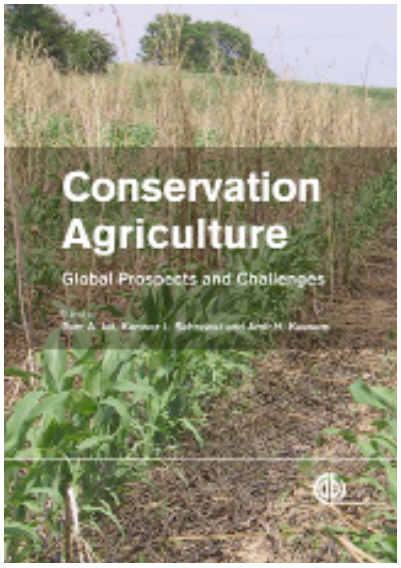
new from CABI



Conservation Agriculture
Global Prospects and Challenges

Edited by **Ram A Jat**, International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India and Directorate of Groundnut Research, Junagandh, India, **Kanwar L Sahrawat**, International Crops Research Institute for the Semi-Arid Tropics and **Amir H Kassam**, Food and Agriculture Organization of United Nations, Rome, Italy and University of Reading, UK

Provides an up-to-date review and status of Conservation Agriculture at the global-level

The book covers the spread of Conservation Agriculture (CA) in countries including Brazil, Argentina, the USA, Canada, Australia and emerging CA destinations in Europe, Asia and Africa. Topics covered include the performance of CA as an approach to sustainable crop intensification and how it can contribute to enhancing productivity, improving food security, reduce land and environmental degradation, enhance the flow of ecosystem services, and respond to climate change. Each chapter is based on the latest scientific and empirical evidences regarding the productivity, environmental and socio-economic benefits that can be harnessed through CA. The book will be useful to teachers, researchers, extensionists, farmers, and students interested in environmental quality, as well as to institutional leaders and policy-makers in promoting sustainable agricultural intensification and development.

December 2013 / 424 pages / Hardback / 9781780642598 / £115 / $220 / €110

Contents

Conservation Agriculture

Global Prospects and Challenges

Dedication

This book is dedicated to the global Conservation Agriculture movement but particularly to all the pioneer farmers, researchers and extension agents as well as all the champions in the public, private and civil sectors and in the donor community who are making Conservation Agriculture a global reality.

Acknowledgement

Editors are very grateful to Theodor Friedrich for his wholehearted support and guidance to edit this volume.

Conservation Agriculture

Global Prospects and Challenges

Ram A. Jat, Kanwar L. Sahrawat

International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India and Directorate of Groundnut Research, Junagadh, India

and Amir H. Kassam

Food and Agriculture Organization of the United Nations, Rome, Italy and University of Reading, UK

www.cabi.org

CABI is a trading name of CAB International

CABI
Nosworthy Way
Wallingford
Oxfordshire OX10 8DE
UK

Tel: +44 (0)1491 832111
Fax: +44 (0)1491 833508
E-mail: info@cabi.org
Website: www.cabi.org

CABI
38 Chauncey Street
Suite 1002
Boston, MA 02111
USA

Tel: +1 800 552 3083 (toll free)
Tel: +1 617 395 4051
E-mail: cabi-nao@cabi.org

A catalogue record for this book is available from the British Library, London, UK.

Library of Congress Cataloging-in-Publication Data

Jat, Ram A.
Conservation agriculture : global prospects and challenges / Ram A. Jat, Kanwar L. Sahrawat, and Amir Kassam.
p. cm.
Includes bibliographical references and index.
ISBN 978-1-78064-259-8 (hbk)
1. Agricultural conservation. 2. Sustainable agriculture. I. Sahrawat, K. L. II. Kassam, A. H. III. Title.

S604.5.J38 2013
631.4′5--dc23

2013025174

ISBN-13: 978 1 78064 259 8

Commissioning editor: Sreepat Jain
Editorial assistant: Emma McCann
Production editor: Simon Hill

Typeset by SPi, Pondicherry, India.
Printed and bound in the UK by CPI Group (UK) Ltd, Croydon, CR0 4YY.

Contents

Contributors

Akmal Akramkhanov, Khorezm Rural Advisory Support Service, Khorezm, Uzbekistan. E-mail: api001@yahoo.com

Juliana Albertengo, Asociación Argentina de Productores de Siembra Directa (Aapresid), Dorrego 1639 - 2°A, 2000 – Rosario, Santa Fe, Argentina. E-mail: albertengo@aapresid.org.ar

Nadine Andrieu, CIRAD, UMR Innovation, Montpellier, France. E-mail: nadine.andrieu@cirad.fr

Frédéric Baudron, International Maize and Wheat Improvement Center (CIMMYT), PO Box 5689, Addis Ababa, Ethiopia. E-mail: F.Baudron@cgiar.org

Malik Bekenov, Ministry of Agriculture and Water Management, Bishkek, Kyrgyzstan. E-mail: mbekenov@yandex.ru

César Belloso, Asociación Argentina de Productores de Siembra Directa (Aapresid), Dorrego 1639 - 2°A, 2000 – Rosario, Santa Fe, Argentina. E-mail: belloso@aapresid.org.ar

