

**TILLAGE AND
CROP PRODUCTION**
(2nd Edition)

By the same author

- **Glossary of Indian Crops**
- **Introduction to Crops of India**
- **Practical Manual on Basic Agronomy with theory**
- **Wheat Crop Management**

TILLAGE AND CROP PRODUCTION

(2nd Edition)

Professor N.R. Das

M.Sc. (Ag.), Ph.D., D.W.P (CIMMYT-MEXICO), FIBR (INDIA)
Ex-Professor of Agronomy, BCKV, West Bengal



Published by
SCIENTIFIC PUBLISHERS (INDIA)

Jodhpur –

5 A, New Pali Road
P.O. Box 91
Jodhpur - 342 001 INDIA

Delhi –

4806/24, Ansari Road
Daryaganj
New Delhi - 110 002 INDIA

© 2017, Das, N.R.

All rights reserved. No part of this publication or the information contained herein may be reproduced, adapted, abridged, translated, stored in a retrieval system, computer system, photographic or other systems or transmitted in any form or by any means, electronic, mechanical, by photocopying, recording or otherwise, without written prior permission from the author.

Disclaimer: Whereas every effort has been made to avoid errors and omissions, this publication is being sold on the understanding that neither the editors (or authors) nor the publishers nor the printers would be liable in any manner to any person either for an error or for an omission in this publication, or for any action to be taken on the basis of this work. Any inadvertent discrepancy noted may be brought to the attention of the publisher, for rectifying it in future editions, if published.

Trademark Notice: Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

ISBN: 978-93-86237-08-8 (HB)
978-93-86237-09-5 (PB)

1st Edition, 2008

Visit the Scientific Publishers (India) website at
<http://www.scientificpub.com>

Printed in India

PREFACE

(2nd Edition)

Updating is common in books after some time due to addition/creation of new information. In this book "Tillage and Crop Production" also new information has been added, besides correction and revision thoroughly.

A new sub-chapter 9.3 has been added after 9.2 in Chapter 9, on "Tillage for multiple cropping systems" (based on field experimental results). In this sub-chapter, field research information has been added.

In Part II some information on 'Water-Crops' has been added, in view of new information, available from 'water-crops' recently.

Some review questions have been set after each chapter.

Some new books have been added to 'References'.

I feel, with these new informations, the students of both the graduate and post-graduate categories of the agricultural universities of the country will be benefitted highly, besides others.

I am very thankful to my colleagues and friends of Bidhan Chandra Krishi Viswavidyalaya, West Bengal; Viswa Bharati University, West Bengal; Orissa University of Agriculture and Technology, Odisha; Calcutta University, West Bengal; Assam Agricultural University, Assam, Uttarbanga Krishi Viswavidyalaya, West Bengal; Tamil Nadu Agricultural University, Tamil Nadu etc., for their encouragement in the additional information added to the book. I am also thankful to my son Partha, daughter Aparna and wife Arati for their direct or indirect help on this aspect. The author specially thanks Dr. I.C. Gupta, Ex-Principal Scientists, Central Arid Zone Research Institute, Jodhpur for suggesting the corrections in the first edition of the book.

Sabuj Niketan,
Kalyani, West Bengal,
September, 2016

(N.R. Das)

PREFACE

(1st Edition)

Field crop research, concerning tillage management in high yielding crop varieties, coinciding with irrigation, fertilization, pest management etc. for improved crop productivity of the country, now-a-days, is very important. This tillage management has changed the entire outlook of agriculture and resulted traditional agriculture into a modern worthwhile enterprises.

Still this high crop-productivity is not enough, because we have to face the growing population of more than 100 crores, for supplying high quality food, feed, fuel, wood, fibre and fodder to our men and cattle, besides clothes for human-beings. To meet this growing need and to maintain the standard of living, we have to produce more and more quality produce for which scientific agricultural technologies, including tillage management, are required.

The crop productivity due to varietal improvement, has almost reached to saturation, resulting into a very nominal increase in productivity. Therefore, it is high time for agronomists to develop non-monetary/less monetary input resources and to reduce various losses of nutrients, water and agricultural products so that efficiency of applied inputs is increased; higher crop yield is harvested sometimes with higher cropping intensity. All these need a time bound, more accurate and problem-oriented quick decisions, like other enterprises.

Tillage, which is essential sometimes, for higher crop production, may be reduced or modified in some cases to some extent, to achieve the maximum economic production of crops of different types in different seasons under different cropping systems, provided all about tillage is known by the growers. So, knowledge about tillage will help in improving the crop cultivation for higher production of crops, in untapped areas and even in tapped areas, where intensity of cropping may be raised with different tillage operations.

Now-a-days tillage is a costly proposition. Reduced tillage or no-tillage relay (*utera/paira*) crops, get momentum in some areas, both

for crop yields, maintenance of soil fertility, with higher production economics, both under rainfed and irrigated conditions.

