attention will be published at the following location:
http://www.biodiversity-plants.de/biodivers_ecol/biodivers_ecol.php

# Biodiversity & Ecology

Journal of the Division Biodiversity, Evolution and Ecology of Plants,
Institute for Plant Science and Microbiology, University of Hamburg

Volume 6:


# Climate change and adaptive land management in southern Africa

## Assessments, changes, challenges, and solutions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Hamburg 2018

Please cite the article as follows:

Chimwamurombe, P. & Munsanje, K. (2018) Food security through improved farm management. In: *Climate change and adaptive land management in southern Africa – assessments, changes, challenges, and solutions* (ed. by Revermann, R., Krewenka, K.M., Schmiedel, U., Olwoch, J.M., Helmschrot, J. & Jürgens, N.), pp. 236-241, *Biodiversity & Ecology*, **6**, Klaus Hess Publishers, Göttingen & Windhoek. doi:10.7809/b-e.00329

Food security

# Food security through improved farm management

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**Abstract:** The Southern African Development (SADC) region is already experiencing the adverse effects of climate change leading to low food productivity and decreasing food security at the household level. The cropping seasons tend to start later and last for a shorter period of time. Unfortunately, this problematic reality is complexed by low awareness in the community regarding climatic changes and several other biotic and abiotic factors. The agriculture tasks in SASSCAL investigated alternative farm management approaches for sustainable agricultural production in farming communities of central, southern and western Zambia (Tasks 157 and 188), in Botswana at several locations throughout the country (Tasks 316, 314 and 308), eastern and central Angola (Task 144), and in the Kavango Regions of Namibia (Tasks 051 and 044). This overview chapter will describe the different farming systems encountered during the studies of SASCCAL and outline potential impacts of climate change on subsistence, commercial and investor-driven agriculture. The reasons for low agricultural crop performance and possible remedies in the SASSCAL region will be discussed in this chapter.

**Resumo:** A região de Desenvolvimento da África Austral (SADC) está já a sentir os efeitos adversos das alterações climáticas, levando à baixa produtividade alimentar e à diminuição da segurança alimentar ao nível doméstico. As épocas de colheita têm tendência a começar mais tarde e duram menos tempo. Infelizmente, esta realidade problemática é complicada pela reduzida sensibilização comunitária em relação às alterações climáticas e a diversos outros factores bióticos e abióticos. As equipas do SASSCAL focadas na agricultura investigaram abordagens alternativas de gestão agrícola para a produção sustentável nas comunidades agrícolas do centro, Sul e Oeste da Zâmbia (Equipas 157 e 188), do Botswana em diversos locais do país (Equipas 316, 314 e 308), do Este e centro de Angola (Equipa 144) e das Regiões do Kavango na Namíbia (Equipas 051 e 044). Este capítulo irá descrever resumidamente os diferentes sistemas agrícolas observados durante os estudos realizados pelo SASSCAL e delinear os potenciais impactos das alterações climáticas na agricultura de subsistência, comercial e orientada para investidores. As razões para o baixo desempenho das culturas e as possíveis soluções na região do SASSCAL serão discutidas neste capítulo.

## Introduction

According to the outcomes of the World Food Summit (1996), food security exists when all people, always, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. It is a major challenge to achieve food security globally for a growing world population. Many factors affect food availability for people in different parts of the world. A mixture of ecological, sociological, political and economic factors has a direct influence on the production, quality, consumption, and distribution of food. Additional challenges to attaining food security arise due to global change and the depletion of soils as a consequence of unsustainable agricultural practices. Thus, there is urgency to develop alternative, sustainable farming practices that are able to produce an optimal yield on limited space and at the same time conserve nature to allow continued benefits of ecosystem services.

In the Southern African Development Community (SADC) region, food security issues have often taken centre stage, but there is still a lack of lasting solutions to securing the nutrition of all. At the producer level, one reason for the lack of progress is that agricultural production does not necessarily follow advice based on empirical research data. Moreover, empirical evidence for sustainable production in small-scale agriculture is still scarce (Steward et al., 2014). Most farmers have no access to recommendations based on scientific studies and thus continue to use conventional approaches established many years ago, that are designed for large-scale industrialised agriculture and are not appropriate for small-scale systems (Holt-Giménez & Altieri 2013). A recent review by Garibaldi et al., (2017) shows that empirical evidence on alternative farming approaches is mostly generated for industrialised agriculture but very scarce for farms operating on a small scale. The contributing authors in this section of the book emphasise that research has to focus on management alternatives for sustainable land use and their implications for people, by taking socio-economic parameters into account. Interdisciplinary research, and the dissemination of its findings to stakeholders, has to be improved in order to promote better land management and higher yields (Francis et al. 2003).

