Atlas of Sulphur and Micronutrient Status in Soils of Northeast India

Indira Sarangthem, Sanjib Kumar Behera, Arvind Kumar Shukla, N. Surbala Devi, Samiron Dutta, Rahul Mishra, Anjali Basumataray, Nivedita Oinam, Vimal Shukla, L. Punilkumar Singh, Akankshya Sikarwar, Yogesh Sikaniya

AICRP on Micro- and Secondary Nutrients and Pollutant Elements in Soils and Plants
ICAR-Indian Institute of Soil Science, Bhopal

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IROISEMBA, IMPHAL, MANIPUR - 795004

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Editors

Dr. Indira Sarangthem
Dr. Sanjib Kumar Behera
Dr. A.K. Shukla
Dr. N. Surbala Devi
Dr. Samiron Dutta
Dr. Rahul Mishra
Dr. Anjali Basumataray
Dr. Nivedita Oinam
Dr. Vimal Shukla
Dr. L. Punilkumar Singh
Mrs. Akanksha Sikarwar
Mr. Yogesh Sikaniya

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Compiled and edited by:

Dr. Indira Sarangthem, Director of Instruction, CAU, Imphal & PI, AICRP-MSPE, Imphal Centre
Dr. Sanjib Kumar Behera, I/c Project Coordinator, AICRP-MSPE, & Head, DSC&F, ICAR-IISS, Bhopal
Dr. Arvind Kumar Shukla, Former Project Coordinator, AICRP-MSPE & Vice Chancellor, RVSKVV, Gwalior
Dr. N. Surbala Devi, Associate Professor, COA, CAU, Imphal and Co-PI, AICRP-MSPE, Imphal Centre
Dr. Samiron Dutta, Professor & PI, AICRP-MSPE center, AAU, Jorhat
Dr. Rahul Mishra, Scientist, AICRP-MSPE, ICAR-IISS, Bhopal
Dr. Anjali Basumataray, Professor & Former PI, AICRP-MSPE center, AAU, Jorhat
Dr. Nivedita Oinam, SRF, AICRP-MSPE, Imphal Centre
Dr. Vimal Shukla, RA, AICRP-MSPE, ICAR-IISS, Bhopal
Dr. L. Punilkumar Singh, SRF, AICRP-MSPE, Imphal Centre
Mrs. Akanksha Sikarwar, SRF, AICRP-MSPE, ICAR-IISS, Bhopal
Mr. Yogesh Sikaniya, YP II, AICRP-MSPE, ICAR-IISS, Bhopal

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अजय कुमार भल्ला
राज्यपाल, मणिपुर
Ajay Kumar Bhalla
Governor of Manipur
ਅਜੈ ਕੁਮਾਰ ਭੱਲਾ
ਮਾਣਯੋਗ ਰਾਜਪਾਲ

सत्यमेव जयते

Imphal
Lok Bhavan-795001
Tel: +91-385-2450278/2442478
Fax : +91-0385-2450278/2442478

MESSAGE

I am glad to know that the All India Coordinated Research Project on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants (AICRP-MSPE), Central Agricultural University, Imphal Centre, is bringing out an Atlas book titled 'Atlas of Sulphur and Micronutrient Status in Soils of Northeast India'.

This Atlas will be a valuable scientific document that presents region-specific information on soil nutrient status and management strategies for the North Eastern States. It will serve as an important reference for researchers, policymakers, extension agencies and farmers in promoting balanced nutrient management, improving crop productivity and ensuring sustainable use of soil resources.

I commend the efforts of the Central Agricultural University, Imphal, ICAR-Indian Institute of Soil Science (IISS), Bhopal and all the scientists involved in bringing out this significant publication. I am confident that this Atlas will contribute meaningfully to sustainable agriculture, food security and ecological resilience in the region.

(Ajay Kumar Bhalla)

भारतीय कृषि अनुसंधान परिषद्
कक्ष क्र. 101, कृषि अनुसंधान भवन-II, पूसा, नई दिल्ली-110 012, भारत
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Room No. 101, Krishi Anusandhan Bhawan-II, Pusa New Delhi-110 012, India

डॉ. ए. के. नायक
Dr. A. K. Nayak
FNASc, FNAAS, FISSS, FARRW
उप महानिदेशक (प्राकृतिक संसाधन प्रबंधन)
Deputy Director General (Natural Resource Management)

10.04.2026

Message

Healty soil forms the foundation of our food systems, livelihoods, and ecological security. Yet, on a human timescale, it is a non-renewable resource that faces mounting pressure from imbalanced fertilization, monocropping, land degradation, and the imperative to feed a growing population. In this context, the stewardship of soil is not merely an agricultural concern; it is a national priority.

I am pleased to present the atlas book entitled **'Atlas of Sulphur and Micronutrient Status in Soils of Northeast India'** as a timely and authoritative work that bridges rigorous science with practical, field-ready guidance. The Northeast region of India, with its extraordinary ecological diversity and rich organic soils, holds immense promise for sustainable agriculture. This atlas provides a comprehensive, data-driven view of sulphur and micronutrient dynamics across the region's varied landscapes, offering a strong scientific bedrock for informed natural resource management.

