

Nutrient Use Efficiency Through **NEXT**
GENERATION
FERTILIZERS



Ummed Singh
Chandra Sekhar Praharaj



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Nutrient Use Efficiency Through Next Generation Fertilizers



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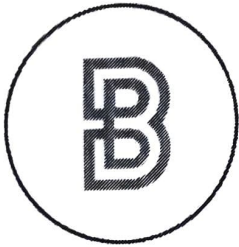
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FOREWORD

The nutrient use efficiency in Indian soils ranges from 30-50%, 15-20%, 60-70%, 8-10% and 1-5% for nitrogen, phosphorus, potassium, sulphur and micronutrients, respectively. The unutilized nitrogen is polluting groundwater and atmosphere due to leaching and denitrification/volatilization loss. Similarly, a considerable amount of phosphorus, potassium sulphur and micronutrients are lost through the process of soil erosion. Fertilizer use is a serious concern due to induced environmental degradation and low use efficiency. Therefore, the development of next generation fertilizer with high nutrient use efficiency and cost effectiveness is required to improve soil health and environmental quality as well as to fulfill food and nutritional security. Next generation fertilizer releases nutrient as per the demand of crops throughout the period of crop growth, thereby, having greater perspectives in terms of enhancement of crop yield and fertilizer response ratio with less amount of applied fertilizers. The smart delivery system has made it possible to develop such fertilizers with huge market potential.

The book entitled "*Nutrient Use Efficiency Through Next Generation Fertilizers*" is quite relevant and will serve as useful resource for various stakeholders and motivate them to put their best efforts towards improving nutrient use efficiency to enhance crop productivity. I congratulate Agriculture University, Jodhpur and ICAR-Indian Institute of Pulses Research, Kanpur for their sincere efforts in bringing out this publication.

(T. Mohapatra)

Date: 3rd June 2021

Place: New Delhi



PREFACE

Plant nutrients have been the key inputs in augmenting crop production and quality of the food. Despite our best and diverse efforts for sustainable crop production, the imbalance in the use of N, P and K still continue to haunt us. Besides this, deficiency of secondary nutrients (especially S) and micronutrients (mainly Zn, Fe and B) are becoming wide spread in the Indian soils, leading to micronutrient malnutrition or '*Hidden Hunger*'; and the repercussion is low yield realization in the field crops. Supplementing this, continuous addition of some of the straight fertilizers results in low nutrient use efficiency, reduced factor productivity and poor crop response with economic fallouts. It triggers for appropriate action and remedies for enhancing factor productivity, crop response, nutrient/input use efficiency, and profitability.

In this account, one of the options available is to develop a suitable blend of fertilizers having all essential nutrients based on crop-need based release kinetics. Since straight fertilizers do provide a few nutrients at one time to the plants which may not commensurate with crop demand and could lead to loss or imbalance in nutrient (availability) in the soil, complex or blending of fertilizer nutrients could be the right answer. Moreover, if these nutrients can be formulated to a fertilizer depending on crop need or requirement of its phenophases/life cycle, it could be of immense useful for scaling nutrient use efficiency and crop productivity *per se*. In addition, due to balanced form with multi-nutrients content, higher nutrient use efficiency, lower production cost, application charges, and enrichment of grain quality characteristics, next generation fertilizers have larger perspectives in terms of its utilities and market values in time to come. Further, these specialty fertilizers (including coated fertilizers, soluble fertilizers, liquid fertilizers, fortified fertilizers, customized fertilizers etc.) constitute balanced use in soil while maintaining and improving soil fertility. Therefore, enabling usage of these could possibly bridge nutrient imbalances in both soil and plant besides enhanced use efficiency and higher output. Thus, application of next generation fertilizers will be the future source of nutrients for the plants.

It is in this context, the book entitled "***Nutrient Use Efficiency Through Next Generation Fertilizers***" is handy as it could provide a suitable platform in our collective efforts for an appropriate dialogue among the academicians, students, scientists, researchers, entrepreneurs, policy makers and farmers' in improving and addressing the budding issues of overall reduced nutrient use efficiency through varied approaches and strategies.