The SASSCAL agriculture tasks investigated alternative management approaches for sustainable agricultural production, defining food production and availability in farming communities of central, southern, and western Zambia (tasks 157 and 188), Botswana (region east to west and south to north on a rainfall gradient; tasks 316, 314 and 308), eastern and central Angola (task 144), and Namibia (in the Kavango region, mostly along the Kavango River; tasks 051 and 044).

This chapter will give a brief overview of the different farming systems encountered during the studies in the SASSCAL region and the potential impacts of investor-driven agriculture, and propose reasons for poor agricultural crop performance. Problems and solutions for the agricultural sector in the SASSCAL region will be discussed. This introduction will serve as a prelude to the chapters compiled for the Agriculture thematic area of the SASSCAL programme.

## Farming systems within southern Africa

### Different agro-ecological zones of southern Africa

For more than 30 years, the Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA) have developed the methodology of Agro-Ecological Zones (AEZ) with the aim to assess the potential and resources of a given region and its suitability for agricultural production (FAO, 2017). According to the FAO, southern Africa encompasses at least eight agro-ecological zones from tropical to arid landscapes (depending on the underlying classification). There are different approaches to dividing these zones in terms of climate, soil type, landcover, etc., so the number of zones varies accordingly. However, there is a similarity of farming systems to be found across all countries in the SADC region. Smallholder farms and large-scale commercial farms coexist, in both cases comprising a mixture of crop farming, animal husbandry, and horticulture, depending on the prevailing climatic factors (FAO/World Bank, 2001). In most studies up to now, agro-ecological zones have been assumed as a stable factor, yet these zones are by definition a function of climate and it is likely that they might shift according to climatic changes (World Bank 2008). This will require adaptive decisions by farmers and consequently will result in a change of farming practices and systems. In general, it is assumed that in the case of decreasing or more variable precipitation, farmers relying on rainfed agriculture will emigrate or switch to livestock production. Livestock producers respond by switching from cattle to sheep and goats if the climate becomes drier (World Bank 2008).

### Subsistence agriculture

For most of the SADC region, smallholder farmers form the majority of the farming populations and their subsistence is hand-to-mouth; very rarely do they have excess produce to sale, especially with the advent of climate change (SADC, 2017). In many areas of southern Africa, smallholder farmers are confronted with low soil fertility, highly variable rainfall with risk of drought or flood, soil erosion, and other constraints. Malnutrition and a high degree of food insecurity are the result (Thierfelder et al., 2013). The one common feature of crop production in the SADC region is fluctuating and steadily declining crop yields, as shown in Figure 1 for the case of maize production in Zimbabwe (Thierfelder et al., 2013). To overcome the low soil fertility, shifting cultivation is practised. This involves the clearing of woodlands for new fields with subsequent burning of the biomass. The ash provides a pulse in nutrients supporting cultivation over a number of years before a fallow period is required (Ruthenberg et al., 1980). However, the burning also causes substantial loss of nutrients, especially nitrogen and phosphate, through volatilisation (Giardina 2000). Due to population increase leading to a higher demand for new areas for agriculture and the change in land ownership policies in the recent past, shifting cultivation is becoming unsustainable (Von Braun et al., 2003): it is no longer easy to find, shift and cultivate new areas of fertile soil. As a consequence, smallholder agricultural systems formerly using shifting cultivation are gradually being transformed into semi-permanent systems, as documented for the Okavango Basin (Gröngröft et al., 2015).

