Information of the 1st CESRA Forum
19-20 September 2022
Bangkok, Thailand, Virtual

Message delivered by Asian Soil Partnership (ASP) (online):
Dr. Gina P. Nilo, Ph. D. Officer in Charge (OIC) Director at the Bureau of Soil and Water Management of the Philippines

Ms Gina highlighted the soil research networks such as CESRA, ASP, GSP and Asia hub is important for sustainable land management (SLM). Soil laboratory network called South-East Asia Laboratory Network (SEALNET) is a successful networking for harmonization of methods. CESRA could make a partnership to create soil research network, implement and contribute to soil management. This national soil monitoring network initiative of Asia region could develop a national strategy, focus on initiative and outcome and global implementation plan.

Welcome:
Dr. Charlie Navanugraha, Director of CESRA Center Association

Mr Charlie Navanugraha, Director of CESRA Center Association, welcomed Mr Arunchai Phutcharoen, Inspector General of the Ministry of Agriculture and Cooperatives, for presiding over the opening ceremony and highlighted the objectives of the meetings, it aims to define the framework of the CESRA in the preparation of a 5-year action plan (2024-2028) in accordance with the guidelines of the Asian Soil Partnership and to inform the attendees of the outcomes of the operation.

Opening Speech:
Mr. Arunchai Puthcharoen, Inspector General for Ministry of Agriculture and Cooperatives

Mr Arunchai Puthcharoen, Inspector General for Ministry of Agriculture and Cooperatives, welcomed all participants in the meeting and expressed gratitude to the Asian Soil Partnership to establish the Center of Excellence for Soil Research in Asia or CESRA. Ultimately, he stressed the success of soil research and management will be transfer to CESRA members and countries in Asia to adopt and scale out in the region. This allows CESRA developing research projects to build a more natural resource sustainability in the region. And this will not achieve CESRA goals, if there is no cooperation among the member countries.

Keynote talk on Farmers'knowledge and perception of sustainable soil management (SSM):
Dr.Wiwat Salyakamthorn, President of the World Soil Association of Thailand

Mr. Wiwat presented the introduction of the King's philosophy and local wisdom in sufficiency economy and new theory agriculture to tangible development results with the objective of ending hunger, achieve food security and improved nutrition and promote sustainable agriculture. In addition, the development of soil doctors will help increase the potential of improving soil fertility.

Panel discussion by representatives from various funding sources on supporting soil research operations:

- FAO RAP : Dr.Hang Thi Thanh Pham
- Stockholm Environment Institute : Mr.Niall O'Connor
- Lancang-Mekong Cooperation : Dr.Sui Pengfai
- Mekong Institute : Mr.Suriyan Vichitlekarn

The moderator is **Dr. Thanapon Piman**. The objective of the discussion is for international or regional organizations to share their experiences and expertise and discuss whether there is a way to support CESRA to expand networks or exchange knowledge on soil. Included on the panel were representatives from 9 countries: Thailand, Laos, Myanmar, Cambodia, China, India, Vietnam, Mongolia, and Sri Lanka. The key points are summarized as follows:

- **The first topic of the discussion was the importance of sustainable soil resource management from your country's perspective or regional soil management issues.**
- **Mr. Pawan Kumar** of Patanjali Organic Research Institute in India has stated that it is particularly challenging to persuade farmers to adopt the methods or knowledge of soil management, especially in adding organic matter to their soil. More so, it is truly vital to disseminate and build networks among farmers, implement successful soil management methods for the future.
- **Dr. Zaw Naing** of Mandalay Technology Co., Ltd, Myanmar, explains that in their country, they have limited soil management and research capability. There is only one agricultural university in the country, and not much research on soil management and research laboratories being done. As such, it requires not only laboratories, equipment, and technology, but also the capacity of establishing for soil-related research with government agencies. These are all problems we need to address in the near future.
- **Dr. Seng Vang** of the Department of Agricultural Land Resources Management (DALRM) in Cambodia highlighted that different countries have different challenges in sustainable soil management due to soil-related restrictions on the global and regional levels. When we look at soil degradation and climate change, we found that human activities such as change of land use and improper land use is the main driver of soil degradation. Therefore, we should assess regional and global land degradation. Then, appropriate methods, through regional cooperation can be developed for use in each country's soil management.
- **Mrs. Renuka Silva** of the Department of Agriculture in Sri Lanka explains that their soil problem is the erosion and accumulation of nutrients and heavy metals in the soil due to their rainy coastal farming. Soil erosion has been a perennial problem, as landslides and sediment accumulation around reservoirs, it depletes most of the nutrients in cropland. The accumulation of phosphorus and potassium could be excessive and it's toxic for the soil. Currently, the government had solved the problem by recommending the use of fertilizer based on soil analysis values. As a result, the agency has developed 32 soil testing laboratories for quality inspection of agricultural inputs, making laboratory soil analysis more convenient.
- **Mr. Ngo Thanh Son** of the Resource Management Department, Faculty of Natural Resource and Environment, Vietnam National University of Agriculture (VNUA), explained that Vietnam is also experiencing soil problem, especially in the Mekong

River due to the development of the hydroelectric power that has resulted in soil erosion and saline soil problems including the impact of climate change.

