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Vulnerability of Agriculture, Water and Fisheries to Climate Change

Toward Sustainable Adaptation Strategies

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About NRCS

The North-South Center for Social Sciences (NRCS) is a research institution founded by a group of researchers and experts from both Global South and North as an independent and apolitical institution. Based in Morocco, NRCS aims to develop research and expertise in many social sciences areas with global and local relevance from a North-South perspective and an interdisciplinary approach. As a Think Tank, NRCS aspires to serve as a reference locally and globally through rigorous research and active engagement with the policy community and decision-making processes. NRCS is currently chaired by Mr. Mohamed Behnassi, Doctor Professor of Global Sustainability and Human Security Politics.

Preface

Human activity is increasingly changing the global environment at an unprecedented rate while humanity is facing a range of complex and interrelated challenges: global warming, ecosystem disruption, biodiversity loss, and for many, increasing dif culty in meeting basic human needs for energy, food, water, and shelter. As a result, environmental issues are inextricably linked to many aspects of local, regional and global development, human security and politics.

A series of recent events have generated interest in food security and food systems, particularly the recent news coverage of high food prices which were variously blamed on biofuels, growing demand for meat and dairy products, commodity speculation, and climate. Other arguments have arisen about the potential impacts of climate change on food availability and water – as the projections of climate change become even more serious – and about the role of integrated policy and governance in shaping food security. The price increases highlighted the connections between food systems in different places – e.g. drought in Australia and demand for meat in Asia, biofuel policy in the USA and Latin America, and between the local food movement in Europe and export farmers in Africa. The challenges facing food systems will accelerate in the coming decades, as the demand for food will double within the next 25–50 years, primarily in developing countries, and with the WTO agriculture talks in disarray, making options for reforming trade policy highly contentious.

Food security and agricultural growth remain high on the science, policy and development agendas. Most research linking global change and food systems focuses solely on the impact of climate change on agricultural production, or the impact of agriculture on land use, pollution and biodiversity. However, interactions with other aspects of the food system – such as food processing, packaging, transporting and consumption, and employment derived from these activities – are often overlooked. There are also important new questions about the interactions between the governance of climate and food such as those associated with carbon trading and labeling, and the role of the private sector in carbon mitigation and in the management of food systems.

Technical prescriptions alone will not manage ef ciently the food security challenge. Adapting to the additional threats to food security arising from major environmental changes requires an integrated food system approach, not just a focus on agricultural practices. Many key issues for the research agenda can be highlighted here: adapting food systems to global environmental change requires more than just technological solutions to increase agricultural yields; tradeoffs across multiple scales among food system outcomes are a prevalent feature of globalized food systems; within food systems, there are some key underexplored areas that are both sensitive to environmental change but also crucial to understanding its implications for food security and adaptation strategies; scenarios speci cally designed to investigate the wider issues that underpin food security and the environmental consequences of different adaptation options are lacking; price variability and volatility often threaten food security; and more attention needs to be paid to the governance of food systems and to the changing of eating patterns.

Addressing food systems holistically, rather than separate components such as agriculture, markets or nutrition, demands the engagement of multiple disciplines and researchers to understand the causes and drivers of vulnerability. This volume is a contribution to the constructing of this new paradigm.

The Editors

Agadir, Morocco — Mohamed Behnassi
Nairobi, Kenya — Margaret Syomiti Muteng'e
Noida, India — Gopichandran Ramachandran
Ahmedabad, India — Kirit N. Shelat

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I have been honored to share the editorship of this book with my colleagues: Margaret Syomiti Muteng'e (Research Scientist, Kenya Agricultural Research Institute-KARI, Kenya), Dr. R. Gopichandran (Principal Research Scientist and Director of Vigyan Prasar, India), and Dr. Kirit N. Shelat (Executive Chairman, National Council for Climate Change, Sustainable Development and Leadership-NCCSD, India) whose commitment and insight made the editing process a wonderful experience and a mutual learning process.

On behalf of my co-editors, I would like to gratefully and sincerely thank the members of the Scienti c Committee who have actively contributed to the peer-review of the pre-selected chapters. Deepest thanks go also to all participants in ICCAFFE2011 who made this event possible even if not all could contribute to this volume. We are grateful to the institutions for their support of this book project. In particular, we thank the sponsors of the 2011 Conference, which in addition to NRCS, include the GIZ and the IRD.

While the real value of this volume should be credited to chapters' authors, whose papers have been accepted for publication after a double-blind peer-review, any shortcomings or omissions remain the editors' responsibility. However, the editors and the publisher are not accountable for any statement made or opinion expressed by the chapters' authors.

