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Foreword

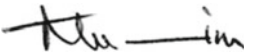
Most countries in Sub-Saharan Africa, including Zimbabwe, are plagued with recurrent food and nutrition insecurity emanating from the adverse impacts of frequent and extreme weather events such as droughts, cyclones, floods, pests and diseases which are associated with the phenomenon of climate change. Consequently, low crop yields and livestock production have been widely reported across the region's drylands. Rural communities are the most vulnerable due to low adaptive capacity. The need to build climate resilience and strengthen adaptive capacities in dryland communities cannot be overemphasized. To address the issues more efficiently, long-term adaptation and mitigation measures that link evidence-based research and development outcomes are preferred to short-term reactive rapid responses.

Based on the nature and context of vulnerabilities and challenges communities are facing, it is envisaged that in the long run, as enshrined in the Global Development Agenda 2030, partners should strengthen collaboration and establish functional facilities aimed at advancing innovation and increasing production in dryland farming. This will effectively serve as an instrument to catalyse change, strengthen the means of implementation and revitalize global partnerships to ensure food and nutrition security. In line with this, the Great Zimbabwe University (GZU), a state university under the Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development (MHTEISTD), Zimbabwe; the Centre for Science and Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), India; and other partners organized a virtual *International Conference on Dryland Agriculture (DA)* to provide a platform for scientists, development practitioners, policy-makers and farmers to showcase and analyse scientific innovations and strategies that can contribute significantly to the transformation and sustainability of dryland agricultural systems.

The conference has culminated in a book volume titled *Climate Change Adaptations in Dryland Agriculture in Semi-Arid Areas* which consists of 26 scientific papers contributed by authors who participated during the conference. The key issues

addressed by the book focus on innovative strategies to turn around the development trajectory in dryland farming systems and ensure effective transformation and sustainability in the face of climate change.

On behalf of the MHTEISTD, We congratulate GZU and the NAM S&T Centre for bringing out this valuable book volume which will be of immense use to researchers, policy-makers, students, farmers and other stakeholders. We remain hopeful that the scientific recommendations made herein shall help to transform our drylands into greenbelts. We wish GZU and NAM S&T Centre the best in their current and future endeavours to enhance productivity in dryland areas.



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Preface

Many countries in the world have "arid" or "semi-arid" climates in which less than 800 mm of annual rainfall is received in more than 85% of the areas. For example, in the case of Zimbabwe, the rain is concentrated in five months from November to March followed by a marked dry season. Farmers in the arid and semi-arid regions are generally low on resources and face challenges related to erratic rainfall associated with long dry spells and or drought, poor soil fertility, poor crop establishment, pest infestation and a shortage of labour at times of peak demand. Given these conditions, it is important to develop farming practices that make efficient use of available resources and reduce risks. In the more arid and semi-arid areas, livestock provide a key mechanism for managing risks, but population increases are fragmenting rangelands in many places, making it increasingly difficult for pastoralists to gain access to the feed and water resources that they have traditionally been able to access. Post-harvest processing also poses a key challenge as small-scale farmers in the rural areas in the developing countries have very limited access to advanced technologies needed for enhanced value addition for sustained food security.

In addition, global climate change poses the greatest danger to world food security and sustainable development. This is also evident in the drylands of the world, as agriculture in the arid and semi-arid regions is adversely affected by the impending climate change phenomena, such as rainfall variability, changes in average temperatures and climate extremes (like heat wave, intense rainfall events, frost, cyclones, hailstorms and dust storms that lower yields of the crops) and also due to changes in atmospheric carbon dioxide. Agriculture in drylands also faces various other inherent abiotic and biotic limitations such as scarce water availability, declining soil quality and pest and disease infestations.

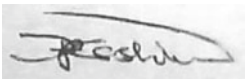
The potential rise in food insecurity during the "COVID-19 pandemic" together with the multiple crises in some countries resulting from more frequent extreme weather events (floods, droughts, etc.) and pests such as the current locusts plague accentuates the importance of raising crop yields and adaptation to climate. There is, therefore, an urgent need to assess the impact of climate change on dryland agricultural production systems and food security in specific regions of the world. Further, the design and implementation of effective coping mechanisms against biotic and

abiotic stresses that impact crop productivity in these regions also require a clear and scientific understanding of the effects and impacts, so that appropriate adaptation measures can be formulated. The emphasis should also be on technological developments such as development and profiling of new plant and animal varieties/hybrids as well as breeds that are tolerant/resilient to biotic and abiotic stresses and identifying or development of agro-ecology-specific natural resource management practices for adaptation.

The present book titled "*Climate Change Adaptations in Dryland Agriculture in Semi-Arid Areas*" being published by Springer Nature, Singapore, is an initiative of the Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi. It has a total of 26 chapters contributed by authors from six developing countries and classified under 4 areas: climate change adaptations in dryland agriculture (9 chapters); research and development in dryland agriculture (11 chapters); livestock feeding and alternative production systems in semi-arid areas (5 chapters); and risk coping in drylands (1 chapter).