Harouna Bougoum, Université Polytechnique de Bobo Dioulasso/Institut de Développement Rural (UPB/IDR), Burkina Faso. E-mail: bougountas@yahoo.fr

Stéphane Boulakia, Centre for International Cooperation in Agricultural Research and Development (France), Conservation Agriculture and Systems Engineering Research Unit, F-34398 Montpellier cedex 5, France; Conservation Agriculture Network in South-East Asia, c/o National Agriculture and Forestry Research Institute (Lao PDR), PO Box 7170, Vientiane, Lao PDR; and Support Project for the Development of Cambodian Agriculture – Ministry of Agriculture, Forestry and Fisheries/General Directorate of Agriculture, Phnom Penh, Cambodia. E-mail: stephane.boulakia@cirad.fr

Hakim Boulal, International Center for Agricultural Research in the Dry Areas (ICARDA), North Africa Program, Rabat, Morocco. E-mail: boulal@cgiar.org

Ademir Calegari, Agricultural Research Institute of Paraná State – IAPAR, Rodovia Celso Garcia Cid, Km 375, CEP-86047-902, Londrina, Paraná, Brazil. E-mail: calegari@iapar.br

Regis Chikowo, University of Zimbabwe, PO Box MP167, Mt Pleasant, Harare, Zimbabwe.

George W. Clayton, Agriculture and Agri-Food Canada, Lethbridge Research Center, 5303-1 Avenue South, Lethbridge, Alberta, Canada, T1J 4B1. E-mail: george.clayton@agr.gc.ca

Sandra Corsi, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla 00153 Rome, Italy and University of Teramo, Italy. E-mail: sandra.corsi@gmail.com

Antonio Costa, Agricultural Research Institute of Paraná State – IAPAR, Rodovia Celso Garcia Cid, Km 375, CEP-86047-902, Londrina, Paraná, Brazil. E-mail: antcosta@iapar.br

Tomás Coyos, Asociación Argentina de Productores de Siembra Directa (Aapresid). E-mail: coyos@aapresid.org.ar

Bill (W.L.) Crabtree, Crabtree Agricultural Consulting, 21 Brixton Street, Beckenham, Western Australia, WA 6107. E-mail: bill.crabtree@no-till.com.au

Jean-Marie Douzet, CIRAD, UR SCA, Ouagadougou, Burkina Faso. E-mail: jean-marie.douzet@cirad.fr

Patrick Dugué, CIRAD, UMR Innovation, Montpellier, France. E-mail: patrick.dugue@cirad.fr

Sjoerd W. Duiker, Penn State Cooperative Extension, Department of Plant Science, The Pennsylvania State University, 408 ASI Building, University Park, PA 16802, USA. E-mail: sduiker@psu.edu

Mohammed El Mourid, International Center for Agricultural Research in the Dry Areas (ICARDA), North Africa Program, Tunis, Tunisia. E-mail: elmourid@cgiar.org

Guillaume Essecofy, CIHEAM/IAM Montpellier, France. E-mail: escoffabio@yahoo.fr

D. Brian Fowler, Crop Development Center, University of Saskatchewan, College of Agriculture and Bioresources, 51 Campus Drive, Room 4D36 Agriculture Building, Saskatoon, Saskatchewan S7N5A8, Canada. E-mail: brian.fowler@usask.ca

Theodor Friedrich, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00153 Rome, Italy. E-mail: theodor.friedrich@fao.org

Serge Ganou, Université de Ouagadougou, Burkina Faso. E-mail: ganouserge@yahoo.fr

Olivier Gilard, French Development Agency, Vientiane, BP 5923, Vientiane, Lao PDR. E-mail: gilardo@afd.fr

María Beatriz Giraudo, Asociación Argentina de Productores de Siembra Directa (Aapresid), Dorrego 1639 - 2°A, 2000 – Rosario, Santa Fe, Argentina. E-mail: pgiraudo@powervt.com.ar

Bram Govaerts, International Maize and Wheat Improvement Center (CIMMYT), Apdo. Postal 6-641, 06600 México DF, México. E-mail: B.Govaerts@cgiar.org

Augusto Guilherme de Araújo, Agricultural Research Institute of Paraná State – IAPAR, Rodovia Celso Garcia Cid, Km 375, CEP-86047-902, Londrina, Paraná, Brazil. E-mail: agaraujo@iapar.br

Raj Gupta, International Maize and Wheat Improvement Center, NAASC complex, New Delhi 110012, India. E-mail: rajgupta@cgiar.org

Atef Haddad, Diversification and Sustainable Intensification of Production System Research Program, International Center for Agricultural Research in the Dry Areas, Aleppo, Syria. E-mail: a.haddad@cgiar.org

Nasri Haddad, West Asia regional Program, International Center for Agricultural Research in the Dry Areas, Amman, Jordan. E-mail: N.Haddad@cgiar.org

Li Hongwen, Beijing Key Laboratory of Optimized Design for Modern Agricultural Equipment, College of Engineering, China Agricultural University, Beijing 100083, China. E-mail: lhwen@cau.edu.cn

Gao Huangwen, Beijing Key Laboratory of Optimized Design for Modern Agricultural Equipment, College of Engineering, China Agricultural University, Beijing 100083, China. E-mail: ghwbgs@cau.edu.cn