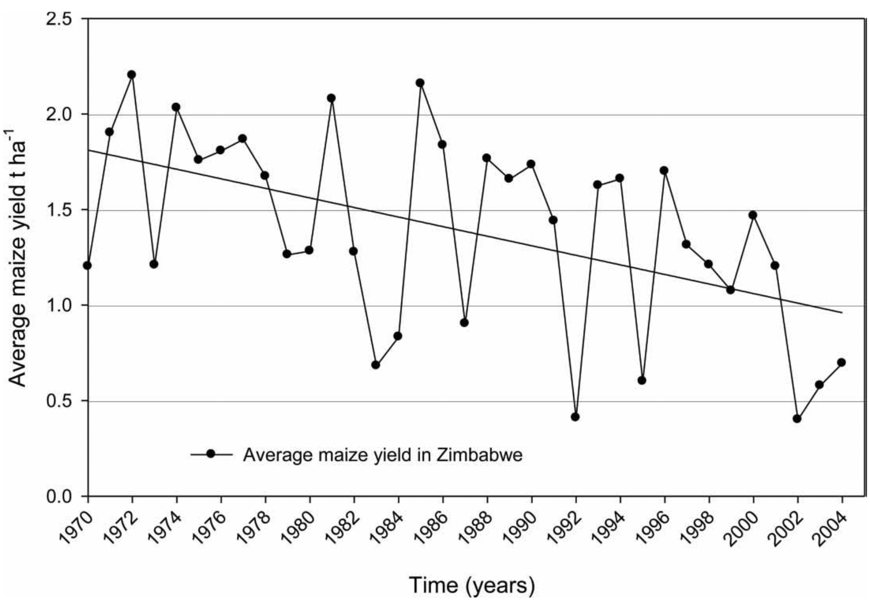


Figure 1: Average maize yield in Zimbabwe (in t ha–1), 1970–2004 (CSO, 1987; CSO, 1984–1989; Adopted from FAOSTAT, 2004).

In spite of these challenges, smallholders rather than large-scale farming enterprises are still the backbone of food security in the SASSCAL region (Tscharntke et al., 2012). However, the interactions of climate change and poor farming methods are starting to pose a threat to food security (Chilonda et al., 2006; Chilonda & Minde 2007; SADC, 2017). This is illustrated by the fact that governments within SADC have had to supply food aid in order to avert calamities due to famine. Namibia had to introduce a food bank system to secure food provisions to its people during times of adversity. Other SADC countries have different schemes of food aid (The Namibian, 2016). Since most farmers rely on subsistence agriculture, this system is the main focus of the agricultural research in SASSCAL.

### Commercial, investor-driven agriculture

It should not be overlooked that within the SADC region there is also commercial large-scale farming. The sector covers crops, animals and horticultural production (SADC, 2017), but there are concerns about its impacts. Industrialised agriculture often exploits natural resources that, at a household level, are important for poverty alleviation. Although productivity is generally higher on commercial farms, this agricultural sector is based on generating individual profit gains. Benefits accrue to the few landowners, whilst the vast majority of the people, who are often employed as labourers and casual workers, become victims to the phenomenon of land-grabbing. This begs the important question: are commercial, large-scale farms an acceptable solution to food insecurity in the SADC? Or should we instead empower small-scale farmers to achieve better productivity? Might there be an underlying and confounding factor of reorganising land tenure and resettlement?

## Reasons for low crop performance in the SADC region

Poor performance in agriculture can be defined as agricultural practice or management strategy that fails to meet its intended objective. The economic objective in agricultural practices is usually emphasised: to ensure food security and improvement of livelihoods for rural households. If this objective is not met, then the agricultural performance is deemed to be poor. It is worth noting that this definition is based on measuring the output only and does not include the *process* of obtaining the output, including the important consideration of the energy return of inputs.

There are many reasons which lead to poor or low agricultural performance. For example, one could point to the negative impact on resource-poor farmers of the monocultural seed practices promoted by large seed companies like Bayer and Monsanto. Other commonly cited reasons for poor agricultural performance are unfavourable biotic and environmental factors. The environmental factors include nutrient-poor soils or poor water availability impacting on crop growth, excessive temperatures, and sometimes floods. These factors can be considered as ecological disadvantages, since their occurrence is linked to the geography of the land available for cultivation and its attributes. The unfavourable biotic factors include prevalence of pests and microbial pathogens on crops. In addition, there are also badly adapted or poor farming methods and farm management practices that lead to poor crop yields, whilst socio-ecological or demographic perspectives can also come into play. Countries that have experienced events leading to internal displacement of people have been known to be characterised by poor agricultural performance (FAO, 2006, Akinsanmi & Abrahams, 2013).