- **Mr. Noov Bayarsukh** from the Institute of Plant and Agricultural Sciences in Mongolia explained that Mongolia has a different climate and terrain from other countries due to its dry climate. There are many soil research laboratories in the country, but we focus on analysis in urban areas. Most of the soil problems encountered in Mongolia are wind-induced soil erosion where there is no long cropping period but still suffer from soil degradation. The main challenge is the ability to build a research lab and promote the development of quality staff. Promoting and educating farmers and relevant agencies on soil information, soil conditions and current soil deterioration problems so that farmers can improve their soil in their own area.
- **Mr. Phimmasone Sisavat** from DALAM, Laos, explained that most of the area in Laos is sloping, 80% of them faces the soil erosion and degradation problem. Although they have a soil research agency in the country, it still needs more information on their soil and modern technology to support farmers and related officials.
- **Dr. Kommireddi Chinni V Naga** of KSCSTE - Center for Water Resources Development and Management from India, addressed two key issues: soil erosion and soil nutrient loss caused by change of land use. For example, the conversion of agricultural land to aquaculture or shrimp farms in coastal areas, which leads to problems of excessive erosion and accumulation of certain nutrients in the soil.
- **Dr. Thanapon Phiman and Dr. Zaw Naing** summarized that, currently, there is a need to improve the communication between universities, research institutes, private sectors, and government agencies. In addition, CESRA lacks research experience in other countries. Therefore, participation between universities and government agencies, the private sector, and other stakeholders, both domestically and internationally, is essential for future sustainable soil management. Links between such agencies will help drive the work of CESRA and expand the network of member countries.
- **The second topic of the panel discussion was how national organizations can support or collaborate with CESRA to expand its network and create soil research work.**
- **Dr. Xu** from the Ministry of Agriculture of China explained that being a large country with a population of about 1.4 billion. Most of their soil problems are the acidic and low fertility levels. There are various soil research and training centers in China, so they need to do more intensive research to solve their soil problems. They look forward to the cooperation of all countries through which the coordination will be coursed through CESRA.
- **Dr. Hang Thi Thanh Pham,** Food and Agriculture Organization of the United Nations (FAO) explains that the main mission of FAO is sustainable soil management for food security by addressing soil degradation, natural resource degradation, and addressing climate change. Therefore, it is a challenge for the FAO to act and work with member countries. **The first** is a new solution, meaning the management of land and resources related to land degradation. For example, Vietnam has a problem with saline soils, with the new FAO guidelines suggesting a possible solution is to find plants that can be grown in saline areas or what kind of farming system? What is soil management regionally appropriate? including how to deal with wetlands and what type of architecture can develop an agricultural system, later sharing the knowledge and experience with other countries. **The second** is to share the technology and policy to

implement, which means agronomic technology supporting more than one type of soil management or water management. Working with farmers to deliver solutions that are economically and financially feasible while also enabling them to access better, higher-value yields for both local and export markets, this goes beyond imparting the technologies with them. Working with the government to develop effective policies that would encourage farmers to embrace sustainable farming methods, as well as working with public-private partnerships to provide the farmers ample financial support and equipment. **The third** is to make sure they understand the needs of their respective countries, which are attempting to address the problem. Supporting farmers in implementing the practice that FAO is actively working on to ensure the successful practice in their countries and highlighting vital data information sharing which is a major challenge in the region and globally, as well. The importance of developing knowledge tools like the global soil map.

- **Mr. Niall O'Connor** from Stockholm Environment Institute (SEI) suggested that several issues need to be highlighted, that are necessary to have a more realistic approach in managing resources, for long term; obviously, climate change is altering everything in all landscape. Changing climate patterns truly impacts on the type of crops growing, affecting its nutrients, and cropping systems. The future farming technologies are essential to adopt to the climate which has a major impact on the fertilizer of agriculture in many countries. The new green, smart technologies and climate-smart agriculture is a way of attracting new factors by using modern technologies.
- **Mr. Suriyan Vichitlekarn** from Mekong Institute (MI) pointed that many national research networks struggled initially, we need to establish linkages, gather as much knowledge, and use this to further their services. We also need to understand present regional conditions, this is where CESRA is recognized as a workable network that can provide solution and knowhow in implementing the policy and demonstrating multiple benefits to impacts the soil and soil management. Oftentimes, the work of regional network research focus too much on national issues. If CESRA is to be successful, it needs to couple with the regional issues and the importance of CESRA presence as an organization to benefit other countries. Final point, climate change sustainability in soil management. If we take it individually, it will be in the best interest when we can achieve something greater, such as sustainable food systems. If we see that soil management provide an enabling factor to attain greater objective this is where the value of CESRA will be needed and recognized. Finally, the MI has agriculture activities, where CESRA is a member of this consortium, works on sustainable food systems in the Mekong subregion. We hope to be able to see how we can continue to collaborate.

CESRA operation for soil research in Asia by Dr. Charlie Navanugraha (Director of CESRA Center Association)

The structure and function of CESRA will work in cooperation with National Soil Institutions (NSIs). CESRA consisted of 3 main department that are located within Land Development Department. These main departments consist of Department of Administration and Collaboration (DAC), Department of Soil Information and Training (DSIT) and Department of Soil Research and Development (DSRD). CESRA will be responsible for promoting research on soil and the practice of soil sustainable soil management in Asia. All activities of CESRA relates to the sustainable management of soils.

