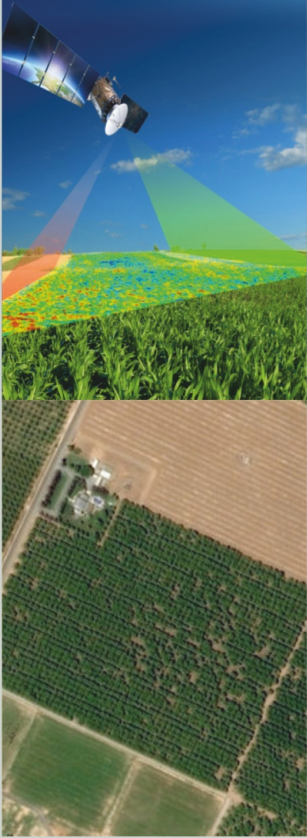




वार्षिक प्रतिवेदन ANNUAL REPORT 2023

ICAR-NBSS & LUP



भा.कृ.अनु.प. - राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो
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PREFACE



During the year 2023, ICAR-National Bureau of Soil Survey and Land Use Planning continued its focus through digital soil mapping (DSM). It is evident from the publications brought out by the Bureau with respect to DSM and land use planning of Bikaner Division of Rajasthan and Marathwada region of Maharashtra and other ongoing DSM activities in various states of the country.

The Bureau also actively supported national priority programmes like Pradhan Mantri Krishi Sinchayee Yojana. Watershed development programme in Bihar is under implementation with soil survey/inventory support by the Bureau to demonstrate the benefits of using soil data in agricultural development. The state agencies of Tamil Nadu and Bihar sought the delineation of fallow land in their states for data-driven decision making, following the success of similar mapping and training services provided to the Goa state. Land resource inventory work was initiated in Tripura with funding support by the state agriculture department. In a first of its kind, a start-up “Krishitantra” entered into an agreement with the Bureau to develop

agronomic platform for carbon farming in selected watersheds. Development efforts for climate resilient agriculture in Maharashtra were continued in 5000 villages. The crop planning, contingency planning and nutrition advisories developed by the Bureau will be implemented in these villages during 2024 crop season.

I feel obliged to express my gratitude to Dr. Himanshu Pathak, Secretary, DARE & DG, ICAR for evincing keen interest in the activities of the Bureau and his leadership. Deputy Director General (NRM) Dr. S. K. Chaudhari has been a source of encouragement and his guidance is specially thanked for mentoring, supporting and causing paradigm shift in the approach of soil survey data acquisition. ADG (S&WM) Dr. A. Velmurugan, ADG (Agronomy & AF) Dr. Rajbir Singh and NRM Division staff at HQrs are thanked for facilitation and ensuring smooth work flow. Gratitude and appreciation is placed on record to my scientists and other colleagues for their enthusiastic efforts.

Place: Nagpur

Date: December, 2023


N. G. Patil
Director

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EXECUTIVE SUMMARY

ICAR-NBSS&LUP continued its land resource inventory work in 2023 with an emphasis on the quick acquisition of soil data using the newly developed Standard Operating Protocol. Soil pH and SOC at 0-30 cm soil depth were mapped on a regional scale in Karnataka using the digital soil mapping (DSM) approach. The role of soil colour in evaluating soil spectral models was studied. The results indicated that considering pedological knowledge in building and evaluating regression models is a robust method to assess the uncertainty in predicting soil properties. The machine learning (*QRF*) models were developed using DSM to predict key soil properties viz., pH, SOC, sand, silt, clay, and depth in Jalpaiguri district, West Bengal. The geo-smart soil management zones based site site-specific agro-technology implementation are expected to enhance water and fertilizer use efficiency in this district.

DSM of the Bikaner division comprising Bikaner, Sriganganagar, Hanumangarh, and Churu districts was completed using 2018 soil samples from 531 geo-tagged soil profiles. The sand, silt, clay, and available water capacity (AWC) of the Bikaner division varied from 24.7 to 97.4%, 0.15 to 46.4%, 1.2 to 31.7%, and 0.70-14%, respectively. The pH, EC, and SOC ranged from 7.81 to 9.15, from 0.0 to 13.87 dS m⁻¹ and from 0.05 to 0.57%, respectively. The CaCO₃ content varied from 1.12 to 21.53%. Similarly, properties of the Barmer district soils were mapped using the DSM technique. Land resources in the Bikaner division of Rajasthan were evaluated for suitability of major crops using the analytical hierarchical process (AHP) in the Geographic Information System (GIS) environment, and district-wise land suitability maps of different crops were generated by integrating AHP weightage and score for each layer in GIS. Sustainable land use plans for the *Kharif* and *Rabi* seasons were suggested for each district of the region. Groundnut/cluster bean/ pulses/pearl millet/sorghum systems were suggested for Bikaner and Churu districts, whereas, cluster bean/pulses/pearl millet/sorghum and cotton/groundnut/cluster bean/pulses were recommended in Sriganganagar, and cluster bean/pulses/pearl millet/sorghum and cotton/cluster bean/pulses/pearl millet/sorghum systems for Hanumangarh district during

Kharif season. Taramira/mustard/chickpea systems were suggested in *Rabi* season for Bikaner and Churu districts whereas barley/mustard/oat/vegetables and chickpea/taramira/mustard/barley were suggested for Sriganganagar and Hanumangarh, respectively.

Digital terrain analysis-based landform characterization was carried out for the Khandesh region of Maharashtra. The major identified landform units are undulating lowlands, denudational upper pediments, undulating uplands, and moderately weathered upper pediments, which cover about 4,45,100, 3,37,300, 2,47,600 and 2,42,200 ha, respectively. Similarly, landforms and terrain mapping units were delineated for Chamrajnagar and Chitrdurga (Karnataka), Gadchiroli (Maharashtra), Gaya (Bihar), Kra-Daadi, Papum Pare, East Kameng, West Kameng, and Tawang (Arunachal Pradesh), Mandi and Bilaspur (Himachal Pradesh). Soil depth and organic carbon in the Chittorgarh district were predicted by using 56 legacy soil profile data by random forest (RF) model with DSM approach. The Length of Growing Period (LGP) map with a 15-day interval was generated by integrating mean annual PET and soil AWC maps of India. The LGP maps show a total of 23 classes. Thematic layers of the bioclimatic zones of India and LGP were integrated by using the intersection tools of GIS to derive a total of 116 classes of bioclimatic zones and the combination of LGP classes. The semi-arid moist region, with an LGP of 105-120 days, occupies a greater area, while less area is covered by semi-arid moist area, with an LGP of 75-90 days.

Different state agencies approached the Bureau for expert assistance in fallow land mapping, watershed development, and skill enhancement, as evidenced by the projects executed during the reporting year. A methodology was developed for the identification of permanent fallow lands in Bihar state by using monthly NDVI of Sentinel 2 satellite data at 10 m resolution for five continuous years. The fallow land maps are now being delineated in GIS. Similarly, the spatial-temporal distribution of fallow lands in Tamil Nadu is being delineated to assist in developing state-level land use policy. Application of integrated remote sensing data and NDVI were used to map the fallow

land area of Tamil Nadu for the years 2005, 2010, 2015, and 2020 using Landsat-8 data. Current fallow lands decreased from 2005 (23,98,540 ha) to 2020 (22,52,504 ha); permanent fallows were observed to be more in the southern zone (14.61%).

Spectral models were developed using 564 soil samples for prediction of soil properties in Maharashtra using hyperspectral remote sensing and evaluate the efficacy of portable sensor-system developed by NeoPerk technologies for spectral data-acquisition of processed soil samples in near-infrared or NIR (ASD FieldSpec) wavelength range. The ASD spectra performed better than Neoperk spectra in the validation data set for soil properties viz. pH, EC, Fe, Mn, and Cu, whereas the performance of Neoperk spectra for N, P, and K were at par with ASD spectra in the validation dataset. The Neoperk spectra gave better results for soil organic carbon (SOC) than ASD spectra in the validation dataset. A system for online soil spectroscopy has been designed and developed under the project ICAR-Network Programme on Precision Agriculture (ICAR-*NePPA*), to reduce the time and cost involved in the laboratory analysis of soil samples. The system can be used to reduce the resources needed to prepare soil health cards across the major ecosystems of India.

Under the Rejuvenating Watershed for Agricultural Resilience through Innovative Development (REWARD) Karnataka project, LRI for Hire-Wankalkunti (8,799 ha), Neeralooti (2,690.3 ha), and Bevura (5,621 ha) sub-watersheds of Yelburga taluk, Koppal district was completed. Soil maps, thematic maps, fertility maps, and land suitability maps for predominant crops (40 crops) were prepared for 21 micro-watersheds of 3 sub-watersheds. Similarly, a soil map with 182 mapping units was developed for the NagathiBasapura sub-watershed. LRI of Forest Development Corporation of Maharashtra divisions comprising Chandrapur, Markhanda, Pranhita, and Yavatmal divisions of Vidarbha region, covering an area of 2.3 lakh ha in 13 ranges and 32 compartments was completed. LRI of Birbhum and Malda districts of West Bengal, and Anjaw, Changlang of Arunachal Pradesh, Patialia and SBS Nagar districts of Punjab, Amreli, Dahod, and Narmada districts of Gujarat and Ahmadnagar and Osmanabad districts of Maharashtra were completed. The soils of selected sub-watershed clusters of Sambalpur and Koraput districts of Odisha covering about 29,000 ha were characterized and mapped under the REWARD, Odisha project.

Phase II of the Project on Climate Resilience (PoCRA) project comprises the mapping and generation

of a soil database for 15 districts of Maharashtra. During 2023, data generation for eight districts of the Marathwada region, namely Aurangabad, Parbhani, Beed, Hingoli, Nanded, Latur, Jalna, and Osmanabad was completed. Soil depth, soil texture, AWC, SOC and pH were predicted using the DSM approach based on the soil data of 700 profiles and legacy soil data.

Cinchona (*Cinchona* sp.) was identified as the most promising and sustainable land use system for C sequestration and soil fertility enrichment in the Eastern Himalayas. The soil quality evaluation showed that the quality of forest soils was better than that of soils under plantation, agriculture, and jhum cultivation in Arunachal Pradesh. Land suitability evaluation for major crops in Lohit, Changlang districts of Arunachal Pradesh, and Mathura district of Uttar Pradesh was completed and land use plans were suggested.

The ICAR-Indian Institute of Farming Systems Research, Modipuram, and ICAR-NBSS & LUP jointly developed a pilot project for crop diversification for the subsequent generation of decision support system to assist in agro-climatic region-based crop planning, linking district-wise data/information on suitability of crops, climate resilient and stress tolerant varieties, crop demonstrations/schemes and up scaling of cropping systems under changing condition under agro-climatic zones for adoption by states. In this project, potential crop zones for 14 major crops namely rice, wheat, maize, sorghum, pearl millet, pigeon pea, chickpea, mustard, soybean, groundnut, cotton, sugarcane, onion, and potato were delineated using relative spread, yield, and soil-climate suitability indices. Potential areas for the cultivation of soybean in India were delineated using GIS modeling techniques and the results showed that about 9.3 and 16.3 M ha is highly suitable to grow soybean in Madhya Pradesh and Maharashtra, respectively.

Soil-site suitability criteria for major crops were revised by collecting and analysing the datasets rainfall, temperature, soil depth, soil texture, soil pH, drainage, erosion, slope, elevation and soil CaCO_3 . The results indicated that soil depth is more important in maize, sugarcane, cotton, tomato, pomegranate, ashwaganda and davana whereas, the productivity of sorghum, groundnut and wheat is highly influenced by the soil texture. The soil-site suitability for major crops in Marathwada was evaluated using GIS-based multi-criteria analysis. The most efficient cropping zones for wheat were identified in Hingoli, Beed, Jalna and Aurangabad, while Jalna, Aurangabad and Latur have efficient cropping zones for soybean.



The assessment of heavy metal contamination in soil, water and vegetables at selected hotspots in Purna River basin, Maharashtra showed that health risks due to contaminated vegetable consumption are low. The heavy metal content in vegetable samples were found in the order Fe>Mn> Cu> Zn> Cr> Ni> Cd and below permissible limits except Cr and Cd in few samples. Salt-tolerant green gram variety was suggested and seeds were distributed to the farmers under SCSP programme in four villages (Jhadol, Bassi, Dhingri and Ghatod) near Jaisamand lake of Udaipur district which resulted in good yield in the soils affected by surface salinity. Similar interventions such as micro-irrigation-based vegetable farming for 200 farmers and animal feed to 200 farmers improved crop productivity, livestock health and milk yield in Nagpur district.

In basic pedological research, a conceptual model of SOC stabilization by nano-size soil minerals was developed. The model indicates that nano-sized crystalline layer silicates in soils break down at acidic pH in highly weathered humid tropical soils, resulting in the formation of nano-size non-crystalline minerals with positive charge surfaces. These positively charged minerals then form complexes with metal humus, effectively sequestering SOC. The relationship between the mineral composition of nano-clays and forms of soil K was explored to study the nutrient-supplying capacity. In Vertisols, a positive and significant correlation of water-soluble, exchangeable, and non-exchangeable K with the quantity of clay-sized mica suggested the mineral as a major K source. In Ultisols, a positive and significant correlation of non-exchangeable K with nano-sized hydroxy interlayered vermiculite and kaolin suggested the mineral as a major K source. Semi-quantitative estimation of the weatherable index minerals olivine,

pyroxene, pedogenic carbonate, and iron nodules present in the sub-humid moist climate of IGP soils indicated variability from surface to subsurface soils. The olivine mineral with dominant constituents of Fe-Mg silicates and pyroxene with Ca, Fe, Mg silicates, and iron nodules, in different stages of weathering, are identified as a major source of nutrients in IGP soils besides micaceous minerals. A dataset of 1058 Vertisol soil profiles was used to study their biodiversity in India. The surface horizon thickness varied from 8 to 23 cm due to variations in land use management. Various types of cracking patterns viz., irregular, hexagonal, and crisscross were observed on the surface of the Vertisols. The depth of surface cracks was higher (30-52 cm) in AER 6 and 7 than in the other AERs indicating the soil moisture deficit in these AERs.

The KRISHI Geoportal was strengthened further during 2023. The 16-day composites of MODIS satellite data-based NDVI and VCI products of India for the years 2000 to 2018 were processed for the Geoportal. API services were created to provide WMS using programming languages and deployed on the central Geoportal server to access the provided services. A soil grid Geoportal on the BHOOMI Geoportal platform has been developed to disseminate the DSM products. An Indian National Soil Archive was established to help studies related to DSM, soil spectroscopy, temporal assessment of soil properties, and other studies. Further, various thematic layers developed for Bundelkhand and Vidarbha regions and soil data of ten blocks at 1:10000 scale were deployed on the BHOOMI Geoportal to visualize and query at the region and district level. A dedicated dashboard has been developed to visualize various thematic information at the state level.

कार्यकारी सारांश

भारतीय कृषि अनुसंधान परिषद-राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो ने नए विकसित मानक ऑपरेटिंग प्रोटोकॉल का उपयोग करके मिट्टी डेटा के त्वरित अधिग्रहण पर जोर देने के साथ 2023 में अपना भूमि संसाधन इन्वेंट्री कार्य जारी रखा है। डिजिटल मृदा मानचित्रण (डीएसएम) एप्रोच का उपयोग करके कर्नाटक में 0-30 सेमी मिट्टी की गहराई पर मिट्टी के पीएच और एसओसी को क्षेत्रीय पैमाने पर मैप किया गया था। मिट्टी के वर्णक्रमीय मॉडल के मूल्यांकन में मिट्टी के रंग की भूमिका का अध्ययन किया गया। परिणामों ने संकेत दिया कि प्रतिगमन मॉडल के निर्माण और मूल्यांकन में पेडोलॉजिकल ज्ञान पर विचार करना मिट्टी के गुणों की भविष्यवाणी में अनिश्चितता का आकलन करने के लिए एक मजबूत तरीका है। प्रमुख मिट्टी के गुणों जैसे पीएच, एसओसी, रेत, गाद, की भविष्यवाणी करने के लिए डीएसएम का उपयोग करके मशीन लर्निंग (क्यूआरएफ) मॉडल विकसित किए गए थे। पश्चिम बंगाल के जलपाईगुड़ी जिले में मिट्टी और गहराई। भू-स्मार्ट मृदा प्रबंधन क्षेत्र आधारित साइट-विशिष्ट कृषि-प्रौद्योगिकी कार्यान्वयन से इस जिले में पानी और उर्वरक उपयोग दक्षता में वृद्धि होने की उम्मीद है।

बीकानेर संभाग का डीएसएम जिसमें बीकानेर, श्रीगंगानगर, हनुमानगढ़ और चूरु जिले शामिल हैं, 531 भू-टैग मिट्टी प्रोफाइल से 2018 मिट्टी के नमूनों का उपयोग करके पूरा किया गया। बीकानेर संभाग की रेत, सिल्ट, क्ले और उपलब्ध जल क्षमता (एडब्ल्यूसी) क्रमशः 24.7 से 97.4%, 0.15 से 46.4%, 1.2 से 31.7% और 0.70-14% के बीच थी। पीएच, ईसी और एसओसी क्रमशः 7.81 से 9.15, 0.0 से 13.87 डीएस एम-1 और 0.05 से 0.57% तक थे। CaCO_3 सामग्री 1.12 से 21.53% तक भिन्न पाई गई। इसी तरह, DSM तकनीक का उपयोग करके बाड़मेर जिले की मिट्टी के गुणों को मैप किया गया था। भौगोलिक

सूचना प्रणाली (जीआईएस) वातावरण में विश्लेषणात्मक पदानुक्रमित प्रक्रिया (एएचपी) का उपयोग करके प्रमुख फसलों की उपयुक्तता के लिए राजस्थान के बीकानेर संभाग में भूमि संसाधनों का मूल्यांकन किया गया था, और एएचपी वेटेज को एकीकृत करके एवं जीआईएस में प्रत्येक परत के लिए स्कोर द्वारा विभिन्न फसलों के जिलेवार भूमि उपयुक्तता मानचित्र तैयार किए गए थे। क्षेत्र के प्रत्येक जिले के लिए खरीफ और रबी सीजन के लिए स्थायी भूमि उपयोग योजनाएँ सुझाई गईं। बीकानेर और चूरु जिलों के लिए मूंगफली/क्लस्टर बीन/दालें/बाजरा/ज्वार प्रणाली का सुझाव दिया गया था, जबकि श्रीगंगानगर में क्लस्टर बीन/दालें/बाजरा/ज्वार और कपास/मूंगफली/क्लस्टर बीन/दालें अनुशंसित की गईं और क्लस्टर बीन /खरीफ सीजन के दौरान हनुमानगढ़ जिले के लिए दालें/बाजरा/ज्वार और कपास/क्लस्टर बीन/दालें/मोती बाजरा/ज्वार प्रणाली। बीकानेर और चूरु जिलों के लिए रबी सीजन में तारामीरा/सरसों/चना प्रणाली का सुझाव दिया गया था, जबकि श्रीगंगानगर और हनुमानगढ़ के लिए क्रमशः जौ/सरसों/जई/सब्जियाँ और चना/तारामीरा/सरसों/जौ का सुझाव दिया गया।

महाराष्ट्र के खाण्डेश क्षेत्र के लिए डिजिटल भू-भाग विश्लेषण-आधारित भू-आकृति लक्षण वर्णन किया गया। पहचानी गई प्रमुख भू-आकृतियाँ इकाइयाँ लहरदार निचली भूमि, अनाच्छादित ऊपरी तलहटी, लहरदार ऊपरी भूमि और मध्यम रूप से अपक्षयित ऊपरी तलहटी हैं, जो क्रमशः लगभग 4,45,100, 3,37,300, 2,47,600 और 2,42,200 हेक्टेयर को कवर करती हैं। इसी प्रकार, चामराजनगर और चित्रदुर्ग (कर्नाटक), गढ़चिरौली (महाराष्ट्र), गया (बिहार), क्रा-दादी, पापुम पारे, पूर्वी कामेंग, पश्चिम कामेंग और तवांग (अरुणाचल प्रदेश), मंडी और बिलासपुर (हिमाचल प्रदेश) के लिए भू-आकृतियाँ और भू-भाग मानचित्रण इकाइयाँ चित्रित की गईं। चित्तौड़गढ़ जिले में मिट्टी की

गहराई और कार्बनिक कार्बन की संभावना डीएसएम दृष्टिकोण के साथ यादृच्छिक वफ. (आरएफ) मॉडल द्वारा 56 लिगेसी मृदा प्रोफाइल डेटा का उपयोग करके की गई थी। 15 दिनों के अंतराल के साथ बढ़ती अवधि की लंबाई (एलजीपी) मानचित्र औसत वार्षिक को एकीकृत करके तैयार किया गया था। भारत के पीईटी और मृदा आंगनवाड़ी मानचित्र। एलजीपी मानचित्र कुल 23 कक्षाएं दिखाते हैं। भारत और एलजीपी के जैव-जलवायु क्षेत्रों की विषयगत परतों को जीआईएस के प्रतिच्छेदन उपकरणों का उपयोग करके जैव-जलवायु क्षेत्रों के कुल 116 वर्गों और एलजीपी वर्गों के संयोजन को प्राप्त करने के लिए एकीकृत किया गया था। 105–120 दिनों के एलजीपी के साथ अर्ध-शुष्क नम क्षेत्र, एक बड़े क्षेत्र को कवर करता है, जबकि 75–90 दिनों के एलजीपी के साथ, अर्ध-शुष्क नम क्षेत्र द्वारा कम क्षेत्र को कवर किया जाता है।

विभिन्न राज्य एजेंसियों ने परती भूमि मानचित्रण, वाटरशेड विकास और कौशल वृद्धि में विशेषज्ञ सहायता के लिए ब्यूरो से संपर्क किया, जैसा कि रिपोर्टिंग वर्ष के दौरान निष्पादित परियोजनाओं से पता चलता है। लगातार पांच वर्षों तक 10 मीटर रिजॉल्यूशन पर सेंटिनल 2 उपग्रह डेटा के मासिक एनडीवीआई का उपयोग करके बिहार राज्य में स्थायी परती भूमि की पहचान के लिए एक पद्धति विकसित की गई थी। परती भूमि मानचित्रों को अब जीआईएस में चित्रित किया जा रहा है। इसी प्रकार, राज्य-स्तरीय भूमि उपयोग नीति विकसित करने में सहायता के लिए तमिलनाडु में परती भूमि के स्थानिक-लौकिक वितरण को रेखांकित किया जा रहा है। एकीकृत रिमोट सेंसिंग डेटा और एनडीवीआई के अनुप्रयोग का उपयोग लैंडसैट –8 डेटा का उपयोग करके वर्ष 2005, 2010, 2015 और 2020 के लिए तमिलनाडु के परती भूमि क्षेत्र को मैप करने के लिए किया गया था। वर्तमान परती भूमि 2005 (23,98,540 हेक्टेयर) से घटकर 2020 (22,52,504 हेक्टेयर) हो गई; दक्षिणी क्षेत्र में स्थायी परती अधिक (14.61%) देखी गई। हाइपरस्पेक्ट्रल रिमोट सेंसिंग का उपयोग करके महाराष्ट्र में मिट्टी के गुणों की भविष्यवाणी के लिए 564 मिट्टी के नमूनों का उपयोग करके स्पेक्ट्रल मॉडल विकसित किए गए थे और निकट-अवरक्त (नियर इन्फ्रारेड) या एनआईआर (एएसडी फील्डस्पेक) में संसाधित मिट्टी के

