



Crop Science and Land Use for Food and Bioenergy

Edited by Michael J. Miguez & C. Flaten

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Land Resources and Land use options - Challenges for food Security and sustainable Development

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Editors: R. K. Behl, W. Merbach, H. Meliczek, C. Kaetsch

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ABOUT THE EDITORS



R.K. Behl

Prof. Dr. R.K. Behl, serving as Professor of Plant Breeding at CCS Haryana Agricultural University, Hisar, India, secured first position in B.Sc Agriculture and M.Sc Plant Breeding, has been editor in chief of Annals of Biology for more than two decades, Associate Editor of Annals of Agri Bio Research, editorial board member of Archives of Agronomy and Soil Science (Germany), International Advisory Board Member of Tropics (Japan), Associate Editor, Cereal Research Communication (Hungary), Associate Editor, South Pacific Journal of Natural Science (Fiji), Sr. Editor, Journal of Basic Microbiology, (Germany), has about 200 publications in international and national journals and 20 edited books, has 31 years teaching and research experience in plant breeding, has been awarded Bharat Ratna C Subhramanyam award for Out Standing Teachers by Indian Council of Agricultural Research, New Delhi, honorary DAAD Advisor by German Academic Exchange Service, Bonn, Germany, has been founder Secretary of Society for Sustainable Agriculture and Resource management (SSARM), India and International Foundation for Sustainable Development in Africa and Asia (IFSDAA), Germany, participated and organized several international conferences in India and abroad, has been associated with the development of plant material with specifically useful traits for stress tolerance and plant microbe interactions in wheat.



Wolfgang Merbach

Prof. Dr. Habil. Wolfgang Merbach, obtained PhD graduation (Dr. agr.) in 1970 at the University Jena and University lecturing qualification (*Facultas docendi*, habilitation) in 1982 at the Martin-Luther-University Halle -Wittenberg (MLU). He has been head of the isotope laboratory at the Research Centre for Soil Fertility Müncheberg from 1986 to 1990 and leader of the workgroup "Ecological Change" and enfranchised member of the central "Round Table" of the GDR in Berlin during 1989/90. He became Professor of the Academy of Agricultural Sciences in 1990, institute leader (1992 - 1998) and deputy director at the Centre of Agricultural Side and Land Use Research (ZALF) Müncheberg (1992 - 1995). He also joined as Professor of Plant Physiology and Nutrition (1998 - 2005) and Dean of the Agricultural Faculty of the MLU (2000-2003). His main lectures and teachings in various fields include plant nutrition and fertilization, ecological toxicology and soil science at the universities of Halle, Jena, Potsdam Cottbus, Zürich, Wien and Hisar (India). His research focus has been on the aspects of symbiotic N₂ fixation, ecophysiology and substance turnover in the rhizosphere, laughing gas emissions of fen areas, nitrogen turnover in ecosystems. He has more than 300 research publications. Also he is editor of numerous books and conference volumes. He is a member of various editorial boards and special commissions. He has been President of the German Society of Plant Nutrition (1997 - 2001), Member of the Council of International Ecological Centre of the Polish Academy of Research, Chairman of International Council of the Society for Sustainable Agriculture Resource Management (1996-2005) and Joint Secretary (Europe), International Foundation for Sustainable Development in Africa and Asia from 2009 onwards.



Hans Meliczek

Prof. Dr. Hans Meliczek has a distinguished career as international expert in rural development, agrarian reform and poverty alleviation. He received his Ph. D. at the Technical University of Berlin, Germany in the field of agricultural economics. Mr. Meliczek is Honorary Professor of the University of Goettingen, Germany and of the Economic University of Nanjing, China. He was guest professor at the Agricultural Faculty of the University of Kabul, Afghanistan and was teaching in Turkey, Japan and China. Before his scientific activities he was working for 30 years with FAO both at headquarters and in the field. His final position was Director of the Human Resources, Institutions and Agrarian Reform Division. During his assignment with FAO he undertook missions to more than 50 countries in Africa, Asia and the Caribbean dealing with the design, planning, monitoring and evaluation of rural development projects. On many occasions he has been seconded as rural development specialist or team leader to other UN Organizations like UNDP, UNODC and WFP as well as EU and World Bank. In recent years Mr. Meliczek works as free lance consultant. He has issued several publications on socio-economic aspects of rural development. In 2007 he has been appointed President of IFSDAA.



