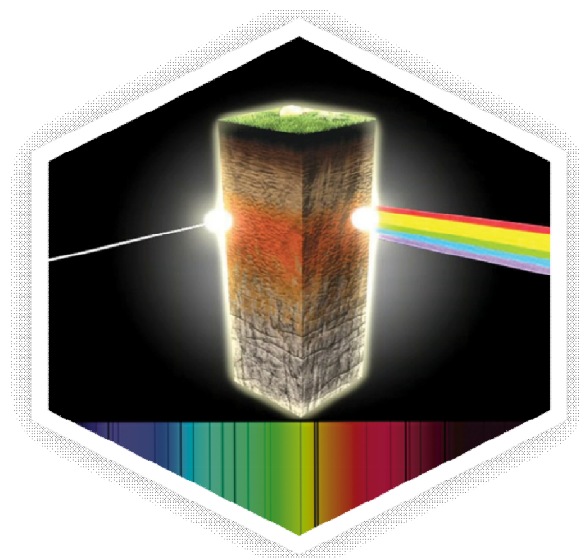


Proceedings

International Webinar on Soil Spectroscopy: An Emerging Technique for Rapid Soil Health Assessment

Date: 1 October 2020



Jointly organized by

ICAR-Indian Institute of Soil Science, Bhopal, India

&

World Agroforestry (ICRAF), Nairobi, Kenya

Proceedings of “International Webinar on Soil Spectroscopy - An Emerging Technique for Rapid Soil Health Assessment” held online on 1st October 2020

An “**International Webinar on Soil Spectroscopy- An Emerging Technique for Rapid Soil Health Assessment**” was organized using online zoom webinar platform on 1st October 2020. The webinar was jointly organized by ICAR– Indian Institute of Soil Science (IISS), Bhopal and World Agroforestry (ICRAF).



The poster features a green background with a white hexagonal inset on the left showing a soil core with a rainbow spectrum of light passing through it. To the right, a handheld soil spectrometer is shown emitting a blue light. Below the main title, there is an image of a laboratory soil spectrometer. The text is in white and green, providing the date and time of the webinar.

INTERNATIONAL WEBINAR

SOIL SPECTROSCOPY

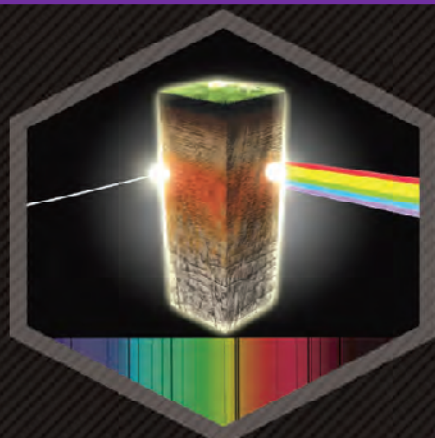
An Emerging Technique for Rapid Soil Health Assessment

DATE : 1 OCTOBER 2020

TIME : 11.00 AM – 4.30 PM IST (+5.30 GMT)

More than 2000 participants from various countries registered for the webinar and 885 participants representing 28 countries with scientific/educational background from private & public research institutions across the globe actively attended the Webinar. The participation was largely from Afghanistan, Argentina, Australia, Austria, Bangladesh, Canada, Europe, France, Germany, Italy, India, Kenya, Japan, Libya, Magnolia, Mexico, Morocco, Myanmar, Nepal, Philippines, S. Korea, Sri Lanka, Spain, Thailand, UK, USA, Vietnam. Besides, members of Inter-Governmental Technical Panel on Soils (ITPS), FAO, Global Soil Laboratory Network, South East Asia Laboratory Network (SEALNET), and representatives from SAARC Agriculture Centre also participated.

Inaugural Session:



SOIL SPECTROSCOPY

An Emerging Technique for Rapid Soil Health Assessment



Join us on Zoom



ABOUT THE WEBINAR

Importance of soil health has gained renewed momentum in the past several years. While awareness of soil health is increasing, it is essential to have a good understanding of what soil health entails, how it is measured, and how to manage it for optimal and sustainable delivery of the ecosystem services besides, food security and climate resilience. However, most of the laboratory analytical procedures are time-consuming, laborious, and costly for large scale sample analysis. Soil Health Card Scheme under the National Mission for Sustainable Agriculture by the Government of India aims at promoting location as well as crop-specific sustainable soil health management, including the judicious application of fertilizers for improving/sustaining soil health and its productivity. For successful implementation of such missions, rapid and accurate soil testing methods using advanced tools and techniques are essential.