नमूनों के वर्णक्रमीय डेटा-अधिग्रहण के लिए नियोपर्क प्रौद्योगिकियों द्वारा विकसित पोर्टेबल सेंसर-सिस्टम की प्रभावकारिता का मूल्यांकन किया गया था। तरंग दैर्ध्य रेंज. मृदा गुणों के लिए सत्यापन डेटा सेट में एएसडी स्पेक्ट्रा ने नियोपर्क स्पेक्ट्रा से बेहतर प्रदर्शन किया। pH, EC, Fe, Mn, और Cu, जबकि N, P, और K के लिए नियोपर्क स्पेक्ट्रा का प्रदर्शन सत्यापन डेटासेट में ASD स्पेक्ट्रा के बराबर था। नियोपर्क स्पेक्ट्रा ने सत्यापन डेटासेट में एएसडी स्पेक्ट्रा की तुलना में मृदा कार्बनिक कार्बन (एसओसी) के लिए बेहतर परिणाम दिए। कम करने के लिए आईसीएआर-नेटवर्क प्रोग्राम ऑन प्रिसिजन एग्रीकल्चर (आईसीएआर-एनईपीपीए) परियोजना के तहत ऑनलाइन मृदा स्पेक्ट्रोस्कोपी के लिए एक प्रणाली डिजाइन और विकसित की गई है। मिट्टी के नमूनों के प्रयोगशाला विश्लेषण में लगने वाला समय और लागत। इस प्रणाली का उपयोग भारत के प्रमुख पारिस्थितिक तंत्रों में मृदा स्वास्थ्य कार्ड तैयार करने के लिए आवश्यक संसाधनों को कम करने के लिए किया जा सकता है।

रिवार्ड (REWARD) कर्नाटक परियोजना के माध्यम से कृषि कायाकल्प जलक्षेत्र के तहत, कोप्पल जिले के येलबर्गा तालुक के हायर-वांकलकुंती (8,799 हेक्टेयर), नीरालूटी (2,690.3 हेक्टेयर), और बेवुरा (5,621 हेक्टेयर) उप-जलक्षेत्रों के लिए एलआरआई कार्य पूरा किया गया। 3 उप-जलक्षेत्रों के 21 सूक्ष्म जलक्षेत्रों के लिए मृदा मानचित्र, विषयगत मानचित्र, उर्वरता मानचित्र और प्रमुख फसलों (40 फसलें) के लिए भूमि उपयुक्तता मानचित्र तैयार किए गए। इसी प्रकार, नागथीबासापुरा उप-जलक्षेत्र के लिए 182 मानचित्रण इकाइयों वाला एक मृदा मानचित्र विकसित किया गया था। विदर्भ क्षेत्र के चंद्रपुर, मरखंडा, प्राणहिता और यवतमाल डिवीजनों को शामिल करते हुए महाराष्ट्र के वन विकास निगम डिवीजनों का एलआरआई, 13 रेंज और 32 डिब्बों में 2.3 लाख हेक्टेयर क्षेत्र को कवर करता है। पश्चिम बंगाल के बीरभूम और मालदा जिलों और अंजाव का एलआरआई पूरा हो गया है। अरुणाचल प्रदेश के चांगलांग, पंजाब के पटियालिया और एसबीएस नगर जिले, गुजरात के अमरेली, दाहोद और नर्मदा जिले और महाराष्ट्र के अहमदनगर और उस्मानाबाद जिलों में काम पूरा हुआ। रिवार्ड, ओडिशा परियोजना के तहत

ओडिशा के संबलपुर और कोरापुट जिलों के चयनित उप-जलक्षेत्र समूहों की लगभग 29,000 हेक्टेयर मिट्टी की विशेषता और मानचित्रण किया गया।

प्रोजेक्ट ऑन क्लाइमेट रेजिलिएंस (पीओसीआरए) परियोजना के दूसरे चरण में महाराष्ट्र के 15 जिलों के लिए मृदा डेटाबेस का मानचित्रण और निर्माण शामिल है। 2023 के दौरान, मराठवाड़ा क्षेत्र के आठ जिलों, औरंगाबाद, परभणी, बीड, हिंगोली, नांदेड़, लातूर, जालना और उस्मानाबाद के लिए डेटा उत्पादन पूरा हो गया। मिट्टी की गहराई, मिट्टी की बनावट, एडब्ल्यूसी, एसओसी और पीएच की भविष्यवाणी 700 प्रोफाइल के मिट्टी डेटा और विरासत मिट्टी डेटा के आधार पर डीएसएम दृष्टिकोण का उपयोग करके की गई।

सिनकोना (सिनकोना एसपी.) को पूर्वी हिमालय में सी सीक्वेस्ट्रेशन और मिट्टी की उर्वरता संवर्धन के लिए सबसे आशाजनक और टिकाऊ भूमि उपयोग प्रणाली के रूप में पहचाना गया। मिट्टी की गुणवत्ता के मूल्यांकन से पता चला कि जंगल की मिट्टी की गुणवत्ता अरुणाचल प्रदेश में वृक्षारोपण, कृषि और झूम खेती के तहत मिट्टी की तुलना में बेहतर थी। लोहित, अरुणाचल प्रदेश के चांगलांग जिलों और उत्तर प्रदेश के मथुरा जिले में प्रमुख फसलों के लिए भूमि उपयुक्तता मूल्यांकन पूरा हो गया और भूमि उपयोग योजनाओं का सुझाव दिया गया।

आईसीएआर-भारतीय कृषि प्रणाली अनुसंधान संस्थान, मोदीपुरम और आईसीएआर-एनबीएसएस और एलयूपी ने संयुक्त रूप से कृषि-जलवायु क्षेत्र-आधारित फसल योजना में सहायता के लिए निर्णय समर्थन प्रणाली की अगली पीढ़ी के लिए फसल विविधीकरण के लिए एक पायलट प्रोजेक्ट विकसित किया है, जो जिलेवार डेटा को जोड़ता है। राज्यों द्वारा अपनाने के लिए कृषि-जलवायु क्षेत्रों के तहत बदलती परिस्थितियों के तहत फसलों की उपयुक्तता, जलवायु और तनाव सहनशील किस्मों, फसल प्रदर्शनों/योजनाओं और फसल प्रणालियों के विस्तार पर जानकारी। इस परियोजना में, 14 प्रमुख फसलों जैसे चावल, गेहूं, मक्का, ज्वार, बाजरा, अरहर, चना, सरसों, सोयाबीन, मूंगफली, कपास, गन्ना, प्याज और आलू के लिए संभावित फसल क्षेत्रों को सापेक्ष प्रसार, उपज का

उपयोग करके चित्रित किया गया। भारत में सोयाबीन की खेती के लिए संभावित क्षेत्रों को जीआईएस मॉडलिंग तकनीकों का उपयोग करके चित्रित किया गया था और परिणामों से पता चला कि मध्य प्रदेश और महाराष्ट्र में क्रमशः 9.3 और 16.3 मिलियन हेक्टेयर सोयाबीन उगाने के लिए अत्यधिक उपयुक्त है।

प्रमुख फसलों के लिए मृदा-स्थल उपयुक्तता मानदंड को वर्षा, तापमान, मिट्टी की गहराई, मिट्टी की बनावट, मिट्टी पीएच, जल निकासी, कटाव, ढलान, ऊंचाई और मृदा कैल्शियम कार्बोनेट CaCO_3 डेटासेट एकत्र और विश्लेषण करके संशोधित किया गया था। परिणामों से पता चला कि मक्का, गन्ना, कपास, टमाटर, अनार, अश्वगंधा और दावाना में मिट्टी की गहराई अधिक महत्वपूर्ण है, जबकि ज्वार, मूंगफली और गेहूं की उत्पादकता मिट्टी की बनावट से अत्यधिक प्रभावित होती है। मराठवाड़ा में प्रमुख फसलों के लिए मिट्टी-स्थान की उपयुक्तता का मूल्यांकन जीआईएस-आधारित बहु-मानदंड विश्लेषण का उपयोग करके किया गया था। गेहूं के लिए सबसे कुशल फसल क्षेत्र हिंगोली, बीड, जालना और औरंगाबाद में पहचाने गए, जबकि जालना, औरंगाबाद और लातूर में सोयाबीन के लिए कुशल फसल क्षेत्र हैं।

महाराष्ट्र के पूर्ण नदी बेसिन में चयनित हॉटस्पॉट पर मिट्टी, पानी और सब्जियों में भारी धातु संदूषण के आकलन से पता चला है कि दूषित सब्जियों की खपत के कारण स्वास्थ्य जोखिम कम हैं। सब्जियों के नमूनों में भारी धातु की मात्रा $\text{Fe} > \text{Mn} > \text{Cu} > \text{Zn} > \text{Cr} > \text{Ni} > \text{Cd}$ क्रम में और कुछ नमूनों में Cr और Cd को छोड़कर अनुमेय सीमा से नीचे पाई गई। नमक-सहिष्णु मूंग की किस्म का सुझाव दिया गया और उदयपुर जिले के जयसमंद झील के पास चार गांवों (झाडोल, बस्सी, ढिंगरी और घाटोद) में एससीएसपी कार्यक्रम के तहत किसानों को बीज वितरित किए गए, जिसके परिणामस्वरूप सतह की लवणता से प्रभावित मिट्टी में अच्छी उपज हुई। 200 किसानों के लिए सूक्ष्म सिंचाई-आधारित सब्जी की खेती और 200 किसानों को पशु चारा जैसे इसी तरह के हस्तक्षेप से नागपुर जिले में फसल उत्पादकता, पशुधन स्वास्थ्य और दूध की उपज में सुधार हुआ।

बेसिक पेडोलॉजिकल अनुसंधान में, नैनो-आकार के मिट्टी के खनिजों द्वारा एसओसी स्थिरीकरण का एक वैचारिक मॉडल विकसित किया गया था। मॉडल इंगित करता है कि मिट्टी में नैनो-आकार की क्रिस्टलीय परत सिलिकेट अत्यधिक मौसमी आर्द्र उष्णकटिबंधीय मिट्टी में अम्लीय पीएच पर टूट जाती है, जिसके परिणामस्वरूप सकारात्मक चार्ज सतहों के साथ नैनो-आकार के गैर-क्रिस्टलीय खनिजों का निर्माण होता है। ये सकारात्मक रूप से चार्ज किए गए खनिज तब धातु ह्यूमस के साथ कॉम्प्लेक्स बनाते हैं, जो एसओसी को प्रभावी ढंग से अलग करते हैं। पोषक तत्व-आपूर्ति क्षमता का अध्ययन करने के लिए नैनो-मिट्टी की खनिज संरचना और मिट्टी K के रूपों के बीच संबंध का पता लगाया गया था। वर्टिसोल्स में, मिट्टी के आकार के अभ्रक की मात्रा के साथ पानी में घुलनशील, विनिमेय और गैर-विनिमेय योग्य K का एक सकारात्मक और महत्वपूर्ण सहसंबंध खनिज को एक प्रमुख K स्रोत के रूप में सुझाता है। अल्टिसोल्स में, नैनो-आकार के हाइड्रॉक्सी इंटरलेयर वर्मीक्यूलाईट और काओलिन के साथ गैर-विनिमेय K का एक सकारात्मक और महत्वपूर्ण सहसंबंध खनिज को एक प्रमुख ज्ञ स्रोत के रूप में सुझाता है। आईजीपी मिट्टी की उप-नम नम जलवायु में मौजूद मौसम योग्य सूचकांक खनिज ओलिविन, पाइरोक्सिन, पेडोजेनिक कार्बोनेट और लौह नोड्यूल के अर्ध-मात्रात्मक अनुमान ने सतह से उपसतह मिट्टी तक परिवर्तनशीलता का संकेत दिया। अपक्षय के विभिन्न चरणों में Fe-Mg सिलिकेट्स और पाइरोक्सिन के साथ Ca, Fe, Mg सिलिकेट्स और आयरन नोड्यूल के प्रमुख घटकों के साथ ओलिवाइन खनिज को सूक्ष्म खनिजों के अलावा IGP मिट्टी में पोषक तत्वों के एक प्रमुख स्रोत के रूप में पहचाना जाता है। भारत में उनकी

जैव विविधता का अध्ययन करने के लिए 1058 वर्टिसोल मिट्टी प्रोफाइल के एक डेटासेट का उपयोग किया गया था। भूमि उपयोग प्रबंधन में भिन्नता के कारण सतह क्षितिज की मोटाई 8 से 23 सेमी तक भिन्न होती है। वर्टिसोल्स की सतह पर विभिन्न प्रकार के क्रैकिंग पैटर्न जैसे अनियमित, हेक्सागोनल और क्रिसक्रॉस देखे गए। सतह की दरारों की गहराई अन्य आईआर की तुलना में आईआर 6 और 7 में अधिक (30-52 सेमी) थी जो इन आईआर में मिट्टी की नमी की कमी को दर्शाती है।

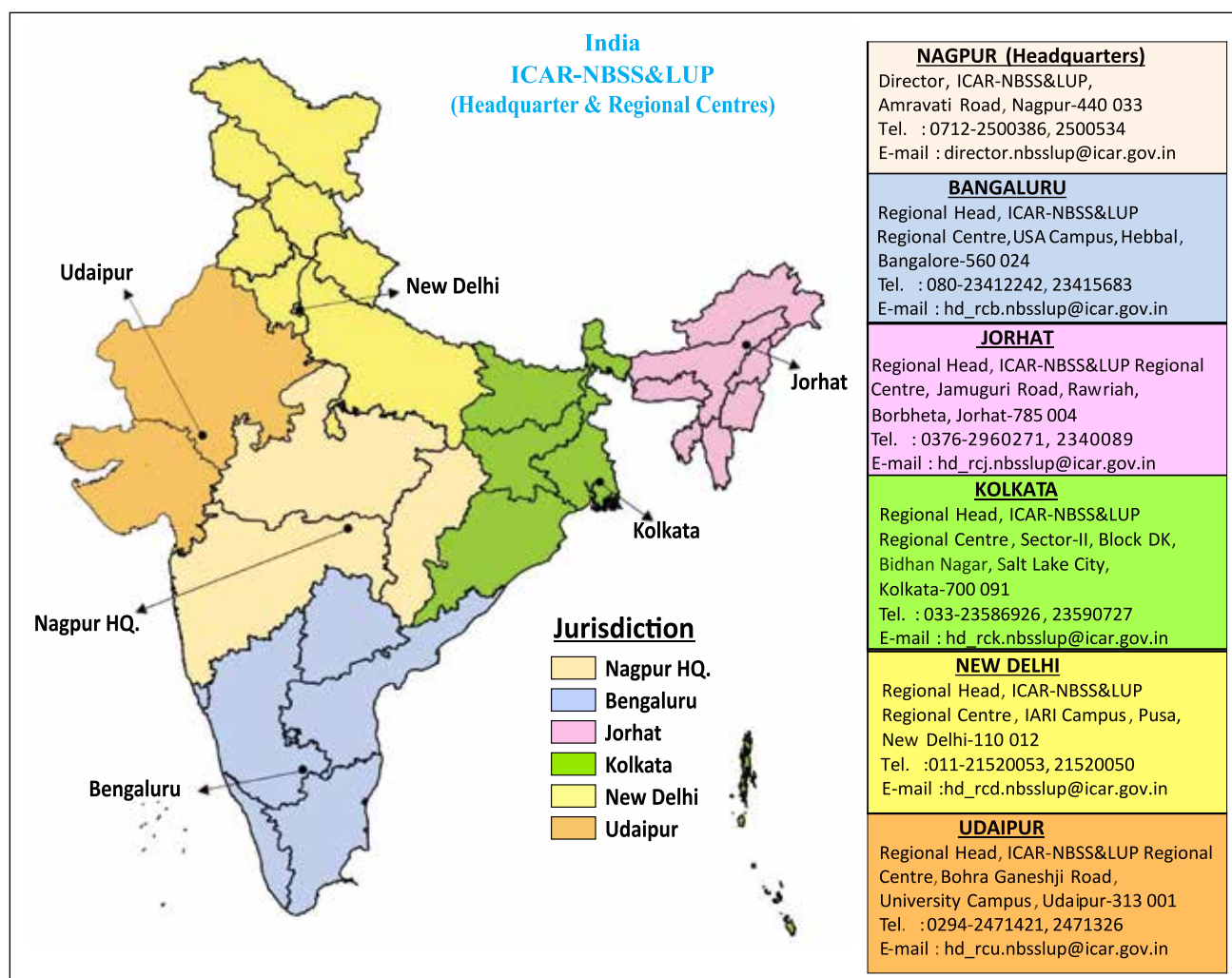
कृषि जियोपोर्टल को 2023 के दौरान और मजबूत किया गया। वर्ष 2000 से 2018 के लिए भारत के MODIS उपग्रह डेटा-आधारित NDVI और VCI उत्पादों के 16-दिवसीय कंपोजिट को जियोपोर्टल के लिए संसाधित किया गया था। एपीआई सेवाओं को प्रोग्रामिंग भाषाओं का उपयोग करके WMS प्रदान करने के लिए बनाया गया था और प्रदान की गई सेवाओं तक पहुंचने के लिए केंद्रीय जियोपोर्टल सर्वर पर तैनात किया गया था। DSM उत्पादों के प्रसार के लिए BHOOMI जियोपोर्टल प्लेटफॉर्म पर एक मृदा ग्रिड जियोपोर्टल विकसित किया गया है। डीएसएम, मृदा स्पेक्ट्रोस्कोपी, मृदा गुणों के अस्थायी मूल्यांकन और अन्य अध्ययनों से संबंधित अध्ययनों में सहायता के लिए एक भारतीय राष्ट्रीय मृदा पुरालेख की स्थापना की गई थी। इसके अलावा, बुन्देलखण्ड और विदर्भ क्षेत्रों के लिए विभिन्न विषयगत परतें विकसित की गईं और 1:10000 पैमाने पर दस ब्लॉकों के मिट्टी के डेटा को क्षेत्र और जिला स्तर पर कल्पना और पूछताछ के लिए भूमि जियोपोर्टल पर तैनात किया गया। राज्य स्तर पर विभिन्न विषयगत सूचनाओं को प्रदर्शित करने के लिए एक समर्पित डैशबोर्ड विकसित किया गया है।

Genesis

After the recognition of Soil Survey as a national priority, a need was felt for creating a centralized information warehouse to assimilate, verify and disseminate information on nature, extent and distribution of soils in the country. Consequently, the Indian Council of Agricultural Research (ICAR) established National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) (to be hereafter referred to as Bureau) in 1976, with its Hqrs. at Nagpur. The Hqrs. houses 3 Research Divisions, namely, Division of Remote Sensing Applications, Division of Soil Resource Studies and Division of Land Use Planning. Subsequently, five regional centres came into

existence that are located at Bangalore, Delhi, Jorhat, Kolkata and Udaipur and address region-specific issues in the mandated areas of work. Besides, there are several units and sections, which provide scientific and technical support to the research divisions and regional centres in accomplishing varied tasks.

The Bureau is the country's only premier national institute mandated for research, development and training (RD&T) in the field of soil survey, land use planning and allied aspects. Over the years, the Bureau has excelled as a centre of RD&T in Soil Survey and Land Use Planning at the national and international level.



Location

The Hqrs. is located on Amravati Road (Kolkata-Mumbai National Highway), Nagpur. It has in its close vicinity ICAR-Central Citrus Research Institute (CCRI), Ginning Training Centre (GTC) a regional centre of ICAR-Central Institute for Research on Cotton Technology (CIRCOT), and Regional Remote Sensing Centre (RRSC, ISRO). The campus of the Bureau is also quite close to Nagpur University. The Hqrs., therefore, has the locational advantage which facilitates multidisciplinary studies, inter-institutional interactions and research linkages, etc. A map showing the location of the Hqrs. and the five regional centres is shown below:

Mandate

- To conduct soil survey and mapping of the soils of the country to promote scientific and optimal land use programmes in collaboration with relevant institutions and agencies.
- To conduct and promote research in the National Agricultural Research System in the areas of Pedology, Soil survey, Remote sensing applications, Land degradation, Land evaluation and Land use planning.
- To impart training and education to create awareness on soil and land resources and their state of health.

The role of the ICAR-National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS&LUP) becomes all the more important due to the serious challenges the country faces in terms of shrinking soil and land resource base, soil/land degradation, depleting nutrient stock, deterioration in soil/land quality, changing climate, land-use conversion and growing crops out of capability domain.

Major Research Themes

- Inventorying natural resources
- Remote sensing and GIS applications
- Basic Pedological Research
- Soil Survey Data Interpretation and Applications
- Land Evaluation and Land Use Planning
- IT Enabled Extension Programme

Training Areas

Soil Survey and Land Evaluation for Land Use Planning

Remote Sensing and GIS Applications in Soil Resources Mapping

Management

A high powered Research Advisory Committee (RAC) comprising eminent professionals, mostly from outside the ICAR system guides the Bureau on formulating its research policies and in planning research thrusts and strategies.

The Institute Management Committee (IMC), constituted and mandated by the ICAR, supervises the functioning of the Bureau. Internal Committees, such as, Institute Research Council, Purchase Committee, Library and Publication Committee, Official Language Committee and a Grievance Cell, to name a few, are operating for decentralization of management. The Institute Joint Staff Council promotes healthy interaction and congenial work environment.

Infrastructural Facilities

Laboratories

The Bureau has various state-of-art laboratories. Some of the modern and sophisticated equipments are listed below.

- X-ray diffractogrameter
- Scanning Electron Microscope
- Inductively coupled Plasma – Atomic emission spectrophotometer
- Atomic Absorption Spectrophotometer
- Spectroradiometer
- Latest Remote Sensing and GIS software
- CN Analyzer

The facilities available in micromorphology and GIS laboratories are the best in the country that match international standards.

Data Centre

The Data Centre is the house for the data generated over the years in the Bureau and equipped with server data storage facility and high-end computers for remote sensing data interpretation. A team of dedicated scientists, technical officers and young professionals are working for the cause of developing the area-specific land-use model. Data Centre is linked with its replica maintained at the regional centres for exchanging data.