Christoph Kätsch

Prof. Dr. Christoph Kätsch is an internationally known expert in Forest Management, Remote Sensing and Geo-Informatics at the University for Applied Science and Arts (HAWK), Faculty Resource Management in Göttingen, Germany since 1992. He received his PhD and his post-doc qualification (Habilitation) from Göttingen University. Before starting his scientific career Dr. Kätsch worked as a forest officer in the forest service of Lower Saxony, Germany. He has also worked for several years as technical advisor and professor in African countries and as short-term specialist in Russia, Vietnam and China. His scientific work covers a wide range of topics regarding forest management, forest resources inventory but also holistic and multidisciplinary approaches in mapping and analysing green landscapes. In his studies he introduced modern systems analysis and information modelling methods into resource information science, forming an important basis for the efficient use of information technology in sustainable resources management. To this day, his scientific work concentrates on all aspects of applied informatics and remote sensing on renewable natural resources and suitable methods to derive useful information from the data gathered. Prof. Kätsch has worked on more than 40 international research projects involving technical cooperation with project partners in many countries around the globe.

COMMEMORATION



PROF. DR. HABIL. DR. H. C. MARTIN KÖRSCHENS

Considering soil as matrix for nutrients dynamics and plant growth and a formidable natural resource base for agriculture, it is imperative to know more and more about lesser known and unraveled mechanisms in arable soils. Prof. Dr. habil. Dr. h.c. Martin Körschens devoted himself in soil science research contributing towards soil sustainability and food security and hence up-liftment in the society.

Born on 15. 06. 1935, Prof. Körschens, joined training as "Agricultural skilled worker" soon after high school and continued the training from 1955-1956 at the Institute of Agricultural Experimentation and Investigation, Halle-Lauchstädt to acquire more practical skills. He successfully completed leaving certificate "Qualified Technical Assistant of Agriculture" before resuming his studies from 1956 to 1960 at the Martin-Luther-University Halle-Wittenberg, Agronomy Faculty, to achieve leaving certificate "Agricultural graduate". He then began his research career and worked as Head Experimental Station of Academy of Agricultural Science at Vollenschier on sandy soil for five years. He obtained Doctorate degree at the University of Bernburg in 1965.

He continued his research strides from 1967 to 1975 as Scientific Co-operator at the Department of Field Experiment Methodology at the Institute Bad Lauchstädt, engaged with biostatistical questions, experimental setups and realization of the data basis "Experimental results of plant production". In

recognition of his good research work he got a coveted elevation in his career to perform as Head of the Department of "Organic Manuring" from 1975 to 1991 to focus on quantification of the dependence of soil organic matter content on local conditions as well as agricultural cropping systems, relations between humus content, soil physical properties, N-supply, C/N transformation, C- and N-dynamics. **During this stint of his career he earned Habilitation in 1981 at the Academy of Agricultural Science in the field of reproduction of soil fertility and soil organic matter.** He was distinguished as a hard working, intelligent and devoted scientist by his peers that led to his appointment as Professor of the Academy of Agricultural Science in 1989. He became in 1992, the most cherished, Head of the Department Soils Sciences at Bad Lauchstädt of the newly founded "Centre for Environmental Research Leipzig-Halle Ltd." He did pioneering work at this station and the centre became known worldwide for its research agenda and facilities.