Ram A. Jat, RP1: Resilient Dryland Systems, International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324, India; Directorate of Groundnut Research, Junagadh, 362001, Gujarat, India. E-mail: rajatagron@gmail.com

He Jin, Beijing Key Laboratory of Optimized Design for Modern Agricultural Equipment, College of Engineering, China Agricultural University, Beijing 100083, China. E-mail: hejin@cau.edu.cn

Ruy Casão Junior, Agricultural Research Institute of Paraná State – IAPAR, Rodovia Celso Garcia Cid, Km 375, CEP-86047-902, Londrina, Paraná, Brazil. E-mail: rcasao@iapar.br

Muratbek Karabayev, International Maize and Wheat Improvement Center, New Delhi, India. E-mail: M.Karabayev@CGIAR.ORG

Amir H. Kassam, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla 00153 Rome, Italy and School of Agriculture, Policy and Development, University of Reading, Reading RG6 6AR, UK. E-mail: kassamamir@aol.com; amirkassam786@googlemail.com

Habib Ketata, International Center for Agricultural Research in the Dry Areas (ICARDA), North Africa Program, Tunis, Tunisia. E-mail: ketata@cgiar.org

Yaseen Khalil, Diversification and Sustainable Intensification of Production System Research Program, International Center for Agricultural Research in the Dry Areas, Aleppo, Syria. E-mail: y.khalil@cgiar.org

Guy P. Lafond*, Agriculture and Agri-Food Canada, Indian Head Research Farm, RR#1 Gov Road, Box 760, Indian Head, Saskatchewan S0G2K0, Canada. *Deceased

John Lamers, Center for Development Research, Bonn, Germany. E-mail: jlamers@uni-bonn.de

Rafael Fuentes Lanillo, Agricultural Research Institute of Paraná State – IAPAR, Rodovia Celso Garcia Cid, Km 375, CEP-86047-902, Londrina, Paraná, Brazil. E-mail: rfuentes@iapar.br

Jean-Claude Legoupil, Centre for International Cooperation in Agricultural Research and Development (France), Conservation Agriculture and Systems Engineering Research Unit, F-34398 Montpellier, cedex 5, France; Conservation Agriculture Network in South East Asia, c/o National Agriculture and Forestry Research Institute (Lao PDR), PO Box 7170, Vientiane, Lao PDR; and National Agriculture and Forestry Research Institute (Lao PDR) – Conservation Agriculture and Land Development Centre, PO Box 7170, Vientiane, Lao PDR. E-mail: jean-claude.legoupil@cirad.fr

Pascal Lienhard, Centre for International Cooperation in Agricultural Research and Development (France), Conservation Agriculture and Systems Engineering Research Unit, F-34398 Montpellier, cedex 5, France; Conservation Agriculture Network in South East Asia, c/o National Agriculture and Forestry Research Institute (Lao PDR), PO Box 7170, Vientiane, Lao PDR; and National Agriculture and Forestry Research Institute (Lao PDR) – Conservation Agriculture and Land Development Centre, PO Box 7170, Vientiane, Lao PDR. E-mail: pascal.lienhard@cirad.fr

María Eugenia Magnelli, Asociación Argentina de Productores de Siembra Directa (Aapresid). E-mail: magnelli@aapresid.org.ar

Martín Marzetti, Asociación Argentina de Productores de Siembra Directa (Aapresid). E-mail: marzetti@aapresid.org.ar

Kizito Mazvimavi, International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324, Andhra Pradesh, India. E-mail: k.mazvimavi@cgiar.org

Saidi Mkomwa, ACT, Nairobi, Kenya. E-mail: saidi.mkomwa@act-act.africa.org

Hafiz Muminjanov, Plant Production and Protection Division, Food and Agriculture Organization of the United Nations, Viale delle Terme di Caracalla, 00153 Rome, Italy. E-mail: Hafiz.Muminjanov@fao.org

Patrice Djamen Nana, ACT, Ouagadougou, Burkina Faso. E-mail: patrice.djamen@act-africa.org

