Government of India

SOIL MICROPLASTIC: CONTAMINATION PATHWAYS AND ANALYSIS

TRAINING MANUAL

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Soil Microplastics: Contamination Pathways and Analysis

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FOREWORD

It gives me immense pleasure to present this training manual on **"Soil Microplastics: Contamination Pathways and Analysis"**, prepared as a part of the Two-Day Training Program held on 12th and 13th February, 2026. Microplastics are increasingly recognized as contaminants not only in marine ecosystems but also in terrestrial environments. Agricultural activities such as plastic mulching, irrigation systems, and the degradation of plastic materials can contribute to the accumulation of microplastics in soil, potentially affecting soil health, microbial activity, and crop productivity.

This manual has been developed to provide comprehensive theoretical knowledge along with practical exposure to the study of soil microplastics. It addresses key topics including the sources and pathways of microplastic contamination, their environmental and ecological implications, sampling design and strategies, laboratory pretreatment procedures, extraction techniques, and identification methods using analytical tools such as stereomicroscopy and Fourier Transform Infrared (FTIR) spectroscopy. The manual also emphasizes hands-on laboratory procedures that enable to gain practical experience in soil sampling, processing, and microplastic identification.

I am confident that this manual will serve as a valuable learning resource and contribute significantly to enhancing awareness, research capacity, and scientific understanding of microplastic contamination in soil ecosystems. Such initiatives are essential for supporting informed decision-making and promoting sustainable environmental management and agricultural development.

I commend the authors for this timely and relevant contribution and extend my best wishes for the successful implementation and wide utilization of this publication.

(Anupam Mishra)

PREFACE

The Eastern Himalayan region, particularly the state of Sikkim, serves as a guardian of ecological integrity and sustainable agriculture. However, the global issue of plastic pollution has now infiltrated these sensitive ecological areas. Emerging evidence indicates that microplastic particles, smaller than 5 mm, are no longer confined to marine environments; they are increasingly found in agricultural soils, posing a silent threat to soil health and food security.

This training manual is compiled and developed as an integral component of the **Two-Day Training Program on "Soil Microplastics: Contamination Pathways and Analysis",** held on 12th -13th February, 2026. The program is a crucial part of a project "**Assessment of Microplastic Pollution in Agricultural Soils of Eastern Himalayan Region of Sikkim State**", (NMHS2024-25/SC-XIII/MG/SL-13/244/33) funded by the **National Mission on Himalayan Studies (NMHS)** under the Ministry of Environment, Forest, and Climate Change. The project focuses on assessing the presence and distribution of microplastic contaminants in Sikkim's agricultural landscapes. This initiative represents a proactive effort to protect our ecologically fragile agro-ecosystems.

The primary objective of this program is to establish a baseline understanding of microplastic contamination, focusing on specific agricultural practices in Sikkim, such as plastic mulching, drip and sprinkler irrigation, and protected cultivation in polyhouses. These practices have been identified as potential pathways for plastics to enter the soil. By identifying these pathways and understanding the scale of microplastic contamination, this training aims to raise awareness and equip participants with the knowledge and skills necessary to address this growing environmental concern.

The program is structured to offer both theoretical knowledge and hands-on experience in soil microplastic analysis. Sessions cover key topics such as the environmental and ecological impacts of microplastics, sampling design, pretreatment methods, extraction techniques, and identification through tools like stereomicroscopes and FTIR (Fourier-Transform Infrared Spectroscopy). The practical sessions provide participants with valuable, real-world experience in handling soil samples and conducting microplastic analysis.

This training will contribute to a more sustainable agricultural future in the Eastern Himalayas. Active participation and collaboration in this endeavor will play a vital role in tackling the local impacts of a global environmental issue.

Dr Ghanashyam Singh Yurembam
Training Co-Ordinator

Dr A. K. Pandey
Dean, CAEPHT

ACKNOWLEDGEMENT

The successful organization of the Two-Day Training Program on "Soil Microplastics: Contamination Pathways and Analysis" on 12th -13th February, 2026 at CAEPHT, Ranipool, Sikkim stands as a testament to the collective dedication, collaboration, and unwavering support of numerous individuals and institutions. We express our profound gratitude to the funding agency of the program NMHS and Directorate of Instruction, Central Agricultural University (CAU), Imphal, for generously funding this important academic, research and extension initiative. Their financial support and institutional encouragement made it possible to conduct this program with the desired depth, quality, and outreach. We sincerely acknowledge their commitment to promoting scientific advancement and capacity building in emerging environmental concerns such as soil microplastic contamination.

