

Climate Impacts on Agricultural and Natural Resource Sustainability in Africa

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 Springer

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Foreword

Climate change and sustainable management of natural resources remain the major issues for all interventions to improve agricultural production, food access, and agriculture-based livelihoods in sub-Saharan Africa (SSA). Agriculture in SSA is predominated by small farms and subsistence farming by hand tools and limited use of other inputs including fertilizers, pesticides, and irrigation. There is also an increasing concern on declining land resources due to rapid soil degradation, harsh and uncertain climate, and the rapidly increasing population. Population of 800 million in 2010 is projected to increase to 1.1 billion in 2020 and to 1.8 billion in 2050 in Africa.

Despite these limitations, signs of agronomic yield increases and noticeable promise with impressive annual growth rates have been observed. However, sustaining the growth rate will become harder in the future due to increasing population, warmer climate, limited water resources, soil erosion and contamination, and more pervasive pests and pathogens. Furthermore, the IPCC Special Report on Global Warming indicates an increase of 1.5 °C change in temperature in SSA, creating a threat to ecosystems, biodiversity, and human health. These threats are more challenging and apparent in SSA than elsewhere. These challenges create a need of generating new knowledge on natural resource management and climate change to provide an enabling environment for smallholder farmers for engaging in sustainable agricultural practices.

Recognizing the value of agricultural production, the problems of natural resource degradation, and the challenge of climate change in SSA, a project entitled “Capacity Building for Managing Climate Change in Malawi” (CABMACC) was supported by the Royal Kingdom of Norway and implemented during the period 2013–2018. The Lilongwe University of Agriculture and Natural Resources (LUANAR) and the Norwegian University of Life Sciences (NMBU) jointly implemented the program. CABMACC was aimed to strengthen the teaching, training, research, technology development, and outreach for climate change adaptation and mitigation planning. A long-term and outstanding collaboration of LUANAR, NMBU, and Sokoine University of Agriculture (SUA) is further extended in this knowledge and experience-sharing platform to enhance dissemination of research

findings from CABMACC project and beyond. The research under the abovementioned project focused primarily in Malawi, and therefore, contributors beyond the project were invited to cover wider geographical regions and their physical and social heterogeneities.

This book, *Climate Impacts on Agricultural and Natural Resource Sustainability in Africa*, deals with both the natural science and social science aspects, under dwindling natural resources, changing climate, and increasing climate uncertainties in SSA.

We convey our thanks to the successful authors, editors, and reviewers of the chapters in this book. We believe that the knowledge presented here is a crucial piece in the ingredients required for sustainable resource management under changing and uncertain climate in SSA.

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Preface

Most countries in sub-Saharan Africa (SSA) are dependent primarily on agriculture for economic growth and livelihoods. Majority of the households, especially rural smallholder farmers, are perpetually food insecure due to unsustainable practices in agriculture, degrading agroecology, poor natural resource management, and political and institutional challenges. Agriculture in SSA countries is dominated by small farms, often less than 2 ha, and is primarily based on hand tools and manual operations with limited use of farm machinery and soil amendments, insufficient supplemental irrigation, and inadequate measures for soil and water conservation.

The harsh and changing climate has further aggravated the situation, adversely affected the natural resources, jeopardized agricultural production, and marginalized the livelihood opportunities. Adverse effects of climate change on agricultural production and the environment have made the SSA region as one of the hot spots leading to severe degradation of soil, drastic depletion of nutrients and soil organic matter stocks, water scarcity and contamination, and reduction of the above- and below-ground biodiversity.

The overall goal of the project “Capacity Building for Managing Climate Change in Malawi” (CABMACC) was to improve livelihoods and food security through innovative responses and enhance the capacity of adaptation to climate change. It was conducted at the Lilongwe University of Agriculture and Natural Resources (LUANAR) in Malawi in cooperation with the Norwegian University of Life Sciences (NMBU). The project was implemented in several districts of Malawi, which are considered the hot spots for climate change-related vulnerability.