Ali Nefzaoui, International Center for Agricultural Research in the Dry Areas (ICARDA), North Africa Program, Tunis, Tunisia.
Amos Ngwira, Department of Agricultural Research Services, Chitedze Research Station, PO Box 158, Lilongwe, Malawi. E-mail: amosingwira@yahoo.co.uk
Aziz Nurbekov, International Center for Agricultural Research in the Dry Areas (ICARDA) Central Asia and the Caucuses Regional Office, Tashkent, Uzbekistan. E-mail: A.Nurbekov@cgiar.org
Isaiah Nyagumbo, International Maize and Wheat Improvement Center (CIMMYT), PO Box MP163, Harare, Zimbabwe. E-mail: I.Nyagumbo@cgiar.org
Justice Nyamangara, International Crops Research Institute for the Semi-Arid Tropics, Matopos Research Station, PO Box 776, Bulawayo, Zimbabwe. E-mail: j.nyamangara@cgiar.org
Roberto Peiretti, Asociación Argentina de Productores de Siembra Directa (Aapresid), Dorrego 1639 - 2°A, 2000 – Rosario, Santa Fe, Argentina. E-mail: robertopeiretti@gmail.com
Hugo Permingeat, Asociación Argentina de Productores de Siembra Directa (Aapresid), Dorrego 1639 - 2°A, 2000 – Rosario, Santa Fe, Argentina; and Universidad Nacional de Rosario, Urquiza 1911, 2000 – Rosario, Santa Fe, Argentina. E-mail: permingeath@gmail.com
Colin Piggin, Australian Centre for International Agricultural Research (ACIAR), GPO Box 1571, Canberra, ACT 2601, Australia. E-mail: c.piggin@cgiar.org
Danilo Rheinheimer dos Santos, Soil Science Department, University of Santa Maria, Rio Grande do Sul (UFSM), Brazil. E-mail: danilo@ccr.ufsm.br
Jean-Francois (John) Rochecouste, Conservation Agriculture Alliance of Australia and New Zealand (CAA), PO Box 4866, Toowoomba, East Queensland, Australia 4350. E-mail: rochecouste@iinet.com.au
Leonard Rusinamhodzi, Centro Internacional de Agricultura Tropical, 12.5 km Peg Mazowe Road, PO Box MP228, Mt Pleasant, Harare, Zimbabwe. E-mail: leonard.rusinamhodzi@gmail.com
Kanwar L. Sahrawat, RP1: Resilient Dryland Systems, International Crops Research Institute for the Semi-Arid Tropics, Patancheru 502 324, India. E-mail: k.sahrawat@cgiar.org
Jules Benoît Da Sansan, ACT, Ouagadougou, Burkina Faso. E-mail: judalino4@yahoo.fr
Lucien Séguy, Agroecoriz, France. E-mail: seguyl@wanadoo.fr
Dossymbek Sydyk, South-Western Research Institute of Livestock and Crop Production, Chimkent, Kazakhstan. E-mail: nii-tassai@rambler.ru
Christian Thierfelder, International Maize and Wheat Improvement Center (CIMMYT), PO Box MP163, Harare, Zimbabwe. E-mail: C.Thierfelder@cgiar.org
Wade Thomason, Virginia Polytechnic Institute and State University, 185 Ag Quad Ln, 422, Smyth Hall (0404), Blacksburg, VA 24061, USA. E-mail: wthomaso@vt.edu
Jozef Turok, International Center for Agricultural Research in the Dry Areas (ICARDA) Central Asia and the Caucuses Regional Office, Tashkent, Uzbekistan. E-mail: j.turok@cgiar.org
Luis Wall, Universidad Nacional de Quilmes, Roque Saénz Peña 352, B1876BXD Quilmes, Buenos Aires, Argentina; and CONICET, Av. Rivadavia 1917, C1033AAJ Buenos Aires, Argentina. E-mail: lgwall@unq.edu.ar
Patrick Wall, Independent International Consultant, La Cañada 177, Sector O, Bahías de Huatulco, Oaxaca 70989, México. E-mail: pcwallmex@gmail.com
Ibrahima Zerbo, UPB/IDR, Burkina Faso. E-mail: pebayiba@yahoo.fr

Preface

The quality of the natural resource base, especially of soil and water, plays an extremely critical role in enhancing productivity and crop quality, and sustainability of various production systems. Moreover, even the agronomic potential of genetically improved crops or cultivars cannot be achieved in practical agriculture on a degraded soil resource base as a result of multiple soil-related physical, chemical and biological constraints. Hence, to meet the ever increasing demands for food, feed and fibre in a sustainable manner the maintenance of soil health is a prerequisite.

It is known that agricultural practices influence the quality and integrity of the natural resource base, especially soil and water quality and availability, which in turn impacts the sustainability of the production system and food quality. Over the last several decades, a general trend in the degradation of soil resource base has been observed. This degradation has been most severe in the developing nations, where the need for increased nutritious food is also the greatest. Lack of required investment in maintaining the quality of the soil resource base coupled with improper management of natural resources, has indeed led to large-scale soil degradation, which is further jeopardizing environmental quality and food security especially for smallholder, resource-poor farmers in the developing world.

However, it is not necessary that agricultural activities should lead to degradation of the natural resource base. In fact, agricultural practices that are focused on soil health and are in harmony with the ecosystem are sustainable in maintaining productivity at an enhanced level. Among the several practices used in diverse intensified production systems, especially in tropical agriculture, soil tillage and the lack of adequate organic matter input to the soil have a heavy toll in maintaining the integrity of the soil.

Nothing short of a new agricultural production paradigm is needed to sustainably enhance the soil resource base and productivity and simultaneously rehabilitate degraded soils. Conservation Agriculture has indeed provided an alternative way of agriculture that conserves and enhances soil and water resources, and thereby is helpful in maintaining soil health in the longer term while at the same time achieving the highest productivity. Of course the success or otherwise of conservation agriculture depends on numerous factors including those related to soil, climate and socio-economic condition of the farmers, to name a few. Nevertheless, Conservation Agriculture has been researched and applied in most regions of the globe.