Besides, about 200 scientific publications and 6 books to his credit, Prof. Körschens earned many laurels and distinctions for himself, scientific fraternity and the nation. He was awarded in 1998 honorary Doctorate degree by the Pannon University of Agricultural Sciences Keszthely, Hungary. He also served several professional societies and working groups in various capacities such as Vice President of the German Soil Science Society (1997 – 1998), President of the international working group "Soil Fertility" in the IUSS (1999 – 2008), Member of the International Council of the Society for Sustainable Agriculture and Resource Management, Hisar, India since 1995, Honorary chairman of "Förderverband Humus e. V." since 2008 and Member of the IUSS and Member of the VDLUFA. He has been associated with the Editorial Board of "Archives of Agronomy and Soil Science" and the Editorial Board of "Plant, Soil and Environment", Prag as a consultant.

Professor Koerschens is an embodiment of knowledge with high values for culture and traditions and simplicity. The age has not belied his zeal in guiding younger researchers to achieve new knowledge.

We gladly commemorate this volume entitled "Crop Science and Land Use for Food and Bioenergy" to Prof. Körschens, a living legend in soil sciences as his path breaking research work ultimately deals with sustainable land use for present and future generations.

**On behalf of Editors, Executive Council,
and the Members of IFSDAA**



FOREWARD

Ensuring food security for teaming millions world over requires multifaceted, multidisciplinary and nationally oriented policies and approaches. In past five decades spectacular gains from agro-technology have been reached in most parts of the world, except in Sub-Saharan Africa and in some poor countries.

In the first group significant improvement in food supplies and hence food security has been achieved. This has been made possible through a variety of agricultural policies protecting local farmers from excessive foreign competition and stimulating the introduction of new technologies and practices (e.g. subsidies for fertilizer like in India, China, and recently in Malawi, subsidies on a land basis or guaranteed prices for agricultural products as in Europe, deficiency payment and other instruments to guarantee farmers' income, as in Europe and the US, etc.). Increased use of fertilizers, of high yielding crop varieties through traditional plant breeding, and of pesticide, have contributed to this leapfrogging. Genetically modified crops may allow making additional progress. However in some parts of this group of countries, due to increased cropping intensity and the use of high yielding crop varieties responsive to intensive inputs of agro-chemicals, the quality of resources such as soil, water and plants, yields are less and less able to be further increased, sometimes they even decrease, mostly as a result of poor management. Adequate technical and political solutions are therefore to be found. This needs more research and extension activities to cope with these new challenges.

But in Sub-Saharan Africa (which consist not only of semi dry areas like the Sahel but also of regions with adequate rainfall) and in the poorest countries of the world –countries with the “bottom billion” as Paul Collier called them- yields could be fairly easily improved to day just by introducing and adapting known technologies, by adequate national or regional policies and in particular by reframing agricultural policies (subsidizing fertilizer, organizing markets etc.), just as did Malawi during the past five years. Economic and political studies to find adequate ways of transition to increase food production deserve here more attention than the research on new biological and agronomical aspects. This does not mean that the latter are not useful and not necessary. They are necessary. All technologies, traditional and new ones should be combined in the best possible manner. But the challenge here is far from being just a technological one. Technologies are insufficient

per se in countries where the average fertilizer consumption per ha is - in spite of the generally low phosphorus content of native soils- 10 times less than the average world consumption, 20 times less than in European countries, and probably more than 30 times less than in some parts of China. The already low mineral content of soils is decreasing further, year after year in these countries. With such low inputs neither can agricultural production become sustainable, nor can long term food security be achieved. Up to now food production increases could only be achieved by increasing the land under cultivation. Therefore we cannot remain satisfied by not tackling this essential issue. Perhaps should we start by considering here another economical paradigm, that we may perhaps call the " Malawi consensus", as opposed to the Washington and Beijing Consensus.

Beside this we should not forget the new environmental challenges, amongst which the necessity to combat climate change and ocean acidification and to protect biodiversity. This requires adequate improvements not only of fossil energy efficiency, but also of land use efficiency: first for food security, to preserve as much as possible forests and grassland and also to make an adequate contribution on non food bioproducts and bioenergy. This is a core issue for this seminar.