Recently, infrared spectroscopy has been recognized as one of the promising techniques to address the limitations of wet chemistry. This technique can be used for rapid and cost-effective precise assessments of various soil properties. The latest research trends demonstrate considerable research effort on developing near-infrared (NIR) and mid-infrared (MIR) methods for the rapid estimation of soil parameters. The diffused reflectance spectroscopy (DRS), comprising both NIR and MIR regions, is emerging as a new tool to obtain information on soil and may be an important step in the fast, reliable, and economic estimation of soil characteristics for sustainable management. These techniques do not use environmentally harmful chemicals, require fewer pre-treatments, and, when combined with multivariate calibrations, a single spectrum can provide estimates of a number of soil properties. The techniques are highly sensitive to both organic and inorganic soil composition, making them potentially useful and powerful tools for the assessment and monitoring of soil and its quality.

In this backdrop, the ICAR-Indian Institute of Soil Science, Bhopal, and World Agroforestry (ICRAF), Nairobi, Kenya are jointly organizing an International Webinar on "Soil Spectroscopy – An Emerging Technique for Rapid Soil Health Assessment" on 1 October 2020. The aim of the webinar is to explore the possibilities of potential use of NIR and MIR techniques for soil health management and digital soil mapping.



Trilochan Mohapatra
SECRETARY (DARE) & DIRECTOR GENERAL
Indian Council of Agricultural Research (ICAR)
New Delhi, India



Tony Simons
DIRECTOR GENERAL
World Agroforestry (ICRAF)
Nairobi, Kenya



S. K. Chaudhari
DEPUTY DIRECTOR GENERAL (NRM)
Indian Council of Agricultural Research (ICAR)
New Delhi, India



Ravi Prabhu
DEPUTY DIRECTOR GENERAL (RESEARCH)
ICRAF, Nairobi



Ashok K. Patra
DIRECTOR
ICAR-Indian Institute of Soil Science
Bhopal



Javed Rizvi
DIRECTOR
South Asia Regional Program
ICRAF, New Delhi

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Nabhaat, B, Berasia Road, Bhopal - 462038
Madhya Pradesh, India



Headquarters: World Agroforestry (ICRAF),
United Nations Avenue, Gigiri, Nairobi, Kenya
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NASC, G. P. S. Varg, Pusa Campus, New Delhi, India 110012

The program was inaugurated by Dr. **Trilochan Mohapatra, Secretary (DARE) and Director General (ICAR)**, New Delhi. During his inaugural remarks, Dr Mohapatra emphasized on the need to understand the Indian soils and best sustainable management of natural resources. He urged the participants for continued studies and understanding about the physical, chemical and biological properties of soils for sustainable soil management. He suggested that alternative methods of soil health measurement could support or compliment the Government of India's efforts on providing soil health cards to farmers. Soil Infrared Spectroscopy is one of such methods. He appreciated the progress made by joint ICAR-IISS and ICRAF team working on MIR spectroscopy to estimate soil health parameters. He further emphasized to use the data generated at National and Global levels to build effective models that will precisely assess soil health for other soil types. Further, development of small handheld devices for soil health assessment is required for large scale application in India. He suggested to join hands with other Mid-Infrared based networks for getting benefits and understandings how MIR spectroscopy-based soil analytical methods can be used in India. He also emphasized the need for building global partnerships on MIR spectroscopy, and pilot large scale use of MIR technology to analyze important parameters of soil health.

Dr S.K. Chaudhari, DDG (NRM), ICAR, informed participants from 28 countries that the purpose of the webinar was to benefit large number of researchers working on soil spectroscopy. He emphasized that ICAR and ICRAF have jointly validated the MIR soil spectroscopy technique for estimation of soil organic carbon (SOC), pH, clay, silt and sand in Alfisols, Inceptisols and Vertisols. He added that the data generated on NIR and MIR will be very useful for managing soils against many challenges including climate change and shaping up the future agriculture through sustainable natural resource management.

Dr Ravi Prabhu, DDG (Research), ICRAF appreciated the joint efforts of ICAR – ICRAF on soil spectroscopy and complemented the collaboration between the two organizations. He expressed high hopes about a great future of the technology in assessment of soil resources of India as well as of world soils.