The aim of this book is to provide an up-to-date state-of-the-art review on various aspects of Conservation Agriculture by reviewing the past and current research from various regions

of the globe so that all others interested in Conservation Agriculture could benefit from experiences gained under different agroclimatic and socio-economic conditions across the globe. This review would aid in learning from the past experience regarding the success or otherwise of Conservation Agriculture. Knowledge gained from this volume should further help in the implementation of Conservation Agriculture and in the understanding of the role and importance of Conservation Agriculture to secure sustainable crop intensification for the benefit of future generations as well. The challenges in implementing Conservation Agriculture that need to be resolved through future research and development for a larger scale support and the spread of Conservation Agriculture are considered. We hope that this volume will further stimulate interest in advancing research and development as well as policy support on this new paradigm of agriculture.

Foreword

If you tell farmers to stop ploughing their land before they plant the next crop because it harms the soil, most of them will either laugh or give you that kind of look that implies you are crazy. More and more farmers, however, will nod their agreement.

Ploughing or digging the soil to turn it over has played a fundamental role in agriculture for thousands of years. It breaks up the soil, making it easy to create a fine tilth into which crops can easily be sown. It also reduces the extent to which weeds compete with crops by burying any vegetation and, in the process, may build up the level of organic matter in the soil. The invention of the plough made it possible for farmers to mechanize agriculture, first by harnessing oxen or horses and later by attaching ploughs to tractors, thereby enabling a family farmer to cultivate much larger areas of crops than was the case when he/she was restricted to manual labour.

The problem is that the rapidly growing demand for food has been pushing up the frequency with which land is cropped. Periods of fallow, which allow the organic matter content of soil to recover after several years of cropping, are getting shorter or have disappeared. When this happens, inversion tillage systems become a leading cause of soil degradation. With each movement of earth, soil particles become finer, allowing less moisture to enter the soil surface and less to be retained for uptake by crop roots. Rain tends to seal the soil surface, accumulate and run off, causing erosion and downstream flooding – and when the land dries out, the fine particles are picked up by the wind and carried away, as happened dramatically when the 'dust bowl' brought farming to a halt in the American prairies during the 1930s.

The structural damage to soils caused by their frequent inversion leads also to a progressive decline in their fertility and health. Organic matter content drops, and with it the extent of the biological activity that helps to make vital minerals and nutrients available to crops. The fertility decline is much faster in tropical than temperate areas because the higher temperatures lead to faster organic matter depletion.

This book shows how farmers all around the world – in both north and south – have woken up to the problems of excessive tillage and are abandoning their ploughs, spades or hoes. As a result of a movement that started in the 1960s, each year farmers now plant over 125 million ha of crops using no or minimum soil disturbance systems – and the area is growing rapidly. The various systems being applied are collectively known as Conservation Agriculture or 'CA'.

Conservation Agriculture offers an important set of technologies to help feed the world sustainably. This is a central element of the Food and Agriculture Organization of the United Nations (FAO) revised strategic framework that focuses the Organization's work on five crosscutting strategic objectives.

Our first strategic objective is to contribute to the eradication of hunger, food insecurity and malnutrition. The second strategic objective is to 'increase and improve the provision of goods and services from agriculture, forestry and fisheries *in a sustainable manner*' (the other strategic objectives are: reducing rural poverty, improving food systems and their fairness, and increasing resilience).

Our focus is, therefore, on sustainable agricultural intensification with the aim of raising agricultural productivity and output while enhancing and maintaining the health and resilience of agroecosystems. This shift has to take place at a time when farmers face the additional intersecting challenges of increasing competition for land and water, rising fuel and production input prices, and climate change.

In our *Save and Grow* approach to sustainable production intensification, we have made it clear that the present paradigm of intensive crop production based on tillage systems cannot meet the challenges of the new millennium. For agriculture to *grow* sustainably, we must learn to *save* by farming differently. Conservation Agriculture, by minimizing soil disturbance, protecting the soil surface with mulch and promoting cropping system diversification, is a central ingredient of *Save and Grow*, along with other good practices of crop, nutrient, pest and water management. Through their ability to harness nature, these can sustainably raise land productivity and efficiency of production while imparting ecological adaptability and resilience to rainfed and irrigated farming systems.

This is why, since 2001, FAO has been sponsoring and supporting the 'World Congress on Conservation Agriculture' process with national and international collaborators, and has played a strong and significant role in promoting CA globally as part of its general support for sustainable agriculture, food security, poverty alleviation, climate change adaptability and mitigation. Conservation Agriculture offers the prospect of a better future to both large-scale and smallholder farmers, and a means to raise productivity and secure economic and environmental benefits. The CA area is just about equally divided between developing countries and industrialized countries, and more recently, after a rapid spread in the Americas, adoption is increasing in Africa and Asia.

The aim of this book is to offer a state-of-the-art assessment of the status of CA in the various regions of the globe, including drawing lessons from past experience regarding its success or otherwise. This, along with new knowledge being generated through research and farmer practice, should help in promoting the further spread of CA in developing countries as well as globally.

I am sure that this volume will further stimulate the mobilization of local, national and international development support for this important approach to sustainable production intensification.