Library

The Bureau houses a fully computerized library located at the Hqrs. that has a comprehensive collection of books, reports and periodicals. The regional centres also have computerized libraries.



ICAR-NBSS&LUP website

The Bureau posts all important information about its activities, particularly about research projects, publications, linkages, educational training, staff and infrastructure on its Website (<http://www.nbsslup.icar.gov.in>).

Bhoomi Geoportal

NBSSLUP maintains a dedicated portal of soils known as Bhoomi Geoportal which has all kind of information on soil and allied resources in geographical information system (www.bhoomigeoportal-nbsslup.in).

Major Achievements

1976-2023

The Bureau, through its journey over the last 4 decades, has every reason to feel proud for its tremendous accomplishments in the domains of research and development.

- Soil resource map of the country (1:1 million scale), states (1:250,000 scale) and 82 districts (1:50,000 scale), selected watersheds (2767), blocks (339), villages (683) and research farms (106) on 1:10000 scale, Geo-referenced soil information system for black soil region (BSR) and Indo-Gangetic plain (IGP) monitoring soil quality by registering observation through hotspot.
- Agro-ecological Region (AER) and Agro-ecological Sub-region (AESR) maps of the country.
- Land evaluation and land use planning of irrigated, rainfed, coastal, arid, and hill and mountain Agro-ecosystems and showcasing of agro-techniques at 56 operational units; land use planning in the coconut-based farming system of Kerala, strategies for natural resource management in backward districts of India, and strategies for arresting other forms of land degradation in India.
- Spectral characteristics of benchmark soils of India, mineral composition of dominant soils, organic carbon stock of Indian soils in general, and cold arid and hot arid region in particular, and Soil Spectral Library.
- Automated Land Evaluation Software for linking socio-economic conditions of the farmers and natural resource information
- Soil erosion map of the country and the states on 1:250000 scale; extent and severity of degradation in the country and land use planning using remote sensing and GIS.

- Methodology for land resource mapping on 1:10000 scale in the different agro-ecological regions of the country using high-resolution remote sensing data and GIS in conjunction with the cadastral map for site-specific information and situation-specific recommendation
- Soil nutrient maps on 1:50000 scale for the state of West Bengal, Kerala, Goa, Karnataka, Jharkhand, Assam, Nagaland, Sikkim, Tripura, Andhra Pradesh and Telangana, and mining the data for delineating areas affected by the low balance of multiple nutrients using GIS and GPS in the Eastern and North-Eastern Region
- Web and Mobile based Farmers' Advisory for nutrient management and input-based land use planning
- Methodology developed for Soil Health Cards for farmers of different regions using Geo-informatics
- Methodology for the district, block and watershed/ village level land use planning on 1:10000 scale.
- Decision Support Systems (DSS) for land use planning.
- Development and updation of Bhoomi Geoportal
- Fallow land mapping of Goa
- Land Resource Inventory of Goa
- Two android based mobile GIS application (Apps) developed namely, i) Land Resource Information System of Goa (LRIS Goa), and ii) Potential Crop Zone (PCZ) Mapper.
- Sustainable areas for 17 crops.
- Revised Agro-ecological Region (AER) map of the country
- Revised Agro-ecological Sub-regions (AESR) of the country
- Agricultural land use plan for 27 aspirational districts submitted to NITI Aayog.

Salient Achievements (2023)

- Land Resource Inventory of 11 districts across the country was completed.
- Land resource Inventory of FDCM divisions covering 2.3 lakh ha was completed.
- Digital soil mapping and alternate land use planning of Bikaner division with four districts and Marathwada region with 8 districts were completed.
- Fallow land mapping of Tamil Nadu was completed.
- An online soil spectroscopy system was developed.

New initiatives

- LRI - Karnataka / Odisha (REWARD Program)
- LUP of Vidarbha region, Maharashtra
- LRI and LUP of 5000 villages under PoCRA phase II
- Evaluating and mapping soil-site suitability for major crops in Central India
- LRI Bihar/Tripura
- Krishitantra for agronomic platform for carbon farming
- GSI, Bangalore for district resource mapping for Karnataka & Goa

Linkages

The Bureau maintains linkages with national and international organizations like NRSC, Hyderabad, ICRIAT, Hyderabad, Govt. of Telangana, Goa, Meghalaya and BISAG, Ahmedabad; ICAR-IISS, Bhopal and ICAR-IIFSR, Modipuram, Sterlite India Ltd., KEC international, WDD, Adani Transmission Ltd., Ahmedabad, Tata Projects Ltd., New Delhi, Govt. of Maharashtra, Neeranchal Project of DoLR, New Delhi, SAUs located in Maharashtra, Govt. of Arunachal Pradesh, Tripura, Bihar, Odisha.

Thrust areas for 2021-2026

- Land Resource Inventory at 1:10000 scale
- Develop concepts and knowledge base on soil formation
- Development of Indian soil taxonomy rationale
- Development of user-friendly classification system for varied conditions
- Explore applicability of remote sensing and GIS techniques and assess their effectiveness and efficiency in soil resource mapping
- Agro-ecological regionalization
- Understand the relevance and importance of soil

functions in eco-system services and generate soil quality indicators and quantify soil quality in different regions

- Develop a national soil resource information system
- Develop a prime land map of the country
- Develop soil carbon and other nutrients maps of different states
- Develop indicators of climate change impact (on soils and land use) and soil processes-based mitigation techniques
- Emerge as a Centre of Excellence for capacity building in soil survey, remote sensing and GIS applications in soil resource mapping, land evaluation and land use planning
- Generate contemporary land use plans at different levels, particularly, at village/ farmlevel

Adapt RD&T programmes to address contemporary societal challenges

- To establish linkage with national and international organizations, stakeholders including farmers

Suggest prospective land-use policies for varied situations

- To equip the policymakers with policy guidelines on various issues towards suggesting perspective land-use policies.

Institute Budget (including salaries): 2023 (Rs. in lakh)

Funds Received	:	10045.69
Funds Utilized	:	10026.74

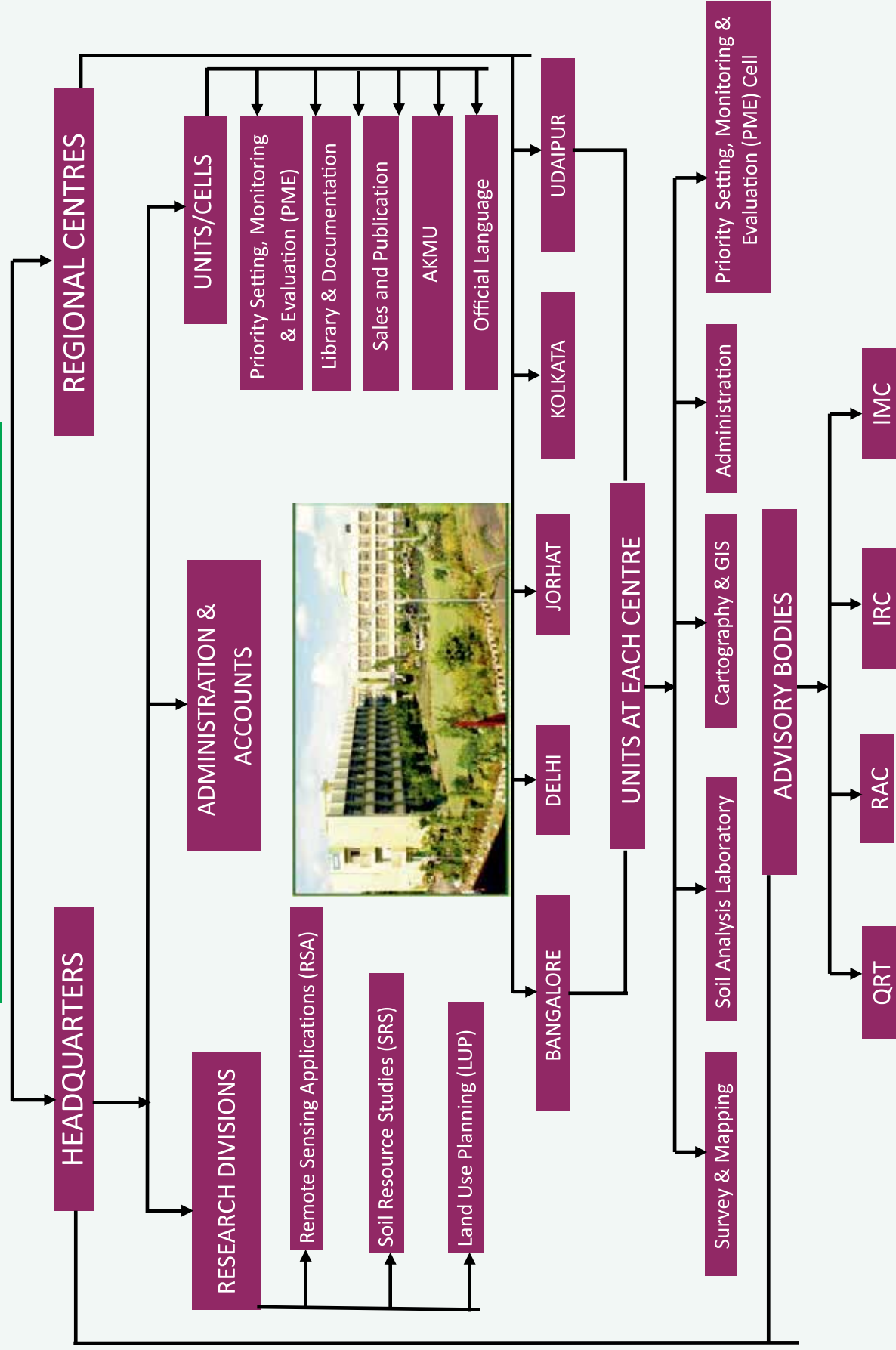
Revenue Generation: 2023 (Rs. in lakh)

Research Projects	:	843.42
Sales of publications	:	0.64
Soil analysis/testing	:	5.26
Total	:	849.32

Staff Strength (as on 31.12.2023)

Category	Sanctioned	Filled	Vacant	%age vacancy
Research Manager Position	1	1	NIL	
Scientific	97	63	34	38
Technical	154	93	61	39.6
Administrative	72	30	42	51.4
Supporting	38	20	18	44.7
Total	362	207	155	41.9

ORGANOGRAM



2

RESEARCH ACHIEVEMENTS

- 2.1 REMOTE SENSING
AND GIS APPLICATIONS
- 2.2 INVENTORYING NATURAL
RESOURCES
- 2.3 BASIC PEDOLOGICAL
RESEARCH
- 2.4 INTERPRETATION OF
SOIL SURVEY DATA
- 2.5 LAND EVALUATION AND
LAND USE PLANNING
- 2.6 IT ENABLED EXTENSION
PROGRAMME



2.1

REMOTE SENSING AND GIS APPLICATIONS

GIS-based fallow land mapping of Bihar state

A methodology was developed for the identification of permanent fallow lands in Bihar state by using monthly NDVI of Sentinel 2 satellite data at 10 m resolution for 5 continuous years. The maximum NDVI of all the Sentinel-2 images was utilized to separate the agricultural and forest areas from permanent features and fallow lands, based on threshold values. The areas

apart from the permanent features, which are fallow in the three seasons for 5 continuous years, were identified as permanent fallow. Additionally, current fallows for the three seasons were also identified with the same methodology by using one-year satellite imageries. The permanent features and/or permanent fallow lands in part of Bihar state are shown in fig. 2.1.1. The permanent features have been erased to identify only the permanent fallow areas.

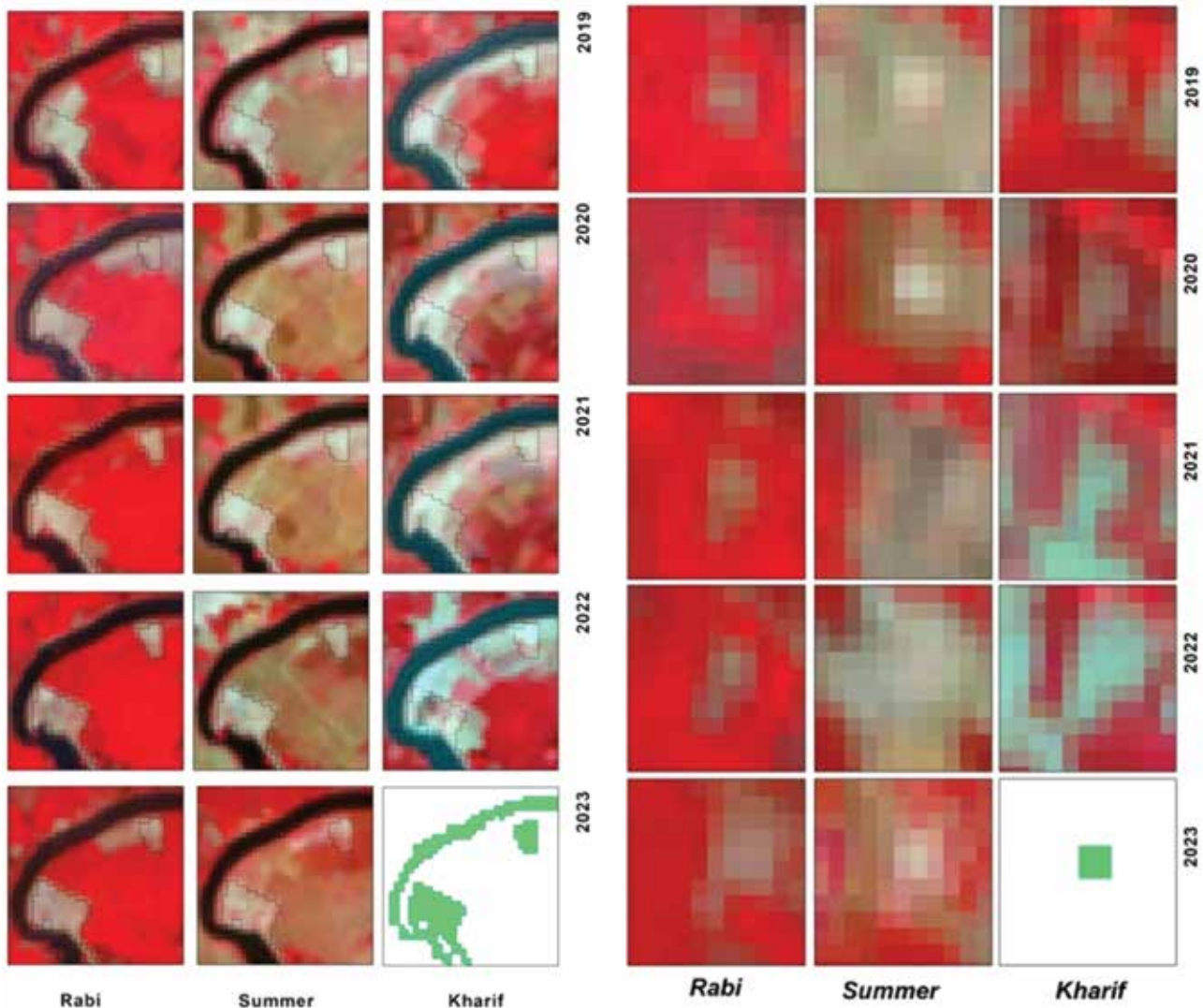


Fig. 2.1.1: Identification of fallow lands by using temporal satellite data

Development of high resolution geo-smart soil management zone as an agri-technology implementation platform in Eastern Himalayan foothills of Jalpaiguri District, West Bengal

Geo-informatics and machine learning model Digital Soil Mapping (DSM) approach derived high resolution (30m) geo-smart soil management zones based site specific agro-technology implementation will ensure district and village level agricultural land use planning and also enhance water and fertilizer use efficiency; thereby optimizing cost effective input management in achieving potential yield. The machine learning Quantile Regression Forest (QRF) models were generated for predicting key soil properties of

Jalpaiguri district using 111 calibration soil profiles and 30 validation soil profiles database. DSM models for predicting pH, SOC, sand, silt, clay, and depth at 30m resolution were developed at six standard depths of world soil grid (0-5, 5-15, 15-30, 30-60, 60-100 and 100-200 cm). The most important environmental co-variables capturing the variability of soil properties of interest were identified. Predicted clay content maps, along with uncertainty maps are depicted in Fig. 2.1.2. Maps and statistics of a few other soil properties are shown in Fig. 2.1.3. Soil management zones (SMZs) were derived using fuzzy c-mean clustering algorithm (Fig. 2.1.4) based on variability of site (elevation) and soil properties (clay, pH and SOC).

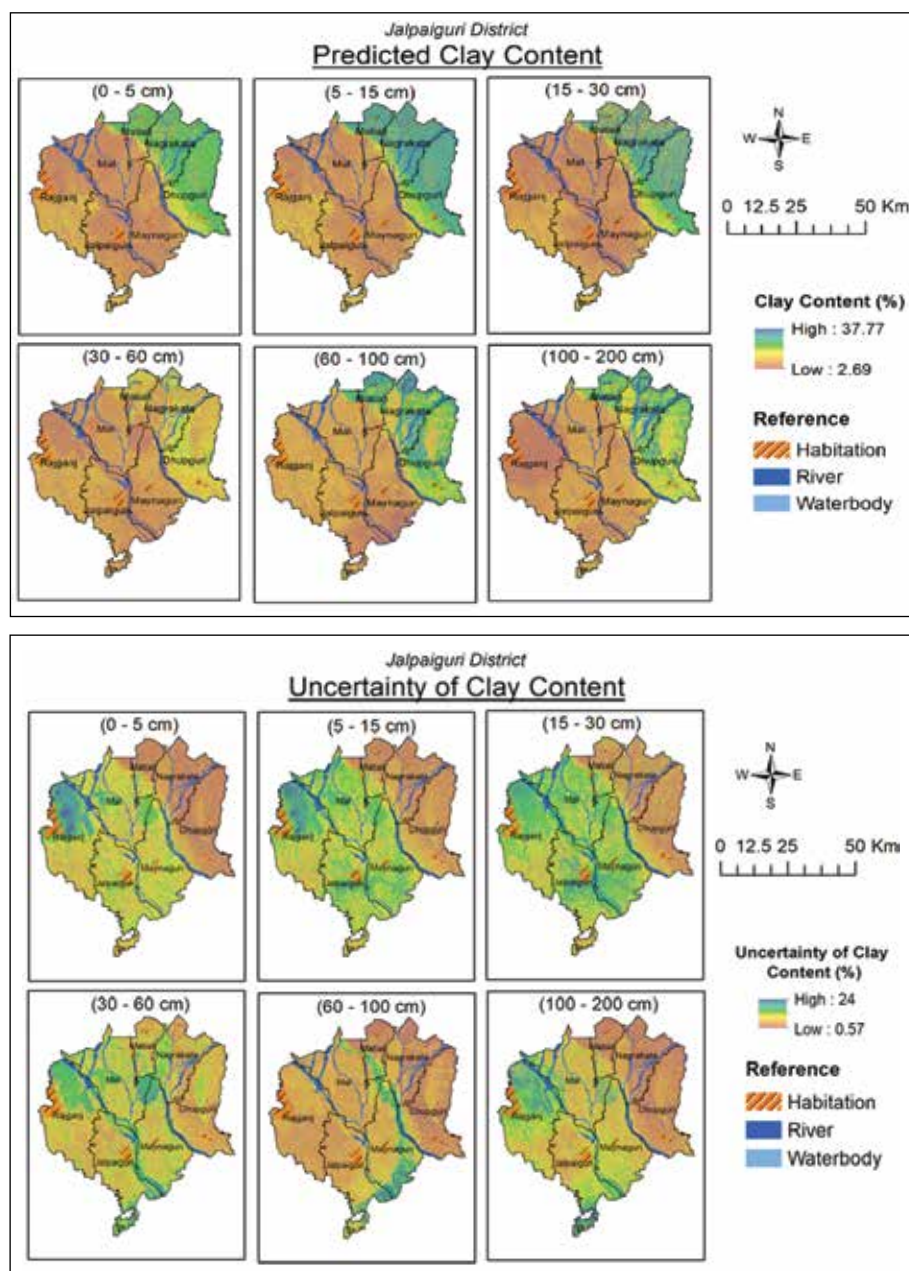


Fig. 2.1.2. Predicted clay content along with uncertainty of clay content at six depth intervals in Jalpaiguri district.

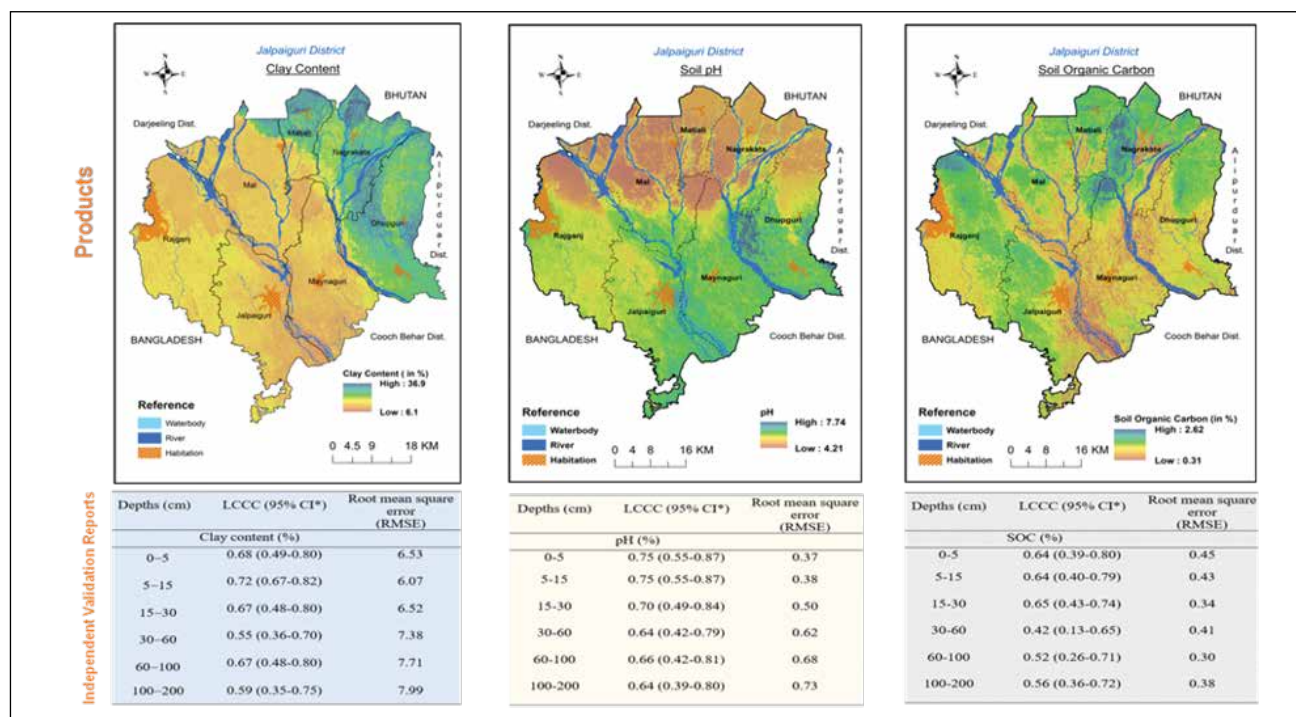


Fig. 2.1.3 Mean clay, pH and SOC content along with independent validation report at six depth intervals in Jalpaiguri district.