## Problems and challenges for agriculture in the SASSCAL region

### Conflicting land uses, human–wildlife conflicts

Some of the biggest challenges agriculture is facing in the SASSCAL region include conflicts between humans and wildlife, between landholder policies, and between land-use priorities. In some places, land that has been set aside as conservation areas and nature reserves to protect the native flora and fauna is being used by humans for settlement and agriculture. This often results in human–wildlife conflicts, since wild animals encounter the human settlements, attack people, or devastate their crop fields, whilst poor people poach on the wildlife for bushmeat or ivory, killing protected and endangered species (see the article by Nyirenda et al., 2018). Similarly, land that has previously been set aside for commercial agriculture is sometimes reallocated for urban settlements, leading to shortage of land for farming purposes. This becomes a trigger for land grabbing and vicious cycles of conflict between the smallholder and commercial farmers, and brings rise to the perennial issue of overhauling the land tenure system (The Namibian, 2017). Such policy shifts are frequent and lead to poor agricultural performance and food insecurity in the long run. Sustainable land planning and management is needed to mitigate these conflicts, involving close collaboration between the governing structures dealing with nature conservation and environmental protection, agricultural production, and planning of settlements and infrastructure.

### Global change: change of lifestyle to modern consumerism

A notable, and perhaps alarming, global trend is the change of an agrarian to modern consumerist lifestyle (Bruinsma, 2003). This has the eventual effect of reducing food security from household to national levels in developing countries, which are dominated by agrarian households. The consumerist lifestyle trend is leading to agriculture being given low priority, both as a means of production and source of livelihoods. The consequence is reduced production on small farms. This shift can generally be managed adaptively, such that farming practices are mechanised and improved. However, technological improvement and support need to be available to small rural communities, including a better infrastructure and therefore access to markets, and improved storage facilities and value chain models for agricultural products (Chilonda, 2006). Such enabling conditions allow farmers to improve their income and act as producers and consumers at the same time. A less easy root cause of low productivity to address is that of climate change.

## What solutions can research offer?

Reaching comprehensive solutions to Africa's low agricultural productivity is a mammoth task. The problems and challenges to agricultural productivity, highlighted above, manifest themselves at varying scales and degrees of severity within the SADC region. This means there cannot be a "one-size-fits-all" toolkit to solve the intricately compounded causes. Some of the solutions will be generated via dedicated research efforts for each scenario. Management systems such as "conservation agriculture" have been tabled as possible solutions to the problem of landscapes increasingly degraded by erosion and excessive and injudicious use of chemical fertilisers and pesticides. To arrive at recommendations for small-scale farmers that are practicable and feasible, alternative management practices have to be developed and tested at a local to regional level. The introduction alone of, for example, a new seed variety or type of fertiliser, will not be enough. Instead, various simultaneous changes are usually needed; whilst more complex to implement, they offer higher and more stable yields when successful (Thierfelder et al., 2013).

There is a need to conduct empirical research to improve varieties of crops and animals that are optimally adapted to local conditions for enhanced productivity (Von Braun, 2003) and allow farmers to adapt to changing conditions. This requires increased effort in seamless germplasm evaluation of local varieties used in crop production and horticulture in the SADC region. Clear evidence of current climate change underlines the necessity to change sowing dates of crops and use adapted cultivars.

As in many parts of the SASSCAL region, yields are nitrogen limited (Gröngröft et al., 2015). Enhancing N supply to the soil by using environment friendly nitrogen fixing plants (legumes) and microorganisms is another sustainable solution, especially when accompanied by conservation management approaches applied to soils and ecosystem services including nutrient supply, natural pest control and pollination.

Political factors affect food security and include war, political stability, emigration/immigration, land tenure, and government policies. For this reason, evaluation of local food production (yield, productivity) alone provides a very incomplete picture of the food security situation (UN/AU, 2003, Akinsanmi and Abrahams, 2013). What is needed is interdisciplinary research into food security.

The agricultural research topics within SASSCAL shared similar characteristics in terms of demographics, gender, and cropping systems, even though the climate ranges from arid and semi-arid to moist and wet conditions. Scientific research was carried out on improved farm management practices for cropping systems, such as minimum tillage, residue retention/soil cover, crop rotation with legumes, intercropping with legumes, and improved fertiliser use efficiency. Other practices investigated included appropriate planting dates and selection of improved varieties to adapt to changing climatic conditions.

