CLIMATE CHANGE AND TERRESTRIAL CARBON SEQUESTRATION IN CENTRAL ASIA

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Climate Change and Terrestrial Carbon Sequestration in Central Asia

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Foreword

The countries of Central Asia and the Caucasus (CAC), which were a part of the former Soviet Union, represent a vast area of some 416 million hectares. This area has great potential for carbon sequestration through better land management. Since the CAC countries are now "economies in transition," they offer an opportunity to examine the role of land use change in both reducing poverty and in ensuring long-term sustainability of natural resources.

Agriculture in CAC occupies around 70% of the land area and is characterized by relatively low productivity and increasing land degradation. After independence, all CAC countries dismantled the former large state-run farms and are now facing the challenge of addressing the problems of smaller leased or privately owned land. During this period of transition, crop and livestock production has declined markedly as inputs have become scarcer and unaffordable. Recovery has been slow, putting enormous pressure on rural populations as they struggle to come to terms with these profound changes. Some areas have been abandoned because of land degradation, lack of resources and low returns. Management of the production systems and of the natural resource base that they depend on remains less than satisfactory in many areas.

A Collaborative Research Program for Sustainable Agricultural Production in Central Asia and the Caucasus was established in 1998, involving nine CGIAR Centers and eight CAC NARS, with ICARDA as the lead Center. The Consortium has helped the region to halt the erosion of its genetic resources, organize joint research on improved crop and livestock production, and on efficient control of pests and diseases. Many conservation agriculture technologies including zero tillage, crop diversification and reduction of summer fallow area, as well as improved rangeland management practices, are contributing to improved soil organic carbon maintenance. The Central Asian Countries Initiative on Land Management (CACILM), in which ICARDA has been playing the lead role in a Research Component on Sustainable Land Management, will address carbon sequestration as one of priority issues.

Since much still remains to be done, it was only timely that Ohio State University, jointly with the USDA-ARS, ICARDA and CIMMYT, organized a workshop on Carbon Sequestration in Central Asia on 1–5 November, 2005. The prospects for carbon trading were discussed at the workshop. The trading schemes that emerged could offer the rural poor in CAC the opportunity to generate income and conserve the natural resource base. The challenge will be to stimulate a widespread adoption of the promising resource-conserving practices that were identified at the workshop and to link them to carbon trading possibilities.

We are delighted that the proceedings of this workshop are now available to a wider audience through this publication. We look forward to participating in, and catalyzing further interactions between the national agricultural research systems of the region and international research organizations and other partners globally.

Mahmoud Solh
Director General, ICARDA.

Preface

Climate change and desertification are major global issues of the 21st century. The earth's mean global temperature rose by 0.6 ± 0.2°C during the second half of the 20th century, at a rate of 0.17°C/decade. If the present trend continues, a drastic increase in global temperature is projected by the end of the 21st century and consequences will be a rise in sea level and accelerated meltdown of polar ice sheets. Scientists recently observed that a shelf of floating ice, which was larger than 100-km^2, and which jutted into the Arctic Ocean for 3,000 years from Canada's northernmost shore, broke away in the summer of 2005 because of sharply warming temperatures. Increasing concentrations of CO_2 along with CH_4 and N_20 are several of the causes of the accelerated greenhouse effect. The problem is exacerbated by a rising global demand for energy and a corresponding increase in fossil fuel combustion. The world used 420 Q of energy in 2003. This amount is projected to increase to 470 Q in 2010 and 620 Q in 2025.

Thus, growing and strong interest in renewable energy sources is rightfully justified. For all their potential, however, wind does not always blow nor does the sun always shine when they are most needed. For this reason a reduction of carbon emissions will remain an essential component of any strategy to address global warming.

The U. N. declared 2006 the "Year of Deserts and Desertification". Despite the severity of the problem and the good intentions of all parties concerned, no concrete action was undertaken during 2006 to combat it nor has a sharply focused action plan been designed for the future.

It is in this context that the topic of terrestrial carbon sequestration in Central Asia is extremely relevant and timely. Serious problems of soil and environmental degradation in general, and that in Central Asia in particular, have been exacerbated by the collapse of Soviet Union which helped to coordinate regional use of soil and water resources. Land use change from natural steppe vegetation to agricultural ecosystems also resulted in severe problems of wind and water erosion and desertification in the region. The total desert area in the region is estimated to be about 150 Mha or 37% of the total land area. Most agricultural and range land soils lost 30 to 50% of their soil organic carbon pool, and soils have experienced a corresponding decline in quality. Inappropriate land use, soil mismanagement, and excessive irrigation with high evaporation have caused severe and unprecedented problems of degradation of soil, water, vegetation and other elements of the environment of the region with long-term adverse impacts on agricultural sustainability, environmental quality and economic well being of the region's inhabitants.

A workshop was held at The Ohio State University campus in fall, 2005. It addressed soil and other environmental problems in the Central Asia region. The rationale for organizing the workshop included the following considerations:

Soil degradation: Large areas of arable land in Central Asia are being lost to production as a consequence of inappropriate cropping systems and inappropriate irrigation schemes. Some of it is being transformed into semi-desert conditions with an attendant loss in soil biodiversity, soil organic carbon pool, plant nutrient reserves, and plant available water capacity. Declines in soil quality have severe adverse impacts on net primary productivity (NPP), agronomic sustainability, and water quality.