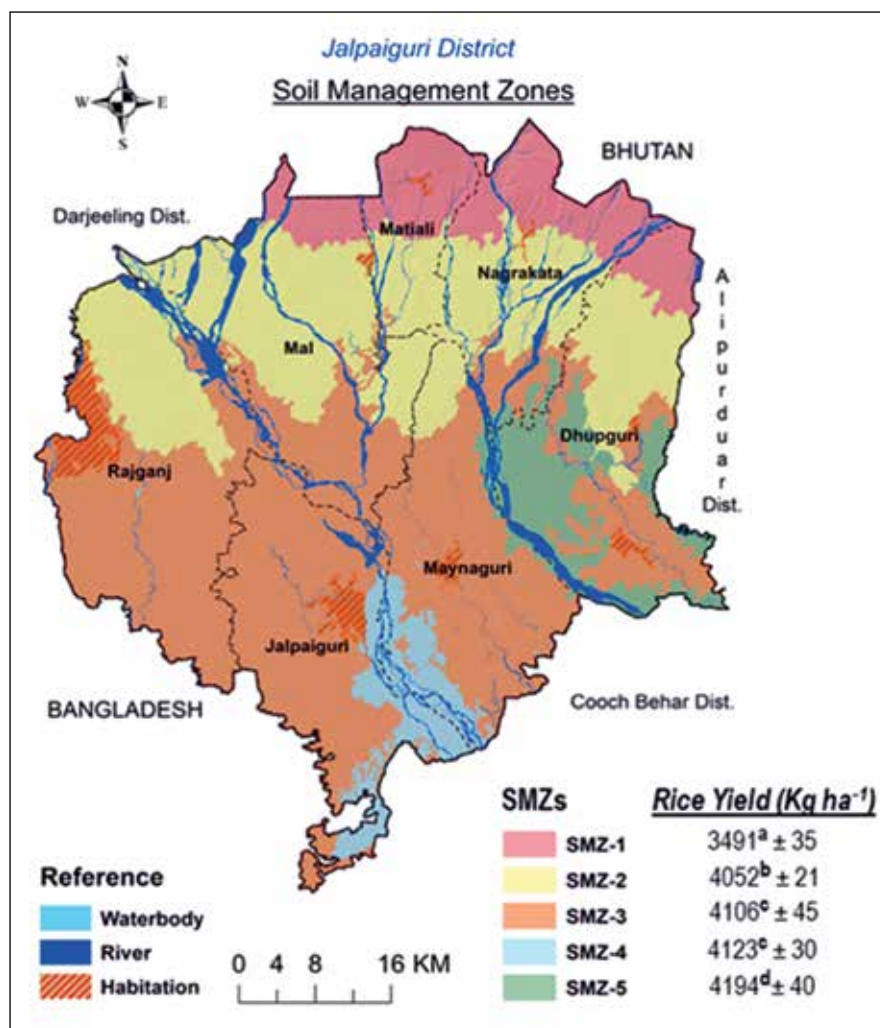


Fig. 2.1.4. Soil management zones of Jalpaiguri district along with mean rice yields (with Tukey's HSD test) at respective zones.

Modeling Soil pH and organic carbon at Karnataka regional scale

Soil pH and soil organic carbon (SOC) at 0-30 cm soil depth were mapped (Fig. 2.1.5) on a regional scale in Karnataka using a combination of various environmental variables and three machine learning

algorithms, namely Support Vector Machine (SVM), Cubist, and Random Forest (RF) using a dataset consisting of 146,044 observations collected under various projects. The RF model exhibited the most satisfactory results for predicting soil pH ($R^2 = 0.61$, RMSE = 0.66) and SOC ($R^2 = 0.40$, RMSE = 0.37).

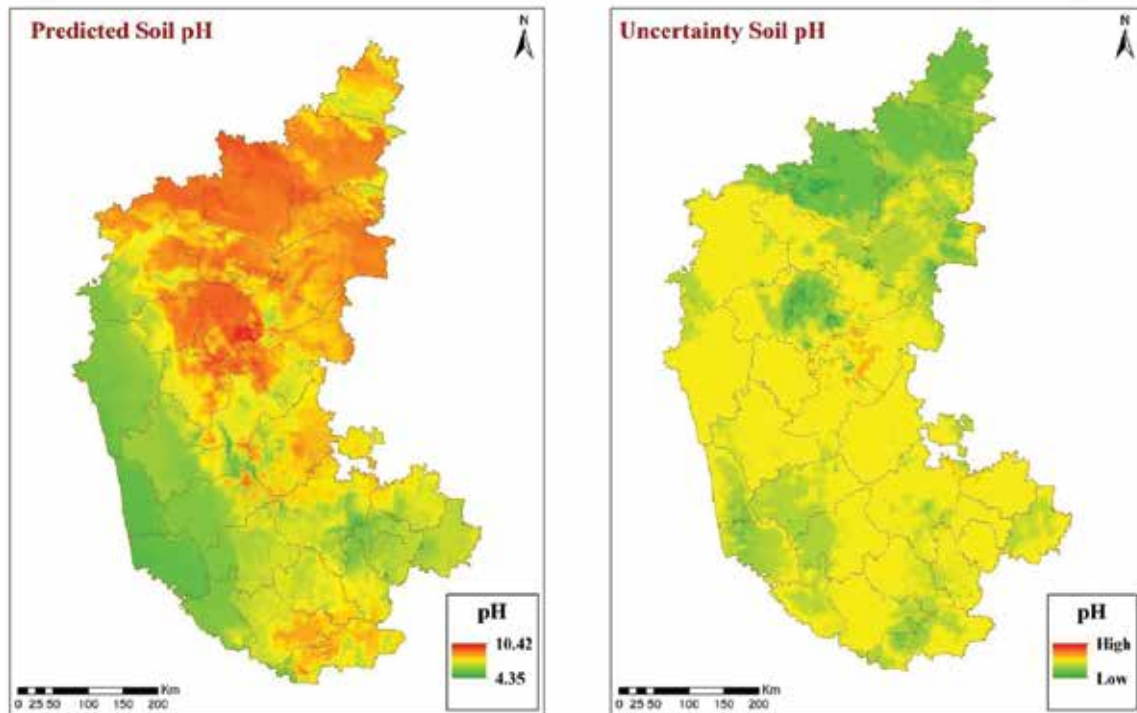


Fig. 2.1.5 (a) Predicted and uncertainty map of soil pH in Karnataka

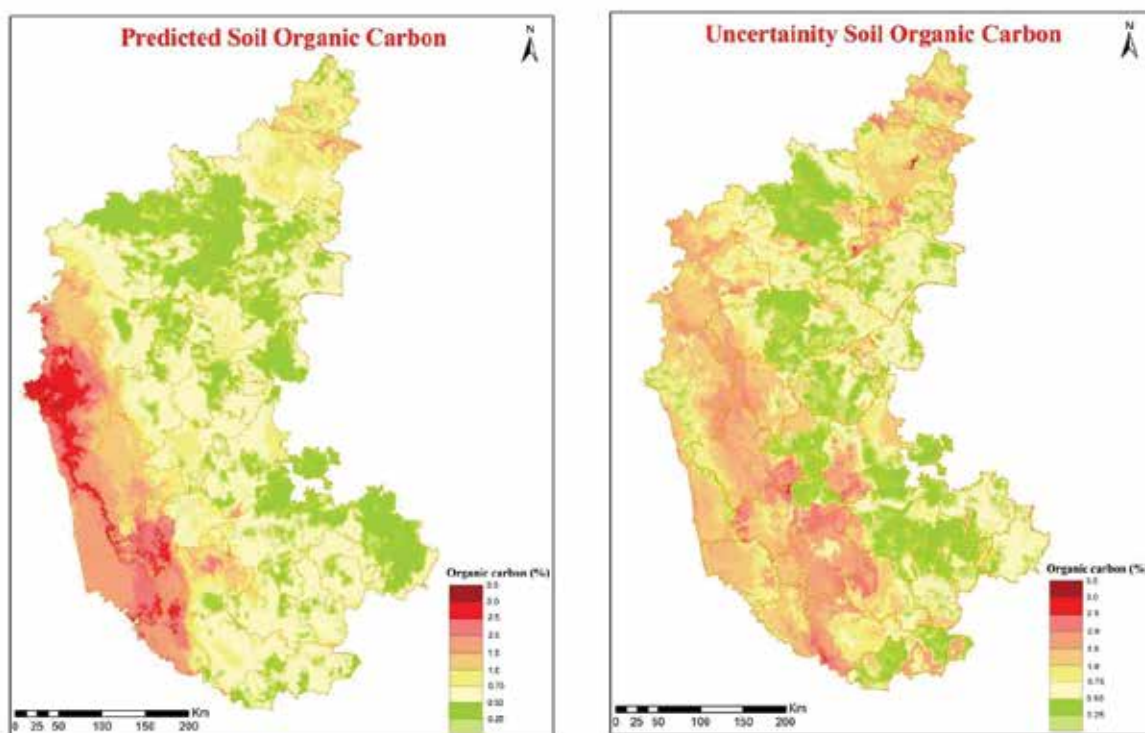


Fig. 2.1.5 (b) Predicted and uncertainty map of soil SOC in Karnataka

Soil colour in evaluating spectral models

A study was carried out to explore the potential of soil colour information, which is an important indicator of the physico-chemical characteristics of soils, as a driver for developing and evaluating regression models for predicting clay content. This study was based on regional database which has been divided into red soils (240 samples) and black soils (209 samples) based on their Munsell soil colour. Partial least squares regression models (PLSR) were calibrated and validated from both the regional datasets and subsets stratified as red and black soils (Fig. 2.1.6). In addition, a Random Forest (RF) model was used to classify the validation soil samples into black and red classes to evaluate model performance. First, while the clay content predicted by the regression model built from regional data was evaluated as correct at the regional scale (R^2_{val} of 0.75), this regression model was evaluated as more accurate over black (R^2_{val} of

0.8) than red (R^2_{val} of 0.63) soil samples. Second, the regression models built from subsets stratified per Munsell soil colour provided different performances than the regression model built from the regional data, both at the regional scale, and soil colour scale. Finally, even if the RF classification of black and red soil samples was estimated as accurate (OA_{val} of 0.89 and K_{val} of 0.73), the regression models built from subsets stratified per Munsell soil colour provided misclassifications over both classified datasets that had a strong impact on the regression model performances. In conclusion, the study showed that the predictions are highly dependent on the calibration dataset and that the interpretation of model regression performances is highly dependent on validation data stratification. Consideration of pedological knowledge in building and evaluating regression models seems a robust and positive method to evaluate the uncertainty of soil properties in prediction.

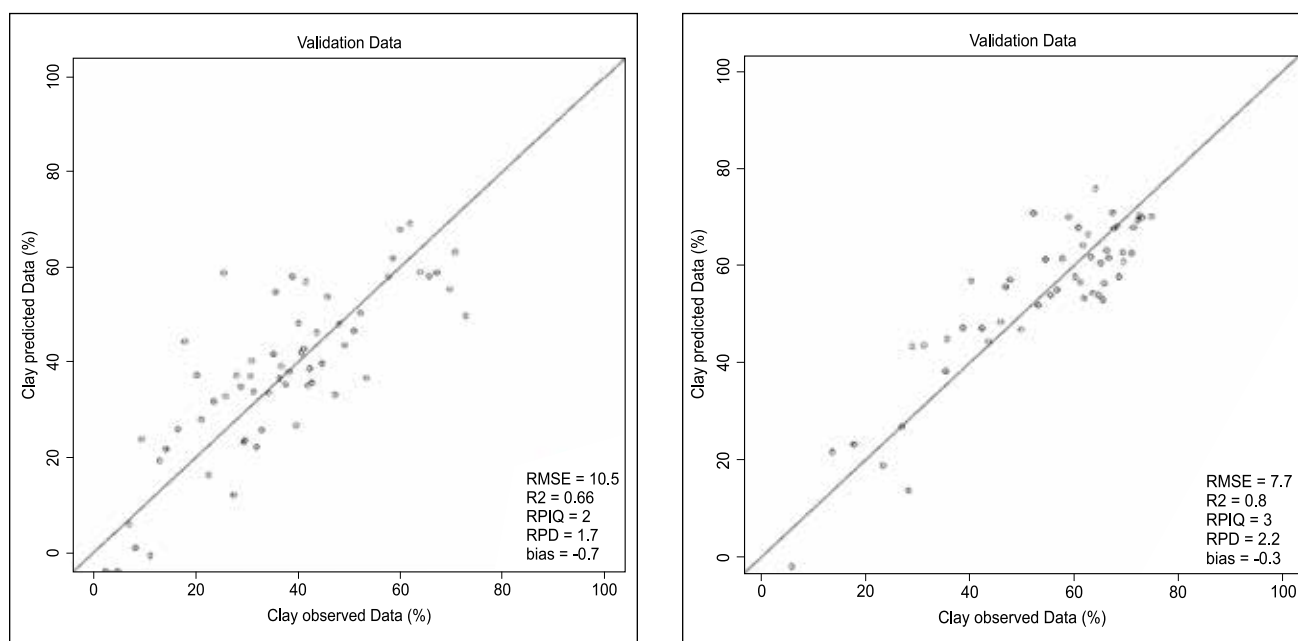


Fig. 2.1.6. Red model against red validation data and black model against black validation data

Identification, Mapping and Characterization of Fallow lands of Tamil Nadu

Mapping of spatial-temporal distribution of fallow land in Tamil Nadu was carried out to assess the accurate classification and develop state level land use policy. Application of integrated remote sensing data and NDVI were used to map the fallow land area of Tamil

Nadu for 2005, 2010, 2015 and 2020 using Landsat-8 data (Fig. 2.1.7). Current fallow land decreased from 2005 (23,98,540 ha) to 2020 (22,52,504 ha). Permanent Fallow is more in Southern zone (14.61%) followed by Western (9.36%), North Western (7.92%), Cauvery Delta (6.16%), North eastern (2.21%), Hilly (0.09%) and High rainfall zone (0.08%) in the 2015-2020 period (Fig. 2.1.8).

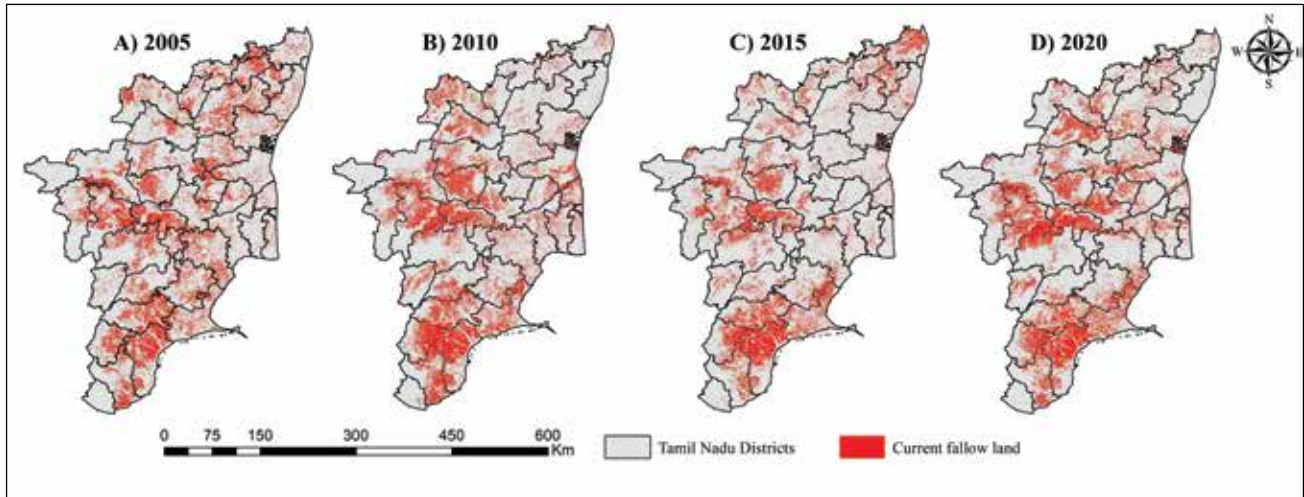


Fig.2.1.1.7. Current fallow land map of Tamil Nadu

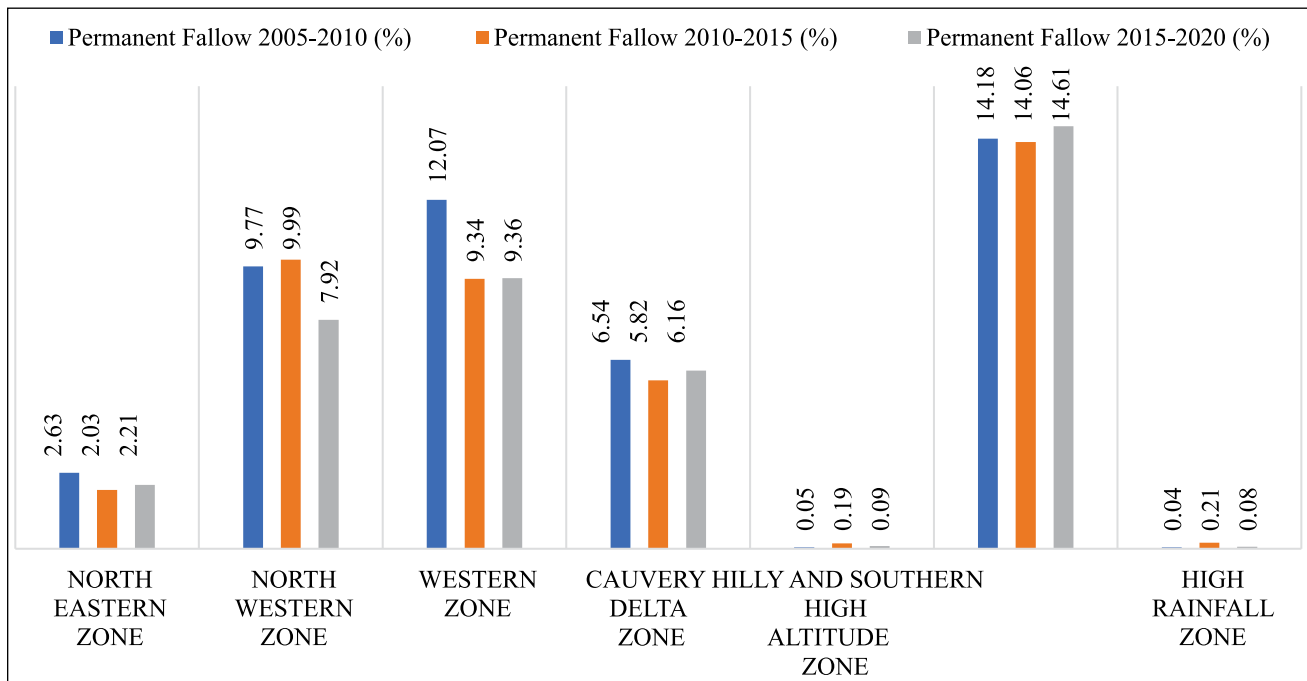


Fig. 2.1.1.8. Changes in the permanent fallow lands in climatic zones of Tamil Nadu

Online Soil Spectroscopy

A system for online soil spectroscopy has been designed and developed under the project ICAR-Network Programme on Precision Agriculture (ICAR-NePPA), to reduce the time and cost involved in the laboratory analysis of soil samples (Fig. 2.1.9). The best-fit models for each soil property has been developed to predict soil properties based on soil

spectra of different soils. These models are deployed on the server for the prediction of soil properties online by users. In the updated version, the user can supply more than one soil spectra at once to predict soil properties between 350 to 2500 nm. The developed system can be used to reduce the resources in the preparation of soil health cards across the major ecosystems of India.



Fig. 2.1.9. The front page of Online-soil spectroscopy

Hyperspectral reflectance and multi-nutrient extractant-based rapid assessment of soil properties for sustainable soil health in India

An agro-ecological region-wise sampling strategy for India was generated by integrating various environmental covariates (Fig.2.1.10). The Latin Hypercube Sampling (LHS) approach, which identifies an optimum number of samples and their locations that cover the variability of the region in terms of soil-forming factors, was used for the identification of the optimum number and appropriate soil sampling

sites for preparing a surface soil database of country. Various terrain parameters derived from the SRTM digital elevation model, from MODIS NDVI of 5 years, and climate parameters at 1 km resolution were used in the model to develop the sampling strategy. However, for the Himalayan region, the sampling was developed based on 30m data from Landsat and SRTM, as the agricultural areas were in small patches. For easy accessibility to the sampling points, a road network was used as a condition so that the sampling points identified are not too far from roads.