Dr. Ashok K. Patra, Director ICAR-IISS Bhopal reiterated the importance of Soil spectroscopy and the importance of collaborative project between ICAR-IISS Bhopal and ICRAF. He emphasized that such collaboration was needed to use MIR spectroscopic technique in assessing Indian soils. The outcome of the project is of great value in bringing out the application of MIR spectroscopy in assessing soil health in India.

Dr Javed Rizvi, Director, South Asia Regional Program, ICRAF talked about the work done by ICRAF in collaboration with ICAR-IISS Bhopal on MIR spectroscopy and the way forward for the MIR technique in India in assessing soil health. He also lauded the efforts of Indian scientists in accepting the MIR technique as an important soil analytical tool for future.

Dr Tony Simons, Director General, ICRAF emphasized that soil is a global asset and presented the historical development of soil analytics supported by number of policies on soil which provide evidence of its importance. Most of the policies on soils around the world and India mainly focus on soil conservation. He mentioned that there are many challenges in soil management that need to be addressed urgently. Infrared spectroscopy is one of the tools that may help to address the challenges of rapid and reliable soil health assessment. India has a large agricultural area and spectroscopy holds good promise to monitor land health cost-effectively through assessing soil health. Dr Tony congratulated ICAR for challenging to its scientists and others for using spectroscopy for soil health assessment. He emphasized that soil spectroscopy is an opportunity for soil health assessment and food security as ICRAF has been using this technique since 1990. He emphasized the need and importance of a quicker, cheaper and more reliable assessment of soil properties, soil spectroscopy holds the promise for the solutions. “I believe the webinar will create mass awareness about the effectivity and utility of MIR spectroscopy to be used for soil health monitoring in India. Before closing the remarks, he suggested a tagline for the webinar: *“Land Health is National Wealth”*”.



Keynote Presentations: Soil Spectroscopy - An Emerging Technique for Rapid Soil Health Assessment

	Keith Shepherd WORLD AGROFORESTRY (ICRAF) Nairobi, Kenya	MIR/ NIR SPECTROSCOPY AND HANDHELD DEVICES FOR SOIL HEALTH MONITORING AND DECISION MAKING: A GLOBAL OUTLOOK
	Budiman Minasny SCHOOL OF LIFE AND ENVIRONMENTAL SCIENCES The University of Sydney, Australia	INFRARED SPECTROSCOPY FOR RAPID AND ACCURATE ASSESSMENT OF SOIL RESOURCES: AUSTRALIAN EXPERIENCE
	Kuntal M. Hati DIVISION OF SOIL PHYSICS ICAR IISS, Bhopal, India	MIR SPECTROSCOPY FOR SOIL HEALTH ASSESSMENT: AN INDIAN PERSPECTIVE
	Gifty Acquah ROTHAMSTED RESEARCH United Kingdom	MIR, NIR AND XRF FOR AGRICULTURAL RESEARCH AND APPLICATION AT ROTHAMSTED
	Leigh Winowiecki WORLD AGROFORESTRY (ICRAF) Nairobi, Kenya	AFRICAN SOIL INFORMATION SERVICE (AFSIS): POTENTIAL FOR SOIL RESOURCE MANAGEMENT AND SUSTAINABLE AGRICULTURE
	Rabi N. Sahoo DIVISION OF AGRICULTURAL PHYSICS ICAR-IARI, New Delhi, India	SPECTROSCOPY OF INDIAN SOILS : A PROSPECTIVE VIEW
	Shreeram Oak BRUKER OPTICS	VIBRATIONAL SPECTROSCOPY IN AGRICULTURAL AND CHEMICAL APPLICATIONS

The technical session, **chaired by Dr S.K. Chaudhari, Deputy Director General (NRM), ICAR**, with **Dr Javed Rizvi, Director, South Asia Regional Program, ICRAF as Co-Chair**, had seven eminent keynote speakers from Australia, Africa, U.K. and India, who shared their research experiences on soil spectroscopy during the Webinar.

Dr Keith Shepherd, World Agroforestry (ICRAF), Nairobi, Kenya gave the global overview of soil spectroscopy and its applications in agriculture. Dr Shepherd also presented information about global spectral libraries which are freely available, easy to use for soil property prediction service and prescription of site-specific nutrient management.

Dr Budiman Minasny, School of Life and Environmental Sciences, The University of Sydney, Australia presented the experience on infrared spectroscopy for rapid and accurate assessment of soil resources in Australia. He emphasized on the use of pedo-transfer functions in building models for soil predictions using MIR. From Australian experience he shared, soil

properties related to soil mineral components, soil solid composition and surfaces can be predicted well whereas, soil properties related to soil surface chemistry, soil solution (extraction) chemistry and pore-space relationships can still be not well predicted.