## SASSCAL Supported Agriculture Tasks: A Results Summary

The effect of improved practices on soil fertility, water stress, pests and diseases, weeds, and yield was measured and compared to conventional farm practices such as disc harrowing, planting densities, weeding and chemical fertiliser application. Conservation farm management practices were found to improve soil fertility by reducing soil acidity and improving the nutrient status of the soil through inputs of organic matter. In some soils, the acidity was reduced from pH 4 to pH 5.6 by the third season of adopting practices that increased soil organic matter from less than 1% to above 2% (Tasks 157 and 144). This resulted in overall improvement in yields and productivity, demonstrating how conservation agriculture has the potential to improve the food security situation in these farming communities. Notably, the best outcome was achieved when all principles of conservation agriculture (minimum tillage, residue retention/soil cover, crop rotation with legumes, intercropping with legumes, and improved fertiliser use efficiency, planting dates and selection of improved varieties) were adhered to.

Another positive effect was the very good performance of locally adapted germplasm, so that the participating local farmers were able to produce their own maize and cowpea seeds. This will ensure the timely availability of good quality, adapted germplasm that gives high yield under stress conditions. Seed production is of high value and can contribute to income security of the household and allow for investment in other farm enterprises. Availability of good quality seed has traditionally been a challenge as it is controlled by global corporations distributing patented hybrid varieties at costs that limit production. Local seed production will make the farmers more independent from global enterprises. This gave a good opportunity for technology transfer to farmers on seed production (Batlang et al., 2018).

However, a few challenges remain, especially natural stresses on crop production such as water stress (either too dry or too wet), varying and unpredictable length of growing season, and pest and disease pressures. These factors may cause lower yields than expected from the agronomic potential of improved crop varieties (SADC 2012). In some areas in and around land used for game management, human–wildlife conflicts were also cited as posing a threat to increased productivity, especially during the high stress months of the dry season (Tasks 314 and 190). In game management areas, wildlife is under protection and controlled utilisation. A lasting solution to human–wildlife conflict is still seemingly elusive, for when people take space for wildlife, the wild animals respond by grazing on planted crops nearby (Nyirenda et al., 2018).

To mitigate these stresses, practices that improve resilience of crop plants to water stress and the pressure of pests and disease were investigated. Studies on germplasm selection for water stress studies were conducted and confirmed the availability of legume and cereal germplasm with traits for water stress resilience within the SASSCAL region (Tasks 157, 044, 308, and 316). Changing climate patterns have been reported in the SASSCAL region, resulting in a general shift in planting season (dates) and length of growing season. Investigations on appropriate planting dates for legumes and cereals in different regions confirmed this shift and planting dates were selected using available 5–10 year weather data (Tasks 308, 144, and 051). To mitigate pest and disease stress, biological control practices, such as inter-cropping with legumes, were investigated. The diversity and abundance of insect pests and natural enemies was observed and found to be more prevalent in cereal-legume intercrops than in monocultures of cereal or legume (Tasks 044, 316, and 051). The increase in pests had a negative impact on yields, though further research is needed in this regard.

## Conclusion and Perspectives

The current sub-optimal performance of cropping systems in the SASSCAL region directly and negatively affects the food security situation, especially of the rural population. Low yields of cereals (maize 1.15 tonnes/ha, rice 0.5 tonnes/ha) and legumes (common beans 1.15 tonnes/ha, soya beans 1.54 tonnes/ha) have been reported in the region, especially among the majority (70%) smallholder farmers during the period 2013–16 (SADC, 2017). Improved farm management practices can improve yields, increase the performance (productivity) of cropping systems, and achieve food security in the SASSCAL region. Addressing soil fertility issues through conservation tillage, inputs of organic matter, adapted crop rotation, and improved fertiliser use, was found to improve yields for maize and beans (Tasks 147 and 157). Crop rotation with legumes was found to help satisfy the nitrogen requirement of beans and successor maize crops (Task 316). Clearly, adopting better farm management practices in cropping systems of the SASSCAL region is a promising option for improving the food security situation in the context of changing weather and climate. It is of concern that these "promising options" remain at the experimental level; their widespread adoption in the SASSCAL region, as in many parts of the developing world where food security is low, is all too uncommon. An agricultural extension service informed of the research results and trained to promote new agricultural practices is urgently needed in all SASSCAL countries.

However, high yields and increased productivity alone may not adequately improve food security, since other location-specific factors come into play. While high yields will provide sufficient, quality food at required times to meet dietary needs, physical and economic access to food may still be limited to both rural and urban household settings (Akinsanmi & Abrahams, 2013). Value chain investigations revealed that there was a positive impact of value addition on household livelihoods and the food security situation. There is a need to further investigate factors that limit physical and economic access to food in the SASSCAL region in order to provide solutions for further improvement in food security. It is also important to make a detailed study of the historical development of the farming systems of the SADC region and then examine where things may have gone wrong and seek reversal or remedy.