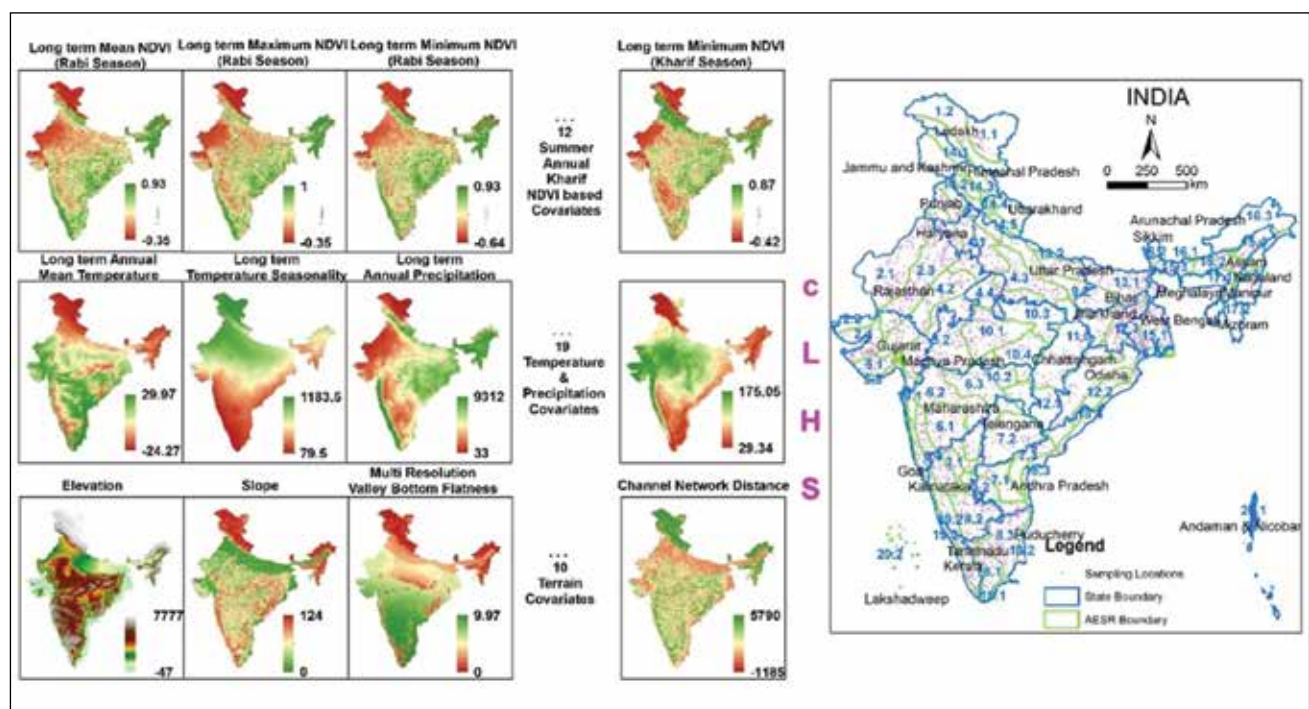


Fig.2.1.10: Various environmental covariates and sampling strategy for agro-ecological region of India

Development of spectral models for prediction of soil properties in soils of Maharashtra using hyperspectral remote sensing

The Neoperk Technologies, a DST and MeitY-supported start-up has developed a portable sensor-system, called a “device”, for spectral data-acquisition of processed soil samples in near-infrared or NIR wavelength range. The present study aimed to develop calibration models for quantitative prediction of soil parameters – pH, EC, soil organic carbon (OC), available nitrogen (N), available phosphorus (P), available potassium (K), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) across different soil types in the state of Maharashtra. This joint study was aimed to evaluate the efficacy of Neoperk’s device in comparison with a Vis-NIR analytical spectral

device (ASD FieldSpec) and assess the performance of NIR-based spectral models for the estimation of soil parameters against the conventional chemical laboratory methods. In the study, 564 samples were collected from six different districts of Maharashtra belonging to different geology, mineralogy, and texture. The Neoperk has a spectral range from 1350 to 2550 nm. ASD spectra performed better than Neoperk spectra in the validation data set for soil properties viz. pH, EC, Fe, Mn, and Cu, whereas the performance of Neoperk spectra for N, P and K was at par with ASD spectra in the validation dataset. The Neoperk spectra gave better results for SOC than ASD spectra in the validation dataset. The central regression line in the scatter plot indicates the relationship between the variables (Fig.2.1.11). Neoperk spectra gave improved results in the validation dataset for Zn.

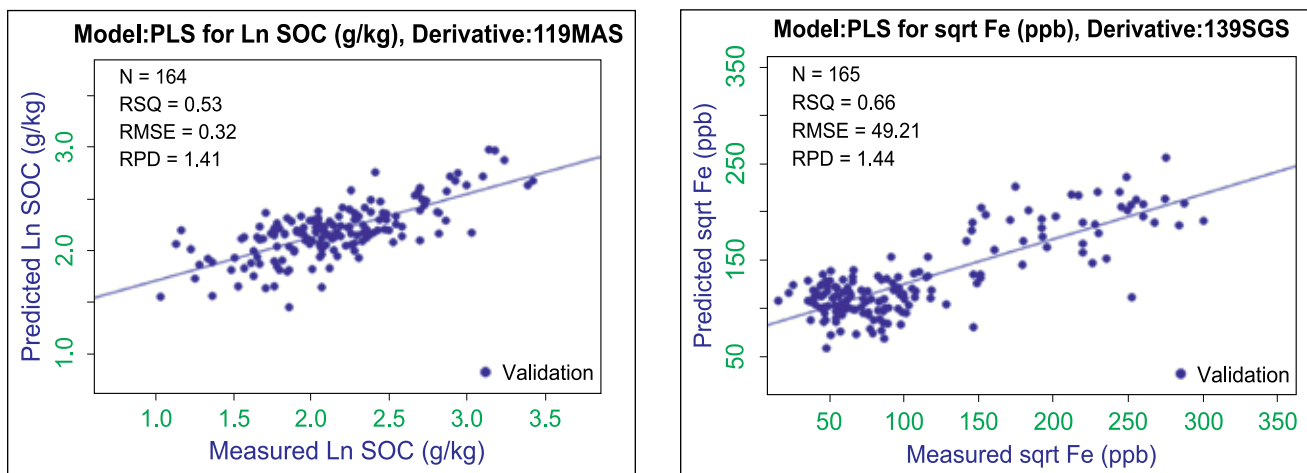


Fig. 2.1.11: Scatter plots of measured and predicted values for SOC (g/kg) and Avl.Fe (ppb) in validation data

Spatial Modelling for Delineation of Agro-Ecological Zones (AEZ's) of India using Earth Observation Time-series Data

The Length of Growing Period (LGP) map with 15-day interval was generated by integrating mean annual PET and soil AWC maps of India. The LGP maps show a total of 23 classes, where the hyper-arid with an LGP of less than 30 days was found especially in western Rajasthan, and the per-humid zone with an LGP of more than 345 days was found especially in the northeastern region of India. Thematic layers of bioclimatic zones of India and LGP were integrated by using the intersection tools of GIS and derived a total

of 116 classes of bioclimatic zones and LGP classes combination. While generalizing the classes, areas with less than 1000 ha were merged with adjacent classes by using bioclimatic zones of India and LGP classes as a reference. During the generalization process, various terrain parameters like elevation and hillshade generated from SRTM 30 m resolution DEM data were used. Subsequently, distinct 97 bioclimatic and LGP classes were delineated. It was observed that the higher area is covered by Semi-Arid Moist with LGP 105-120 days, and the smaller area is covered by Semi-Arid Moist with LGP 75-90 days. The LGP map of India (2020) generated in the project is shown as figure 2.1.12.

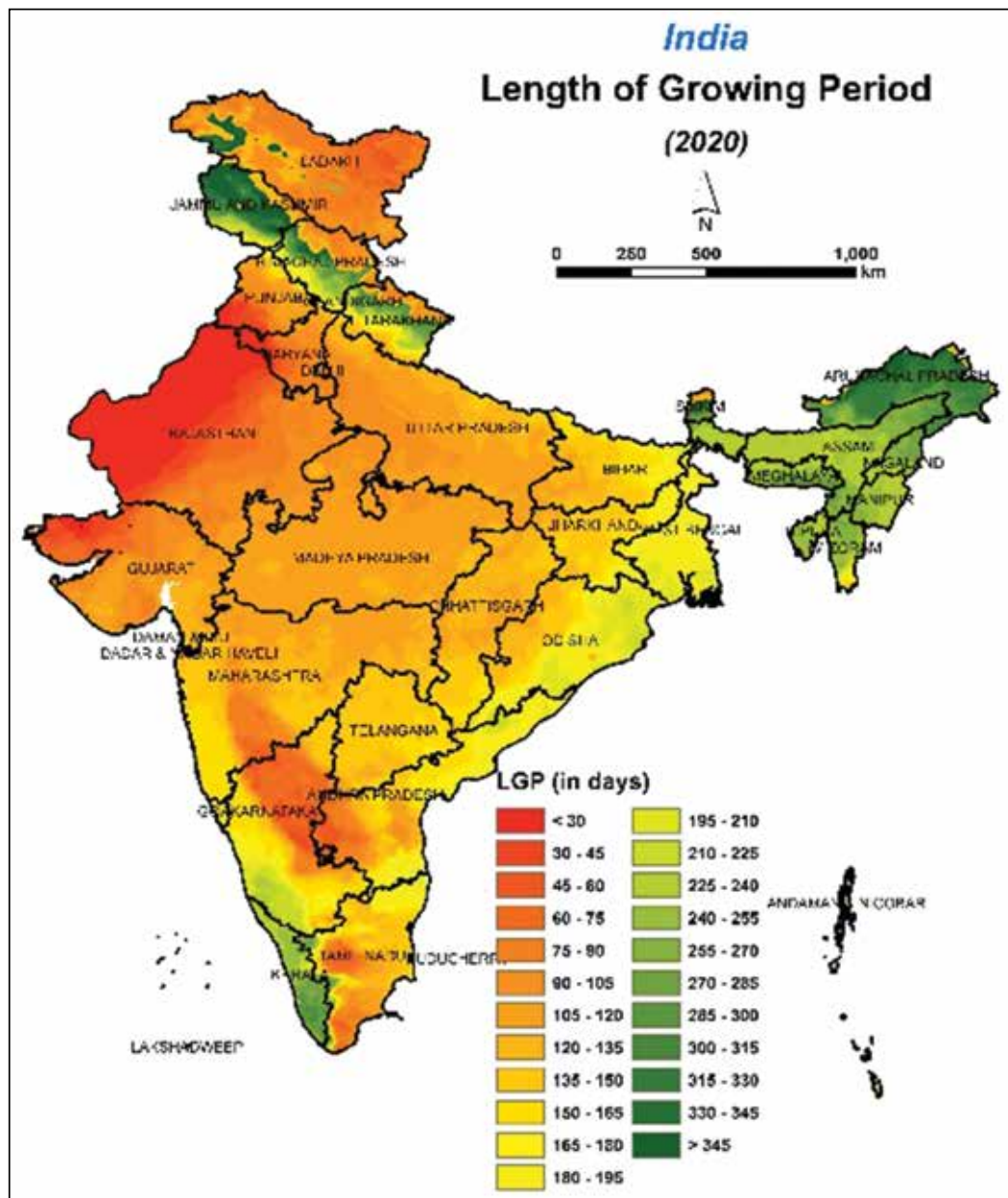
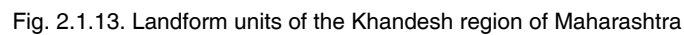


Fig. 2.1.12: Length of Growing Period (LGP) map of India (2020)

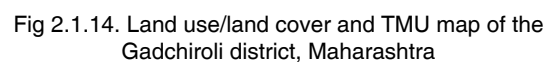
Digital Terrain Analysis and Characterization of Landforms for Soil-Landscape Modelling in Maharashtra Using Remote Sensing Data, DEM and GIS

Digital terrain analysis and characterization of landforms of the Khandesh region of Maharashtra was taken up for soil-landscape modelling. The terrain parameters of contours, slope, drainage, aspects, hill shade, plan curvature, profile curvature and total curvature were generated from SRTM DEM (30m) for the Khandesh region of Maharashtra. The Sentinel-2 of Khandesh region was used in the terrain analysis

to analyse different image characteristics. The region-wise terrain parameters derived from SRTM 30m and vegetation parameters derived from Sentinel-2 data were integrated through GIS-based digital terrain analysis modelling to derive distinct landform units under different physiography, sub-physiography and major landforms. The major identified landform units of the Khandesh region of Maharashtra are undulating lowlands, denudational upper pediments, undulating uplands and moderately weathered upper pediments, that cover about 4,45,100, 3,37,300, 2,47,600 and 2,42,200 ha, respectively (Fig.2.1.13)



The Gadchiroli district, covering an area of 14042.98 km², is located between 18°08' and 20°50' N latitudes, and from 79°45' to 80°54' E longitudes. The slope map and landform map of the district were prepared using ALOS DEM. Eight major landform units (denudational hills, structural hills, undulating pediplain, alluvial plain, flood plain, undulating upland, slightly dissected plateau and undulating pediments) were delineated. The land use/land cover map of the district was generated using Sentinel-2 satellite data and Google images. About 22 terrain mapping units (TMU) were delineated by integrating slope, land use land cover, broad landform and major landforms (Fig. 2.1.14).



Prediction of soil depth and organic carbon in Chittorgarh district

Soil depth and organic carbon in Chittorgarh district were predicted by using 56 legacy soil profiles data by RF model. Landsat data, terrain attributes and bioclimatic variables were used as environmental variables. Ten-fold cross-validation was used to evaluate the model (Fig. 2.1.15). Soil depth varied

from 23 to 123 cm. Elevation, MRVBF and CNBL were the most important covariates for predicting soil depth and organic carbon. The classical uncertainty estimates such as coefficient of determination R^2 , root mean square error (RMSE) and bias were calculated for the validation datasets to assess the model performance. An R^2 of 22% and RMSE of 44 cm were obtained for soil depth prediction.

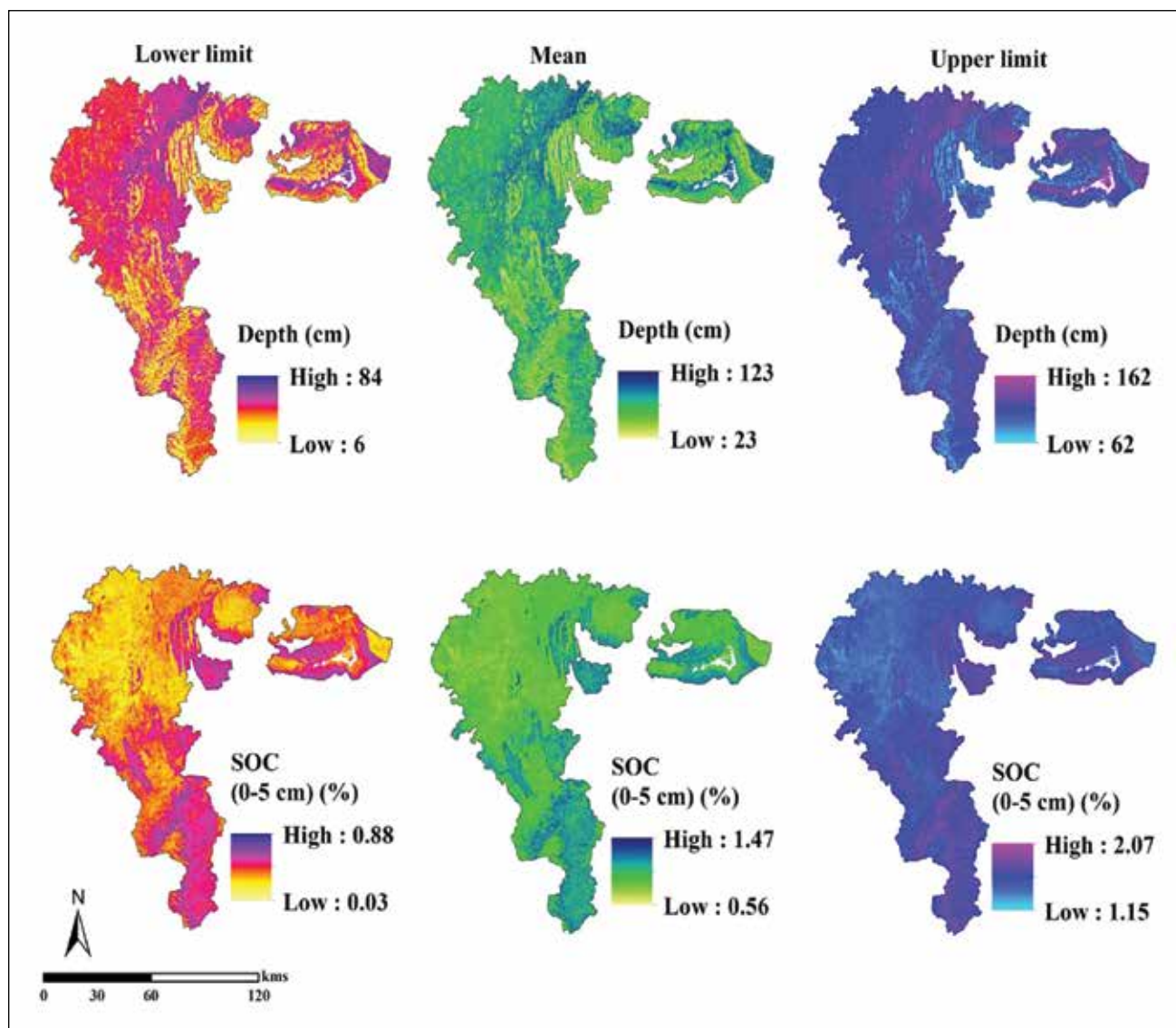


Fig. 2.1.15. The lower prediction limit and higher prediction limit are displayed on maps showing the mean predicted soil depth and organic carbon in the Chittorgarh district, Rajasthan

Land Resource Inventory at 1:10000 scale

Digital terrain analysis and characterization of landforms for different districts across the country was carried out for soil-landscape modeling. Satellite data were analyzed and interpreted for delineation of terrain

parameters such as DEM, contours, slope, drainage, aspect, hill shades, curvature, landform units and land use/land cover. The landforms delineated for the districts are shown in Table 2.1.1.

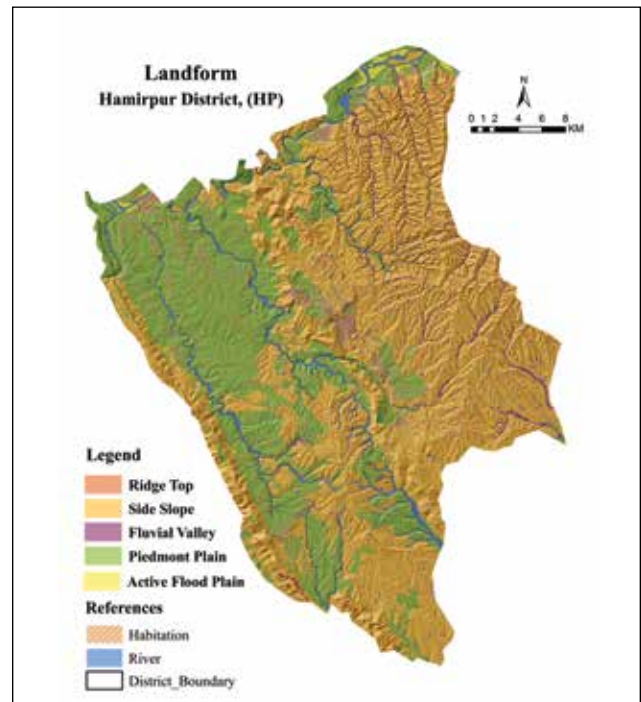
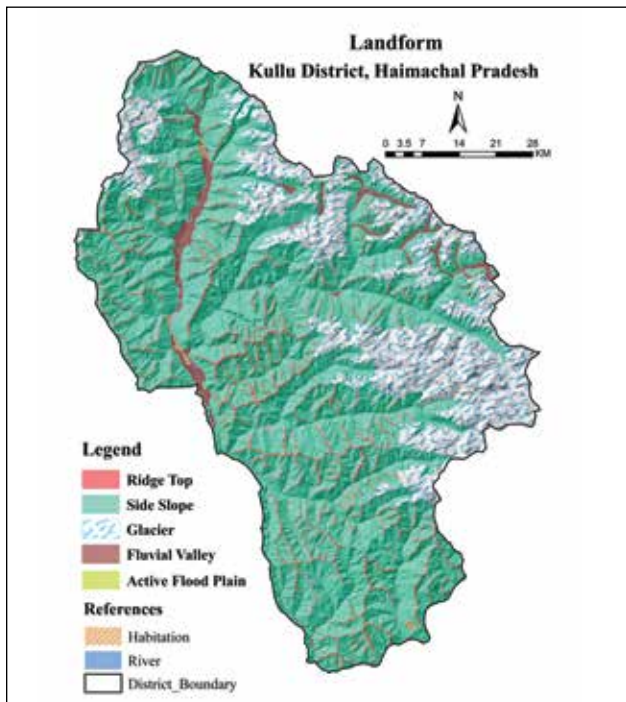
Table 2.1.1. Major landforms delineated under LRI projects.

District	State	AER (AESR)	Landforms
Chamrajnagar	Karnataka	8 (8.2)	Denudational hills, dissected hills, residual hills, structural hills, upper pediplain, lower pediplain, valley fringes, and pediplain
Chitradurga			Narrow valley, pediment, pediplain, main valley, shallow pediplain, alluvial plains, structural hills, denudational hills, residual hills, inselberg, isolated mounds, and linear ridges
Gaya	Bihar	9.2	Hills (14.49% of TGA), residual hills (1.22%), plateau top (2.42%), foot hills (1.23%), valley (11.65%), pediment (44.19%), undulating upland (4.34%), ravenous land (15.54 %) and gullied land (0.57%)
Kra-W	Arunachal Pradesh	16 (16.3)	Denudational hills and dissected hills (97.9% of TGA), and narrow valleys
Papum Pare			Denudational hills (47.3% of TGA), dissected hills (40.2%), subdued hills (8.02%), and valley floors (3.0%)
East Kameng			Denudational hills (61.4% of TGA), dissected hills (37.2%), and narrow valleys (0.87%)
West Kameng			Denudational hills (58.0% of TGA), dissected hills (40.2%), and narrow valleys (0.85%)
Tawang			Denudational hills (46.5% of TGA), dissected hills (52.2%), and narrow valleys (1.11%)

Digital terrain analysis of Mandi Region, Himachal Pradesh

Mandi Region ($31^{\circ}13'20''$ to $32^{\circ}04'30''$ N & $76^{\circ}37'20''$ to $77^{\circ}23'15''$ E; TGA: 25,572 km²) is situated in western Himalayas, comprising five districts of Himachal Pradesh namely Mandi, Kullu, Hamirpur, Bilaspur and Lahul & Spiti. This region falls in the mid hills sub-humid zone and high hills temperate wet agro-climatic zone of Himachal Pradesh. Digital terrain analysis and characterization of landforms for Mandi, Kullu, Hamirpur, Bilaspur districts were carried

out for soil-landscape modeling. Satellite data (ALOS PALSAR DEM 12.5 m and Sentinel-2) were analyzed and interpreted for delineation of terrain parameters such as DEM, contours, slope, drainage, aspect, hill shades, curvature, landform units and land use/land cover. Most part of the region has very steep to strongly sloping topography (25-33% and >33% slopes). Landform and land use land cover (LULC) were delineated for Mandi, Bilaspur, Hamirpur and Kullu districts. Landforms in the Kullu and Hamirpur districts are piedmont plain, side slope, ridge top, fluvial valley and active flood plain (Fig.2.1.16)

**Fig.2.1.16.** Landforms in Kullu and Hamirpur districts, Himachal Pradesh

Digital soil mapping in Mandi and Bilaspur district (HP)

The cLHS model was run with all the input parameters to identify sampling sites in Mandi and Bilaspur districts of Himachal Pradesh for digital soil mapping of various soil properties. An optimum soil sample size of 116 and 52 profiles (cLHS model) has been identified for Mandi and Bilaspur district, respectively, based on the inter-quartile range matching technique (Fig. 2.1.17).