Dr Kuntal Mouli Hati, ICAR-Indian Institute of Soil Science (ICAR-IISS), Bhopal presented and shared experience of joint efforts of ICAR-IISS and ICRAF on MIR spectroscopy for soil health assessment of Indian soils. Dr. Hati showed the usefulness of MIR spectroscopy for successful prediction of SOC, pH, sand, silt and clay with good accuracy levels for the two major Indian soils viz. Inceptisols and Alfisols of India. The models developed are also capable of predicting soil water retention capacity with reasonably good accuracy whereas predictability was relatively low for soil extractable/available nutrients. The work is in progress on fine tuning of the prediction models.

The latest development on application of MIR, NIR and XRF technologies for the agricultural research was presented by Dr Gifty Acquah, Rothamsted Research, United Kingdom.

Dr Leigh Winowiecki, World Agroforestry (ICRAF), presented and discussed on building the evidence base for soil restoration and sustainable agriculture interventions using soil spectroscopy. She also discussed critical examples from African Soil Information Service (AfSIS) project. She emphasized on generating global soil spectroscopy database for accurate landscape-scale assessment of the soil and land health and management.

A prospective view on spectroscopy of Indian soils was presented by **Dr Rabi N. Sahoo**, ICAR-IARI, New Delhi. He discussed on the spectral signatures and library of soil (VNIR and MIR) and spectral models for soil fertility and quality. Dr Sahoo elaborated vast scope of soil spectroscopy in near future in digital soil mapping and use of various air born spectral sensors.

Dr Shreeram Oak, Bruker Optics gave an overview of various spectroscopy instruments available for assessment and application in soil and agriculture.

Towards the end of the technical session, experts responded on the questions and comments raised by the participants.

Panel Discussion: Soil Spectroscopy: Perspective & Way Forward

An expert panel discussion session on soil spectroscopy was chaired by Dr Ravi Prabhu, DDG (Research), ICRAF and co-chaired by Dr. A.K. Patra, Director, ICAR-IISS, Bhopal. Five eminent experts presented their views in the panel discussion.

PANEL DISCUSSION

Soil Spectroscopy: Perspective & Way Forward



Ravi Prabhu
Deputy Director General
(Rescience)
ICRAF, Nairobi



J. Adinarayana
Professor and Head, CSRE,
Indian Institute of Technology -
Bombay (IITB), Powai, Mumbai



Bhabani Sanikar Das
Professor, Agricultural and Food
Engineering, Indian Institute of
Technology, Kharagpur



R. S. Chaudhary
IC HoD & Principal, Scientist
Division of Soil Physics
ICAR-ISS, Bhopal, India



B. S. Sekhon
Associate Professor
College of Agriculture
PAU, Punjab, India

Dr J. Adinarayana, IIT, Mumbai gave an overview on the importance of digital technology, integrated approach for development of tools and technologies especially the sensors for the agriculture research and data driven science. He further suggested to have farming system approach for maintaining sustainable agricultural production system. He also emphasized for strong collaboration on the emerging areas of technology and leverage on smart technology for digital agriculture.

Dr. B.S. Das, IIT, Kharagpur shared the practical difficulties, challenges and opportunities in application of soil spectroscopy and digital soil mapping in India. He also highlighted the use of artificial intelligence and remote sensing techniques for prediction of soil properties.

Dr. R.S. Chaudhary, ICAR-IISS, Bhopal shared the challenges in achieving acceptable accuracies while estimating soil properties using MIR techniques. He suggested the need for robust analytical methods built on globally accepted standards and highlighted the importance of soil spectroscopy in the context of rapid and cost-effective soil properties assessment.