Global assessment, general threats to soils in the region as follow:

- Erosion by wind and water
- Soil organic carbon change
- Soil contamination
- Soil acidification
- Loss of soil biodiversity
- Nutrient imbalance

The impact of risks related to food-land-energy-water (FLEX) nexus on governments, society and populations, and business. In the case of Thailand, the matric related research field from soil such as soil pollution, soil erosion, land slide, sedimentation, soil nutrient depletion, water bank etc.

The activities with Asia hub made to exchange knowledge and experience including national and international meetings in southeast Asia. CESRA will invest in networking and communication through the international local funding agency (Strategic collaborative fund, Toyota Mobility Foundation, Sustainable Infrastructure Partnership and Thailand Toray Science Foundation). However, CESRA still required supporting the fund for the project to achieve the objectives of work.

National Research Funding Agencies:

- สำนักงานกองทุนสนับสนุนการวิจัย Thailand Research Fund (สกสว.), http://www.trf.or.th
- สำนักงานคณะกรรมกรรมการอุดมศึกษา (กระทรวง อว.) (Ministry of Higher Education,Science, Research and Innovation), http://www.mua.go.th
- สำนักงานวิทยาศาสตร์และเทคโนโลยีแห่งชาติ (สวทช.) National Science and Technology Development Agency, http://www.nstda.or.th
- ศูนย์เทคโนโลยีอิเล็กทรอนิกส์และคอมพิวเตอร์แห่งชาติ (National Electronics and Computer) https://www.nectec.or.th
- ศูนย์พันธุวิศวกรรมศาสตร์และเทคโนโลยีชีวภาพแห่งชาติ (National Center for Genetic Engineering and Biotechnology), http://www.biotec.or.th
- สำนักงานคณะกรรมการอ้อยและน้ำตาลทราย (Council of Sugar cane and Sugar), http://www.csb.in.th
- สภาวิจัยแห่งชาติ (วช.) National Research Council of Thailand (NRCT), http://www.nrct.net
- สำนักงานการพัฒนาการวิจัยการเกษตร (สวก.) (Agricultural Research and Development Agency), https://www.arda.or.th
- การยางแห่งประเทศไทย (กยท.) (Rubber Authority of Thailand), https://www.raot.co.th

International funding Agency:

- ASEAN Foundation: ASEAN Science and Technology Fellowship: Fellows will be hosted by entities that support technical work in the following ASEAN science and technology priority areas:
- Climate Change – to achieve UNFCCC goals, and/or to mitigate and adapt on effects of climate change and related areas, using evidence-based scientific methods and harnessing STI (digital and disruptive technologies, etc.) for policy development.

Sustainable Energy – to enhance energy efficiency and conservation through leveraging on renewable energy and related areas using evidence-based scientific methods and harnessing STI (digital and disruptive technologies, etc.)

Keynote talk on the importance of creating a sustainable food system by the ambassador (Agriculture) in Rome (Online):
Dr.Thanawat Tiansin, Director of Animal Production and Health Division, FAO

Mr Thanawat Tiansin, Director of Animal Production and Health Division, highlighted what CESRA's framework and what needs to be done next. Mr Thanawat also introduced ongoing actions must be driven to achieve SDGs 2030, which includes nourishing all people, boosting nature- based solutions, advancing equitable livelihoods, decent work and empowered communities, accelerating the means of Implementation and building resilience to vulnerabilities.

Keynote talk on Global Soil Partnership Action Framework by Global Soil Partnership (GSP) Representative (Online):
Ms.Lucrezia Caon, Global Soil Partnership (GSP) Secretariat

Ms Caon presented the new GSP action framework, proposes the development of a globally unified approach to soil health based on progress made in national soil indicator programs, research, and including already agreed indicators of the Protocol for the assessment of sustainable soil management. She also reiterated about the solution soil health and the halting of soil degradation.

Soil Status of Asia, Highlights of ASP activities, donors, success model of networking cooperation under GSP by Global Soil Partnership:
Dr. Pitayakon Limtong, National Focal Point of Thailand

Dr. Pitayakon Limtong, National Focal Point of Thailand presented on the topic "Soil Status of Asia, Highlights of ASP activities, donors, success model of networking cooperation under GSP by Global Soil Partnership". He has briefed the background of GSP and ASP and activities on issues related to soils. The highlight of ASP activities can be summarized as follow:

- Global Soil Doctors Program
- International Network on Black Soils (INBS)
- Activities on Salt-affected Soils
- Digital soil mapping
- Global Soil Laboratory Network (GLOSOLAN)
- International Network on Fertilizer Analysis (INFA)

The importance of soil resources, Asia soil research and development by Mr.Satira Udomsri, Head of Department of Soil Information and Training (DSIT)
Overview: Soil is our life that support the system. Soil can perform many functions, and these include functions related to the natural ecosystems, agricultural productivity, environmental quality, source of raw material, and as base for buildings. Functions of soil in the global ecosystem that perform 5 functions as follows:

1. medium for plant growth,
2. regulator of water supplies,
3. recycler of raw materials,
4. habitat for soil organism, and
5. landscaping and engineering medium

Soil plays a vital role in Earth's ecosystem. Soil layers tend to vary from place to place as to their number, individual thickness, color, physical and chemical characteristics. The soil types are classified based on a combination of soil properties that are considered indicative of the way they have been formed. The quantity and the depth at which soil characteristics such as organic matter, clay, iron and soluble salt content occur are some of the factors that are used to define the major soil classes. The changes of the soil are caused by chemical, physical, and biological processes. These processes can be intensified by the action of the climate, relief, parent material, living organisms and time, which are the main factors of soil formation (Jenny, 1941).