More than a compilation of maps, this atlas serves as a strategic manual for action. It affirms a central truth of modern agriculture: crop improvement is inseparable from soil health. By translating soil intelligence into site-specific management strategies, the atlas enables a shift from generalized recommendations to precision-guided, high-efficiency production essential for resilient harvests and sustainable intensification.

I am confident that scientists, farmers, extension professionals and policymakers alike will find this volume invaluable. For governance, it provides the evidence base needed to align agricultural policy with ecological reality. For farmers and practitioners, it offers practical pathways to restore soil fertility, enhance nutrient use efficiency and secure productivity gains without compromising environmental integrity. For policy makers, this atlas is also a call to invest in our most fundamental infrastructure—the soil itself.

I commend the authors and contributors for their dedication and scientific rigor and I am sure that this atlas will help to lead collective action for higher and maintaining good soil health toward a more productive, sustainable and food-secure future for Northeast India.

(A.K. Nayak)

Ph. : +91-11-25848364 Fax : +91-11-25848366 E-mail : ddgnrm.icar@gmail.com, ak.nayak@icar.org.in Website : www.icar.org.in

सत्यमेव जयते

डॉ .एम.एल .जाट
DR. M. L. JAT
सचिव (डेयर) एवं महानिदेशक (आईसीएआर)
Secretary (DARE) & Director General (ICAR)

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GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION (DARE)
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
Krishi Bhavan, New Delhi 110 001
Tel: 23382629 / 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

FOREWORD

Agriculture in Northeast India is characterized by a high reliance on traditional, subsistence-based farming. Key features include shifting (*Jhum*) cultivation in hilly regions, monsoon dependence, low productivity, and dominance of rice-based cropping systems. He region is a global biodiversity hotspot and a critical biogeographical junction (Indo-Malayan, Indo-Chinese, Indian), hosting over 30% of India's total biodiversity.

Jhum is major land use system in North East followed by terrace cultivation. Undulating terrain, poor marketing infrastructure, limited mechanization, vulnerability to natural calamities like floods and landslides are some of the bottlenecks in agricultural development in the region. Further, soil acidity coupled with deficiency of macro and micronutrients, especially in *jhum* intense land use, limits the agricultural production to a great extent.

In this context, Central Agricultural University, Imphal Centre under All India Coordinated Research Project on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants (AICRP–MSPE) is bringing out the ***'Atlas of Sulphur and Micronutrient Status in Soils of Northeast India'***. This publication indicates widespread deficiency of sulphur and micronutrients in the soils of Northeast India.

This atlas, with its diagnostic approach and detailed nutrient mapping across all eight states of the region, will serve as a strategic roadmap for understanding soil fertility constraints and guiding informed decision-making. By integrating scientific insights with practical management options, the atlas has the potential to support sustainable agricultural practices, enhance crop productivity, and improve the livelihoods of farmers while conserving the delicate ecosystem of the North East.

This publication will be useful to the researchers, policymakers, extension workers, and planners. I extend my sincere appreciation to all the scientists and institutions involved in publication of this document.

Dated the 2nd March, 2026
New Delhi

(M. L. Jat)

केन्द्रीय कृषि विश्वविद्यालय
लम्फेलपात, इम्फाल - ७९५००४, मणिपुर (भारत)
CENTRAL AGRICULTURAL UNIVERSITY
LAMPHELPAT, IMPHAL-795004, MANIPUR (INDIA)

Dr. Anupam Mishra,
Vice-Chancellor

Tel : (0385) 2415933(O)
Fax : 2410414
Email : vcofficecau@yahoo.in

FOREWORD

I am pleased to share a few of my reflections on this atlas, compiled by the All India Coordinated Research Project on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants (AICRP-MSPE), Central Agricultural University, Imphal, in collaboration with the Indian Institute of Soil Science (IISS), Bhopal.

The study compiled a scientific and comprehensive soil fertility maps of the studied north east region and characterized the spatial distribution of soil properties in eight states of NE India viz. Arunachal Pradesh, Assam, Meghalaya, Manipur, Mizoram, Nagaland, Tripura, Sikkim. The generated fertility maps and spatial distribution patterns will serve as valuable tools for farmers and planners, enabling them to understand the existing soil conditions and to devise judicious strategies for effective soil management aiming at ensuring sustainability and enhancing productivity. These soil maps will contribute to improving crop yields as well as enhancing the nutritional quality of crops, thereby addressing public health concerns such as nutritional deficiencies, while also supporting soil health and environmental sustainability. Furthermore, in the context of North East India, the use of soil maps will greatly assist in the judicious application of fertilizers by taking into account the region's diverse topography, varied soil types, and unique cropping patterns. It is a prerequisite for the economic prosperity of the Northeast farmer and the nutritional security of the nation.

I hope that this atlas book **'Atlas of Sulphur and Micronutrient Status in Soils of Northeast India'** will provide effective learning and research assistance to all learners, educational professionals and farmers leading to optimal academic and agricultural importance.

