



# **Climate Smart Agriculture: Principles and Practices**

**BADAL VERMA  
DOPPALAPUDI VIJAYA RANI  
SHALINI ROY  
M. H. CHAVDA  
DR. K. RAMYA KRISHNA  
CHALLA OMPRIYA**

**Kripa Drishti Publications, Pune.**

# CLIMATE SMART AGRICULTURE: PRINCIPLES AND PRACTICES

## Editors

### **Badal Verma**

ICAR SRF Ph.D. Scholar,  
Department of Agronomy,  
JNKVV, Jabalpur.

### **Doppalapudi Vijaya Rani**

PhD Scholar in Agronomy,  
College of Agriculture,  
Sardar Vallabhbhai Patel University of Agriculture &  
Technology in Meerut, Uttar Pradesh.

### **Shalini Roy**

PhD Scholar in Agronomy,  
Sardar Vallabhbhai Patel University of Agriculture and  
Technology, Meerut, Uttar Pradesh.

### **M. H. Chavda**

Ph.D Scholar in the Department of Agronomy,  
C. P. College of Agriculture, SDAU, Sardarkrushinagar,  
Gujarat.

### **Dr. K. Ramya Krishna**

Head of the Department,  
Agriculture and Rural Development,  
Andhra Loyola College,  
Vijayawada.

### **Challa Ompriya**

Master's Student, Department of Agronomy,  
Sustainable Agriculture at University of Padua,  
Padua, Italy.

**Kripa-Drishti Publications, Pune.**

Book Title: **Climate Smart Agriculture: Principles and Practices**

Edited By: **Badal Verma, Doppalapudi Vijaya Rani,  
Shalini Roy, M. H. Chavda,  
Dr. K. Ramya Krishna, Challa Ompriya**

Price: ₹399

1<sup>st</sup> Edition

ISBN: 978-81-19149-15-5



Published: **June 2023**

**Publisher:**



**Kripa-Drishti Publications**

A/ 503, Poorva Height, SNO 148/1A/1/1A,  
Sus Road, Pashan- 411021, Pune, Maharashtra, India.

Mob: +91-8007068686

Email: [editor@kdpublishations.in](mailto:editor@kdpublishations.in)

Web: <https://www.kdpublishations.in>

© Copyright Badal Verma, Doppalapudi Vijaya Rani, Shalini Roy, M. H. Chavda,  
Dr. K. Ramya Krishna, Challa Ompriya

All Rights Reserved. No part of this publication can be stored in any retrieval system or reproduced in any form or by any means without the prior written permission of the publisher. Any person who does any unauthorized act in relation to this publication may be liable to criminal prosecution and civil claims for damages. [The responsibility for the facts stated, conclusions reached, etc., is entirely that of the author. The publisher is not responsible for them, whatsoever.]

# CONTENT

<b>1. Climate Resilient Agriculture Potential and Productivity - Sharad V. Gosavi, Pundlik K. Waghmare, Mamta J. Patange .....</b>	<b>1</b>
1.1 Introduction:.....	2
1.2 Climate Resilient Agriculture Potential and Productivity: .....	4
1.3 Impact of Climate Change on Indian Agriculture:.....	4
1.4 The Probable Impacts of Climate Change on Various Sectors of Indian Agriculture Are: .....	6
1.4.1 Effects on Crops:.....	6
1.4.2 Effects on Water: .....	7
1.4.3 Effects on Soil:.....	7
1.4.4 Effects on Livestock:.....	7
1.4.5 Effects on Fisheries:.....	8
1.5 Climate Resilient Agriculture Working:.....	8
1.5.1 Climate-Resilient Agriculture (CRA) Include 3 Phases: .....	8
1.6 Recognition of Threats in Agriculture:.....	9
1.7 Curing of the Threats to Reduce the Effect of Climate Change: .....	10
1.7.1 Improved techniques for adaptation to climate change:.....	10
1.7.2 Improved Techniques to Mitigate Climate Change: .....	15
1.8 Sustaining or Maintaining the Measures to Reduce the Effect of Climate Change: .....	18
1.9 Conclusion: .....	18
1.10 References:.....	19
<b>2. Conservation Agriculture and Carbon Sequestration - Shani Gulaiya, Abhishek Sharma, Priya Kochale, Parikha P. Singh .....</b>	<b>1</b>
2.1 Introduction:.....	2
2.2 Why We Need Conservation Agriculture? .....	2
2.3 Philosophy of Conservation Agriculture: .....	4
2.3.1 CA Is Based on Three Principles Applied Simultaneously (FAO, 2012): .....	5
2.4 Conservation Agriculture Practices Includes: .....	6
2.4.1 Conservation Tillage: .....	6
2.4.2 Mulch Tillage: .....	8
2.4.3 Crop Residue Management (CRM): .....	10
2.4.4 Crop Rotation: .....	11
2.5 Carbon Sequestration:.....	12
2.5.1 Carbon Sequestration Methods:.....	13
2.6 Conclusion: .....	16
2.7 References:.....	17