The research articles in this book (by various contributing authors of the SASSCAL Agriculture Tasks) provide scientific evidence that farm management practices can improve the performance of cropping systems. Farmers are therefore encouraged to adopt these practices to ensure that their food and income security requirements are met. The food security situation can be improved by increasing food production and by addressing factors that limit physical and economic access to food.

It is anticipated that, after reading this section on agriculture, an open-minded approach to increasing food security will be followed, embracing some of the non-conventional ideas discussed in these chapters (e.g. using rhizobial bacteria to improve plant growth and development). The research ideas presented in these chapters are a direct outcome of farmer–researcher participatory interactions and should therefore be easy to implement in full on a larger scale. It is important to prioritise participatory approaches – at least until better empowerment tools come in – when dealing with complex matters like climate change effects. Climate change impacts to the SADC region are already signaling that now is the time to develop local crops and farming methods that, after millennia of evolution, are resilient and adapted to local environments. Perhaps this way we may improve the livelihoods of the rural population and combat climate change effects, which have a negative bearing on food security in the SASSCAL region. One can only remain hopeful that after reading these chapters, farmers and their practices will change. Furthermore, it is also hoped that the erroneous reasons given on why there is current underperformance of cropping systems will be abandoned by all stakeholders in the SASSCAL region and that of the wider SADC.

## Acknowledgements

The research was carried out in the framework of SASSCAL and was sponsored by the German Federal Ministry of Education and Research (BMBF) under promotion number 01LG1201M.

## References

African Union New Partnership for Africa's Development (UN/NEPAD 2003). Comprehensive Africa Agriculture Development Program (CAADP). Midrand, South Africa

Akinsanmi T. and Abrahmans L. (2013) Developing a framework for a community informatics policy networks: Agriculture for rural development in Southern Africa Report.

Batlang, U., King Jr., C., Ngwako, S., Nkomazana, C., Malambane, G., Mpuisang, T., Moroke, T.S., Mashungwa, G.N., Bagwasi, G., Pule-Meulenberg, F., Ng'uni, D. & Munkombwe, G. (2018) Germplasm evaluation for climate adaptation and drought tolerance: The cases of local varieties of maize in Zambia and cowpea in Botswana. This volume.

Bruinsma, J. (ed) 2003 World agriculture: towards 2015/2030: an FAO perspective. FAO/Earthscan: Rome and London.

Chilonda, P. & Minde I.J. (2007), Regional strategic analysis and knowledge support for Southern Africa, (RESAKSS-SA), Discussion Paper No. 1, 2007 ReSAKSS-SA: Pretoria.

Chilonda, P., Machethe, C. & Minde I.J. (2006) Poverty, food security and agricultural trends in Southern Africa, ReSAKSS-SA. Discussion Paper No. 3, 2006 ReSAKSS-SA: Pretoria.

FAO (2006) FAOSTAT data. Food and Agriculture Organization of the United Nations, Rome. Available online at http://faostat.external.fao.org/default.jsp

FAO/World Bank (2001) Farming Systems and Poverty: Improving farmers' livelihoods in a changing world, FAO and World Bank: Rome and Washington D.C.

Food and Agricultural Organization (FAO 2008)

Francis, C., Lieblein, G., Gliessman, S., Breland, T.A., Creamer, N., Harwood, R., Salomonsson, L., Helenius, J., Rickerl, D., Salvador, R., Wiedenhoeft, M., Simmons, S., Allen, P., Altieri, M., Flora, C. & Poincelot, R. (2003) Agroecology: The Ecology of Food Systems. *Journal of Sustainable Agriculture*, **22**, 99–118.

Garibaldi, L.A., Gemmill-Herren, B., D'Annolfo, R., Graeub, B.E., Cunningham, S.A. & Breeze, T.D. (2017) Farming Approaches for Greater Biodiversity, Livelihoods, and Food Security. *Trends in Ecology and Evolution*, **32**, 68–80.