I wish all the best to the team.

(Dr. Anupam Mishra)

Prof. Indira Sarangthem
Director of Instruction

CENTRAL AGRICULTURAL UNIVERSITY
IMPHAL 795 004 (MANIPUR), INDIA
Website: cau.ac.in
E-mail : di.office @ yahoo.com

PREFACE

The North Eastern Region (NER) of India is often described as the country's "green lungs," characterized by high organic matter and lush landscapes. However, beneath this verdant exterior lies a complex nutritional crisis. The book **'Atlas of Sulphur and Micronutrient Status in Soils of Northeast India'** serves as a definitive guide to understanding the diagnostic mapping, providing actionable management frameworks, ameliorative measures to ensure long-term soil resilience.

In the NER, where nearly 91% of the geographical area is occupied by acidic soils, the availability of essential nutrients follows a unique and often detrimental pattern. While nitrogen and potassium are frequently addressed, the "hidden hunger" for sulphur, boron, and zinc remains largely unmanaged. The shift from traditional fertilizers to high-analysis alternatives has left soils depleted of sulphur, critical for the region's oilseed and pulse production. High rainfall leads to severe leaching, making boron deficiency the most significant micronutrient constraint in the NER, directly impacting the "fruit set" of horticultural crops. Restoring the micronutrient balance is not just a scientific endeavour; it is an economic imperative for the millions of farmers in the Northeast. This publication is intended for researchers, policy planners, and extension specialists as a tool to transition from blanket fertilizer recommendations to precision soil health management.

I sincerely thank Dr. Sanjib Kumar Behera, I/c Project Coordinator, AICRP-MSPE, & Head, DSC&F, ICAR-Indian Institute of Soil Science (IISS), Bhopal, without whom, this publication would not be possible. The team, AICRP-MSPE, CAU, Imphal Centre is truly grateful for his guidance, instructions and continuous support in publishing this atlas book.

I acknowledge the cooperation of Dr. A.K. Shukla, Hon'ble Vice-Chancellor, RVSKVV, Gwalior, and former Project Coordinator, AICRP-MSPE, ICAR-ISSS, Bhopal, for his valuable suggestions.

I appreciate the generous support of Indian Institute of Soil Science, Bhopal in all aspects.

I express my sincere gratitude to Dr. Anupam Mishra, Hon'ble Vice-Chancellor, Central Agricultural University, Imphal for his constant inspiration and encouragement throughout the course of this publication.

I firmly believe that this atlas will serve as a valuable source of knowledge for researchers, extension functionaries dedicated to the farming community, policymakers, NGOs, and the academic fraternity.

(Prof. Indira Sarangthem)

PREFACE

The North Eastern Region (NER) of India is widely celebrated as the nation's *"green lungs"*; a landscape of rolling hills, dense forests and rich organic matter that sustains remarkable biodiversity and agricultural potential. Yet, beneath this verdant façade lies a less visible but deeply consequential challenge: a pervasive imbalance of secondary and micronutrients that threatens soil health, crop productivity and farmers' livelihoods. Recognizing and addressing this paradox forms the foundation of the present atlas.

Soils of the NER are predominantly acidic, covering nearly 91% of the geographical area and are shaped by high rainfall, fragile topography and continuous nutrient losses through leaching. While macronutrients such as nitrogen and potassium often receive due attention, deficiencies of sulphur and micronutrients particularly boron and zinc remain largely unrecognized and unmanaged. This *"hidden hunger"* silently constrains crop yields, impairs quality and limits the economic potential of agriculture in the region. The transition from traditional fertilizers to high-analysis fertilizers devoid of sulphur has further aggravated these deficiencies, with serious implications for oilseeds, pulses, cereals and horticultural crops. Among micronutrients, boron deficiency has emerged as the most widespread and critical constraint, directly influencing flowering, fruit set and yield stability under high rainfall conditions.

The atlas book **"Atlas of Sulphur and Micronutrient Status in Soils of Northeast India"** has been conceived as a comprehensive and practical reference to bridge this critical knowledge gap. By integrating large-scale soil diagnostic data with geospatial mapping, this atlas presents a clear picture of the spatial distribution of sulphur and micronutrient deficiencies across the Northeast states. More importantly, it goes beyond diagnosis to offer scientifically sound, location-specific management options and ameliorative measures aimed at restoring nutrient balance and enhancing long-term soil resilience.

Our intent is to facilitate a shift from blanket fertilizer recommendations toward precision-based soil health management, aligned with the principles of sustainable and climate-resilient agriculture. The atlas is designed to serve as a decision-support tool for researchers, extension functionaries, policymakers, planners, NGOs and the academic fraternity who are collectively engaged in improving the productivity and profitability of farming systems in the NER.

We firmly believe that this publication will not only enrich the understanding of sulphur and micronutrient dynamics in acidic soils but also contribute meaningfully to evidence-based policy formulation, targeted nutrient interventions and improved livelihood outcomes for the farming community of Northeast India. It is our hope that this atlas will inspire informed action, foster collaboration and support the stewardship of soil resources for present and future generations.

The Authors