Soil Sampling Strategy for Digital Soil Mapping in Panchmahals and Mahisagar districts of Central Gujarat

The soils of Panchmahals and Mahisagar districts

of central Gujarat region, covering 3290 and 2515 km², respectively, were mapped using digital soil mapping techniques. Sampling strategies were prepared using the conditioned Latin Hypercube Sampling (cLHS) method based on terrain, climate and vegetation parameters developed from SRTM 30 m DEM, Worldclim (version 2.1), and Landsat 30 m data, respectively. About 85 sampling points for the Panchmahal district and 78 sampling points for the Mahisagar district could explain most of the soil variation in the agricultural area. The sampling point distribution developed for two districts is shown in Fig. 2.1.18.

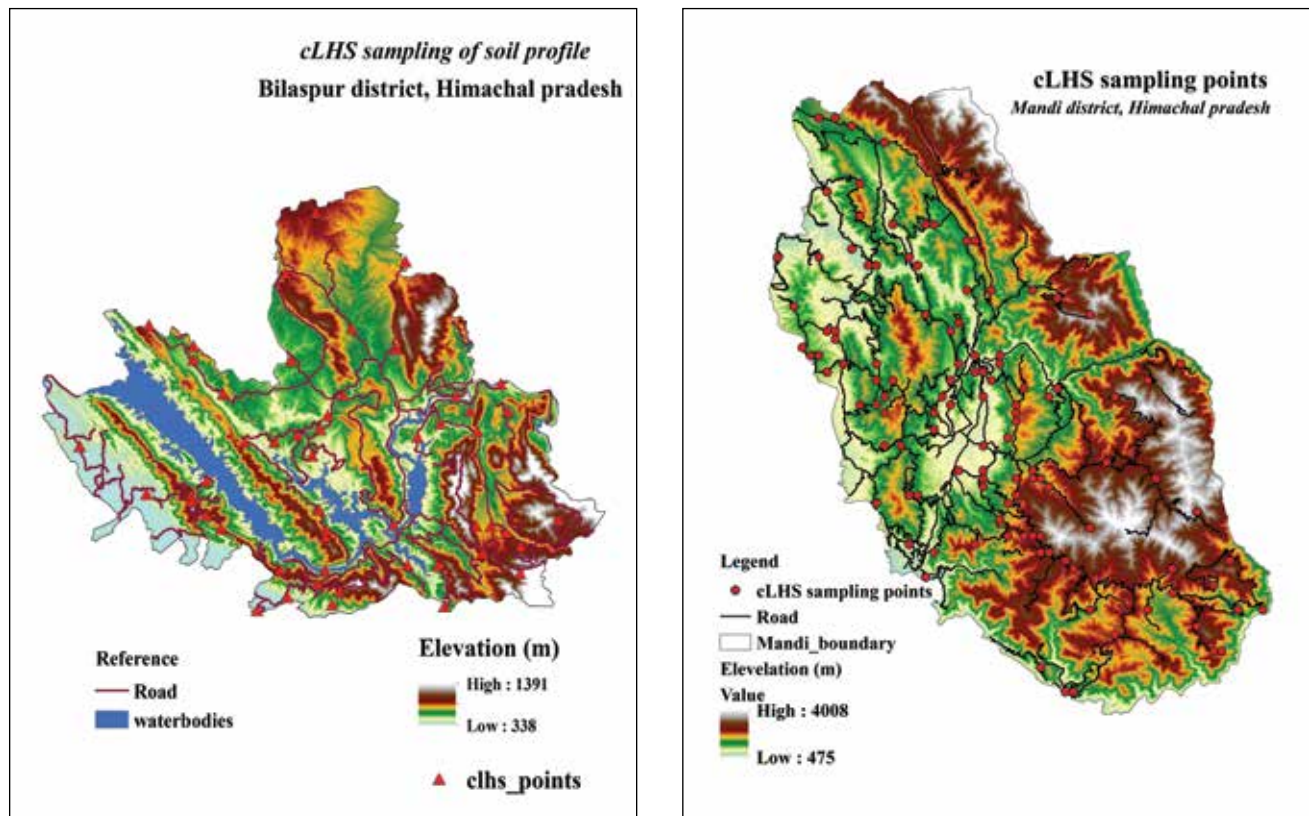


Fig.2.1.17. Identification of sampling points in Mandi and Bilaspur district by cLHS method

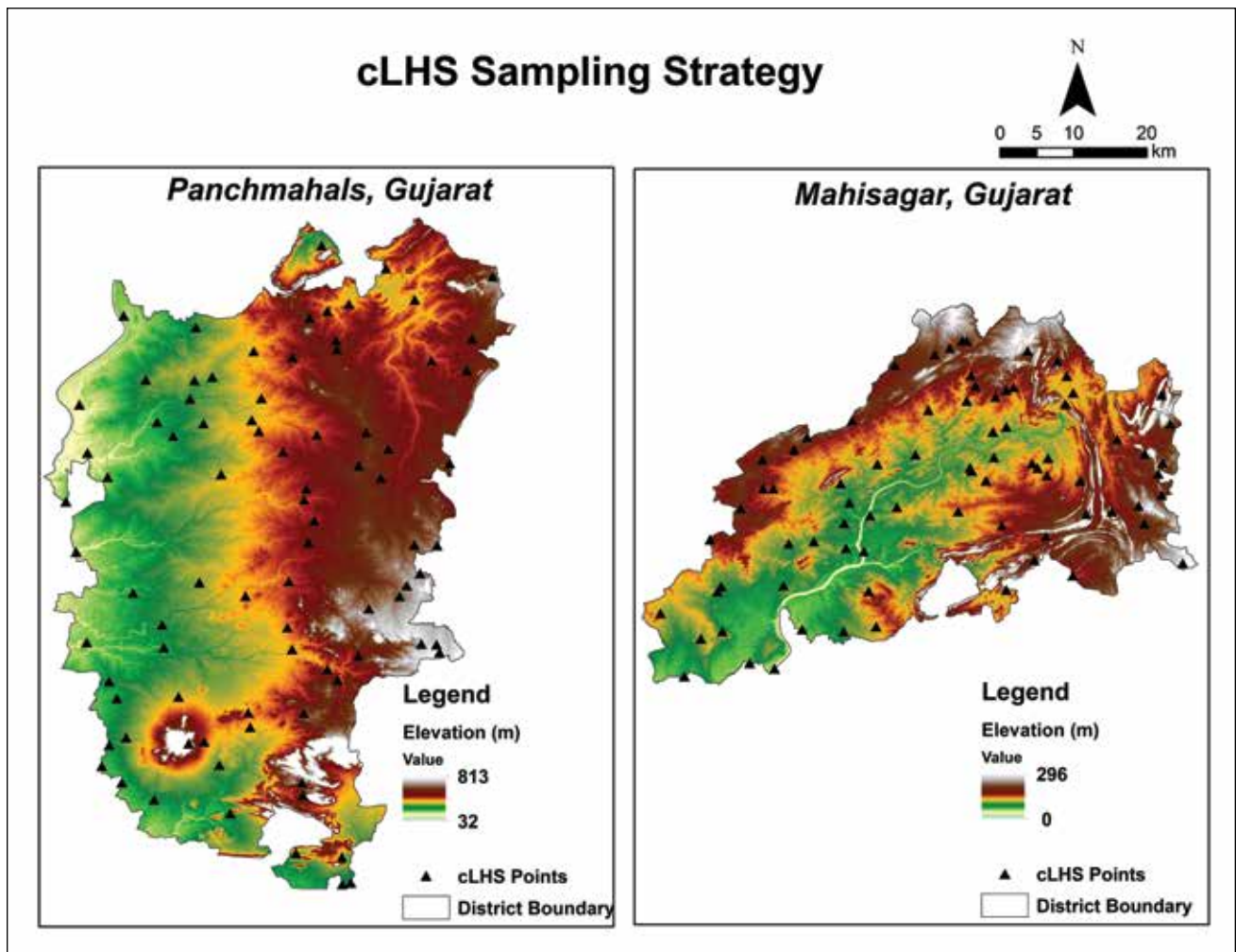


Fig. 2.1.18: Sampling locations for Panchmahals and Mahisagar districts of Central Gujarat

2.2

INVENTORYING NATURAL RESOURCES

Digital soil mapping of Bikaner Division, Rajasthan

The Bikaner division of Rajasthan is known for its extreme climatic conditions, such as very low temperatures in winter and very high in summer, extremely low rainfall and severe wind erosion. A study was carried out to create a detailed inventory of land resources and provide recommendations based on the soil data. About 2018 soil samples from 531 geo-tagged soil profiles were characterized for eight soil properties covering the four districts of the division (Fig. 2.2.1). The digital soil mapping technique was used to generate the spatial distribution maps of sand, silt, clay, available water content (AWC), pH, electrical conductivity (EC), soil organic carbon (SOC), and calcium carbonate (CaCO_3) content across the six standard depths as per Global Soil Map specifications. Among physical properties, sand, silt, clay and AWC of the Bikaner division varies from 24.7 to 97.4%, 0.15 to 46.4%, 1.2 to 31.7% and 0.70-14%, respectively (Fig. 2.2.2). The pH, EC and SOC ranges

from 7.81-9.15, 0.01—13.87 dS m^{-1} and 0.05-0.57%, respectively (Fig. 2.2.3). The CaCO_3 content in the soils of division ranges from 1.12 to 21.53%.

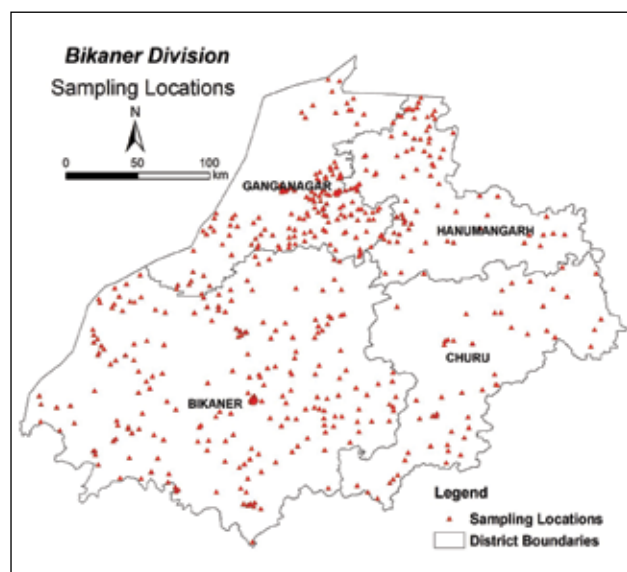


Fig. 2.2.1. Sampling locations in Bikaner division, Rajasthan

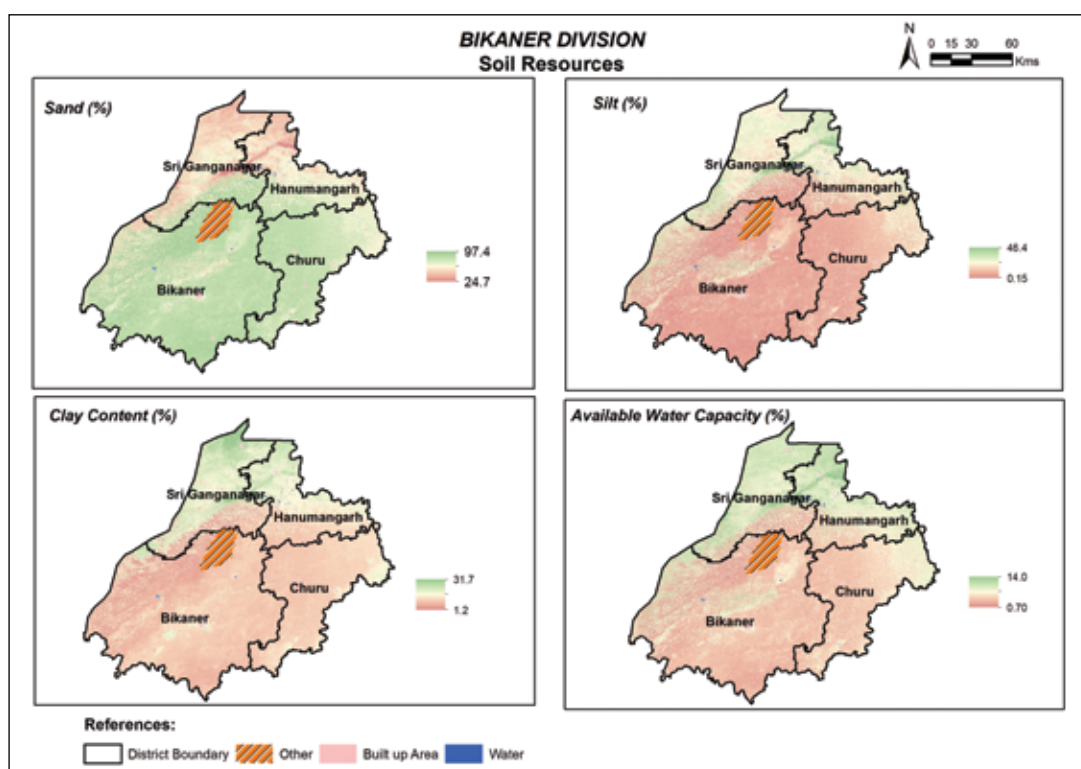


Fig. 2.2.2. Soil physical properties of Bikaner division, Rajasthan

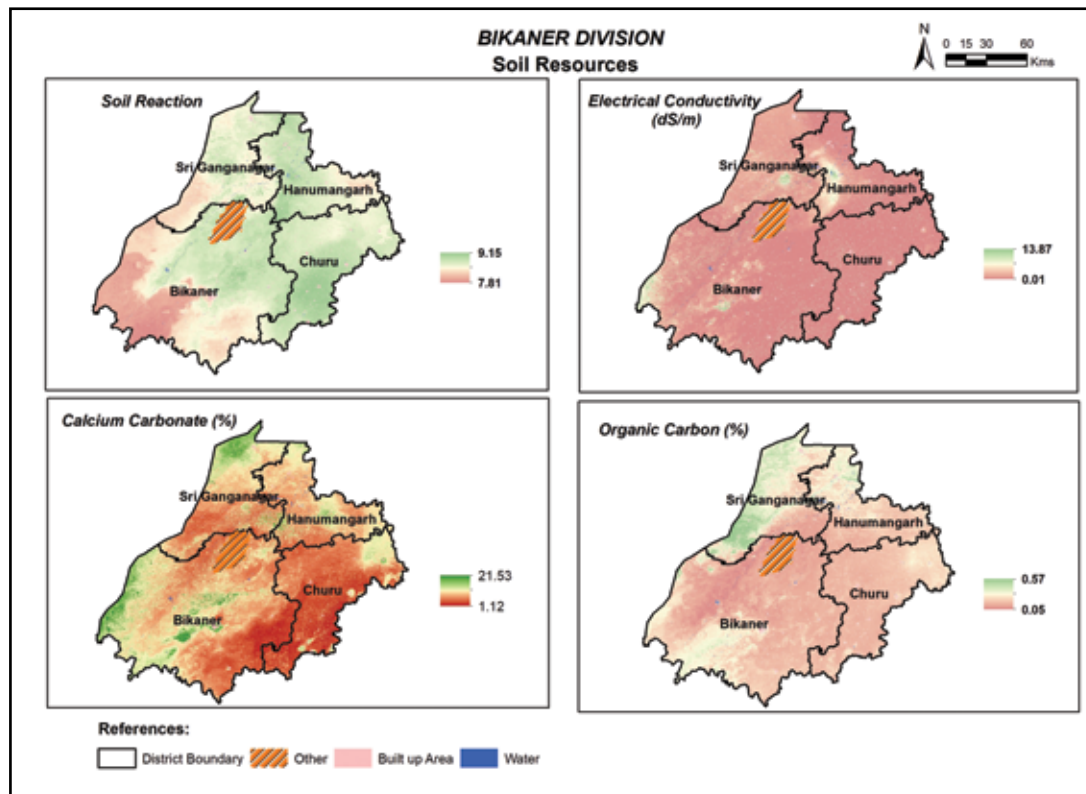


Fig. 2.2.3. Soil chemical properties of Bikaner division, Rajasthan

LRI of Micro-watersheds in REWARD project

In the World Bank funded REWARD project, land resource inventory for Hire-Wankalkunti (8,799 ha), Neeralooti (2,690.3 ha), and Bevura (5,621 ha) sub-watersheds of Yelburga taluk, Koppal district was completed. Soil maps, thematic maps, fertility maps,

and land suitability maps for predominant crops (40 crops) were prepared for 21 micro-watersheds of 3 sub-watersheds. Similarly, soil map with 182 mapping units was developed for Nagathi Basapura sub-watershed. The soils of Mudengudi and Basarkod subwatershed were mapped into 25 soil series in Ron taluk of Gadag district, Karnataka (Fig. 2.2.4).

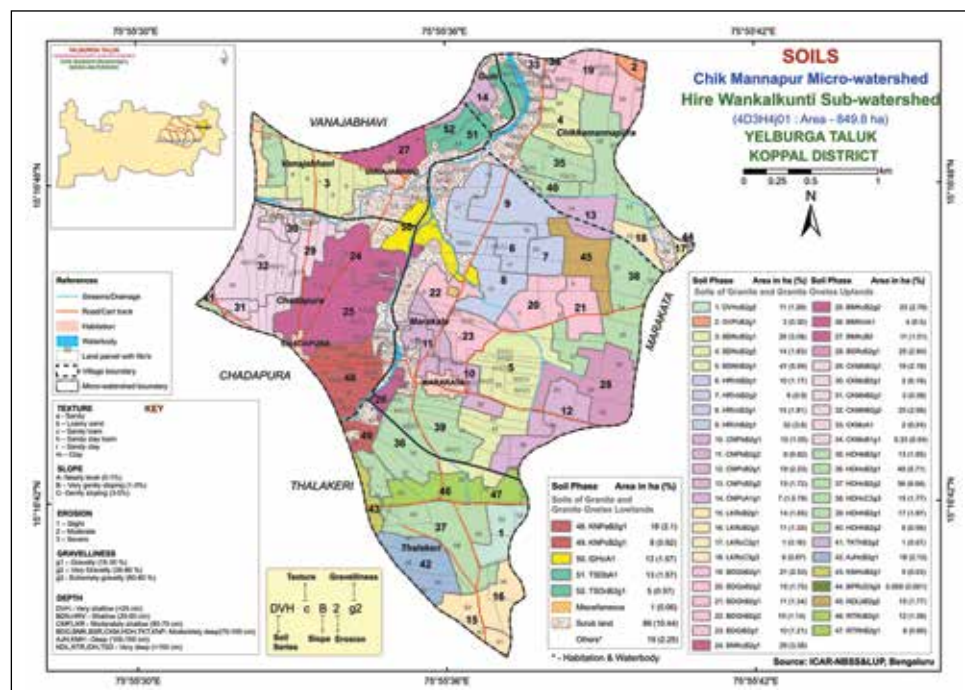


Fig.2.2.4 Soil map of Chikmannapur micro-watershed of Hire-Wankalkunti Sub watershed, Yelburga taluk, Koppal District, Karnataka

Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

Surface soil texture

Surface soil texture map (Fig. 2.2.5) was generated for Gummlapalli Sub-watershed, Bagepalli Taluk,

Chikkaballapura district, Karnataka. It was found that an area of about 659 ha (11 %) is sandy (loamy sand) at the surface, while 744 ha (12%) is loamy (sandy loam, sandy clay loam). Clayey (sandy clay, clay) soils are predominant in the watershed, covering an area of about 991 ha (17%).

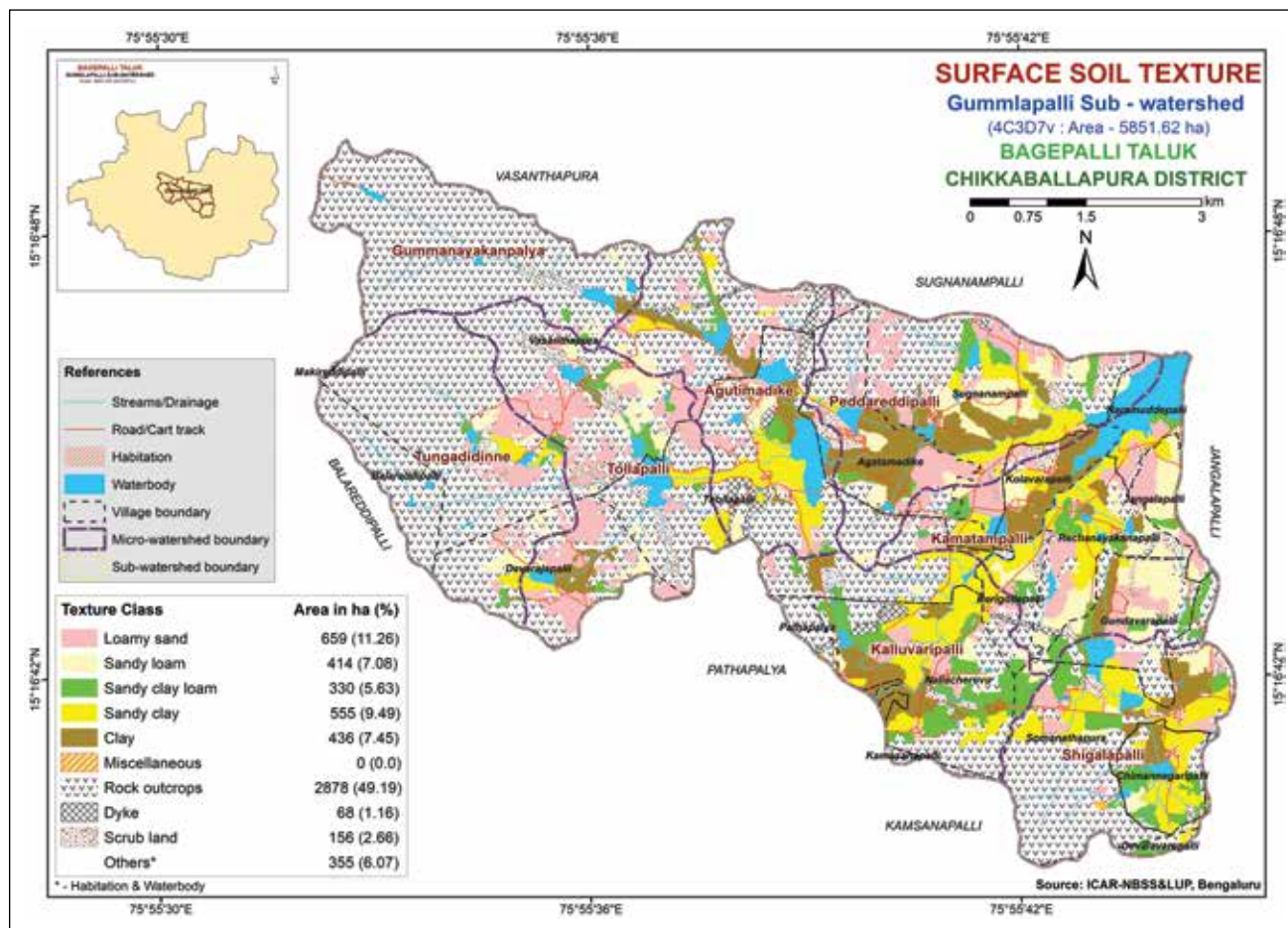


Fig. 2.2.5. Surface soil texture of Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

Land resource inventory of Chikkaballapur district of Karnataka

LRI activities in Karudipalli and Kudumalakunte (Fig. 2.2.6) sub-watershed (SWS) of Gowribidanur taluk, Chinnahalli SWS of Chikkaballapur taluk, Somenhalli SWS of Shidlagatta taluk and Kuruvalu SWS of Chinthamani taluk of Chikkaballapur district has been carried out under Watershed Development to Prevent Drought (WDPD) programme. Different thematic maps were prepared and evaluated for suitability of different crops. Based on the potentials and constraints of each mapping unit, drought management strategies are proposed.