We extend our sincere gratitude to Directorate of Research, Central Agricultural University (CAU), Imphal, for the continuous encouragement, valuable guidance, and unwavering support in promoting research and academic initiatives under the university. The support and encouragement provided by the Directorate of Research significantly contributed to the successful implementation of this training program and the advancement of research activities related to soil microplastic contamination.

We extend our respectful gratitude to Dr. A.K. Pandey, Dean, CAEPHT, whose constant encouragement, administrative support, and valuable guidance greatly facilitated the smooth conduct of this program. The Dean's support in providing institutional resources and fostering an enabling academic environment played a pivotal role in the overall success of the training program.

We extend our heartfelt appreciation to the Training Co-Ordinator: Dr Ghanashyam Singh Yurembam, whose visionary leadership, meticulous planning, and tireless efforts ensured the smooth conceptualization and execution of the program. The Co-Ordinator's guidance was instrumental in shaping the academic structure, identifying expert resource persons, and maintaining high standards throughout the two-day event.

Our sincere thanks are also due to the Co-Coordinators: Dr. D, Jhajharia, Dr. G.T. Patle and Dr. Y. Ranjana Devi for their constant support, coordination, and dedication at every stage of the program. Their collaborative spirit and active involvement significantly contributed to the seamless organization and management of technical sessions, participant engagement, and logistical arrangements.

We gratefully acknowledge the valuable contributions of the resource persons and subject experts, who shared their knowledge and expertise on contamination pathways, analytical methodologies, and the environmental implications of soil microplastics. Their insightful lectures, practical demonstrations, and interactive discussions greatly enriched the learning experience of all participants.

Special appreciation is extended to the Project Staff: Dr. N. Bidyarani Chanu (RA) and Miss Saya D (SPF) for their behind-the-scenes efforts, including documentation, communication, technical arrangements, and on-site coordination. Their efficiency and commitment ensured that every session progressed smoothly and that participants were provided with a conducive learning environment.

We also express our sincere gratitude to the Organizing Committee members: Ms Barsha Mondal, Mr. Abhishek and Mr Rohesh Laishram, whose collective efforts in planning, logistics, hospitality, and overall management were vital to the program's success. Their teamwork and dedication played a key role in achieving the objectives of the training program.

Finally, we thank all the participants for their enthusiastic involvement, active discussions, and keen interest in the subject matter. Their engagement made the program intellectually vibrant and truly meaningful.

It is through the combined efforts and cooperation of all stakeholders that this Two-Day Training Program was successfully completed. We once again extend our heartfelt thanks to everyone who contributed directly or indirectly to making this academic event a fruitful and memorable endeavor.

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About the Manual

This manual has been prepared as part of the research project titled "Assessment of Microplastic Pollution in Agricultural Soils of the Eastern Himalayan Region of Sikkim State" (NMHS2024-25/SC-XIII/MG/SL-13/244/33), funded by the National Mission on Himalayan Studies (NMHS) under the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. The project focuses on assessing the presence and distribution of microplastic contaminants in the agricultural landscapes of Sikkim, a region characterized by ecologically fragile mountain ecosystems and diverse farming practices. This initiative represents a proactive effort to safeguard the sustainability and health of these sensitive agro-ecosystems.

The project aims to evaluate the extent of microplastic contamination in agricultural soils of Sikkim and establish a baseline understanding of their occurrence across different farming systems. It further investigates the spatial distribution, size, abundance, and pollution characteristics of microplastics in agricultural soils to identify patterns and potential sources of contamination. In addition, the project seeks to assess and model the environmental risks associated with microplastic pollution in agricultural ecosystems, with particular emphasis on soil health, crop productivity, and ecological sustainability. Based on these findings, the study also aims to develop suitable eco-friendly agro-environmental mitigation strategies to reduce microplastic contamination and promote sustainable agricultural practices in the region.

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