To deliberate some of the challenging issues stated above, an international conference on Sustainable Agriculture and Natural Resource Management under Changing Climate in sub-Saharan Africa was organized at LUANAR, Lilongwe, Malawi, from 16 to 18 October 2018. The conference was an avenue to bring in researchers who conducted research in SSA and share findings that can be documented to provide scientific evidences to form policies to attain sustainable agriculture and natural resource management under changing climate. The major objectives of the conference were to bring new knowledge on sustainable use of natural resources to enhance agricultural productivity under changing climate and

explore new avenues of policies, value added chain, and adoption of innovative technologies on smallholder's farms.

The 34-chapter book represents the oral presentations made during the conference. The book includes, in addition to introductory and concluding chapters, five thematic parts, namely, (i) Conservation Agriculture, Carbon Sequestration, and Soil and Water Management, (ii) Sustainable Crop/Livestock/Aquaculture/Fish Production, (iii) Policy and Institutions for Sustainable Agriculture and Natural Resource Management, (iv) Value Added Options for Smallholder Market Access and Integration, and (v) Upscaling Innovative Technologies on Smallholder Farms.

Nearly 150 participants attended the conference from Malawi, Rwanda, Ethiopia, Tanzania, Kenya, Norway, and the USA. The steering committee involved in the organization of the conference included representatives from LUANAR, Malawi; NMBU, Norway; Ohio State University (OSU), USA; and Sokoine University of Agriculture (SUA), Tanzania. The conference was a concluding activity of the project "CABMACC" in Malawi funded by the Royal Kingdom of Norway.

We, the editors, wish to thank all the authors for their outstanding contributions for the book. We also thank the staff at Springer for following the proposed publication schedule and bringing out the publication on time. Our special thanks are due to PCO staff at LUANAR for their help in the organization of the conference and managing the flow of manuscripts between the authors and the editors.

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Editors Biographies



Bal Ram Singh, PhD is a professor emeritus at the Norwegian University of Life Sciences. He earned his PhD degree from G.B. Pant University of Agriculture and Technology, India. His program focuses on bio-availability and mobility of heavy metals in the soil and plant system, fertility management and agricultural sustainability in soils of the tropics, and carbon sequestration in soils. He has served as chairman of the program board “Soils and Plants” of the Research Council of Norway and as deputy head of the Department, in addition to many national and international committees. He chaired the Cost Action FA0905 (EU) “Mineral Improved Crop Production for Healthy Food and Feed,” in which more than 200 scientists from 31 countries participated. He has supervised 76 graduate students and 16 visiting fellows/scientists from 20 countries and published 456 articles, of which 260 are in peer-reviewed journals and books. He is a fellow of ASA (2004) and SSSA (2005) and recipient of the International Soil Science Award (SSSA) in 2011. He is currently chair of Division 3 of the International Union of Soil Science, president of the Norwegian Society of Soil Science, and member of the Geomedicine Committee – Food, Environment, and Health of the Norwegian Academy of Science and Letters.



Andy Safalaoh, PhD is an associate professor of Animal Nutrition at the Lilongwe University of Agriculture and Natural Resources (LUANAR), Lilongwe, Malawi. He earned his PhD degree in Science and Technology Studies from the University of Nottingham, UK, and his Master of Science in Animal Science from Oklahoma State University, USA. His research interests focus on nutrient evaluation of unconventional feedstuffs such as sorghum and millet and recently on the use of insects as feeds. In addition, he has developed interest in the development and exploration of climate-resilient agricultural technologies and innovations as instruments for climate change adaptation and mitigation with a focus on the food-feed nexus. He has previously served as deputy head, Animal Science Department, and postgraduate and seminar coordinator and chairperson, Research and Publications Committee, LUANAR. He is currently the university program coordinator at LUANAR and has been leading the implementation of the 5-year (2013–2018) Norwegian Government-funded Capacity Building for Managing Climate Change in Malawi (CABMACC) Program and other projects. He is also a Leadership in Environment and Development (LEAD) Cohort 12 fellow (2004), Imperial College London. At regional level, he has facilitated several training sessions on agriculture, science, technology, and innovation (ASTI) in collaboration with Technical Centre for Agricultural and Rural Cooperation (CTA), Wageningen, Netherlands, and under the RAEIN-Africa Innovation Systems Approach Competency Building Training Program in eight countries. Before joining the university, he worked with Save the Children USA-Malawi Country Office in various portfolios as training and development coordinator, food production coordinator, and program manager.