Soils = f (cl, o, r, p, t, …)

CESRA, a hub of research institutions for advancing research on soil protection, management and restoration. The establishment of the research center, located in Pak Chong district, Nakhon Ratchasima province. The objectives of CESRA are:

- To encourage interdisciplinary and trans-disciplinary targeted soil research and the development of sustainable soil management tools and techniques through technical cooperation using different approaches including South-South cooperation. To promote education on sustainable soil and land management (SSM and SLM), encourage partnership with different stakeholders and support informed decision making.
- Promote the exchange of knowledge, data, technical cooperation and experience in the Asian region by establishing the Asian Soil Information System (ASIS) as direct contributor to the Global Soil Information System (GLOSIS).
- To build the capacity of CESRA's member countries on sustainable soil management following a demand-driven approach where countries will determine the needs.

<u>Soil research and development for sustainable soil management</u>

1. CESRA should be the core agency to create the integrated soil research proposal. Fundraising should be based primarily on the needs of the donors and need to seek source of funding in national and international level.

2. Prioritize research topic and work plans on soil, water and crops. Therefore, all department stakeholders should discuss on the preparation of the integrated soil research projects in order to avoid duplicated project and can work together, which need to set up meeting and discussion with selected stakeholders.

3. The soil research projects should focus on the area base problem with the integrated proposal in soil organic carbon change, GHG emission reduction with climate change, soil degradation and quality assessment, using satellite data and assessment, using modelling for sustainable soil management.

4. Projects deliverable in various activities: seminar, workshop, site visits in domestic and other countries, including exchanging of personnel in field of scientific research to enable and foster research innovation and international cooperation.

<u>Area of work</u> contains 10 works (Awareness raising, soil biodiversity, capacity building, soil information, soil erosion, soil fertility, soil governance, soil pollution, soil salinity and soil organic carbon).

Technical networks contain 7 networks (Global Soil Laboratory Network, International Network of Black Soils, International Network of Fertilizer Analysis, International Network of Salt-Affected Soils, International Network of Soil Information Institutions, International Network on Soil Biodiversity and International Network on Soil Pollution).

How to support CESRA

Firstly, support soil data and linking other relevant data, promote integrated research-both members and international network, promote the development of knowledge, develop learning center and internship for students and farmers and secondly, support research laboratories and a network.

Soil concerns, existing research on soils, and knowledge gaps by CESRA members, Thailand will present 5 best practices on saline soil:
Dr. Bunjirtluk Jintaridth, Head of Department of Administration and Collaboration (DAC)

Dr. Bunjirtluk Jintaridth, Head of the Department of Administration and Collaboration (DAC) presented an overview about the 5 best practices of saline soils in Thailand. The extent of salt-affected soils in Thailand are mostly found in the Northeast saline soils: Salts came from rock salts, strata of sandstone, shale impregnates salts and saline ground water. Coastal saline soils, most of which are derived from marine deposits, and Central Plain Saline soils; And were derived from underlying old marine deposits. Problems such as saline soils, acid soils, and sandy soils including low organic matter reduce the plant production and impacted the environment. Improper land use resulted in soil degradation, that lead to poor living condition of farmers. Due to the decrease in production, lesser income, it greatly affected their livelihood. The low production in turn would raise the market price of food supply because of limited output.

1) **Managing areas with saline soil by practicing eco-agriculture** by Dr. Jatuporn Thienma, 2022. The eco-agriculture is located in the zone of Pratai soil series (saline sodic soils), area of Maha Sarakham province. This has made farmers living in the area with saline soils have better products, incomes, and life qualities.
2) **Fish farming for saline soil** management by Apasiree Meeglang et al., 2022. At, Ban Phai District, Khon Kaen Province, farmers earned income from fish (Tilapia) farming 1,600 dollars per production cycle., This fish is fed and produced by balancing the acidity and alkalinity (pH) of the soil by adding manure and lime to the pond.
3) **Extension of using the green manure plant (sunn hemp) in saline soils** by Ms. Wannaporn et al., 2022. There has been gathering of farmers in the area of Non Thai district, Nakhon Ratchasima province. Green manure crops are used for saline soil amendment suitably to increase organic matter and nitrogen in the soil. This is because they are cheap when compared with using other types of organic matter. Moreover, this approach helps reduce soil salinity indirectly. The soil properties are improved. Costs of production per unit reduce and incomes increased.
4) **Ked Forest Park, a prototype of community forest management in the brackish water ecosystem** by Mr. Pramote et al., 2022 in Khung Bang Krachao. The best practice was to conserve and propagate indigenous plant varieties and green areas available for environmental restoration to prevent and treat soil and water pollution and take advantage of land use in the brackish water ecosystem.
5) **Tung Kula Ronghai - Managing areas with saline soil for exporting Hom Mali rice** by Dr. Bunjirtluk Jintaridth et al., 2022. The territory covers the areas of 12 districts in 5

provinces, namely Roi Et, Surin, Si Sa Ket, Yasothon and Maha Sarakham. The best practices conclude saline soil management has been used to replace the traditional method by conducting integrated farming. The rice variety of Dok Mali 105 is planted together with Acacia amplicons on the levee. After the rice is harvested, vetiver grass, watermelon, and corn are planted as plants after rice harvesting. Also, the cropping system will lead to building additional income enough for living.