We are thankful to all the contributors of the book chapters for their sustained efforts in bringing out this publication. We are confident that this edited publication prepared out of experts' opinions and suggestions will be quite useful to all those directly or indirectly concerned with the emerging issues related to nutrient use efficiency; and would find a possible solution to it through next generation/customized fertilizers.

Editors

Ummed Singh

Chandra Sekhar Praharaj



CONTENTS

Foreword	v
Preface	vii
1. Next Generation Fertilizers - Introduction, Status and Future Outlook	1
<i>Ummed Singh and C.S. Praharaj</i>	
2. Customised Fertilisers: Manufacturing Methodologies, Guidelines and Processes	27
<i>Kanwar Singh and Ummed Singh</i>	
3. Nanofertilizers for Enhanced Nutrient Use Efficiency and Improved Crop Productivity	47
<i>Divya Sharma, Vikas Sharma and Ummed Singh</i>	
4. Coated and Value-added Fertilizers: A Comprehensive Review of Current Status and Future Perspectives	75
<i>Shantanu Kar, O Siva Devika, Sonam Singh, Amitava Rakshit and Ummed Singh</i>	
5. Biochar for Agricultural Soil Health Improvement and Adaptation to Climate Change	91
<i>G. Venkatesh, K.A. Gopinath, K. Sammi Reddy, M. Prabhakar, G. Ravindra Chary, B. Sanjeeva Reddy, S. Bhaskar, V. Visha Kumari and Vinod Kumar Singh</i>	
6. Seaweed Extracts: Biostimulants for Agricultural Crops	111
<i>Doongar R. Chaudhary and Arup Ghosh</i>	
7. Enhancing Nutrient Use Efficiency Through Differential Formulations of Fertilizers having Slow Release Matrix	129
<i>Lalit Kumar, Ummed Singh and Vijay Laxmi</i>	
8. Liquid Biofertilizers: Addresses Nutrient Use Efficiency and Crop Productivity	153
<i>Krishnashis Das, M. Senthilkumar, Ummed Singh and Krishna Saharan</i>	

9. **Rock Phosphate: An Emerging Source of Phosphorus for Higher Use Efficiency in Field Crops** 175
A.O. Shirale, B.P. Meena, Priya P. Gurav, Sanjay Srivastava, A.K. Biswas, R. Elanchezhian, V.D. Meena, H. Das, R.H. Wanjari and A.K. Patra
10. **Zincated Fertilizers: Balanced Fertilizer Use for Food, Nutrition and Health Security** 199
Soumitra Das and Andrew Green
11. **Organic Fertilizers: Towards Higher Nutrient Use Efficiency and Enhanced Soil Health** 215
Vinod Kumar Sharma, Sarvendra Kumar, Ankita Trivedi, Kapil A. Chobhe, Rosin K.G., Mohankumar K.T. and Ajin S. Anil
12. **Nitrification Inhibitors: Precursor for Higher Nitrogen Use Efficiency and Soil Health** 237
K.C. Kumawat, Sharon Nagpal, Ummed Singh and Shivani Sharma
13. **Urease Inhibitors: Precursor for Higher Use Efficiency and Soil Health** 275
K.C. Kumawat, Shivani Sharma, Sharon Nagpal and Ummed Singh
14. **Heavy Metals Restraining Nutrient Use Efficiency in Cereals and Pulses** 309
Vasudev Meena, M.L. Dotaniya, B.P. Meena, J.K. Saha and A.K. Patra
15. **Recent Advances in Enhancing Nutrient Use Efficiency for Higher Crop Productivity** 343
B.P. Meena, A.O. Shirale, A.K. Biswas, B.L. Lakaria, V.D. Meena, Priya P. Gurav, B. Lal, A.P. Pandirwar, H. Das and Ashok K. Patra
16. **Smart Nutrient Delivery to Field Crops for Higher Use Efficiency** 383
D.R. Palsaniya, Mukesh Choudhary, Sushil Kumar, Mahendra Prasad and Vikas Khandelwal
17. **Aqua-fertilization: An Easy Approach for Higher Nutrients Acquisition under Arid and Semi-arid Ecosystem** 417
D.S. Gurjar, Ummed Singh and V.K. Choudhary
18. **Variable Rate Fertilizer Applicator: A Precision Tool for Higher Input Use Efficiency** 427
Man Mohan Deo, Ummed Singh, Prasoon Verma, Om Prakash and Amit Kumar