In order to highlight this global concern and with the quest to find solutions to these vexed problems, the International Foundation for Sustainable Development in Africa and Asia (IFSDAA) in collaboration with Afro Asian Studies Promotion Association (AASF), Mahatama Gandhi House, Goettingen, Germany organized an international seminar on Land Resources and Land Use Options: Challenges for Food Security and Sustainable Development from July 14-16, 2009. The papers presented and/ or prepared for the seminar have been compiled and are published in this book. Besides vision for future research and development, 36 papers included in this book cover topics on genomics and plant breeding, management of natural resources and applied inputs for plant nutrition, sustainable agriculture, bio-energy and land use patterns in different parts of the world.

I sincerely hope that this volume will serve useful purpose for the academics and the students to have holistic view of crop science applications for optimization of land use and its diversification in changing scenario. I congratulate the editors for their sincere efforts in bringing out this publication.



PROF. DR.ARTHUR RIEDACKER
Former Director of Research at INRA France
Vice President, IFSDAA and President of Oikos-Food Security

PREFACE

The ultimate aim of sustainable agriculture is to enhance food production by maintaining the natural resource base. This should be achieved in accordance with the carrying capacity of the supporting agro-ecological system s for the ever increasing human and animal population all over the world.

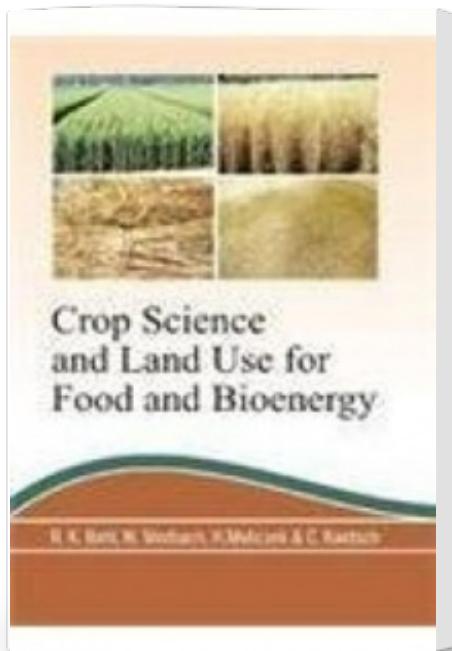
In many parts of the world arable lands, the depletion of the natural resource base has already become apparent, including soil degradation due to over mining of nutrients, imbalanced fertilization, salinity due to excessive irrigation, water deficits and environmental pollution. Further, global warming, the uncertainty in rainfall; perpetual droughts and floods of varying intensities etc. affect crop production and land use. Additionally crop production on arable lands for bio-energy will lead to conflict until land resources are judiciously used. Increasing urbanization, the creation of special economic zones, government policies regarding land ownership, small holders' priorities and other socio-economic factors would determine land use as well as crop diversification.

Crop productivity is predominantly determined by the production environment, crop genotype and their interaction. In order to sustain food and bio-energy supplies it is important to improve the inherent potential of crops for increased use efficiency of natural and applied inputs, to increase stress tolerance, to harness plant microbe interactions, to use improved agro-technology and appropriate land use patterns for sustainable development.

This book entitled "**Crop Science and Land Use for Food and Bio-Energy**" is based on the research findings prepared for and/or presented at the International Seminar on Land Resources and Land Use Options: Challenges for Food Security and Sustainable Development. It was organised by the International Foundation for Sustainable Development in Africa and Asia (IFSDAA) in collaboration with the African Asian Studies Promotion Association (AASF), Goettingen, Germany. from July 14 to 16, 2009. This book covers a wide range of topics like crop sciences and crop improvement, plant microbe interactions, resource management, bio-energy, sustainable development and socio economic aspects of land use and other natural resources that can compliment the objectives of sustainable land use.

The editors express their sincere gratitude to the authors who have contributed their papers for publication They also thank Prof. Brigitta Benzing, President of Afrikanisch-Asiatische Studienförderung (AASF) / Vice

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