Cambodia's soils: Concerns, knowledge gaps and on-going research by Dr. Seng Vang and Phy Chhin from Department of Agricultural Land Resources Management, GDA provided the presentation about the soil resources, soil concerns, Knowledge gaps on soil research, and On-going research on soils in Cambodia.

Dr. Seng Vang, the representative of the Department of Agricultural Land Resources Management, GDA of Cambodia presented "Cambodia's soils: Concerns, knowledge gaps and on-going research" which can be summarized as follow:

1. Soil concerns

- Land cover and land use change accelerate land degradation.
- Soil erosion: Soils have a high erodibility rate (0.45 million ha) and moderate erodibility rate (7.63 million ha).
- Soil organic carbon stock (0-30cm) is relatively low.
- Land productivity is low.
- Institutional capacity: Lack of experts and facilities for soil survey and classification, digital soil mapping, soil research and conservation, and soil science education.

2. Knowledge gaps in soil research

- Overcoming soil constraints limiting farming system productivity.
- Soil organic matter management.
- Land suitability assessment for sustainable and profitable crop production.
- Impact of different land uses and farming systems on soil organic carbon dynamics, greenhouse gases emission, and water balance.
- Soil erosion and its economic assessment.
- Soil Database Management. Digital soil information system and knowledge sharing.
- Soil advocacy: Awareness raising, soil education, and extension.

3. On-going research on soils

- Soil Conservation (CA) Program. Conservation agriculture R4D is based in Bos Khnor CA research station under the Cambodia Conservation Agriculture R4D Center (CARDEC)/DALRM.
- AFACI Soil Project on Development of harmonized digital soil information systems and soil resources atlas for sustainable land management in Cambodia (RDA/AFACI).
- CUSP (Cambodia upland soils project). ACIAR funded a project focusing on the improvement of upland soil constraints for profitable crop production in Kampong Speu province.

India's Challenges to Soil Resources and Knowledge Gaps in Soil Research
KSCSTE- Centre for Water Resources Development and Management (KSCSTE-CWRDM): K.Ch.V. NagaKumar and U Surendran

Mr. NagaKumar explained that soil quality greatly influences the quality of the food, water, air we consume; it is the foundation of our health. The numerous biogeochemical cycles and different interactions among spheres (atmosphere, geosphere, biosphere, anthroposphere, hydrosphere) all converge into the pedosphere. Soil degradation in India is estimated to be occurring on 147 million hectares (Mha) of land, including 94 Mha from water erosion, 16 Mha from acidification, 14 Mha from flooding, 9 Mha from wind erosion, 6 Mha from salinity, and 7 Mha from a combination of factors. This is extremely serious because India supports 18% world's human population and 20% of the world's livestock population, but had only 2.4% of the world's land area, declining soil health, and low soil, water, and crop productivity. According to **National Academy of Agricultural Sciences (NAAS)**, the annual soil loss rate in India is about 16.35 tons per ha, resulting in loss of 5.37 to 8.4 million tons of nutrients: Soil Erosion, Deficiency in fertility, Desertification, Waterlogging, Salinity and Alkalinity, and Acidic Soil.

Knowledge gaps:

- Land degradation neutrality
- Emerging pollutants and its mitigation measures viz., microplastics/ antibiotics/PAH etc
- Climate change/ extreme events/ disasters /forecasting/ Adaptation measures
- Declining soil health – issues and its management
- Site specific information – Available information are scattered
- Use of advanced technologies –Big data, AI, and ML etc
- Conflicts of interest – Organic/ Conventional /Sustainable – etc
- Needs a clearcut message

Way forward – Strategies:

CESRA – Initiate the process of developing the national frame work for India in collaboration with research institutes and organizations such as CWRDM, ICAR, NRSC,SAUs etc.

Model-based quantification systems, if supported by robust, distributed measurement and monitoring networks, have the capability to improve the cost-effectiveness and standardization of soil fertility and sustenance of soil health – Needs to be promoted.

- More research must be conducted in these areas over the medium to long term with appropriate funding
- Interdisciplinary Research – Collaboration – CESRA /FAO/ICAR/Other R&D institutes

Data sharing /Open access data to soil scientists

Status of soil in India: Existing research and knowledge gaps by Mr. Pawan Kumar from Patanjali Organic Research Institute

Mr. Pawan Kumar shared the information on soil health aspects and status of soil in India. Deficits in soil nutrients require the application of sufficient fertilizer, and decision-making that is focused on results is essential for accomplishing sustainable soil management. For the soil status in India, the results from all around India show that the condition of Indian soils is declining. Most Indian soils are lacking in macro- & micro-nutrients.

- Given that half of the soil samples from the twenty-four states and the union territories have inadequate levels of organic carbon, the organic carbon deficit is widespread across the country.