José Graziano da Silva
Director-General
Food and Agriculture Organization of the United Nations

Acronyms and Abbreviations

2,4-D:	2,4-dichlorophenoxyacetic acid
AAAID:	Arab Authority for Agricultural Investment and Development
AAPRESID:	Asociación Argentina de Productores en Siembra Directa – No-Till Argentinean Farmers Association
ABACO:	Agro-ecology based aggradation-conservation agriculture (Burkina Faso)
ABC Foundation:	Cooperative foundation, which integrates three cooperatives: Arapoti, Batavo and Castrolanda (Brazil)
ABS:	Australian Bureau of Statistics
ACIAR:	Australian Centre for International Agricultural Research
ACSAD:	Arab Center for the Study of Arid Zones and Dry Lands
ACT:	African Conservation Tillage Network
A-C-W:	Arid, cool winter, warm summer
ADAM:	Support Project to Conservation Agriculture Extension in Mountainous Areas of Vietnam
ADB:	Asian Development Bank
ADP:	Agricultural Diversification Project (Vietnam)
AEACSV:	Spanish CA Association for living soils – Asociación Española para Agricultura de Conservación – Suelos Vivos
AFD:	Agence Française de Développement (French Development Agency)
AIGACoS:	Associazione Italiana per la Gestione Agronomica e Conservativa del Suolo (Italy)
AFD:	French Development Agency
AIDS:	Acquired Immunity Deficiency Syndrome
A-K-W:	Arid, cold winter, warm summer
AN:	Ammonium nitrate
APAD:	Association to Promote Sustainable Agriculture – Association pour la Promotion d'une Agriculture Durable (France)
APOSOLO:	Portuguese Association for Conservation Tillage
APSIM:	Agricultural Production Systems simulator

APW1:	Australian Prime Hard Wheat 1
AREC:	Agricultural Research and Educational Center at AUB
ART:	Agricultural Research Trust
ASP:	Agroservicios Pampeanos (Argentina)
AUB:	American University of Beirut
AU-NEPAD:	African Union, The New Partnership for Africa's Development
AusAID:	Australian Agency for International Development
B. Wheat:	Bread wheat
Baldan:	Machinery manufacturer
Banco Do Brasil:	Brazilian Bank
BFS:	Bed planter furrow system
BIOSPAS:	Proyecto de Biología de suelo para una producción sustentable – Soil biology Project for Sustainable Production (Argentina)
Buffalo:	Machinery manufacturer
C:	carbon
CA:	Conservation Agriculture
CA2AFRICA:	Conservation Agriculture in Africa: Analysing and Foreseeing its Impact – Comprehending its Adoption
CAAANZ:	Conservation Agriculture Alliance of Australia and New Zealand
cm:	centimetre
CAAPAS:	Confederation of American Associations for Sustainable Agriculture (Brazil)
CACAARI:	Central Asian and Caucasus Association of Agricultural Research Institutes
CA-CS:	Conservation agriculture-based cropping system
CADP:	Community Agricultural Development Plans
CAIR:	CA Ireland
CANSEA:	Conservation Agriculture Network in South-east Asia
CA SARD:	Conservation Agriculture for Sustainable Agricultural Rural Development
CEIS:	Compagnie Européenne d'Intelligence Stratégique (France)
Cerrado:	Brazilian Savannah Region
CETAPAR:	Technological Centre for Agriculture, Paraguay
CF:	Conservation Farming
CFI:	Carbon Farming Initiative (Australian carbon market legislation)
CFU:	Conservation Farming Unit
CGIAR:	Consultative Group for International Agricultural Research
CIEC:	International Scientific Centre of Fertilizers (Italy)
CIMMYT:	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center)
CIRAD:	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (Centre for International Cooperation in Agricultural Research and Development – France)
CKARI:	Central Kazakh Agricultural Research Institute
Clube da Minhoca:	Earthworm Club (Brazil)

CLUSA:	The Cooperative League of the United States of America
CNPT/EMBRAPA:	Brazilian Wheat Research Centre, Rio Grande do Sul State (Brazil)
CO_2:	carbon dioxide
COMESA:	Common Market for Eastern and Southern Africa
CONAB:	Brazilian National Supplying Company
CONICET:	Consejo Nacional de Investigaciones Científicas y Técnicas – National Council of Scientific and Technical Research (Argentina)
ConvA:	Conventional agriculture
ConvT:	Conventional tillage
CORS:	Continuously Operating Reference Stations
CRS:	Catholic Relief Services
CSIRO:	Commonwealth Scientific and Industrial Research Organisation (Australia)
CT:	Conservation tillage
CTC:	Technical Cereal Center (Tunisia – now part of INGC: National Institute of Field Crops)
CTF:	Control Traffic Farming
CTIC:	Conservation Tillage Information Center (USA)
D. Wheat:	Durum wheat
Defra:	Department for Environment, Food and Rural Affairs (UK)
DNEA:	National Directorate for Agricultural Extension (Mozambique)
DPRK:	Democratic People Republic of Korea
DS:	Direct seeding
E&S Africa:	Eastern and Southern Africa
EC:	European Commission
EC:	electric conductivity
ECAF:	European Conservation Agriculture Federation
EMATER:	Rural State Extension Service, Brazil
EMBRAPA:	Brazilian Agricultural Research Corporation
EMBRAPA SOJA:	Soybean Research Brazilian Centre – Londrina, Paraná State
EPAGRI:	Research & Extension Institute of Santa Catarina State, Brazil
ESAK:	Academic Agricultural Education School at Kef (Tunisia)
ETH:	Eidgenössische Technische Hochschule (Zürich, Switzerland)
EU:	European Union
Fankhauser:	Machinery manufacturer
FAO:	Food and Agriculture Organization of the United Nations
FAT:	Eidgenössische Forschungsanstalt für Agrarwirtschaft und Landtechnik (Tänikon, Switzerland)
FEBRAPDP:	No-Till Brazilian Federation (Brazil)
FFS:	Farmer Field School
FINCA:	Finnish CA Association
Fitarelli:	Machinery manufacturer
FRDK:	Danish CA Association
FTC:	Farmer Training Centre
GAPs:	good agricultural practices