**3. Conservation Agriculture in India, History, Status, Implications and Sustainability Uses - Buriga Teja Swaroop, Kobagapu Mani Ratnam, Palli Susan Grace, Yalamala Prasanghi ..... 20**

3.1 Introduction: ..... 20

3.2 Conservation Agriculture Definition and Goals:..... 21

    3.2.1 How Is Conservation Agriculture Different from Sustainable Intensification? ..... 23

    3.2.2 How Is Conservation Agriculture Differing from Organic Agriculture?..... 23

    3.2.3 How Is Conservation Agriculture Differing from Climate-Smart Agriculture?..... 23

3.3 Principles of Conservation Agriculture: ..... 24

    3.3.1 Minimal Mechanical Soil Disturbance:..... 24

    3.3.2 Permanent Organic Soil Cover: ..... 24

    3.3.3 Diversified Crop Rotations:..... 24

3.4 History and Status of Conservation Agriculture in India and World: ..... 25

    3.4.1 Benefits of Conservation Agriculture: ..... 26

    3.4.2 Prospects of Conservation Agriculture: ..... 27

    3.4.3 Constraints in Adoption of Conservation Agriculture: ..... 28

3.5 Conservation Agriculture's Challenges:..... 34

3.6 Implications and Sustainability Uses:..... 35

3.7 Conclusion: ..... 37

3.8 References:..... 38

**4. Soil Health Management Under Conservation Agriculture - Deepasree A., Mayurakshi Chanda, Pundlik K. Waghmare ..... 42**

4.1 Introduction: ..... 43

4.2 Soil Health:..... 44

4.3 Conservation Agriculture (CA):..... 45

4.4 Soil Health Management Under Conservation Agriculture (CA):..... 46

    4.4.1 Influence of CA On Soil Physical Properties: ..... 47

    4.4.2 Influence of CA On Soil Chemical Properties: ..... 49

    4.4.3 Influence of CA On Soil Biological Properties: ..... 50

4.5 Conclusions: ..... 52

4.6 References: ..... 53

**5. Robotics in Agriculture - Hradesh Shivhare, Suraj Luthra..... 54**

5.1 Introduction: ..... 54

5.2 Concepts and Components of Robots:..... 55

    5.2.1 Applications of AI in Agriculture Sector: ..... 56

5.3 Robotics and Automation Reasons:..... 56

5.4 Production of Vegetables Using Robots:..... 57

5.5 Conclusion: ..... 65

5.6 References:.....	66
----------------------	----

**6. Crop Modelling of Adaptive and Mitigating Potential of Climate Smart Practices - Pundlik K. Waghmare, Sharad V. Gosavi, Mamta J. Patange.....67**

6.1 Introduction:.....	68
6.2 Modelling for Crop Improvement:.....	69
6.3 Crop Modelling of Adaptive and Mitigating Potential of Climate Smart Practices .....	70
6.3.1 The Role of Crop Models in Assessing Risk and Adaptation:.....	70
6.3.2 Towards Improved Framing of Risks Posed by Climate Change to Food Production Systems:.....	71
6.3.3 Developing and Running Crop Models:.....	73
6.3.4 Crop-Climate Resembles:.....	75
6.3.5 Modelling Adaptation:.....	77
6.3.6 Towards Targeted Use of Models:.....	79
6.4 Conclusion:.....	81
6.5 References:.....	82