THE EDITORS



Dr. Ummed Singh is a Distinguished University Professor of Agronomy and University Head of Department of Agronomy and Director (Prioritization, Monitoring & Evaluation) of Agriculture University, Jodhpur, Rajasthan, India. Prof. Ummed Singh obtained BSc (Honours) Agriculture (1998) and MSc (Ag) Agronomy (2000) from Rajasthan Agricultural University, Bikaner; PhD Agronomy (2005) from Indian Agricultural Research Institute, New Delhi; and Post Doctorate (2011) from Nanjing Agricultural University, Nanjing, P R China. Prof. Singh have served as Assistant Professor-cum-Jr Scientist (2005-2012) at SKUAST-K, Srinagar; Senior Scientist (2012-18) and Principal Scientist (2018) at ICAR-Indian Institute of Pulses Research, Kanpur; Dean, College of Agriculture, Jodhpur (2018-19). Prof. Singh has made outstanding research contribution in the field of Biofortification, Cropping Systems Research and Plant Nutrition. He has handled and concluded 23 inhouse research projects and 6 externally funded projects in the capacity of PI and Co-PI/Nodal officer. He has delivered 114 invited lectures in trainings/refresher courses/conferences, 26 TV/Radio talks, organized 16 trainings/winter/summer schools/workshop for Scientists/Teachers, participated in 58 national/international conferences, symposia, webinar, seminar, workshops and have attended 15 summer/winter schools/short trainings.

He has published 63 research papers, 13 review paper, 18 proceeding/lead Paper, 12 technical bulletin/training manual, 3 extension folders, 20 book chapters, 1 book, 1 conference souvenir, 1 annual report, 2 knowledge papers, 44 compendium chapters, 27 conference/symposia/seminar papers, 65 popular articles, 17 extended summaries and 43 abstracts. As a distinguished academician, he is teaching advance courses of Agronomy to the students of PhD (Agronomy), MSc (Ag) Agronomy and BSc (Hons) Agriculture and guiding PhD (Agronomy) and MSc (Ag) Agronomy students. He is and has been life membership of 14 Scientific/Professional Societies, reviewer of 22 journals, editor of 7 journals.

Prof. Singh was conferred SHRIRAM PURUSKAR (2019-20), GKV Society Fellow (2018), Distinguished Scientist Award (2017), ISPRD Fellow (2016), Reviewer Excellence Award (2016), Indian Society of Agronomy Associateship (2015), SERS Fellow (2015), Innovative Scientist of the Year (2014), SHRIRAM PURUSKAR (2013-14), IMPHOS-FAI Award (2013), Chinese Government Scholarship (2009-11), Best Oral Presentations, Best Poster Presentations etc. Prof. Singh is having international exposure and has been visited to the countries viz; P R China, Malaysia, Hong Kong, Thailand, United Arab Emirates and United States of America.