Nyambilila A. Amuri, PhD is a senior lecturer at Sokoine University of Agriculture (SUA), Morogoro, Tanzania. Currently, she serves as a coordinator for research and publication and head of Department of Soil and Geological Sciences at SUA. She earned her PhD in Soil Science from the University of Arkansas, Fayetteville, USA, and her Bachelor of Science in Horticulture and MSc in Soil Science and Land Management from SUA, Morogoro, Tanzania. Her research, university teaching, and outreach experience

and interest are on C and N dynamics and residue management in agricultural soils, integrated soil fertility and agroecological management, appropriate fertilizer uses in agriculture, agronomic micronutrient fortification and mineral nutritive quality of food crops, site-specific fertilizer recommendations and innovative and cost-effective soil testing methods, and soil chemistry. Currently, she serves as a secretary general for the Soil Science Society of East Africa (SSSEA) and also chaired East Africa Fertilizers and Soil Conditioners of the Agriculture and Agrochemicals Technical Committee. She has supervised 17 graduate students and published 50 papers in peer-reviewed journals, conference proceedings, chapters in books, and extension manuals. She is a recipient of the Fulbright Scholar Award, Margaret MacNamara Memorial Fund Award, and NORAD Sponsorship Award.



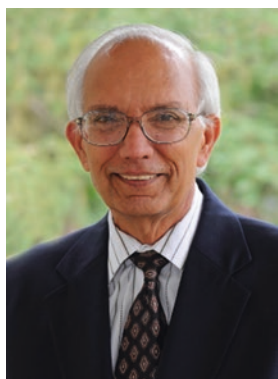
Lars Olav Eik is a professor at the Norwegian University of Life Sciences (NMBU) specialized in animal nutrition and small ruminant production systems. After graduating from NMBU, he joined Sokoine University of Agriculture (SUA), Tanzania, working on dry season feeding of ruminants and introduction of dairy goat keeping in Tanzania. After this assignment, he returned to NMBU and completed his PhD based on work with dairy goats in Norway.

Since 2005, he has coordinated three major research programs in collaboration with SUA. He has also participated in research projects in Ethiopia, Malawi, and South Africa. Often working together with farmers and private sector, his main interest is developing multi-functional production systems and value chains for small ruminants, both in tropical and temperate regions. He has supervised a number of PhD students, particularly from East Africa. His teaching covers small ruminant nutrition and production systems and tropical animal husbandry and aquaculture.



Bishal K. Sitaula, PhD is a professor at the Norwegian University of Life Sciences, where he earned his PhD degree. His program focuses on various institutional collaboration programs in higher education and research in South Asia, Africa, and Western Balkan. His international collaboration experiences in diverse environmental and development issues, in inter- and multi-disciplinary framework, mainly focus on ecological

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Rattan Lal, PhD is a distinguished university professor of Soil Science and director of the Carbon Management and Sequestration Center, Ohio State University, and an adjunct professor of the University of Iceland. He was president of the World Association of Soil and Water Conservation (1987–1990), International Soil and Tillage Research Organization (1988–1991), Soil Science Society of America (2006–2008), and International Union of Soil Sciences (2017–2018). His professional research interests include soil carbon sequestration for food and climate security, conservation agriculture, principles and practices of soil erosion control, eco-intensification of agroecosystems, soil restoration, and sustainable management of soils. He authored 950 journal articles, authored/edited 100 books, mentored 350 researchers, has 144 h index and total citations of 95,000, and is editor of the *Advances in Soil Science* and *Encyclopedia of Soil Science*. He is laureate of the GCHERA World Agriculture Prize 2018, Glinka World Soil Prize 2018, and Japan Prize 2019.