GART:	Golden Valley Agricultural Research Trust (Zambia)
GHGs:	greenhouse gases
GLS:	Grey leaf spot
GM:	gross margins
GMCC/gmcc:	green-manure cover crops
GNSS:	Global Navigation Satellite System
Gov:	Government
GPS:	Global Positioning System
Gralha Azul:	First animal-drawn no-till planter prototype from IAPAR (Brazil)
GTZ:	German Development Corporation
ha:	hectare
HIV:	Human Immunodeficiency Virus
IAARD:	Indonesian Agency for Agriculture Research and Development
IACPA:	Integrated Arable Crop Production Alliance (UK)
IAD:	Institute for Sustainable Agriculture – Institut de l'Agriculture Durable (France)
IADEL:	Machinery manufacturer (Brazil)
IAPAR:	Agricultural Research Institute of Paraná State (Brazil)
ICAR:	Indian Council for Agricultural Research
ICARDA:	International Center for Agricultural Research in the Dry Areas
ICI:	Imperial Chemical Industries
ICONA:	Instituto Nacional para la Conservación de la Naturaleza (Spain)
ICRAF:	International Council for Research in Agroforestry
ICRISAT:	International Crop Research Institute for the Semi-Arid Tropics
IFAD:	International Fund for Agricultural Development
IGME:	Instituto Geológico y Minero de España (Spain)
IIAM:	Mozambican Institute for Agricultural Research
IMASA:	Machinery manufacturer
INE:	Instituto Nacional de Estatística (Portugal)
INIA:	National Institute for Agricultural Research (Mozambique)
INRA:	Institut National de la Recherche Agronomique (National Institute of Agricultural Research – France)
INTA:	Instituto Nacional de Tecnología Agropecuaria (National Institute of Agricultural Technology – Argentina)
IPCC:	Intergovernmental Panel on Climate Change
IPM:	Integrated Pest Management
IPNI:	International Plant Nutrition Institute
IRD:	French Research Institute for Development
ISFM:	Integrated Soil Fertility Management
ISTRO:	International Soil Tillage Research Organization
ITAIPU:	Bi-national Hydroelectric Power Company (Brazil and Paraguay)
ITCF:	Institut Technique des Cereales et Fourrages (France) (new name: Arvalis)
IWM:	Integrated weed management
Jahnel:	Machinery manufacturer

K:	potassium
Knapik:	Machinery manufacturer (Brazil)
KRIGF:	Kazakh Research Institute of Grain Farming
KTBL:	Kuratorium für Technik und Bauwesen in der Landwirtschaft (Germany)
KU:	Kasetsart University (Thailand)
LEAF:	Linking Environment and Farming (UK)
LFC:	Soil light fraction carbon
LIFE:	Less Intensive Farming Environment (UK project)
LKV:	Verordnung über die Erhaltung der Lebensgrundlagen und der Kulturlandschaft (Switzerland)
LOP:	Landwirtschaft ohne Pflug (Germany)
MAFF:	Ministry of Agriculture, Fisheries and Food (UK); 2002 merged into Defra
MAF(F):	Ministry of Agriculture and Forestry (and Fisheries)
Mafrense:	Machinery manufacturer
MAGIC:	Ministerio de Agricultura, Ganadería, Industria y Comercio – Argentinean Ministry of Agriculture, Cattle, Industry and Commerce
MAP:	Monoammonium phosphate
Marchesan:	Machinery manufacturer
MBC:	Soil microbial biomass
MCPA:	4-chloro-2-methylphenoxyacetic acid
METAS:	Group of institutions, companies and specialists that work with no-tillage system development in Brazil
Mg:	magnesium
Mha:	million hectare
mm:	millimetre
MOA:	Ministry of Agriculture
MOFA:	Ministry of Food and Agriculture (Ghana)
Mt:	megatonnes
N:	nitrogen
NAFRI:	National Agriculture and Forestry Research Institute (Lao PDR)
NGOs:	non-government organizations
NIR:	National Institute of Rubber (Vietnam)
NOMAFSI:	Northern Mountainous Agricultural and Forestry Science Institute (Vietnam)
NPK:	nitrogen, phosphorus and potassium
NSCP:	National Soil Conservation Program (Canada)
NSW:	New South Wales (Australian State)
NT:	No-till/no-tillage/minimum tillage
NTA:	No-till agriculture
NTCN:	Controlled traffic with no tillage and full residue cover
NTG:	No tillage, with grass mulch
NTL:	No tillage, with legume mulch
NW:	north-west
Offset ploughing:	ploughing without driving in the furrow (for compaction control)
ORCATAD:	Open Resource on Conservation Agriculture for Trade and Development (Lao PDR)