Giardina, C., Sanford, R., Døckersmith, I. & Jaramillo, V. (2000). The effects of slash burning on ecosystem nutrients during the land preparation phase of shifting cultivation. *Plant and Soil* 220:247–260

Gröngröft, A., Azebaze, N., Brown, L., Cauwer, V. De, Domptail, S., Erb, C., Falk, T., Finckh, M., Göhmann, H., Gwatidzo, C., Hinz, M., Huber, K., Jürgens, N., Korn, E., Kowalski, B., Kralisch, S., Landschreiber, L., Lubinda, A., Luther-Mosebach, J., Maiato, F., Murray-Hudson, M., Pröpper, M., Reinhold, B., Revermann, R., Simfukwe, M., Stellmes, M., Stirn, S., Thito, K., Tsheboeng, G., Weber, T., Wehberg, J., Weinzierl, T., Zimmermann, I., 2015. Key findings and recommendations, in: Pröpper, M., Gröngröft, A., Finckh, M., Stirn, S., De Cauwer, V., Lages, F., Masamba, W., Murray-Hudson, M., Schmidt, L., Strohbach, B., Jürgens, N. (Eds.), The Future Okavango – Findings, Scenarios and Recommendations for Action. Research Project Final Synthesis Report 2010 — 2015. University of Hamburg, Hamburg, pp. 53–96.

Holt-Giménez, E. & Altieri, M.A. (2013) Agroecology, Food Sovereignty, and the New Green Revolution. *Agroecology and Sustainable Food Systems*, **37**, 90–102.

Nyirenda, V.R., Kaoma, C. & Nyirongo, S. (2018) Farmer-wildlife conflicts in rural areas of eastern Zambia. This volume.

Ruthenberg, H., MacArthur, J. D., Zandstra, H. D. & Collinson, M.P. (1980) Farming systems in the tropics. Clarendon Press, New York

SADC Food Security Quarterly Update, March 2017

SADC Policy Paper on Climate Change: Assessing the Policy Options for SADC Member States (2012)

Steward, P.R., Shackelford, G., Carvalheiro, L.G., Benton, T.G., Garibaldi, L.A. & Sait, S.M. (2014) Pollination and biological control research: are we neglecting two billion smallholders. *Agriculture & Food Security*, **3**, 5.

The Namibian Newspaper, 22 June 2016: Namibia to roll out food bank programme.

The Namibia Newspaper, 21 July 2017: Towards the Peoples Land Conference.

Thierfelder, C., Rusinamhodzi, L., Ngwira, A.R., Mupangwa, W., Nyagumbo, I., Kassie, G.T. & Cairns, J.E. (2013) Conservation agriculture in Southern Africa: Advances in Knowledge. Renewable Agriculture and Food Systems pp.1–21.

Tscharntke, T., Clough, Y., Wanger, T.C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J. & Whitbread, A. (2012) Global food security, biodiversity conservation and the future of agricultural intensification. Biol. Conserv. 151, 53–59. doi:10.1016/j.biocon.2012.01.068

Von Braun, J., Hazell, P., Hoddinott, J. & Babu S. (2003) Achieving long term food security in southern Africa: International perspectives, investment strategies and lessons. Key note paper prepared for the southern Africa regional conference on 'Agricultural recovery, trade and long-term food security', March 26–27: Gaborone, Botswana.

## References [CrossRef]


African Union New Partnership for Africa's Development (UN/NEPAD), 2003. Comprehensive Africa Agriculture Development Program (CAADP). Midrand, South Africa

Akinsanmi T and Abrahmans L, 2013, Developing a framework for a community informatics policy networks: Agriculture for rural development in Southern Africa Report.

Batlang, U., King Jr., C., Ngwako, S., Nkomazana, C., Malambane, G., Mpuisang, T., Moroke, T.S., Mashungwa, G.N., Bagwasi, G., Pule-Meulenberg, F., Ng'uni, D. & Munkombwe, G. (2018) Germplasm evaluation for climate adaptation and drought tolerance: The cases of local varieties of maize in Zambia and cowpea in Botswana. This volume. CrossRef

Bruinsma, J. (ed). 2003. World agriculture: towards 2015/2030: an FAO perspective. FAO/ Earthscan: Rome and London.

Chilonda P and Minde IJ, 2007, Regional strategic analysis and knowledge support for Southern Africa, (RESAKSS-SA), Discussion Paper No. 1, 2007 ReSAKSS-SA: Pretoria.

Chilonda P., Machethe C. and Minde I.J. 2006. Poverty, food security and agricultural trends in Southern Africa, ReSAKSS-SA. Discussion Paper No. 3, 2006 ReSAKSS-SA: Pretoria.