- Nitrogen insufficiency is very common and serious and is found in at least half of the soil samples from 32 states and union territories. The 27 states and union territories have samples that are more than 90% inadequate. Nitrogen shortage is found in nearly all (99-100%) of the samples from 15 states and union territories.
- Deficiency of available phosphorus in soils of Indian states and Union territories. Phosphorus insufficiency is found in more than 90% of samples from 19 states and union territories
- Indian soils are also deficient in potassium. The 32 states and Union territories have at least half of their soil samples deficient in potassium. Of these, 8 states and Union territories have more than 90% deficient samples.

Existing research on soils: Indian perspective: Currently, well-known soil testing methods include,

- Optical sensing,
- Laboratory measurement,
- Ion selective electrodes,
- Chemical processes,
- Inductively coupled plasma (ICP) spectroscopy, and
- Fluorescence spectroscopy.

The bulk of these techniques, however, are either prohibitively costly, demand for complex setups, or cannot be used for in-situ measurement. The two most often used methods are,

- Electrochemical sensing, and
- Optical sensing.

Technological advances in soil testing:
The Pre-side-dress Soil Nitrogen Test (PSNT) (Rakshit et al., 2020); Soil Testing Kit® Transchem (SK) Idrish et al. (2022); Potentiometric multi-sensor system Khaydukova et al. (2021); Visible Near-Infra-Red (Vis-NIR) (pH, nutrients); Visible Mid-Infra-Red (Vis-MIR) (Nitrogen); Attenuated Total Reflection Spectrophotometer (ATR Spec.) (nutrients); Raman (nutrients); Ion-Selective Electrode (ISE) (pH, nutrients); Ion-Selective Field-Effect Transistors (ISFET) (pH, nutrients) (Yan et al., 2015; Ramesh & Rajeshkumar, 2021).
Artificial Intelligence (AI) Techniques:

- Fiber optic sensor (NPK levels) Ramane et al. (2015)
- X-ray diffraction technique (soil health assessment) Bertacchini et al. (2012)
- iMETOS MobiLab is a simple and innovative soil macro-nutrient analyzer

The iMETOS MobiLab LabOnAChip (soil samples via capillary electrophoresis)

Challenges to Soil Resources and Knowledge Gaps in Soil Research in Mongolia:
Bayarsuk Noov, Institute of Plant and Agricultural Science, Mongolia

Mr. Noov Bayarsukh presented the climate and soil condition in Mongolia. The climate extreme continental, average temperature between +25°C–25°C in 4 seasons. Annual rainfall 200-350 mm, Frost free days 90-100 days.
Soil research laboratory facilities: There are 4 public and 9 private soil laboratories in Mongolia.

- The IPAS laboratory of Soil Science and Agro-chemistry is one key government research laboratory in crop sector. Laboratory has 7 staff and annual capacity of

analysis 2500-3000 soil samples by 12 agro-chemical and 5 soil physical properties.

- The IPAS soil research focus on identification and improvement of soil fertility and erosion of arable soil in the country.

The arable soil status in Mongolia:

- The IPAS implemented complex soil analysis in 926400 ha arable crop covering 15 provinces of Mongolia in 2008-2013.
- Identified 60.6% of arable land is heavily eroded. The high fertility decline including soil organic matter, NPK and other elements.
- The desertification and degradation of pastures are increasing, and soil erosion is becoming more severe.
- The 78.8 % of the pastureland is eroded including 14.1 % is water eroded, 58.6 % water-wind eroded and 5.1 % wind eroded.

Technology packages for arable soil conservation and improvement:

- Strip cropping technology
- Soil conservation shallow tillage technology
- Green manure fallow technology
- Fertilization system of agricultural crops
- Wheat cultivation technology on chemical fallow
- Soil straw mulching technology
- New bacterial fertilizer production technology etc.

Challenges in soil research:

- Deficiency in laboratory and equipment for soil water-physics and physical properties and new protocols,
- Capacity building of soil researchers using high throughput laboratory equipment and data processing.
- Assistance to improve soil research on arable land and pasture using remote sensing technique.
- Sustainable soil management under irrigation as use of irrigation is increasing,
- Education and awareness among farmers and other SHs about sustainable soil management practices,

Emerging soil pollution especially in urban areas

Challenges to Soil Resources and Knowledge Gaps in Soil Research in Myanmar by Dr.Zaw Naing, CEO Mandalay Technology Co., Ltd.

Dr. Zaw Naing explained that the agricultural productivity and efficiency in Myanmar are constrained by many factors, including soil-based challenges poor nutrient acquisition by plants, infertile soil due to ineffective nutrient management, removal of nutrients in residues, and continual erosion of topsoil, and many challenges and knowledge gaps on soil resources. Challenges: Political instability, climate change, urbanization, unhealthy soil, lack of basic soil education and agricultural vocational education in education system, outdated soil laboratories, financial, technical and human resources, policies and law enforcement, population growth, effective stakeholders' analysis, lack of knowledge on waste disposal, food security, natural disasters and biodiversity.

Soil education and research:

- Yezin agricultural university

- Department of Agriculture (DOA)/Land Use Bureau
- Department of Agricultural Research (DAR)

Department of soil, water, and climate:

- To provide the scientific knowledge on the process and interaction of earth system among soil, water, and climate.
- To seek the improvement of the quality of soil, air, and water resources in both natural and to manage ecosystem and to predict and mitigate impact of climate change through research and teaching.