P:	phosphorus
PADAC:	Support Project for the Development of Cambodian Agriculture
PADER/BGN:	Programme d'Appui au Développement Rural en Basse Guinée Nord
PAMPA:	Multi-country Support Programme for Agroecology (AFD, France)
PASS:	Development project for the South of Sayabouri Province (Lao PDR)
PB:	permanent bed
PDRD:	Programme de Développement Rural Durable
PES:	Payment for Ecosystem Services
PHF:	Rubber for Smallholder project (Cambodia)
PICOFA:	Programme d'Investissement Communautaire en Fertilité Agricole
PIUCS:	Integrated Programme of Soil Use and Conservation (Brazil)
PLUP:	Participatory Land Use Planning
PMISA:	Soil and Water Integrated Management Programme (Brazil)
PPILDA:	Programme Promotion des Initiatives Locales de Développement à Aguie
PRB:	permanent raised bed
PRECOP:	Proyecto de eficiencia en cosecha y poscosecha de granos – Harvest and Postharvest Efficiency Project (Argentina)
PRODESSA:	Project for the Development of the South of Sayabouri Province (Lao PDR)
PRODS/PAIA:	Integrated Agricultural Production Systems as a Priority Area for Interdisciplinary Actions (PAIA) approach
Programa Paraná Rural:	Paraná State Rural Development Programme (Brazil)
PRONAE:	National Agroecology Programme (Lao PDR)
PROSA:	Sector-based agroeology programme (Lao PDR)
PRP:	Protracted Relief Programme
PSFI:	permanent skip furrow irrigation
Qld:	Queensland (Australian State)
QMS:	Quality Management System
RELMA:	Regional Land Management Unit of the Swedish International Development Agency
rpm:	revolutions per minute
RT:	Roto-tilling with straw cover
RTK:	real-time kinematic
RTO:	Refundable Tax Offset (tax terminology referring to depreciation of assets; Australia)
RUE:	rainfall use efficiency
RWUE:	rainwater use efficiency
RYC:	Machinery manufacturer
S:	sulfur
SA:	South Australia (Australian State)
SA-C-W:	Semi-arid, cool winter, warm summer
SA-K-W:	Semi-arid, cold winter, warm summer
SAM:	Mountainous Agrarian Systems Project (Vietnam)

SANREM CRSP:	Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (Cambodia, the Philippines)
SCAP:	Smallholder Conservation Agriculture Promotion project (Burkina Faso, Guinea and Niger)
S.D.:	standard deviation
SEA:	South-east Asia
SEAB-PR:	Secretary of Agriculture of Paraná State, Brazil
SEMEATO:	Machinery manufacturer (Brazil)
SFRI:	Soils and Fertilizers Research Institute (Vietnam)
SG2000:	Sasakawa Global 2000
Sgarbossa:	Machinery manufacturer
SIA:	Società Italiana d'Agronomia
SLM:	Sustainable Land Management
SMB:	soil microbial biomass
SMI:	Soil Management Initiative (UK)
SOC:	soil organic carbon
SOM:	soil organic matter
SON:	soil organic nitrogen
SOS:	Save Our Soils programme (Canada)
ST:	Subsoiling with straw cover
STCN:	Controlled Traffic with Shallow Tillage and Full Residue Cover
Teagasc:	'Learning' (Gaelic) – semi-state Agriculture and Food Development Authority (Ireland)
TLC:	Total Land Care
Triton:	Machinery manufacturer
UFRGS:	Universidade Federal do Rio Grande do Sul, Brazil
UFSM:	University of Santa Maria, Rio Grande do Sul State, Brazil
UQ:	University of Queensland (Australia)
USAID:	United States Aid
VAAS:	Vietnamese Academy of Agricultural Science
Vic:	Victoria (Australian State)
UK:	United Kingdom
UN:	United Nations
US$:	United States dollar
UZS:	Uzbek soum (national currency of Uzbekistan)
WA:	Western Australia (Australian State); West Asia
WANA:	West Asia and North Africa
WB:	World Bank
WCA:	West and Central Africa
Werner:	Machinery manufacturer
WESTCO:	Fertilizer company (Canada)
WFP:	World Food Programme
WHC:	water holding capacity
WUE:	water use efficiency
YAAS:	Yunnan Academy of Agricultural Science (China PRC)
ZCFU:	Zambia Conservation Farming Unit
ZNFU:	Zambia National Farmers Union
ZT:	zero-tillage

This page intentionally left blank

Keywords

Numbers indicate Chapter(s) in which keywords are used.

maize yield 14
mulch 11
nitrogen fertilizer management 4
no-till 3,4,5,9,11,12
no-tillage systems 1,6,15
North Africa 12
pesticide use 2
plant diseases 4
planting basins 14
policy 9
precision agriculture 5
prospects for diffusion 7
recycled organics 5
reduced tillage 5
residue accumulation 4
residue decomposition 4
residues 8
seeders 8
smallholder farming 13
smallholders 12
soil degradation 1,11
soil organic carbon 3
soil organic matter 15
soil properties 14
soil quality 4,9
South-east Asia 7
Southern Africa 14
stubble retention 5
sustainability 1,13,15
sustainable agriculture 3
technology adoption 11
water conservation 8
water use efficiency 15
weeds 4
West and Central Africa 13