**7. Site Specific Nutrient Management as Climate Smart Practice - Anjali Rawat,  
Ananya Gairola, Deepti Joshi .....83**

7.1 Introduction:.....	83
7.2 Important Features of SSNM:.....	85
7.3 Plant Analysis Based SSNM:.....	85
7.3.1 Soil-Cum-Plant Based SSNM:.....	86
7.3.2 Site Specific Nutrient Management for Precision Agriculture:.....	86
7.4 Importance of SSNM:.....	88
7.5 Elements of SSNM:.....	88
7.6 Basic Steps in SSNM:.....	89
7.7 Dissemination Tools for SSNM:.....	90
7.8 SSNM for Potassium:.....	90
7.9 Models for SSNM:.....	91
7.10 Nutrient Expert as A Decision Support Tool:.....	91
7.11 Nutrient Manager:.....	93
7.12 References:.....	95

**8. Concept and Practices Under Conservation Agriculture -  
V. V. S. Jaya Krishna, Jhadi Rakesh, Md. Anwar Ali, J. S. S. Priyanka .....96**

8.1 Introduction:.....	96
8.2 Principles of Conservation Agriculture:.....	97
8.2.1 Permanent Organic Soil Cover:.....	97
8.2.2 Diversified Crop Rotations:.....	98
8.2.3 Minimum Mechanical Soil Disturbance:.....	98
8.3 Conservation Tillage Practices Include:.....	99
8.4 Status of Conservation Agriculture and Its Extent of Adoption in India:.....	100

8.5 Conservation Agriculture Benefits: .....	100
8.5.1 Economic Benefits:.....	101
8.5.2 Environmental Benefits: .....	101
8.5.3 Benefits in Resource Conservation and Improvement: .....	102
8.5.4 Soil Physical Health:.....	102
8.5.5 Crop Productivity: .....	102
8.5.6 Water and Nutrient Use Efficiency:.....	103
8.5.7 Soil Erosion Control: .....	103
8.5.8 Climate Change Mitigation/Adaptation: .....	103
8.6 Management Practices Concentric to Conservation Agriculture:.....	104
8.6.1 Conservation Tillage Practices: .....	104
8.6.2 Residue Management Practices That Avoid Burning: .....	104
8.6.3 Crop Diversification Practices: .....	105
8.6.4 Nutrient and Water Management Practices:.....	105
8.6.5 Weed Management Practices:.....	105
8.7 Effect of CA On Crop Yields: .....	105
8.8 Predictions of Conservation Agriculture: .....	106
8.8.1 Limitations for Adoption of CA: .....	107
8.8.2 Bottlenecks for Adoption of Conservation Agriculture: .....	107
8.9 Lack of Appropriate Machineries:.....	107
8.9.1 Infrastructural Constraints: .....	108
8.9.2 Obnoxious/Stubborn/Resistant Weeds: .....	108
8.10 Conclusion: .....	108
8.11 Reference: .....	109

## **9. New and Innovative Technologies and Machinery in Conservation**

**Agriculture - Muskan Porwal, Badal Verma, A. K. Jha ..... 113**

9.1 Introduction: .....	113
9.2 CA Technologies and Machinery in India: .....	115
9.2.1 Machineries and Technologies for Sowing Management: .....	116
9.2.2 Nutrient Management Technologies and Equipment:.....	126
9.2.3 Cover Crop and Weed Management Equipment: .....	128
9.3 Water Management Technologies and Machineries: .....	131
9.3.1 Direct Seeded Rice:.....	132
9.3.2 System of Rice Intensification: .....	132
9.3.3 Micro-Irrigation Systems:.....	133
9.3.4 Harvest Management Using Combine Harvesters: .....	133
9.4 Conclusions: .....	134
9.5 References: .....	134

**10. Nanotechnology in Agriculture Against Climate Change - K. Srikanth Reddy, Kadapa Sreenivasareddy, G. Alekhya, Doppalapudi Vijaya Rani, G. Raja Reddy, B. V. Jayanth ..... 138**

