

Conservation Agriculture

Muhammad Farooq • Kadambot H. M. Siddique
Editors

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ISBN 978-3-319-11619-8

ISBN 978-3-319-11620-4 (eBook)

DOI 10.1007/978-3-319-11620-4

Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014955208

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Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

Conventional agriculture has largely been characterized by tillage, which leaves soil vulnerable to erosion. Continuous use of conventional farming practices with conventional tillage and burning crop residues has degraded the soil resource base and intensified soil degradation, with concomitant decreases in crop production capacity. Soil loss is expected to be a critical issue for global agricultural production under conventional farming practices. For instance, global erosion rates from conventionally ploughed agricultural fields averaged one to two orders of magnitude greater than erosion under native vegetation, long-term geological erosion and rates of soil production. Likewise, conventional tillage has also made agriculture a major contributor to global warming due to increasing greenhouse gas emissions. Soil and vegetation on the earth's land surface store three times as much carbon as is present in the earth's atmosphere. Land clearing and degradation turn this valuable carbon sink into a major source of greenhouse gas emissions.

Conservation agriculture is widely recognized as a viable approach to creating a sustainable agriculture. It is a resource-saving agricultural production system that aims to achieve production intensification and high yields while enhancing the natural resource base through compliance with four interrelated principles viz. minimal soil disturbance, permanent residue cover, planned crop rotations and integrated weed management, along with other good production practices of plant nutrition and pest management.

Conservation agriculture is environment friendly and requires less fuel, resulting in lower emissions of carbon dioxide—one of the gases responsible for global warming. In addition, conservation agriculture is very effective in reducing soil erosion. A wide range of other environmental benefits accrue in conservation agriculture, including reduced run-off, improved nutrient cycling, reduced soil degradation, reduced soil and water pollution and enhanced activities of soil biota.

Although several papers and conference proceedings are available on the subject, a comprehensive textbook on conservation agriculture was lacking. This book is a timely effort to fill the gap. The book describes various elements of conservation agriculture, highlights the associated breeding and modeling efforts, analyses the experiences and challenges in conservation agriculture in different regions and proposes some pragmatic options and new areas of research in this very important area of agriculture.

I anticipate that this volume will be a ready reference on conservation agriculture and will reinforce the understanding for its utilization to develop environmentally sustainable and profitable food production systems.

Dr. Nick Austin
Chief Executive Officer
Australian Centre for International
Agricultural Research
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Preface

The conventional mode of agriculture through intensive agricultural practices achieves production goals, but simultaneously degrades the natural resources. The growing concerns for sustainable agriculture are in response to the limitations of both low-input, traditional agriculture and intensive modern agriculture relying on high levels of inputs for crop production. Sustainable agriculture relies on practices that help to maintain ecological equilibrium and encourage natural regenerative processes such as nitrogen fixation, nutrient cycling, soil regeneration, and the protection of natural enemies of pest and diseases as well as the targeted use of inputs. Agricultural systems relying on such approaches not only support high productivity, but also preserve biodiversity and safeguard the environment. Conservation agriculture is a new paradigm for achieving sustained agricultural production and is a major step in the transition to sustainable agriculture.

Over the past few decades, resource conservation technologies, such as zero and reduced-tillage systems, better crop residue management and planting systems, have evolved to enhance water and nutrient conservation. Conservation agriculture—an array of four components including permanent soil cover, minimum soil disturbance, diversified crop rotations and integrated weed management—is now considered the principal road to sustainable agriculture and the protection of natural resources and the environment. Currently, conservation agriculture is practiced on more than 125 million ha worldwide.

While the adoption of conservation agriculture is increasing globally, in some regions it is either slow or non-existent. As a result, we felt it timely to collect and synthesize the latest developments on conservation agriculture research. The contents of this book are divided into five sections and 23 chapters as detailed below:

(1) Introduction

Chapter 1 is a brief history and overview of the components and adaptation of conservation agriculture.