LRI of Birbhum district, West Bengal

Birbhum district, West Bengal is situated both in hot-moist sub-humid AESR of Bengal basin (AESR 15.1) and hot, dry-subhumid AESR of Chhotanagpur Plateau covering an area of 4545 km². LRI at 1:10000 scale was carried out in three blocks (Bolpur-Sriniketan, Illambazar and Nanor) situated in the south-eastern part of the district covering AESR 15.1. Soils are deep to very deep, with silty clay loam to sandy loam surface texture, strongly acidic to moderately alkaline in reaction with low to high soil organic carbon. Tentatively sixteen soil series have been identified in these three blocks.

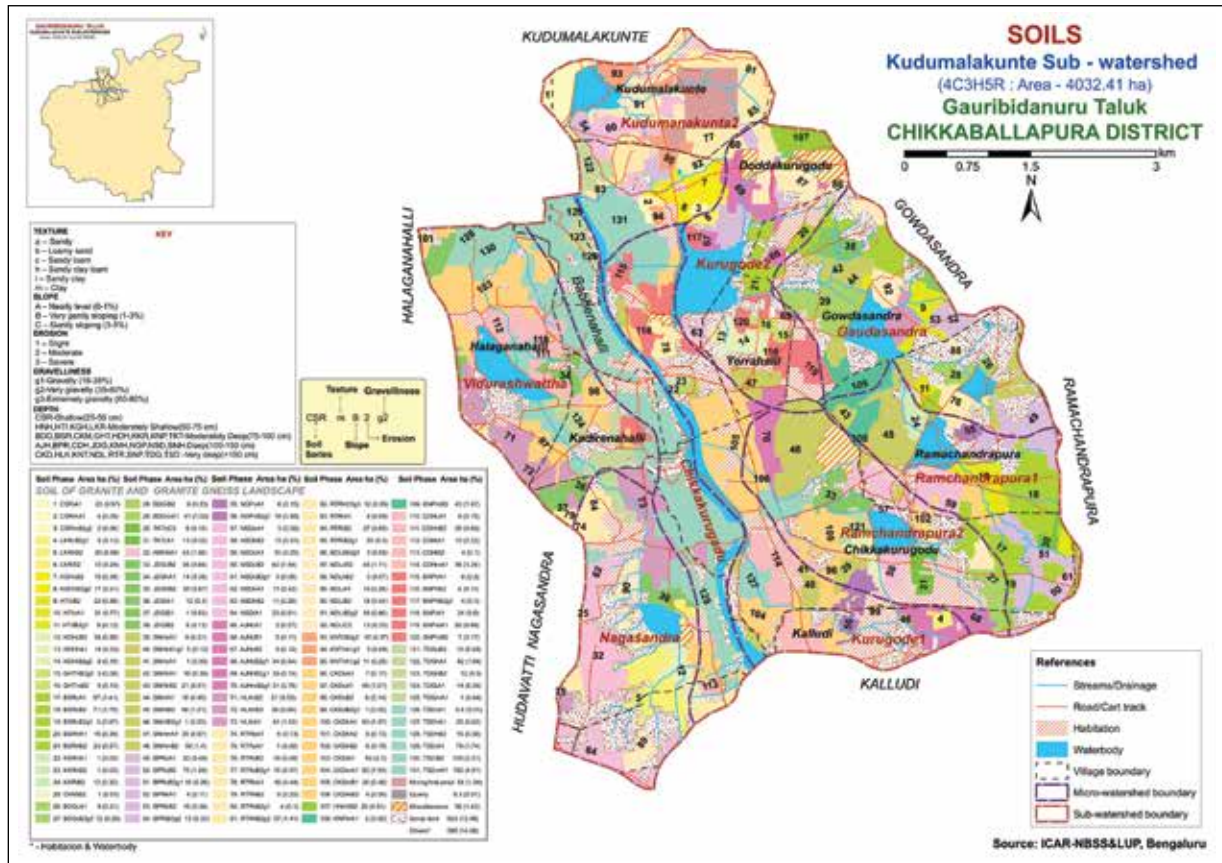


Fig 2.2.6. Soil map of Kudumalakunte sub-watershed

LRI of Malda district, West Bengal

Malda district, West Bengal is situated in hot-moist sub-humid ecological sub-region (AESR 15.1) covering an area of 3733 km². LRI at 1:10000 scale was carried out and 31 soil series with 59 soil mapping unit (phase level) were identified (Fig. 2.2.7). Alfisols were the dominant soils (*Fine-silty Oxyaquic Haplustalfs*, *Fine-silty Typic Haplustalfs*, *Fine-silty Aerice Endoaqualfs*) in old alluvial plains. About 11 soil series were identified in young alluvial plains. Vertic Intergrade (COLE: 0.06-0.17) is present in soils of young alluvial plain. Calcium carbonate (2-22 %) was present in all the soils. Soils in the active alluvial plains of Ganga river has 5-22% CaCO₃ equivalent whereas the soils in old and young alluvial plains of Mahananda, Tangon and Haria rivers has < 5.0 % CaCO₃ equivalent in surface. The soil pH ranged from very strongly acidic (4.5-5.0) to moderately alkaline (7.9-8.4) with highest area (23.6% TGA) under slightly acidic (6.1- 6.5) range. Soil organic carbon and its stock ranged from low (0.5%) to high (> 0.75%) and < 10 Mg ha⁻¹ to > 20 Mg ha⁻¹, respectively.

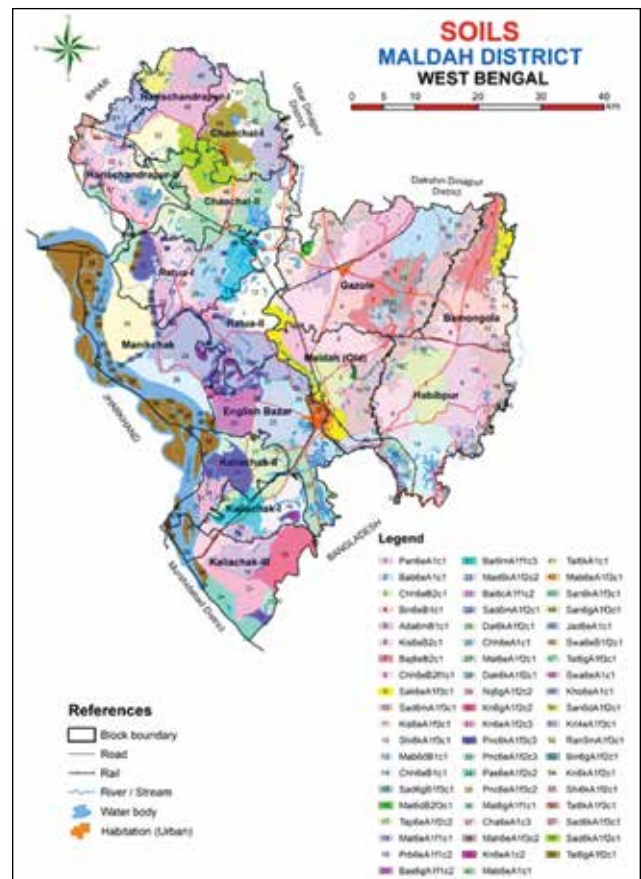


Fig.2.2.7. Soil Map of Maldah district.

Rejuvenating Watershed for Agricultural Resilience through Innovative Development (REWARD), Odisha

Red Ferruginous Paleo-Alfisols of Eastern Ghats landscape of Odisha were characterized and classified in selected sub watershed clusters of Sambalpur and Koraput districts of Odisha covering about 29,000 ha. LRI at large scale was conducted at micro-watershed level (1: 8,000 scale). Soils on hills are deep, well drained, slightly gravelly, loamy to clay loam textured and classified as *Typic Rhodustalfs*, whereas, soils on uplands are very deep, clay loam to clayey textured and classified as *Rhodic Paleustalfs* and *Typic Paleustalfs*. Soils on valleys are very deep, moderately well to imperfectly drained, silty clay loam to silty clay and clayey textured and classified as *Typic Endoaqualfs*, *Aquic Haplustalfs*, *Aquic Rhodustalfs* and *Oxyaquic Rhodustalfs*. Soil map of Publignuda watershed located in the study area is depicted in Fig. 2.2.8.

LRI of Arunachal Pradesh

Anjaw district

Anjaw district is located in the easternmost part of the state and lies between 27°33 and 29°22 N latitudes, and 95°15 and 97°24 E longitudes. Total geographical area of the district is 6,52,896 ha. Soils of the district were mapped into 16 phases of 12 soil series. Chipru series has the largest area (28.26% of TGA) followed by Chelia series (7.13%) and Sarti series (6.83%). Soils of the Chipru series were moderately deep, well drained, coarse silty, moderately acidic in reaction with silt loam surface with moderate erosion occurring on very steeply sloping low hills and classified as *coarse-silty mixed, thermic, Typic Dystrudepts*. The soil pH was neutral (pH 6.5-7.7) in 71.4% of surveyed area whereas, slightly acidic (pH 5.5-6.5) and moderately acidic (pH 4.5-5.5) occur in 19.1 and 9.38% of surveyed area of the district, respectively.

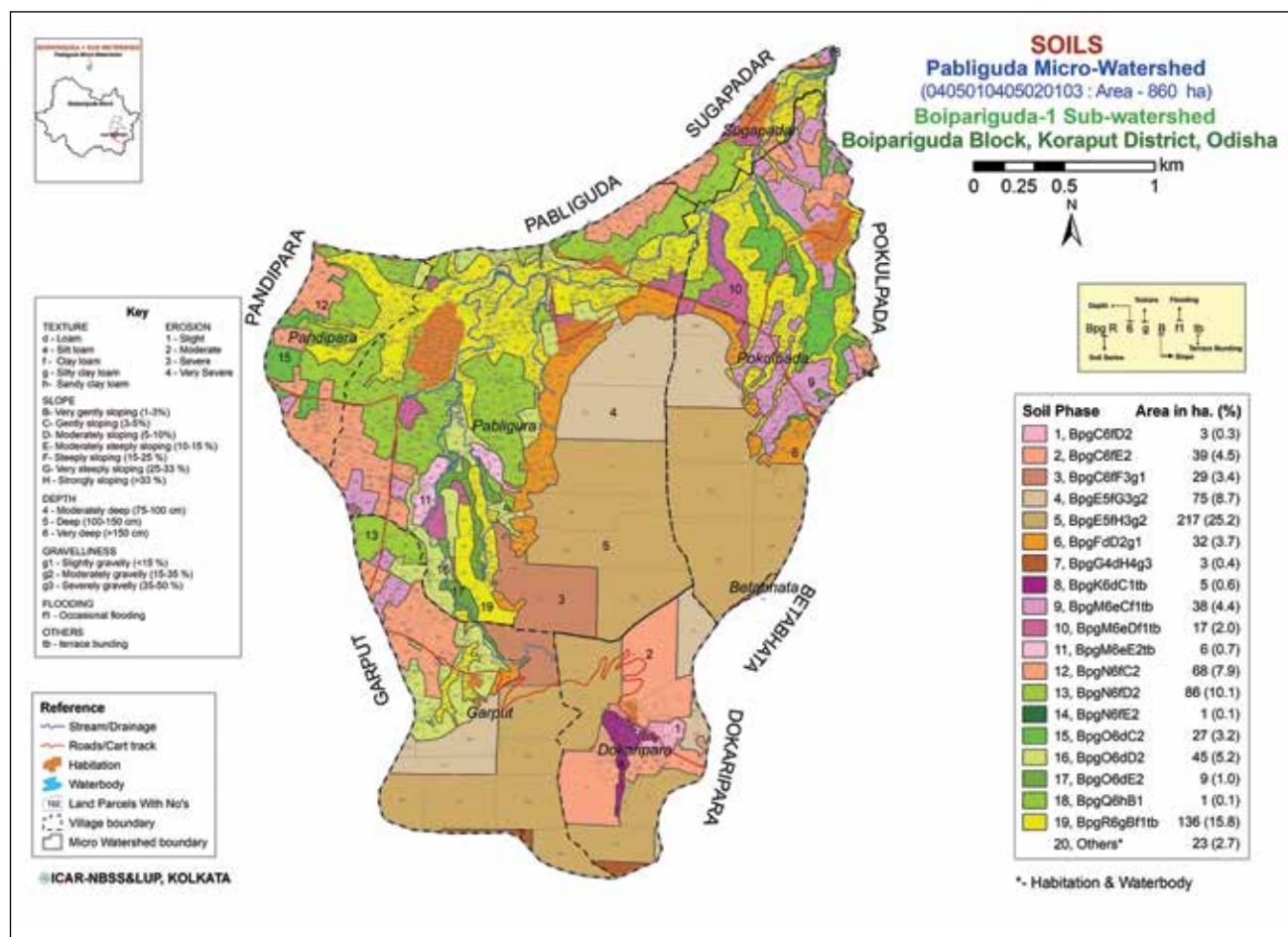


Fig.2.2.8. Soil Map of Publignuda Micro-Watershed

Changlang district

Changlang district of Arunachal Pradesh is situated in the geographic extent between 26°40' N and 27°40' N latitudes and 95°11' E and 97°11' E longitudes covering an area of 5,08,000 ha. Soils of the district were mapped into 28 phases of 19 soil series. Sallang series has the largest area occupancy (12.3% of TGA) occurring on very strongly slopping low hills and it was classified as *Fine, mixed, thermic, Typic Dystrudepts*, followed by Longran series (9.53 %) occurring on steeply slopping to strongly slopping low amplitudinal hills and classified as *Fine, mixed, thermic, Typic Hapludalfs* and Yangchang New series (9.43 %) occurring on very strongly slopping low hills classified as *Fine, mixed, thermic, Pachic Humudepts*.

2.2.1 LRI of Patiala district, Punjab

Patiala district (29°49' to 30°47' N and 75°58' to 76°54' E; TGA: 3318 km²) is situated in northern plain, hot dry sub humid ecosystem agro-ecological sub-region (AESR 9.1) and comprises ten blocks. The annual rainfall is 754 mm. The district is part of Indo-Gangetic alluvial plain and consists of recent to old alluvium parent material. The soils of the Patiala district were mapped into 29 soil series and 63 soil phases (Fig. 2.2.9).

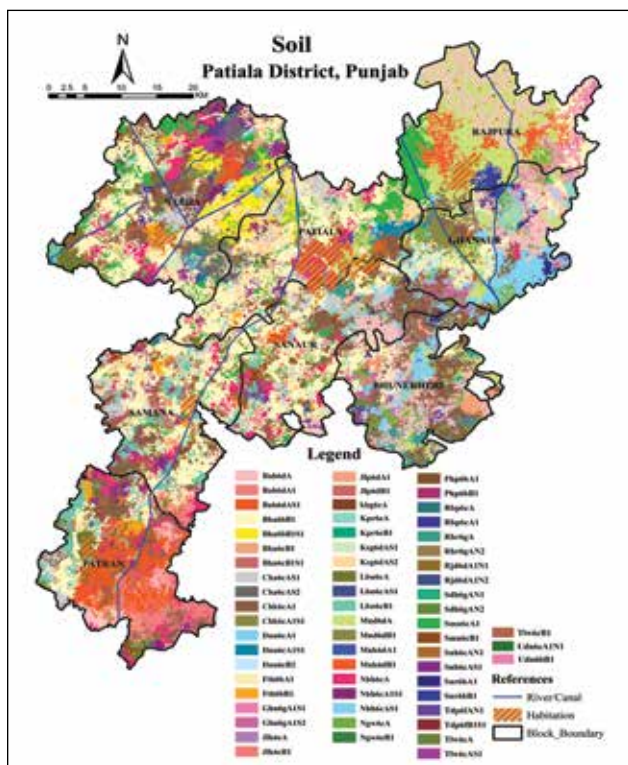


Fig. 2.2.9. Soil map of Patiala district of Punjab

LRI of Shahid Bhagat Singh Nagar district, Punjab

Shahid Bhagat Singh Nagar is located in the north-eastern part of Punjab and representative of Shiwalik hills and Indo-Gangetic plains. Soils of the district were mapped into 23 soil series and 45 soil phases (Fig. 2.2.10). Soils of Shiwalik hills, piedmont plain, old alluvial plain, recent alluvial plain and active flood plain were mapped into 5 (Chandpur Rurki, Torowal, Tundewal, Kukar Suha and Bagowal), 4 (Makhupur, Jeowal, Chandpur Rurki and Udhawal), 8 (Mehrapur, Jandiali Kalan, Pragpur, Langroya, Bangal Kalan, Sujjon, Langeri and Rahon), 4 (Garhi Padhana, Mutton, Garhi fateh khan and Shahpur) and 2 (Khoja and Mahnadipur Khurd) soil series, respectively. These soils belong to 3 orders *i.e.* Entisols (45%), Inceptisols (34.3%) and Alfisols (12.5%); 6 sub-orders *viz.* Ustepts (31.7%), Psamments (27.3%), Fluvents (14.4%), Ustalf (12.5%), Orthents (3.3%), and Aquepts (2.6%), 6 great groups namely Haplustepts (31.6%), Ustipsamments (27.3%), Ustifluvents (14.4%), Haplustalf (12.5%), Ustorthents (3.32%), and Halaquepts (2.6%); 8 sub-groups and 6 families namely fine loamy (33.5%), sandy (26.1%), coarse loamy (18%), fine (5.4%), coarse loamy over sandy (5.4%) and sandy skeletal (3.3%). About 25% area is under well drained soils, followed by somewhat excessively drained (21.6%), moderately well drained (20.5%), somewhat poorly drained (15.6%) and excessively drained (9%) soils. About 85.6% soils are very deep followed by deep (2.9%), moderately deep (2.2%) and moderately shallow (1.2%) soils. About 66.3%, 19.1%, 6% and 0.4% area is affected by slight, moderate, severe and very severe erosion, respectively.

LRI of Bhimtal Block, Nainital district, Uttarakhand

Soils of Bhimtal block were mapped into 7 soil series and 10 soil mapping units (Fig. 2.2.11). Soils of upper hillside slopes comprises of *Tirchhakhet*, *Salri* and *Jangaliya Gaon* soil series and mapped into five phases. The soils are shallow to moderately shallow, somewhat excessively to well drained, very dark grayish brown to dark grayish brown/dark reddish brown, loamy skeletal to coarse loamy texture with moderate to very severe erosion. These soils were classified as *Loamy skeletal to coarse loamy, mixed, thermic, Lithic Udorthents/ Typic Udorthents*. Soils of lower hillside slopes comprises of *Bohra Gaon* and *Thapliya* soil series and two phases. The soils are moderately deep, moderately well drained to well

drained, dark grayish brown to brown, coarse loamy to fine loamy texture with moderate to severe erosion. They were classified as *Coarse loamy, mixed, thermic, Typic Eutrudepts* and *Fine loamy, mixed, thermic, Typic Udorthents*. Soils of intermountain valley comprises of *Gethiya* and *Okhal Dhunga* soil series and mapped into three phases. The soils were very deep, moderately well drained to well drained, dark grayish brown to brown and brown to dark grayish brown, coarse loamy texture with moderate to severe

erosion. They were classified as *Coarse loamy, mixed, thermic, Dystric Eutrudepts*. Major area of the block is medium in organic carbon (52%) while 44% area is high in organic carbon. Major area of the block is low in available nitrogen (57.8%) while 38.2% area is medium in available nitrogen. Major area is sufficient in available manganese (53.9%) while 42.0% area is deficient in available manganese. About 44.3, 39.9 and 11.8 % area of the block are high, medium and low in available potassium, respectively.