10.1 Introduction: .....	139
--------------------------	-----

10.2 Nanoparticles and Its Technical Aspects: .....	141
10.3 Application of Nanomaterials in Agricultural Industry to Mitigate Climate Change: .....	142
10.4 Role of Nanomaterials to Mitigate Environmental Stresses: .....	145
10.5 Nano Materials in The Form of Polymer Coatings as Seed Priming: .....	146
10.6 Conclusion: .....	148
10.7 References: .....	149

**11. Climate-Smart Fisheries and Aquaculture Globally and in India -  
Martina Meinam, Teresa Meinam, Huiem Bharati .....153**

11.1 Introduction: .....	153
11.2 Importance of Fisheries and Aquaculture in India: .....	154
11.2.1 Impact of Climate Change on Fisheries and Aquaculture: .....	154
11.2.2 Climate-Smart Fisheries and Aquaculture: .....	155
11.3 Fisheries and Aquaculture have Distinct Characteristics: .....	156
11.4 An Ecosystem Approach to Fisheries and Aquaculture: .....	157
11.5 Climate Change Processes and Impacts: .....	159
11.6 People, Communities and Vulnerability: .....	161
11.7 Conclusion: .....	163
11.8 References: .....	164

**12. Agriculture Practices to Reduce In-Field Greenhouse Gas Emissions -  
Badal Verma, Muskan Porwal, A. K. Jha, Tarun Sharma .....166**

12.1 Introduction: .....	167
12.2 Agriculture Practices to Reduce In-field Green House Gas Emissions: .....	170
12.2.1 Adoption of Conservation Tillage Practices: .....	170
12.2.2 Agronomic Practices: .....	171
12.2.3 Reduce Enteric Fermentation Through New Technologies: .....	172
12.2.4 Soil Amendments for Reducing GHG Emissions: .....	173
12.2.5 Improved Manure Management: .....	173
12.2.6 Fertilizer Management: .....	174
12.2.7 Rice Management and Varieties: .....	174
12.2.8 Increase Agricultural Energy Efficiency and Shift to Non-Fossil Energy Sources: .....	175
12.1.9 Focus on Realistic Options to Sequester Carbon in Soils: .....	175
12.3 Conclusion: .....	175
12.4 References: .....	176

**13. Crop Breeding Strategies for Climate Resilient Agriculture - Kapil,  
Ayushi Nanda, Neha Pal.....181**

13.1 Introduction: .....	182
13.2 Pre-Breeding and Crop Wild Relatives (CWR): .....	183
13.3 Biotechnology: A Strategy for Climate Resilient Agriculture: .....	186
13.4 Genome Editing: A Revolutionary Tool for Breeders' Toolbox: .....	188



13.5 Phenomics and Artificial Intelligence: .....	189
13.6 Speed Breeding: an Acceleration to Crop Improvement: .....	190
13.7 Conclusion: .....	191
13.8 Reference: .....	192

#### **14. Conservation Agriculture in Drylands of World and India -**

*Shruti Grace George, Prateek Kumar, Shalini Roy, Doppalapudi Vijaya Rani..* **195**

14.1 Introduction: .....	196
14.2 An Overview of Global Perspectives on Conservation Agriculture in Drylands: .....	197
14.3 An overview of Indian Perspectives on Conservation Agriculture in Drylands: .....	199
14.4 Conservation Agricultural Practices in World & India: .....	200
14.5 Conclusion.....	200
14.6 References: .....	201

#### **15. Conservation Agriculture in World, History, Status, Implications and Sustainability Issues - Shalini Roy, Doppalapudi Vijaya Rani, Prateek Kumar, Shruti Grace George .....**

**203**

15.1 Introduction: .....	204
15.2 Sustainability Issues: .....	208
15.3 Conclusion: .....	209
15.4 References: .....	209

#### **16. Regenerative Agriculture - Priya Kochale, Shani Gulaiya, Abhishek Sharma .....**

**211**

16.1 Introduction: .....	211
16.1.1 Need of Regenerative Agriculture: .....	212
16.1.2 Principles of Regenerative agriculture: .....	212
16.2 Benefits of Regenerative Agriculture: .....	214
16.2.1 Increased Soil Carbon: .....	214
16.2.2 Pest, Pathogen, and Weed Control / Suppression: .....	220
16.2.3 Climate Mitigation: .....	221
16.3 Conclusion: .....	222
16.4 References: .....	223

## ABOUT THE EDITORS



**Badal Verma** is ICAR SRF Ph.D. Scholar, Department of Agronomy, JNKVV, Jabalpur. He is a recipient of the CSDA-NAHEP Fellowship Award. He has also qualified ASRB-NET exam in 2020 and 2021. He has been awarded Best Poster Award from the Indian Society of Agronomy, Best Oral Presentation Award, Best M.Sc. Thesis Award and the Outstanding Research Scholar Award. He is a life member of ISA and ISWS. He has published around 10 research papers, 03 book chapters, and many abstracts and popular articles.