The present book entitled, '**Tillage and Crop Production**' covers 'tillage' with different objectives, affecting factors, implements, impact of soils-crops-weeds-cropping systems, both under irrigation and fertilization, including special types of tillage, leading to the maximum crop production. It describes need of tillage operations both under irrigated and rainfed conditions for most of the arable/aquatic crops in different seasons under different cropping systems, for maximum economic yields. There are eleven chapters in Part I viz. (1) Introduction, (2) Tillage and tith, (3) Types and methods of tillage, (4) Factors affecting tillage, (5) Tillage implements, (6) Effects of tillage, (7) Tillage in relation to crop production, (8) Tillage versus irrigation and fertilization, (9) Tillage for special crops, cropping and situations, (10) Tillage, crop production and production economics (11) Financial aspects of tillage and crop management, Part II deals with important information and terminology.

The book has been written for the graduate and post-graduate students of agricultural universities of the country. It will be very useful for researchers, extension personnel and planners of agriculture. Even the farmers of different states will be benefitted from it. I will be happy if it is used for the benefit of crop production in the country, for which it has been aimed at.

I am very thankful to my colleagues and friends of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, Kalyani University, West Bengal, Viswa Bharati University, West Bengal, Tamil Nadu Agricultural University, Tamil Nadu, Andhra Pradesh Agricultural University, Andhra Pradesh, North Bengal Agricultural University, West Bengal and Calcutta University, West Bengal, for their encouragements in writing this book. I am thankful to my students for utilizing their research work. I am also thankful to my son Partha, daughter Aparna and wife Arati for their help.

Sabuj Niketan,
Kalyani, West Bengal,
2008

(N.R. Das)

CONTENTS

PART - I

CHAPTER 1. INTRODUCTION	1
1.1 History and development of tillage	1
1.2 Seeds and germination	7
1.3 Tillage variations in continents/countries	11
1.4 Root and shoot development versus tillage	14
1.5 Modern concept of tillage for agriculture	16
CHAPTER 2. TILLAGE AND TILTH	23
2.1 Tillage	23
2.2 Tilth	30
CHAPTER 3. TYPES AND METHODS OF TILLAGE	34
3.1 Arable and dry lands	34
3.2 Wetlands	44
3.3 Special type of tillage	51
CHAPTER 4. FACTORS AFFECTING TILLAGE	55
4.1 Weather parameters	55
4.2 Seasons	57
4.3 Soils	59
4.4 Topography	60
4.5 Land situations (plains/flat areas)	62
4.6 Crops and cropping systems	64
CHAPTER 5. TILLAGE IMPLEMENTS	69
5.1 Primary tillage implements	69
5.2 Secondary tillage implements	70

5.3	Intercultural operations implements	70
5.4	Special highly-needed inter-tillage implements	72
CHAPTER 6.	EFFECTS OF TILLAGE	74
6.1	Soils	74
6.2	Crops and cropping system (in respect of production)	78
6.3	Weeds in the seasons	81
6.4	Environment	83
CHAPTER 7.	TILLAGE IN RELATION TO CROP PRODUCTION	84
7.1	Single crops (including inter crops/tier-crops)	84
7.2	Multiple cropping systems	90
CHAPTER 8.	TILLAGE VERSUS IRRIGATION AND FERTILIZATION	93
8.1	Tillage versus irrigation	93
8.2	Tillage versus fertilization	97
CHAPTER 9.	SPECIAL TILLAGE FOR CROPS, CROPPINGS AND SITUATIONS WITH MULTIPLE CROPPING SYSTEMS	100
9.1	Tillage for special crops	100
9.2	Tillage for croppings and situations	104
9.3	Tillage for multiple cropping systems	106
CHAPTER 10.	TILLAGE, CROP-PRODUCTION AND PRODUCTION-ECONOMICS	114
10.1	Crop production under tillage	114
10.2	Tillage and production-economics	116
CHAPTER 11.	FINANCIAL ASPECTS OF TILLAGE AND CROP MANAGEMNT	119
11.1	Tillage information	119
11.2	Crop management information	124
11.3	Terms used in crop management (in respect of financial aspects)	127

PART - II

IMPORTANT INFORMATION AND TERMINOLOGY	143
1. Requirement of NPK-fertilizers for unit area of crop production	143
2. Yield estimation of some crops	144
3. Classified arable crops in seasons and water-crops with scientific, English and local names under different families	148
4. <i>Paira/Utera</i> (no-tillage relay) crops in seasons	155
5. Climatological data	158
6. Soil analytical data (Mechanical, Chemical and Physical properties)	161
7. Soil moisture status in rice-fallows in different dry months (<i>rabi</i>)	162
8. Rainfed crops in different seasons (<i>Rabi</i> , <i>Pre-kharif</i> and <i>Kharif</i> seasons) alongwith rainfall	163
9. Terms commonly used in agriculture	165
10. Terms used in tillage operation	168
11. Tillage implements	171
12. Types of crops	175
13. Measuring instruments in crop research	181
REFERENCES	183
APPENDICES	185
A. Soil fertility in rainfed rice-based <i>paira</i> cropping system (3-crop system)	185
B. Production economies of rainfed rice-based 3-crop system	186
C. Production of irrigated crops in wheat-based 3-crop system	186

PART – I