Dr. Chandra Sekhar Praharaj is a Distinguished Principal Scientist of Agronomy and Head of the Division of Crop Production at ICAR-Indian Institute of Pulses Research, Kanpur, India. Dr. Praharaj obtained his graduation with Merit Fellowship in Agriculture (1988) from OUAT Bhubaneswar; Master (1991) and Doctorate in Agronomy (1994) with Distinction Awards from PAU, Ludhiana. After successful completion of ARS (1992) and NET (1993), he served as a Scientist (1995-99) and Scientist Senior Scale (1999-2001) at CPRI Regional Station, Patna; Senior Scientist at IISWC Regional Centre, Koraput (2001-02) and CICR Regional Station, Coimbatore (2002-08), Principal Scientist (2009-21) and Head, Crop Production Division (2017 onwards) at ICAR-IIPR, Kanpur. Dr. Praharaj has made significant research contribution in the field of precision water management, long-term experimentation, and conservation agriculture enhancing water and nutrient use efficiency in multiple cropping systems involving cereals, potato, cotton and pulses in diverse agro-ecosystems. These works have been reflected from his >400 research publications including >100 refereed research articles, 8 books, 40 book chapters, 100 popular articles, 60 bulletins/manuals; presented 80 lead/oral papers and 100 poster papers in National and International Conferences/Symposia; and delivered 30 talks in Television and All India Radio Programmes. Dr. Praharaj have also visited/presented papers in foreign countries including Egypt, Morocco, Canada, Bangladesh, Nepal and India. Dr. Praharaj is currently Editor-in-Chief of Journal of Food Legumes (ISPRD), Associate Editor-in-Chief of Current Advances in Agricultural Sciences (SAP) and Editor of several NAAS journals. Besides recipient of Six best paper awards (by International Potash Limited and Professional Societies recognized by NAAS, India), Dr. Praharaj was conferred with Fellow of ISA (2014) and ISPRD (2016), Sri Ram Puraskar (FAI, 2013-2014; 2019-20), NCSG Award (2014); Reviewer Excellence Award (ARCC, 2016); Outstanding Scientist Award (ICAR-IIPR, 2017), Best Team Award (ICAR-IIPR, 2019) and ISPRD Recognition Award (2020). He has also received Awards of Appreciation by DOCD, Mumbai, DSASRD, Kanpur, and Government of Odisha (for watershed management). Dr. Praharaj's dedicated efforts, as Nodal Officer cum Member Secretary in both SFC/EFC & Project Monitoring and Evaluation (PME) Cell of ICAR-IIPR, Kanpur (2017 onwards), and Chickpea Network Programme (2014 onwards), has brought recognitions to the Pulses Institute through Choudhary Devi Lal Outstanding AICRP Award (AICRP on Chickpea, 2016) and Sardar Patel Outstanding ICAR Institution Award (ICAR-IIPR, 2017).

Nutrient Use Efficiency Through NEXT GENERATION FERTILIZERS

About the Book:

The book chapters presented in this book '*Nutrient Use Efficiency Through Next Generation Fertilizers*' depicts about next generation fertilizers and innovative agricultural technological interventions related to applications of fertilizers and alternative sources of plant nutrients which play a pivotal role in improving nutrient use efficiency. This book also highlights the recent advances in enhancing nutrient use efficiency, smart nutrient delivery systems, precision tools for higher fertilizer use efficiency and aqua-fertilization that deal with the challenges of low nutrient use efficiency and soil health. Different kinds of next generation fertilizers viz; customized fertilizers, nano-fertilizers, coated and value-added fertilizers, slow release fertilizers, liquid biofertilizers, zincated fertilizers and organic fertilizers have been included in the book covering the diverse aspects of enhancing nutrient use efficiency and productivity of field crops. In addition, certain alternative nutrient sources for the crops like biochar, seaweed biostimulants, rock phosphate, nitrification inhibitors and urease inhibitors have also found place in order to address the issues of nutrient use efficiency on a holistic way. As next generation fertilizers are technologically superior over straight or traditional fertilizers both in terms of higher nutrient use efficiency and cost effectiveness, these could have the real potential to pace faster in future as need based sources of plant nutrients. The content and information elaborated in this book will certainly provide multiple novel ideas of advance techniques; and will further stimulate innovative directions amongst researchers, academicians and policy makers in the field of plant nutrition. Further, the scientific contributions presented in the book will be a good source of background knowledge and technical know-how to educate the students and bring new scientists/technologists into the agriculture field.



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