**Doppalapudi Vijaya Rani** is a PhD Scholar in Agronomy, at the College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture & Technology in Meerut, Uttar Pradesh. She was born in Jujuru Village in Krishna District, Andhra Pradesh. She finished her bachelor's degree program in Agriculture at Acharya N.G Ranga Agriculture University, Guntur, Andhra Pradesh from 2014-2018. Moreover, she obtained a Master's degree in Agronomy from Bidhan Chandra Krishi Viswavidyalay in Mohanpur, West Bengal from 2018-2020. During her PG, she was awarded a Junior Research Fellowship from the Indian Council of Agriculture Research. She qualified for the ASRB-National Eligibility Test as well. She worked as a Young Professional-II (S.M.S) at the ICAR-Central Tobacco Research Institute-Krishi Vigyan Kendra, located in Kandukur, Prakasam District of Andhra Pradesh.



**Shalini Roy**, born in the year 1996 in Bihar, India is a PhD Scholar, Department of Agronomy in Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh. She obtained her Bachelor's and Master's degrees in Agriculture and Agronomy in 2017 and 2019, respectively from Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. She has also qualified the National Eligibility Test (NET) conducted by the ASRB in the year 2021.



**Mr. M. H. Chavda** is a Ph.D Scholar in the Department of Agronomy at C. P. College of Agriculture, SDAU, Sardarkrushinagar, Gujarat. He has received his B.Sc (Agri) degree from Anand Agricultural University, Anand, Gujarat and M.Sc (Agri) in the discipline of Agronomy from C. P. College of Agriculture, SDAU, Sardarkrushinagar, Gujarat. He has published 08 research paper, 02 book chapters, 05 abstract and 10 articles in reputed magazine, newsletters and various national and international repute journals. He has also member of 04 repute professional society. He has attained and participated in national and international level seminar, conference, workshop, training and webinars.



**Dr. K. Ramya Krishna** was born in Machilipatnam, India in 1993. She obtained her Bachelor's degree from Acharya N.G.Ranga University, Agricultural college, Bapatla in 2015, and obtained her Master's degree in Soil science and Agricultural Chemistry from Banaras Hindu University, Varanasi, U.P. in 2017. Her Master's thesis on the effect of FYM and Vermicompost on chromium contaminated soil was her first work as a researcher. She pursued her Doctoral degree in Soil Science and Agricultural Chemistry from Bidhan Chandra Krishi Vishwavidyalaya, West Bengal, India with the research on "Effect of Municipal Bio-waste Compost on the dynamics of nutrients in Potato-Bhindi-Rice cropping system in New Alluvial Zone of West Bengal" in 2021. She received Young Soil Scientist Award in 2021. She worked as Assistant professor and Currently she was appointed as Head of the Department, Agriculture and Rural Development, Andhra Loyola College, Vijayawada.



**Ompriya Challa** is currently master student in Sustainable Agriculture at University of Padua, Padua, Italy. She was born in Anantapur district, Andhra Pradesh, India. She obtained her bachelor's degree from Lovely Professional University, Punjab, India, and also obtained her Master's degree in Plant Pathology from Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal. In addition, she has worked as a Subject Matter Specialist (SMS) in agriculture for Organic farming project at Rural Development Trust, Anantapur District, Andhra Pradesh, India.



Kripa-Drishti Publications  
A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk,  
Pune - 411021, Maharashtra, India.  
Mob: +91 8007068686  
Email: editor@kdpublications.in  
Web: <https://www.kdpublications.in>

Price: ₹ 399

ISBN: 978-81-19149-15-5



9 788119 149155