(2) Elements of conservation agriculture

- Chapter 2 collates and performs a meta-analysis on existing literature on the effect of crop rotations and crop residue management on maize grain yield under conservation agriculture.

- Chapter 3 describes weed problem in conservation agriculture systems and proposes the strategies for integrated weed management.
 - Chapter 4 discusses the nutrient management perspectives in conservation agriculture, and suggests the strategies for improving the nutrient use efficiency in conservation agriculture systems.
 - Chapter 5 is an overview of the essential machinery requirements for the different farm operations involved in conservation agriculture. Regional-specific issues with emphasis on developing countries are also discussed, and pragmatic solutions of vital interest to researchers, academia and policy makers globally are proposed.
 - Chapter 6 describes the impact of conservation agriculture on the prevalence of insects, insect biodiversity, and proposes options for integrated insect pest management in conservation agriculture.
- (3) Modeling and crop improvement for conservation agriculture
- Chapter 7 covers crop breeding for conservation agriculture. Crop improvement and breeding strategies are proposed to develop improved crop genotypes better adapted to conservation agriculture.
 - Chapter 8 introduces the SALUS model and its tillage component to evaluate the effects of tillage on soil water infiltration, time to ponding and soil biophysical properties.
- (4) The status of conservation agriculture including some case studies
- Chapter 9 discusses the evolution and adoption of conservation agriculture in the Middle East.
 - Chapter 10 discusses Syrian experiences on conservation agriculture.
 - Chapter 11 describes the experiences, challenges and options regarding conservation agriculture in South Asia.
 - Chapter 12 covers conservation agriculture in South East Asia and introduces the Conservation Agriculture Network for South East Asia.
 - Chapter 13 discusses conservation agriculture in China, particularly in rain-fed areas, including early history and progress on research and adoption for better soil and water conservation.
 - Chapter 14 discusses the future of conservation farming in Australia and New Zealand, and recent advances in weed control strategies.
 - Chapter 15 outlines future prospects for up-scaling of conservation agriculture in Europe, and describes the likely impact of global changes and constraints for its adoption and spread.
 - Chapter 16 describes the origins and impacts of conservation agriculture in different regions of Latin America, highlights the factors limiting its adoption and outlines the innovations and strategies developed in some countries to overcome these limitations.
 - Chapter 17 illustrates the diversity of conservation agriculture adoption in North America, and provides an overview of several contrasting production regions.

- Chapter 18 describes the diversity and heterogeneity of farms in sub-Saharan Africa, and highlights the experiences and constraints in conservation agriculture in the region.
- (5) Conservation agriculture in agricultural systems.
- Chapter 19 covers the sustainable use of soil and other natural resources in relation to agronomic productivity and environment quality. It also addresses soil C sequestration potential through conservation agriculture, and its management in diverse soils and agro-ecosystems.
 - Chapter 20 discusses the potential applications of microbiology in conservation agriculture.
 - Chapter 21 discusses the experiences, challenges and opportunities of conservation agriculture in organic farming in Europe.
 - Chapter 22 outlines the potential role of conservation agriculture in mitigating the impact of climate change on crop production.
 - Chapter 23 discusses the factors driving the adoption of conservation agriculture and proposes some possible future directions for conservation agriculture adoption research.

Professor Kadambot Siddique's research on conservation agriculture is partly funded by the Australian Centre for International Agricultural Research (ACIAR) and is gratefully acknowledged. We thank all the authors for their contributions, and their help and cooperation during the manuscript writing and revision process. We also thank Dr. Maryse Elliott, Senior Publishing Editor and Melanie van Overbeek, Senior Publishing Assistant, Agronomy and Life Sciences Unit, Springer Dordrecht, The Netherlands.

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Conservation Agriculture

Farooq, M.; Siddique, K. (Eds.)

2015, XIX, 665 p. 40 illus. in color., Hardcover

ISBN: 978-3-319-11619-8