We hope and are sure that the book will definitely help in bridging the knowledge gap present today in the area of dryland agriculture especially among the scientific community in the NAM and other developing countries.

We are grateful to Prof. dr. Amon Murwira, Hon'ble Minister of Higher & Tertiary Education, Innovation, Science and Technology Development, Zimbabwe, for kindly agreeing to write a "Foreword" for the book and for his strong support towards Research and Development on Dryland Agriculture. The editors also want to thank Prof. R. J. Zvobgo, Vice Chancellor, Great Zimbabwe University; Dr. Amitava Bandopadhyay, Director General, Centre for Science & Technology of the Non-Aligned and Other Developing Countries (NAM S&T Centre), New Delhi; and partner organizations for hosting and organizing the International Conference on "Climate Change Adaptations in Dryland Agriculture in Arid and Semi-Arid Areas".



Masvingo, Zimbabwe — Xavier Poshiwa

Hyderabad, India — G. Ravindra Chary

Introduction

It is well known that drylands represent more than a third of the world's land mass, 90% of which are in developing countries and rely mainly on degrading agricultural lands for their livelihoods. In fact, there are pronounced differences within drylands, particularly in terms of water availability, poverty, stage of development and sustainable intensification options.

Sadly, dryland farmers face multiple constraints due to poor soil, short growing seasons, low and uncertain rainfall, desertification and recurrent droughts along with poorer infrastructure and market access that affect their abilities to overcome chronic poverty and food insecurity.

Climate change and agriculture are interrelated processes that take place at a global scale. Climate change-related phenomena, such as changes in average temperatures, rainfall and climate extremes (like heat waves), and changes in atmospheric carbon dioxide-level and ground-level ozone concentrations, affect farming in several ways. Climate change is already affecting "dryland agriculture" with effects unevenly distributed across the globe. Higher temperatures eventually reduce the length of growing seasons and force large regions of marginal agriculture out of production, while encouraging weeds and pest proliferation. Also, heat waves cause lower yields of the crop and wilted growth in plants. In simple words, the overall impacts of climate change are expected to be significantly negative as it threatens the global food security.

The impacts of climate change on agriculture in developing countries depend on the extent to which agricultural production in the semi-arid regions adapts to the influences of climate change. Therefore, in order to deliberate on how to avoid the short- and long-term effects of climate change and the adaptation strategies that can minimize such effects, the Centre for Science & Technology of the Non-aligned and Other Developing Countries (NAM S&T Centre), New Delhi, India, jointly with the Great Zimbabwe University (GZU), Masvingo, Zimbabwe, and the Ministry of Higher & Tertiary Education, Innovation, Science and Technology Development, Zimbabwe, organized an International Conference on *Climate Change Adaptations in Dryland Agriculture in Semi-Arid Areas* during 21–23 July 2020 in virtual mode.

As a follow-up, the NAM S&T Centre has brought out this book which contains 26 papers contributed by the participants of the conference from various developing countries and a few other eminent experts in this area. The volume has been edited by Dr. Xavier Poshiwa, Dean, Gary Magadzire School of Agriculture, Great Zimbabwe University, Masvingo, Zimbabwe, and Dr. G. Ravindra Chary, Project Coordinator, All India Coordinated Research Project for Dryland Agriculture (AICRPDA), ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, India.

I take this opportunity to thank Prof. Dr. Amon Murwira, Hon'ble Minister of Higher & Tertiary Education, Innovation, Science and Technology Development, Zimbabwe, for writing the "Foreword" of the book in spite of his extremely busy schedule. I would like to express my gratitude to Dr. Xavier Poshiwa, Corresponding Editor from Zimbabwe, and Dr. Ravindra Chary, Co-Editor from India, for their valuable contributions towards editing the book and coordinating all associated activities for bringing out this publication. We are thankful to Dr. Loyola D'Silva, Executive Editor, Springer Nature, Singapore, and Mr. Ramesh Kumaran, Project Coordinator—Total Service, Books Production, Springer Nature, Chennai, India, for their support and encouragement during the publication process.

I also acknowledge the interest and valuable efforts of the entire team of the NAM S&T Centre, especially Ms. Nidhi Utreja, Programme Officer, for compilation, proofreading and overseeing the publication process and Mr. M. Bandyopadhyay, Senior Adviser, for his guidance and supervision. I am also thankful to Mr. Pankaj Buttan, Data Processing Manager, and Mr. Rahul Kumra, Private Secretary, NAM S&T Centre, for their valuable support in bringing out this publication.

I am sure this timely and valuable publication will be a useful reference material that will help young researchers, scientists, government officials and policy-makers who are engaged in climate change adaptation and mitigation strategies in *Dryland Agriculture*.

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