Loss of Aral Sea and Water Resources: Land us change and expansion of irrigation have had a major negative impact on the hydraulic balance of the region. Two major rivers (Amu-Darya and Syr-Darya) feed the Aral Sea. Overuse of their flowage for irrigation purposes has drastically shrunk the Aral Sea and adversely affected its water quality. This has resulted in a major reduction in the availability of water to sustain human and animal populations in the region and major adverse changes in the surrounding ecoregions.

Water Pollution and Contamination: Excessive water use and indiscriminate use of agricultural chemicals have led to considerable salinization and water logging of soils. Pollution and contamination of water resources are serious problems throughout the region.

Unsustainable Agriculture and Food Insecurity: The severe problems of soil degradation and depletion of water resources in the region threaten the production of food for inhabitants of the region. The problem is exacerbated by the projected climate change which may accentuate the frequency and intensity of extreme events.

Global Climate Change: Depletion of the soil organic carbon pool exacerbates emission of CO_2 into the atmosphere. Soil degradation decreases CH_4 uptake by agricultural soils. Indiscriminate use of nitrogenous fertilizers and water logging also accentuate N_2O emissions from croplands. The projected climate change may be a positive feedback which increases the risk of soil degradation and the rate of decomposition of soil organic matter.

Eminent scholars, who are familiar with these problems in Central Asia, were invited to contribute chapters to this book. Topics and authors were specifically chosen to achieve the following 5 objectives: (a) identify land use and soil/vegetation management strategies that restore degraded soils and ecosystems, enhance soil quality, improve water use efficiency, and sequester carbon in soil biomass; (b) develop strategies to facilitate dialogue among scientists and policy makers so that soil and ecosystem recovery is an integral component of any governmental program to mitigate climate change; (c) encourage dialogue on scientific and technological exchange; (d) create multi-disciplinary teams to facilitate carbon trading in national and international markets; and (e) identify social, economic, and bio-physical factors and processes that restore degraded soils and ecosystems, thus making agriculture a contributor to the solution of the environmental degradation problems in Central Asia.

The 34-chapter volume is a state-of-the-knowledge compendium on terrestrial C sequestration in Central Asia. It is sub-divided into 8 thematic sections. Section A deals with the biophysical environments of the region and consists of 3 chapters: one describing the principal biomes and the other two reviewing the predominant vegetative cover of the region. Section B deals with the water resources of Central Asia. It consists of 4 chapters that address the current water regime, possible impacts on it of climate change, problems caused by water mismanagement, contamination of surface and ground waters by non-point source pollution, and increasing salinization. Section C also consists of 4 chapters in which existing challenges to sustainable agriculture, problems of soil degradation, and the effects of irrigation schemes on secondary salninzation are discussed. Section D consists of 12 chapters that address the principal theme of the book, namely, "soil management and its relationship to carbon dynamics". Several chapters focus on the impact of tillage methods, soil fertility management, and summer fallowing on soil carbon dynamics, water conservation and agronomic productivity. Section E, contains two chapters that describe the important relationship between forest management and carbon dynamics. Section F also contains two chapters in which economic analyses of land use practices are presented. Materials found in Section G deal with important methodological issues regarding the use of GIS, remote sensing, carbon budgeting and scaling. Section H consists of only one chapter in which knowledge gaps on carbon and climate change are identified and related researchable priorities are recommended.

Organization of the workshop and publication of this volume were possible because of the cooperation and support of sponsoring organizations. The workshop was jointly sponsored by The Ohio State University, the International Center for Agricultural Research in Dry Areas (ICARDA), the United States Department of Agriculture – Agricultural Research Service (USDA-ARS), and the International Maize and Wheat Improvement Center (CIMMYT). Dr. Mekhlis Suleimenov, Assistant Regional Coordinator, of ICARDA-CAC Office in Tashkent, Uzbekistan played an important role in identifying and contacting scientists from the region. All authors are to be thanked for their outstanding efforts to document and present current research information and summary analyses of the current status of accumulated knowledge on these topics. The authors' contributions help increase general understanding of opportunities and challenges encountered when attempting to enhance terrestrial carbon sequestration in Central Asia, and the potential sink capacity of different biomes through adoption of recommended land use and management practices. Research

reported in this volume has advanced the frontiers of soil and environmental science with regards to terrestrial C sequestration, enhancing biomass-productivity, improving soil quality, advancing sustainability and mitigating climate change.

Special thanks are also due to Dr. Bobby A. Stewart. He undertook the most difficult and tedious task of formatting each of the 34 chapters and getting them camera ready. It is a pleasure and honor to work with him. He is a role model regarding dedication, hardwork, sincerity and commitment to excellence. Thanks are also due to Dr. Jerry Ladman of OSU for his support through the CIRIT-Climate Change initiative. Help received from staff of the Carbon Management and Sequestration Center and Ms. Lynn Everett in relation to organizing the workshop is also much appreciated. Preparation of this volume also depended on assistance from many staff of the publisher Taylor & Francis, Leiden, The Netherlands.

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