Mohamed Behnassi

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About the Editors

Dr. Mohamed Behnassi

Mohamed Behnassi, Ph.D. in International Environmental Law and Politics, is Associate Professor and Head of Public Law Department at the Faculty of Law, Economics and Social Sciences of Agadir, Morocco. He is the Founder and Director of the North-South Center for Social Sciences (NRCS) and member of the advisory board of the World Forum on Climate Change, Agriculture and Food Security. His core teaching, research and expertise areas cover the global environmental and human security politics, adaptation to environmental change, and social responsibility. He has published many books with international publishers (such as: *Sustainable Food Security in the Era of Local and Global Environmental Change*, Springer 2013; *Global Food Insecurity*, Springer 2011; *Sustainable Agricultural Development*, Springer 2011; *Health, Environment and Development*, European University Editions 2011; *Climate Change, Energy Crisis and Food Security*, Ottawa University Press 2011) and published numerous papers in accredited journals and communicated several oral presentations in relevant international conferences. In addition, Dr. Behnassi has organized many outstanding international conferences covering the above research areas. On 2011, he had completed the Civic Education and

Leadership Fellowship at Syracuse University and the Maxwell School of Citizenship and Public Affairs (Syracuse, New York). Dr. Behnassi has also managed many research and expertise projects on behalf of national and international institutions such as the Royal Institute of Strategic Studies (IRES) in Morocco (Food and health security face to climate change in Morocco: An adaptation strategy within the perspective of an integrated governance), GIZ (Mainstreaming climate risk in local development planning), Carrfour Associatif and UNICEF (University Social Responsibility).

Margaret Syomiti Muteng'e

Mrs. Syomiti holds a Master Degree in Animal Nutrition and Feed Science from the University of Nairobi, a Bachelor of Science in Animal Production from Egerton University, and she is currently pursuing her Ph.D. in Natural Resources Management from Egerton. Mrs Syomiti began her research career in Kenya Agricultural Research Institute (KARI) on 12 February, 2001, at KARI Muguga South, Animal Production Research Programme. She was promoted from Research I to Research II in 2011. Ms Syomiti is a member of several professional bodies, both local and international. From 2002 to date, she is a member of Animal Production Society of Kenya (APSK). In 2009, she joined the Kenya Professional Association of Women in Agriculture and Environment (KEPAWAE). In 2010–2012, she was competitively selected as an AWARD Fellow, African Women in Agricultural Research and Development, a Gender & Diversity program in the CGIAR. AWARD offers tailored, 2-year fellowships designed to fast-track the careers of African women scientists and professionals delivering pro-poor agricultural research and development that bene ts rural communities, especially women. Its goal is to help fellows increase their contributions in the ght against hunger and poverty in sub-Saharan Africa. As an AWARD Fellow,

Ms. Margaret Syomiti has achieved a lot in her research career development: Mentoring Orientation skills in August 2010; AWARDs' Women Leadership and Management Course, in September 2011; and IFS-AWARD science writing, communication and presentation skills course held in February 2011. With AWARD facilitation, she could have the international membership of Women Organizing for Change in Agriculture and Natural Resource Management (WOCAN). During 2011–2014, she is an international Ph.D. Graduate Fellow in Livestock Climate-Collaborative Research Support Program (LCC-CRSP) for Adapting Livestock Systems to Climate Change of Colorado State University. During her research career, Ms. Syomiti has authored and co-authored several scienti c papers, which have been published in refereed journals and conference proceedings.

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Dr. R. Gopichandran

Dr. R. Gopichandran is currently the Director of Vigyan Prasar, an autonomous institution of the Department of Science and Technology, Government of India. He has two doctoral degrees in biological sciences specializing in the areas of microbial and chemical ecology. His extensive work on preventive environmental management motivated him to secure a degree in law. Most of his 23 years of scienti c, research, communication and capacity building work and output relate to chemical ecological aspects of natural resources management, cleaner production and chemical substitution. The latter two aspects have been through a dynamic association with the Compliance Assistance Programme of the United Nations Environment Programme in particular and with special reference to ozone layer protection, centred on locally relevant action by industry at the national and regional levels. This included innovative work on destruction of ozone depleting substances to twin the objectives of climate and ozone layer protection. His recent contributions to India's 12th Five

Year Plan as member of the Working Group on Natural Resources Management are on the chemical ecological aspects of conservation and sustainable management of agriculture to tackle challenges posed by climate change. He has a large number of publications including books and papers through well-recognized publishers and journals. He has also taught extensively in several centres of higher learning including the Centre for Environmental Planning and Technology and the Indian Institute of Management, Ahmedabad. Prior to joining Vigyan Prasar, he has served in three important institutions over the last 23 years: the Gujarat Energy Research and Management Institute, Gandhinagar, as the Principal Research Scientist; Centre for Environment Education, Ahmedabad, as Scientist SH (Environment and Climate Change Wing); and Environment Management and Entomology Research Institute, Chennai, as Programme Director/Scientist SG. He is also an Alumnus (Year 2000) of the International Visitors Leadership Programme of the Department of State, USA.