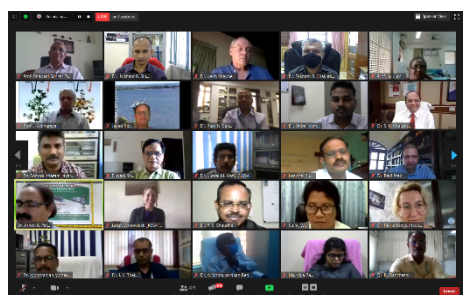
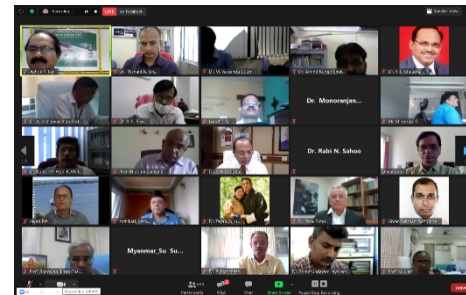
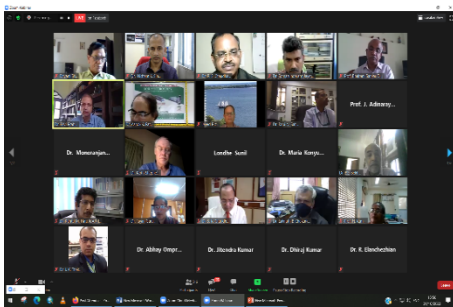
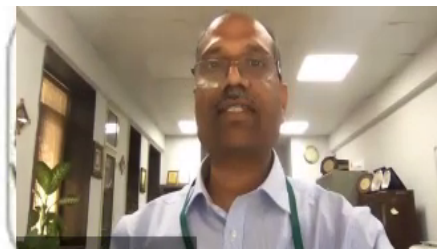
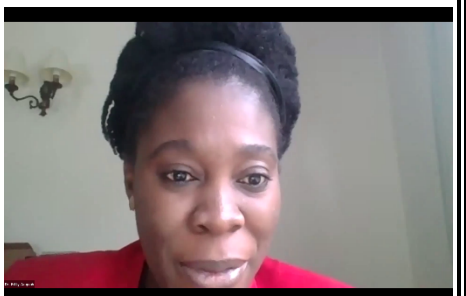
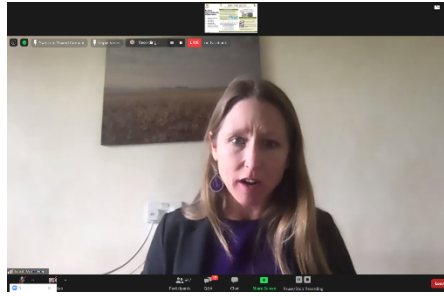
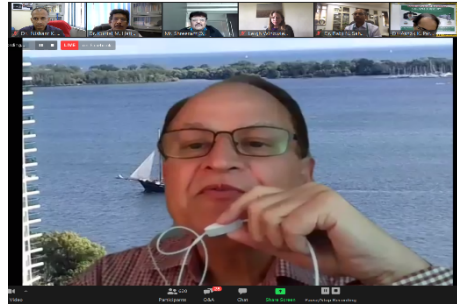
Dr. B.S. Sekhon, Punjab Agriculture University, Ludhiana emphasized on the critical thinking for addressing the gaps in the soil spectroscopy *vis-à-vis* soil stewardship. Highlighting the major points of the panelist, Dr. Prabhu suggested for creation of a Digital Soil Analysis Forum.

Dr S.K. Chaudhari in his concluding remarks about the Webinar envisioned on the potential of 'soil spectroscopy' technology for soil health assessment of Asian countries. He emphasized on the NIR, MIR and handheld devices to achieve the global commitment of India on Land Degradation Neutrality targets. The future of assessment of soil health depends on the development and use of soil spectroscopy, he emphasized. He also suggested adopting a step by step approach in implementation of soil spectroscopy in India and the need to develop a network in India on soil spectroscopy and soil information system. Further, he emphasized the need to expand this network in Asia and across the globe. He suggested to establish a Centre of Excellence at the regional level.

Recommendations:

Based on the deliberations and discussions in the “**International Webinar on Soil Spectroscopy - An Emerging Technique for Rapid Soil Health Assessment**” the following recommendations were made:

- The Mid-infrared technology has been validated for the estimation of the soil organic carbon, pH, clay, silt and sand in Alfisols, Inceptisols and Vertisols of India; and may be rolled out for the rapid analysis of such parameters in these soil types.
- ICAR-IISS, Bhopal and ICRAF along with other national and international partners would continue the work on refinement of estimation of soil properties using MIR techniques for other important soil properties in Alfisols, Inceptisols and Vertisols.
- It was felt necessary to create a Forum on Soil Digital Analysis and to develop spectral library, on the line of African Soil Information Service (AfSIS) which will help in quick interpretation of results.
- There is a need to develop a soil spectroscopy network in India and further expand this network to Asia and across the globe in association with Global Soil Partnership (GSP) and other agencies and also establish a ‘Centre of Excellence on Soil Spectroscopy’ at ICAR-Indian Institute of Soil Science, Bhopal.



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