Recommendations for additional maps in the Agro-ecological Atlas:

- Identify farmed land outside surveyed and titled “Kwin Map” land.
- Include Township data on planted area and crop yield.
- Identify current crops in commercial cropping areas.
- Identify new areas suitable for current crops.

Assess impacts of climate change on rice yield with improved varieties and practices.

Challenges to Soil Resources and Knowledge Gaps in Soil Research in Philippines by Dr.Gina P. Nilo and Ms. Karen S. Bautista, Food-Secure and Resilient Philippines

Ms. Bautista explained the status of soil/ land degradation in the Philippines. The vulnerable areas are about 11.45 M ha or 38% of the total, including sloping agricultural areas, which are not practicing soil and water conservation measures, and sloping areas with minimal vegetative cover or those denuded forests, shrubs, and grasslands. Hotspots, which cover an area of about 2.6 M ha, include areas requiring immediate interventions or priority area for land conservation measures, agricultural areas, greater than 18% slope with severe erosion, and denuded forests, shrubs, and grasslands with slopes of more than 18%.

The National Soil and Water Resources Research, Development and Extension Agenda (NSWRRD/E) Agenda (2017-2022) sets the direction of soil/land and water resources research in the Philippines for the next five (5) years. It serves as planning tool to prioritize and allocate resources for agricultural R & D. It is supplemental to the current RDEAP 2016-2022 of the DA-BAR.

The SWRRD/E Agenda focused on the following programs:

- Soil Health Improvement
- Conservation and Management of Soil Biodiversity
- Organic Agriculture
- Mitigation of Soil and Water Pollution
- Effective Watershed Management for Improved Agricultural Productivity
- Assessment and Conservation and Management
- Enhancement of Rainwater Harvesting and Utilization
- Water Resources Development and Water Productivity Enhancement
- Management and Fertility Rehabilitation of Problem Soils
- Soil and Water Resources Database and System Development
- Laboratory Test Methods Validation and Verification
- Extension Modalities

Knowledge gaps on soil research:

- Mitigation of soil and water pollution
  Proposal: Assessment of soil pollution on Agricultural lands and Agricultural uses
  Objective: Baseline data on soil threats (pollution) to agricultural lands

- Management interventions to address salinity in agricultural soils near the coastal areas

  Proposal: Combating salinity through adaptive BFS and S&W management in lowland rice areas/ COMBAT-Salinity

  Objective: Manuals/protocols/technical and policy recommendations on suitable and location-specific combinations of soil, water and crop management technologies and best practices in lowland rice areas in coastal plains affected by different levels of salinity (i.e., slightly saline, moderately saline, and severely saline)

Laboratory test methods validation and verification

Challenges to Soil Resources and Knowledge Gaps in Soil Research in Sri Lanka by N.R.N. Silva (Principal Agriculture Scientist, Horticultural Crops Research and Development Institute, Department of Agriculture)

Mrs. Silva pointed out that natural resources degradation in Sri Lanka occurred as land degradation, deforestation, coastal degradation, water, and air pollution. Soil erosion is the major factor responsible for land degradation, which leads to serious environmental problems such as siltation of reservoirs, pollution of surface and ground water bodies, landslides, fertility decline in organic matter and plant nutrients, etc. Poor farming practices, mismanaged seedling tea, chena cultivation, and vegetable Farming on sloppy lands in hill country all contributed to soil erosion.

Policy and Institutional Issues:

- Lack of a comprehensive database on land management
- Inadequate awareness among stakeholders
- Lack of technology related skills among farmers
- Financial restrictions of farmers for land restoration work
- Weak institutional integration
- Gaps in policies and the need of strategic plans
- Inadequate strength of regulatory services.

Major control approaches:

- Introduction of agro forestry system
- Conservation farming
- Building up the organic matter content
- Promotion of Integrated Plant Nutrient Management system by application of balance chemical fertilizer and organic manures
- Better water management
- Improvements in drainage facilities to prevent soil salinization
- Promotion of site-specific fertilizer recommendation
- Addressed to quantify the accumulated chemical residues in soil (nutrients and heavy metals)
- Implementation of the conservation Act
- Initiatives Rehabilitation of degraded agricultural lands
- Rehabilitation of marginal lands

Knowledge Gaps on Soil Research:

- Understanding the SOC sequestration
- Adaptation of Soil to Climate Change
- Soil biodiversity

- Greenhouse gas emission
- Technologies to maintain/improve the physical and biogeochemical process
- No data on soil compaction

No data on land use pattern

Concept notes on soil carbon, saline soil and soil erosion

Dr.Sumitra Watana, Head of Department of Soil Research and Development (DSRD)

The objectives of DSRD are:

1. To promote research on soil and the practice of sustainable soil management in the Asian region.

2. To combine local research results and indigenous knowledge to international finding in the framework of developing and applying new technologies.