Dr. Kirit Nanubhai Shelat

Dr. Shelat holds a Ph.D. in Public Administration. He has served as the Principal Secretary of Agriculture and Cooperation Department, Government of Gujarat, following several other leadership public administration roles in the energy and industry sectors. He recently retired from the Indian Administrative Service. During his career of 40 years, he formulated and implemented many relevant policies covering the stated sectors. This includes his focus on the bene t of poor families, farmers, and micro-entrepreneurs and remote rural areas through micro-level planning for integrated development. He established the new extension approach of meeting with farmers at their door step prior to monsoon by teams led by agriculture scientists. Importantly he introduced soil health and moisture analysis based agriculture systems and provided soil health cards to every farmer in the State of Gujarat. He is also among the Founders of International School for Public Leadership and Executive, Chairman of National Council for Climate Change Sustainable Development and Public Leadership (NCCSD), and Chairman of the Sub Group “Enhancing Preparedness for Climate Change” set up by the Planning Commission, India, for the 12th Five Year Plan. He is author of many books related to rural and agricultural development and public leadership.

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Abbreviations and Acronyms

ABARE	Australian Bureau of Agricultural and Resource Economics
ADAFSA	Abu Dhabi Agriculture and Food Safety Authority
ADFCA	Abu Dhabi Food Control Authority
ADP	Agricultural Development Programme
AEZ	Agro-Ecological Zones
ANOVA	Analysis Of Variance
ANRH	Agence Nationale des Ressources Hydrauliques
APMC	Agricultural Produce Market Committee
AWC	Arab Water Council
BCM	Billion Cubic Meters
CA	Copenhagen Accord
CC	Climate Change
CCAFS	Climate Change, Agriculture and Food Security
CCI	Climate Change Impacts
CGIAR	Consultative Group on International Agricultural Research
CP	Compromise Programming
CSIRO	Commonwealth Science and Industrial Research organization
EAD	Environment Agency – Abu Dhabi
ECHAM3TR	European Centre Hambourg, Germany
EPA	US Environmental Protection Agency
ESF	European Social Fund
ET	Evapotranspiration
FAO	Food and Agriculture Organization
GCM	General Circulation Models
GEF	Global Environment Facility
GFDL	Geophysical Fluid Dynamics Laboratory
GGA	Grain Growers Association
GHE	Greenhouse Effect
GHGs	Greenhouse Gases
GISS	Goddard Institute for Space Studies
HDI	Human Development Index

HLPE	High Level Panel of Experts on Food Security and Nutrition
HMRDF	Hellenic Ministry of Rural Development and Food
ICBA	International Center for Biosaline Agriculture
ICRISAT	International Crop Research Institute for the Semi- Arid Tropics
IFPRI	International Food Policy Research Institute
ILUC	Indirect land use change
INM	National Meteorological Institute
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
IRMS	Isotope Ratio Mass Spectrometer
IUCN	International Union for Conservation of Nature
IWASRI	International Water logging and Salinity Research Institute
IWMI	International Water Management Institute
KISR	Kuwait Institute for Scienti c Research
KP	Kyoto Protocol
KSU	King Saud University
LCA	Life Cycle Assessment
LUT	Land Utilization Types
MEECC	Ministry of Environment, Energy and Climate Change
MENA	Middle East and North Africa
MOA	Ministry of Agriculture
MOP	Multi-Objective Programming
MREP	Mona Reclamation Experimental Project
NAMA	Nationally Appropriate Mitigation Action
NAPA	National Adaptation Programme of Action
NATCOM	India's Second National Communication
NEPAD	The New Partnership for Africa's Development
NRCS	North-South Center for Social Sciences
NSRF	National Strategic Reference Framework
NSSG	National Statistical Service of Greece
ONM	Of ce National de la Météorologie
OSU	Oregon State University
PICCMAT	Policy Incentives for Climate Change Mitigation Agricultural Techniques
RCM	Regional Climate Model
RIRDC	Rural Industries Research and Development Corporation
RPWRC	Red Palm Weevil Research Chair
SAC	Space Application Centre
SCAR	Standing Committee on Agricultural Research
SIC	Soil Inorganic Carbon
SLR	Sea Level Rise
SOM	Soil Organic Matter
TCD	Thermo-Conductive Detector
UAE	United Arab Emirates

UKHI	United Kingdom Meteorological Of ce High Resolution
UNDP	United Nation development Program
UNEP	United Nation Environment Program
UNESCO	United Nations Educational, Scienti c and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
WANA	West Asia North Africa
WBGU	German Advisory Council on Global Change
WGP	World Gross Product
WHO	World Health Organization
WR	Water Requirement
WUE	Water-Use Ef ciency Evaluation
WUE	Water Use Ef ciency

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