FAO 2006. FAOSTAT data. Food and Agriculture Organization of the United Nations, Rome. Available online at http://faostat.external.fao.org/default.jsp

FAO/World Bank, 2001, Farming Systems and Poverty: Improving farmers' livelihoods in a changing world, FAO and World Bank: Rome and Washington D.C.

Food and Agricultural Organization (FAO), 2008

Francis, C., Lieblein, G., Gliessman, S., Breland, T.A., Creamer, N., Harwood, R., Salomonsson, L., Helenius, J., Rickerl, D., Salvador, R., Wiedenhoeft, M., Simmons, S., Allen, P., Altieri, M., Flora, C. & Poincelot, R. (2003) Agroecology: The Ecology of Food Systems. *Journal of Sustainable Agriculture*, **22**, 99–118. CrossRef

Garibaldi, L.A., Gemmill-Herren, B., D'Annolfo, R., Graeub, B.E., Cunningham, S.A. & Breeze, T.D. (2017) Farming Approaches for Greater Biodiversity, Livelihoods, and Food Security. *Trends in Ecology and Evolution*, **32**, 68–80. CrossRef

Giardina, C., Sanford, R., Døckersmith, I. and Jaramillo, V. 2000. The effects of slash burning on ecosystem nutrients during the land preparation phase of shifting cultivation. *Plant and Soil* 220:247–260. CrossRef

Gröngröft, A., Azebaze, N., Brown, L., Cauwer, V. De, Domptail, S., Erb, C., Falk, T., Finckh, M., Göhmann, H., Gwatidzo, C., Hinz, M., Huber, K., Jürgens, N., Korn, E., Kowalski, B., Kralisch, S., Landschreiber, L., Lubinda, A., Luther-Mosebach, J., Maiato, F., Murray-Hudson, M., Pröpper, M., Reinhold, B., Revermann, R., Simfukwe, M., Stellmes, M., Stirn, S., Thito, K., Tsheboeng, G., Weber, T., Wehberg, J., Weinzierl, T., Zimmermann, I., 2015. Key findings and recommendations, in: Pröpper, M., Gröngröft, A., Finckh, M., Stirn, S., De Cauwer, V., Lages, F., Masamba, W., Murray-Hudson, M., Schmidt, L., Strohbach, B., Jürgens, N. (Eds.), The Future Okavango – Findings, Scenarios and Recommendations for Action. Research Project Final Synthesis Report 2010 — 2015. University of Hamburg, Hamburg, pp. 53–96.

Holt-Giménez, E. & Altieri, M.A. (2013) Agroecology, Food Sovereignty, and the New Green Revolution. *Agroecology and Sustainable Food Systems*, **37**, 90–102.

Nyirenda, V.R., Kaoma, C., & Nyirongo, S. (2018) Farmer-wildlife conflicts in rural areas of eastern Zambia. This volume. CrossRef

Ruthenberg, H., MacArthur, J. D., Zandstra, H. D. and Collinson, M.P. 1980. Farming systems in the tropics. Clarendon Press, New York

SADC Food Security Quarterly Update, March 2017

SADC Policy Paper on Climate Change: Assessing the Policy Options for SADC Member States 2012

Steward, P.R., Shackelford, G., Carvalheiro, L.G., Benton, T.G., Garibaldi, L.A. & Sait, S.M. (2014) Pollination and biological control research: are we neglecting two billion smallholders. *Agriculture & Food Security*, **3**, 5. CrossRef

The Namibian Newspaper, 22 June 2016: Namibia to roll out food bank programme.

The Namibia Newspaper, 2017 21 July 2017: Towards, the Peoples Land Conference.

Thierfelder C, Rusinamhodzi L, Ngwira AR, Mupangwa W, Nyagumbo I, Kassie GT and Cairns JE. 2013. Conservation agriculture in Southern Africa: Advances in Knowledge. Renewable Agriculture and Food Systems pp.1-21.

Tscharntke, T., Clough, Y., Wanger, T.C., Jackson, L., Motzke, I., Perfecto, I., Vandermeer, J., Whitbread, A., 2012. Global food security, biodiversity conservation and the future of agricultural intensification. Biol. Conserv. 151, 53–59. CrossRef

Von Braun J., Hazell P., Hoddinott J. and Babu S. 2003. Achieving long term food security in southern Africa: International perspectives, investment strategies and lessons. Key note paper prepared for the southern Africa regional conference on 'Agricultural recovery, trade and long-term food security', March 26- 27: Gaborone, Botswana.