In 2022, the first activity of CESRA workshop was established in Pak Chong Model Project, area management model according to the King's Philosophy model for balance and sustainability of ecosystems (March to September 2022). On august 10-11, Strengthening CESRA network workshop on Developing National Network and Research Projects to drive CESRA forward at Novotel hotel, Pathum Thani. In the workshop that had 3 issues as priority then the projects conceptual framework has been set up by brainstorming from all members as follow:

Group 1: Soil carbon

Project topic: Managing soil organic carbon for climate change mitigation and increasing food security. The goal is the contribution in implement the Paris Agreement, with balancing sustainable agricultural production in SEA countries, supporting NDC development in agricultural sector, and supporting national and regional agricultural development plans. The project objectives are potential of agricultural soil carbon sequestration is evaluated and appropriate Agri-management practices are recommended for increasing SOC.

- This project consists of 5 research units:
  1) Greenhouse gases
  2) On-site assessment
  3) Off-site assessment
  4) Socio-economic assessment
  5) Decision support system development
- Output and activities:

1) Database: Harmonized database and digital mapping of potential of SOC sequestration and Assessment and monitoring data on SOC sequestration.

2) Potential C sequestration: Assessment C credit as to possibility motivation farmer for C management and Estimating potential of SOC sequestration and saturation under different soil type and managing.

3) Model SOC: Development C model employing remote sensing techniques, Development of soil C and N model, Modeling C flux and sequestration.

4) Community and networks: Strengthening regional network, Building and establishment of cooperation networks between organizations, and Enhancing community innovative model for sustainable soil C management.

- Expected outcome:
  1) Effective knowledge base decision support system.
  2) Improving production and long-term food security
  3) Reducing vulnerability to erosion effect and other degraded soil

4) Understanding of ecological engineering in terms of a unified soil and water-related policies, Institutional arrangement, and financing and incentive mechanism

5) Provide opportunities for researchers in the Asia and other regions

Group 2: Soil erosion

Project topic: Sustainable soil and water management to combat soil erosion. The main goal is to build the framework for decision support systems and develop knowledge ways for soil erosion problems. It consisted with 5 sub working group including: Greenhouse gases, On-site effect, Off-site effect, Socio-Economic, and Decision support development.

- The projects aim to answer following key questions:

1) what kind of agricultural management can increase SOC in southeast Asia?

2) How large potential for increasing SOC can be expected in Southeast Asian countries?

3) How much benefits of increasing SOC, expect for food security and climate change mitigation.

Driving factors of soil erosion are:

- Climate change: Flood and drought, and Land slide
- Biophysical: Climate, Soil fertility, and Topography
- Social: Values and beliefs, Individual perceptions, and Attitudes
- Economic: Market growth, commercialization, Output & Input prices, and Economic incentives
- Policy & Institutional: Agricultural policies and Marketing regulations

- Expected outcome:

1) Appropriate agricultural management practices are recommended for increasing SOC.

2) The potentials of soil carbon sequestration are presented for supporting national and regional sustainable agricultural development plans.

3) A regional research network is developed foe exchanging up-to-date information and transferring its research outputs to other stakeholders.

Group 3: Soil salinity

Project topic: Mainstreaming sustainable land management coupling technology innovation for the salt-affected soil area in the context of climate change. The project aims at the development of saline-climate database and sustainable Innovative soil & land management/ climate smart agriculture.

- The project consist of 4 components are:

1) Development of a saline-climate database.

- Exiting database: Salt effected soil map, Lessons Learned
- New/ Update database: High accuracy digital map (saline, soil organism, groundwater), Best practice for land management, and Land use change and land degradation study.

2) Sustainable innovative soil & land management/ climate smart agriculture.

- Soil & water reclaimants: salinity and biodiversity, capillary barrier & desalination for agricultural usage.

- Soil carbon sequestration: Integrated soil-water-crop mgt, Biomass application and establishment of plants, Resource conservation technologies, and Biotechnology/Biochar.
- Plant adaptive: Salt-tolerance, Encouraging market & uptake of halophytes & non-conventional crops creating, and Improve crop production.

3) Policy & decision system and a saline-climate knowledge platform.

4) Empowering communities and strengthening resilience.

- Expected outcome:

1) Up to date saline-climate database system.

2) Sustainable salt-affected land management for climate-smart agriculture.

3) DSS for saline-climate knowledge platform.

4) Long-term systematic capacity building on soil salinity management

Action Plan

Outcome	Output	Duration	Funding requested (USD)
Soil research in Asia is promoted	- Coordinated and targeted research on soil - New technologies - Technical and scientific cooperation	2023-2028 (Must be done in 5 years)	- Countries contribution - GEF - Fertilizer companies - FAO

Discussion on CESRA next step to drive the implementation of top 3 priorities

Group 1: Soil carbon:

Group 2: Soil erosion:

- choose common ecological zone
- Set up committee group
- Concept note/ Proposal template

Group 3: Soil salinity:

- Research of modern technique for soil mapping and updating maps
- Development of methodology for monitoring and forecasting salt-affected soils and background factors of salinization and sodification.
- Focus on soil microbial community assessment using next generation sequencing and identification of novel species of halophiles that could be used in the development of salt-tolerant inoculants.
- Research on bio stimulants and biofertilizers/microbial-based inoculants to facilitate effective pant-soil microbe interaction
- Frameworks: concept paper and timeline
- Finding grants for the research
- Call for proposals from members
- Summarize project proposal by project manager
- Finalize project by donors.

Next step of CESRA, the 2nd workshop for finalize project proposal is expected to be held on March in 2023. However, capacity building during April-September 2023 CESRA need some idea feedback from all members.