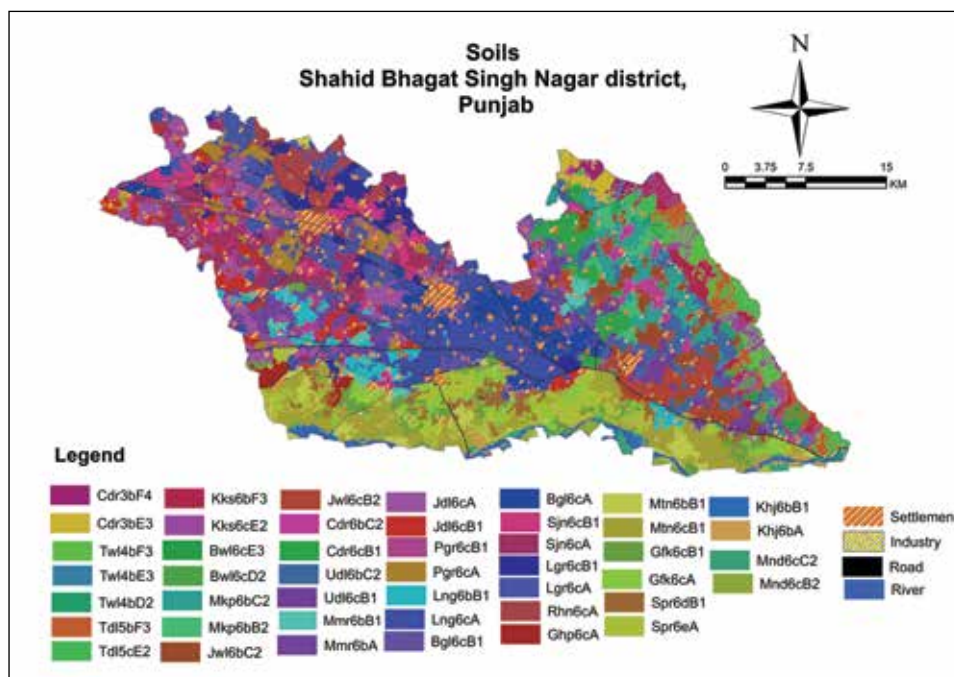


Fig.2.2.10. Soil map of Shahid Bhagat Singh Nagar district, Punjab

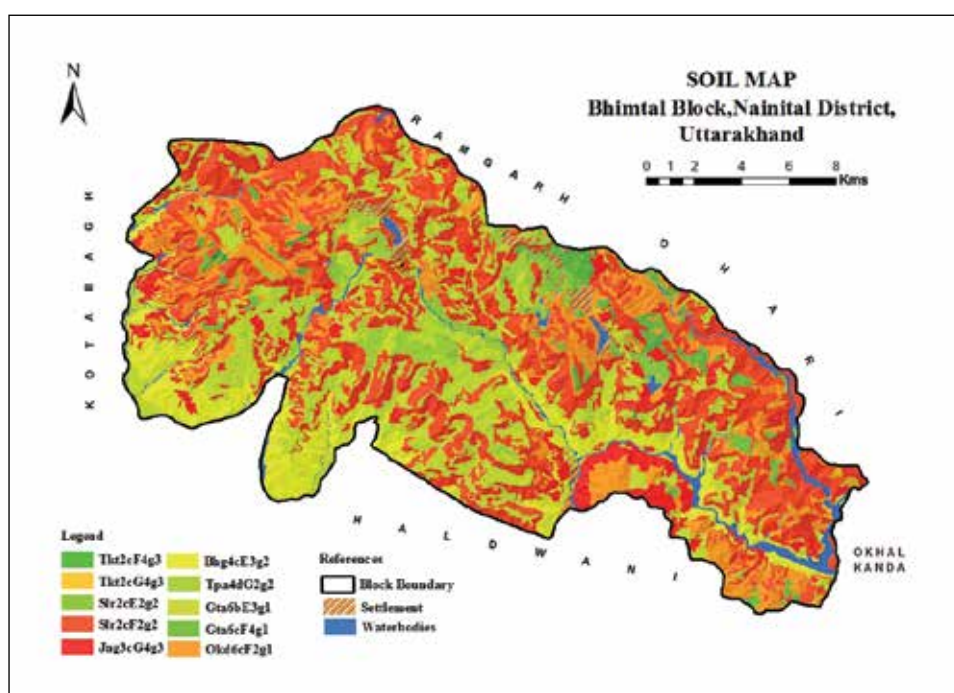


Fig. 2.2.11. Soil map of Bhimtal block, Nainital district, Uttarakhand

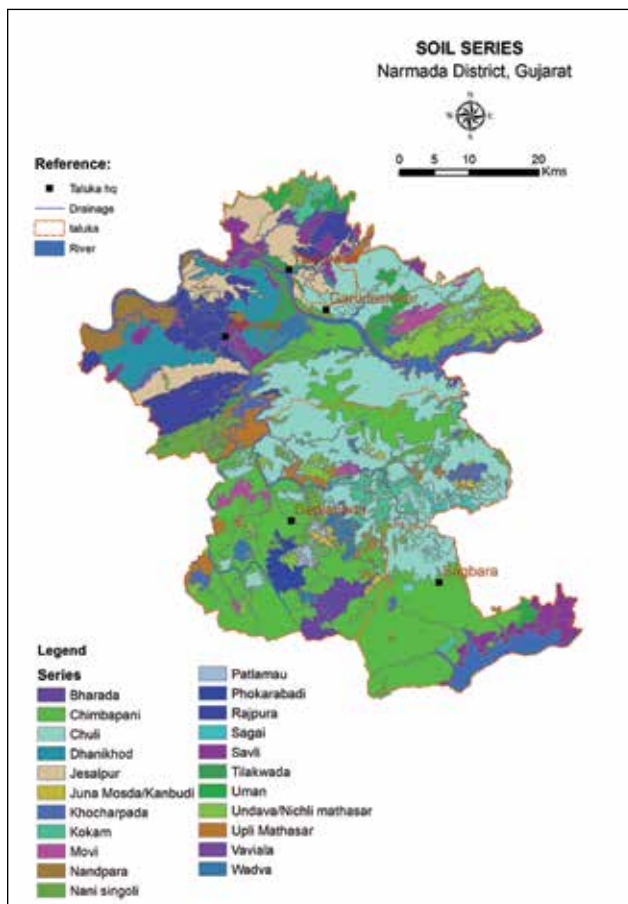


Fig. 2.2.14. Soil map of Narmada district, Gujarat

clay texture. Soils of dissected plateau are shallow to very deep with loam to clay texture. Soils of dissected

hills and valleys are very deep with sandy loam to sandy clay. Soils of pediplain are moderately shallow to very deep, sandy loam to clay, non-calcareous to calcareous in nature. Soils of pediment are moderately shallow with clay loam texture. The soils of rolling plain are shallow to deep with loam to clay loam texture.

Land Resource Inventory of Ahmednagar District (Northern Part), Maharashtra

The delineated landforms are pediment, foothills, upland, escarpments, degraded hills, plateau, alluvial plains and valley. Soils occurring on degraded hills, foot hills, plateau and valley positions were shallow to moderately deep to deep. Surface soil texture varied from clay to clay loam. Soil pH varied from 6.2-9.2. The soils of degraded hills and upland has neutral to slightly alkaline pH (7.3-8.1), whereas, pediment and valley has slight to moderately alkaline pH (8.1-8.6) at 0-30 cm depth. Organic carbon generally decreased with depth, and it varied from 0.30 to 1.25 % in surface and from 0.20 to 1.16 % in the sub-surface.

Land resource inventory of Osmanabad district, Maharashtra

About 19 soil series were identified from detailed soil survey of Osmanabad district (Figs 2.2.15). Most of the Vertisols were calcareous in nature.

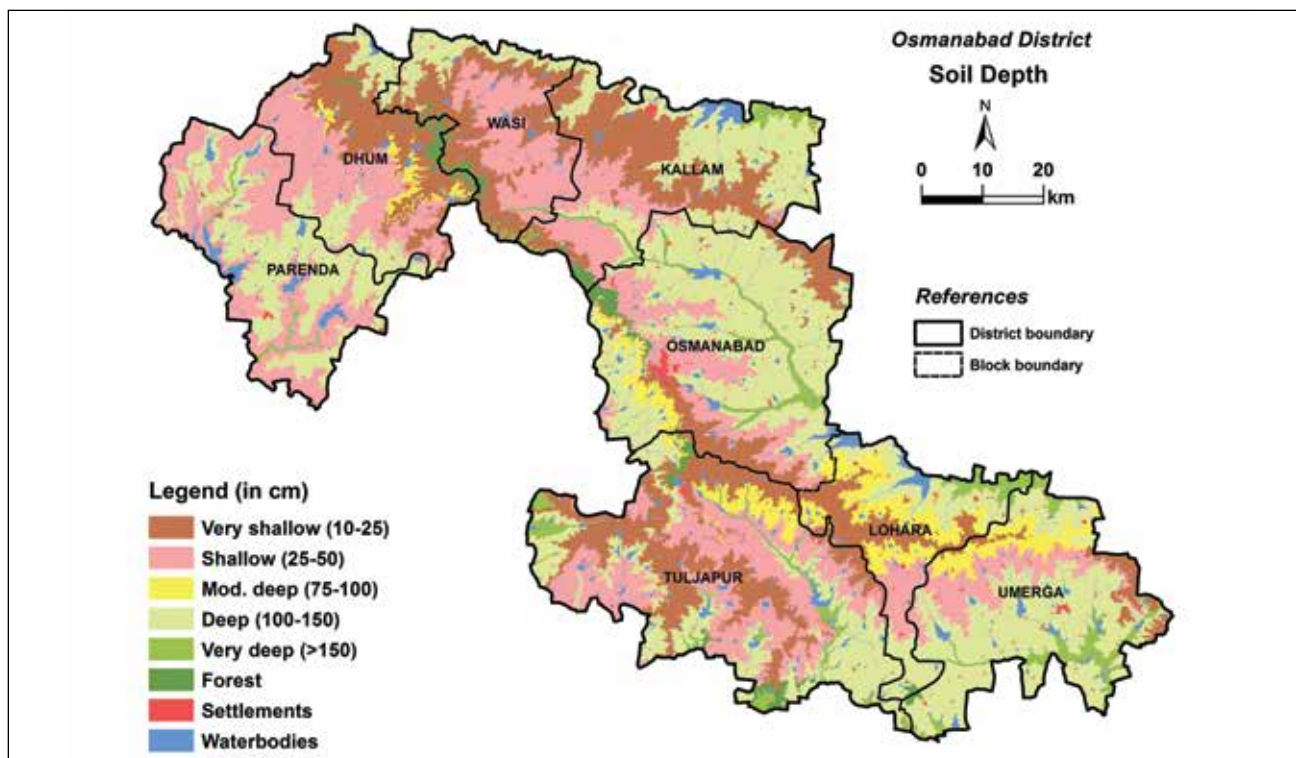


Fig. 2.2.15. Terrain mapping units and soil depth map of Osmanabad district

Digital mapping of soil properties and available nutrients in Barmer district, Rajasthan

The soil properties of Barmer district were predicted and thematic maps were prepared using random forest (RF) model, which included 19 environmental covariates. The primary and secondary derivatives of DEM, viz. elevation (Elev), slope (Slp), aspect (Asp), convergence index (CI), valley depth (VD), channel network base level (CNBL) and distance (CND), relative slope position (RSP), plan curvature (Plac), profile curvature (PrC), topographic wetness index (TWI), topographic ruggedness index (TRI), topographic position index (TPI), LS factor, multi-resolution index of valley bottom flatness (MRVBF), multi-resolution ridge top flatness (MRRTF), total

catchment area (TCA), eleven bands of landsat-8 imagery, normalized difference vegetation index (NDVI), enhanced vegetation index (EVI), average monthly temperature (MAT) and annual precipitation (AP) from the WorldClim were used as covariates for prediction. Predicted maps of pH, EC, OC, and CaCO_3 are presented in Fig. 2.2.16. Statistical measures such as coefficient of determination (R^2), mean error (ME), root mean square error (RMSE), and concordance correlation coefficient (CCC) were used to assess the effectiveness of the RF model. The calibration and validation results indicate that the combination of different covariates explains the variability of predicted soil properties and available nutrients (Table 2.2.1).

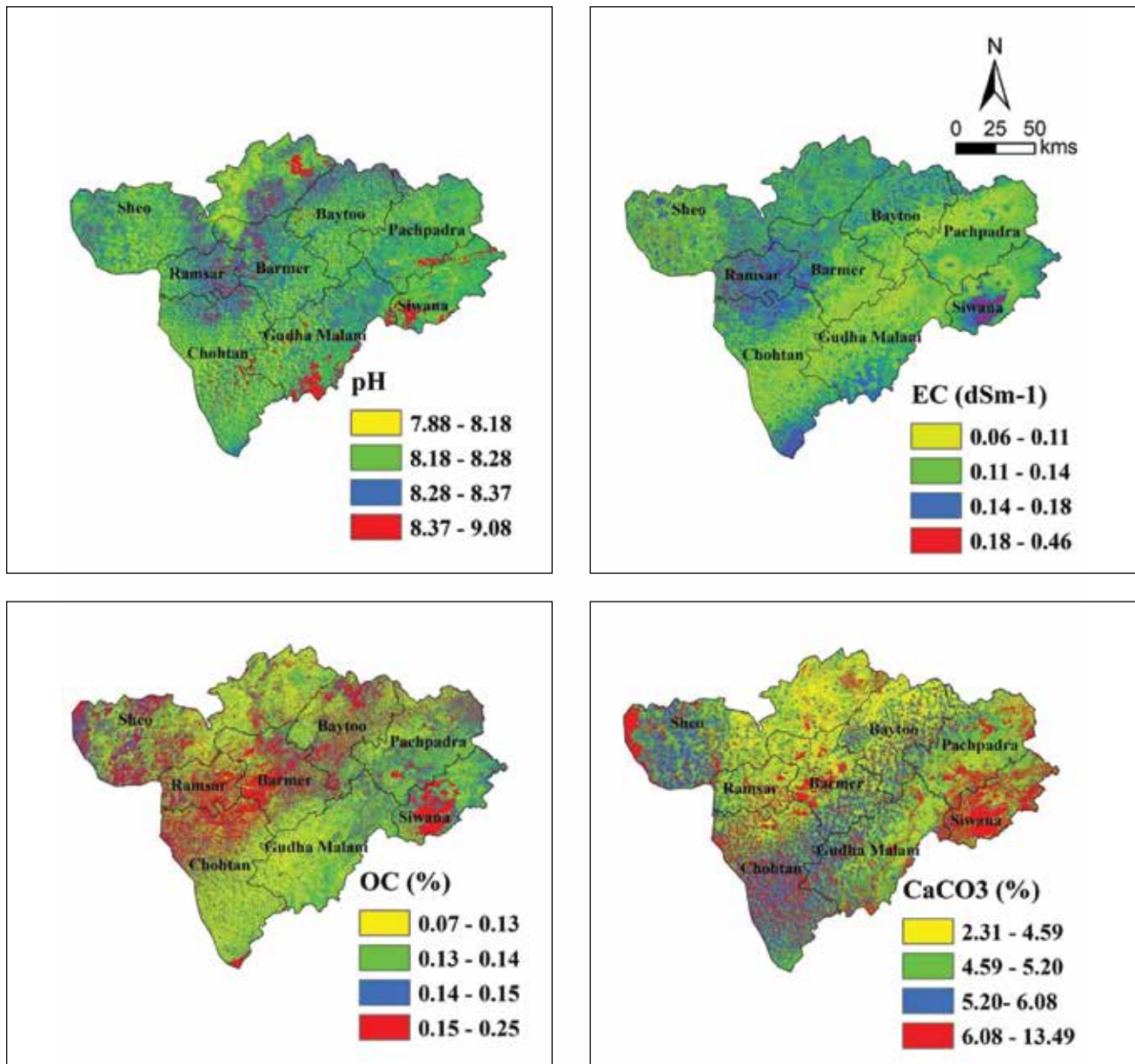


Fig. 2.2.16 Variation of soil properties in the Barmer district, Rajasthan

Table 2.2.1 Results of RF model for prediction of soil properties and available nutrients in the in the Barmer district, Rajasthan

Soil parameters	Calibration				Validation			
	R ²	CCC	RMSE	ME	R ²	CCC	RMSE	ME
pH	0.979	0.838	0.170	0.004	0.333	0.398	0.353	0.030
EC	0.931	0.781	0.067	0.006	0.101	0.198	0.125	0.011
OC	0.970	0.826	0.033	0.001	0.233	0.245	0.086	0.004
CaCO ₃	0.935	0.803	2.023	0.153	0.502	0.349	2.816	2.285
N	0.964	0.825	16.772	0.704	0.078	0.086	43.262	2.772
P	0.958	0.816	5.713	0.205	0.249	0.257	14.206	3.700
K	0.944	0.819	64.299	4.766	0.132	0.136	100.506	11.570
Cu	0.908	0.720	0.738	0.065	0.237	0.255	0.652	0.401
Zn	0.955	0.825	0.074	0.002	0.239	0.259	0.143	0.002
Fe	0.941	0.796	0.853	0.045	0.039	0.035	1.892	0.422
Mn	0.943	0.847	0.633	0.011	0.138	0.144	2.432	0.578

ME: mean error; RMSE: root mean square error; R²: coefficient of determination; CCC: Lin's concordance correlation coefficient

Land Resource Inventory of FDCM Divisions

Detailed soil survey was completed for the second phase of the project comprising Chandrapur, Markhanda, Pranhita and Yavatmal divisions of Vidarbha region, covering an area of 2.3 lakh ha in 13 ranges and 32 compartments. The landform maps of these divisions were generated in the GIS environment by integrating google image, Sentinel data and ALOS DEM (Fig. 2.2.17). A total of 120 soil profiles were studied in the different landforms, from which around 250 soil samples were analysed for their soil-site, morphological, physical and chemical properties.

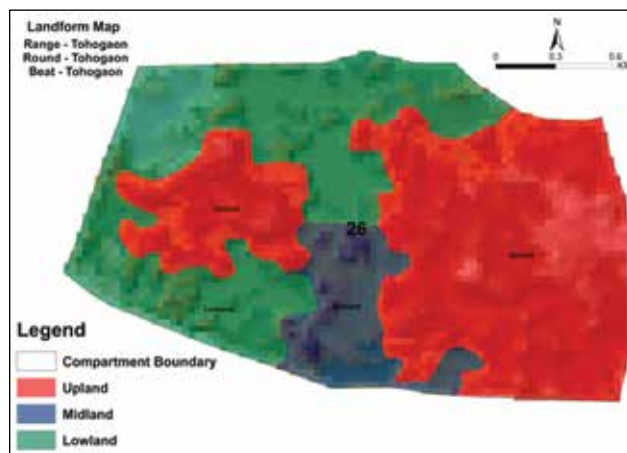
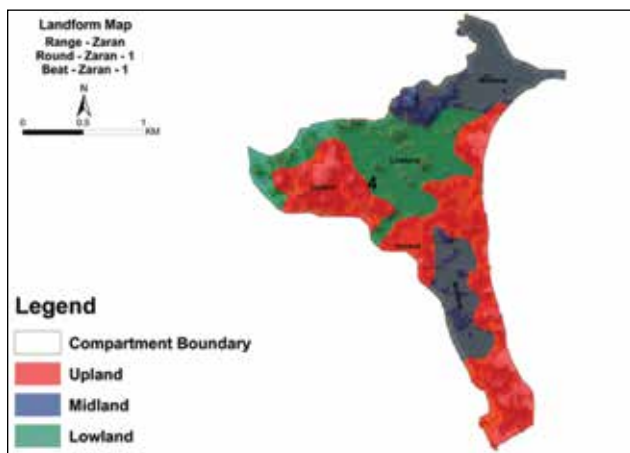
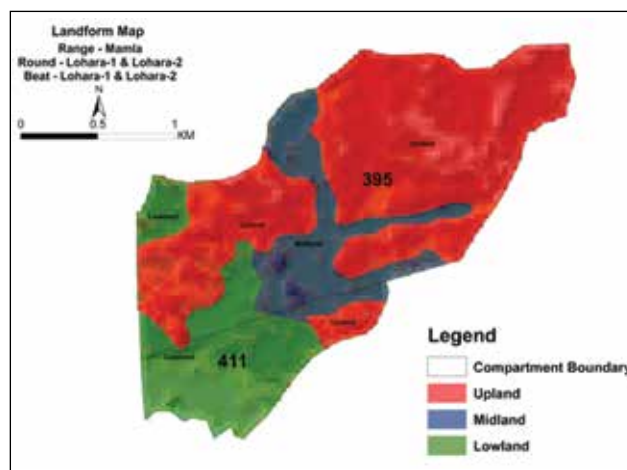


Fig. 2.2.17. Landform maps of Mamla, Tohogaon and Zaran range, Chandrapur division



The soils of the Chandrapur division, covering Mamala, Tohogaon and Zaran ranges varied from shallow (Mamala range) to very deep (Zaran range), moderate to well drained, dark brown (7.5 YR3/3) to very dark grayish brown (10 YR3/2). The soils were moderately acidic to moderately alkaline in reaction with very low electrical conductivity. Soil organic carbon content varied from very low (0.24%) to very high (2.36%) and decreased with depth in all the soils (Table 2.2.2). The mean available nitrogen and phosphorous content is low in all the ranges and

decreased with depth. The mean available potassium content varied from very low to low and ranges from 51 to 157 kg ha⁻¹. Soils of all the FDCM ranges are sufficient in available copper, medium to high in iron content, sufficient in available manganese. However, all the soils are deficient in available zinc. The texture of the soils varied from sandy loam to clay. The clay content varied from 18.4 to 52.7% and the sand content ranged from 15 to 65.8%; The soils of the division were classified as *Typic Ustorthents*, *Lithic Haplustepts*, *Typic Haplustepts* and *Typic Haplusterts*.

Table 2.2.2. Soil properties in the Chandrapur FDCM divisions in Maharashtra

Soil properties	Chanda Division		
Mamla Range		Tohogaon Range	Zaran Range
pH	5.3-6.1 (5.8)	5.5-6.3 (6.0)	7.0-8.3 (7.9)
EC (dS m ⁻¹)	0.01-0.05 (0.02)	0.01-0.02 (0.01)	0.04-0.11 (0.07)
OC (%)	0.3-1.4 (0.76)	0.24-0.66 (0.48)	0.48-2.36 (0.92)
Av. N (kg ha ⁻¹)	75.3-150.5 (113.5)	62.7-150.3 (100.3)	62.7-150.5 (92.8)
Av. P (kg ha ⁻¹)	4.5-18.8 (9.9)	8.5-13.0 (9.9)	10.3-14.3 (11.5)
Av. K (kg ha ⁻¹)	30.2-81.1 (50.8)	75.8-253.3 (157.1)	97.1-303.1 (149.4)
Cu (mg kg ⁻¹)	0.5-3.2 (1.7)	0.6-2.4 (1.2)	1.20-2.63 (1.6)
Fe (mg kg ⁻¹)	14.0-69.3 (28.5)	7.7-30.0 (19.0)	3.20-33.15 (11.5)
Mn (mg kg ⁻¹)	23.9-89.6 (54.5)	26.5-80.3 (51.7)	8.5-58.7 (26.2)
Zn (mg kg ⁻¹)	0.2-1.7 (0.66)	0.4-0.9 (0.5)	0.27-1.3 (0.52)
Ex. Ca	1.6-5.6 (3.1)	0.8-3.6 (2.2)	23.2-26.8 (24.6)
Ex. Mg	0.8-7.2 (2.6)	0.4-2.8 (1.1)	4.4-9.2 (7.0)
Ex. Na	0.22-0.43 (0.27)	0.01-0.39 (0.12)	0.13-0.26 (0.19)
Ex. K	0.04-0.12 (0.07)	0.88-0.33 (0.19)	0.14-0.39 (0.19)
Sand (%)	25.4-65.9 (41.8)	37.2-65.8 (52.3)	15.0-27.2 (21.5)
Silt (%)	11.8-33.7 (17.9)	10.2-24.9 (18.3)	31.9-32.8 (32.3)
Clay (%)	18.4-41.3 (40.3)	13.3-50.5 (29.3)	40.8-52.7 (46.1)
BD (Mg m ⁻³)	1.3-1.5 (1.4)	1.3-1.6 (1.4)	1.25-1.33 (1.29)
Values in parenthesis shows the mean values			

The Pranhita division covers Aheri, Allapalli and Jimalgatta ranges of FDCM. The soils varied from shallow (Jimalgatta ranges) to very deep (Allapalli range), well drained, very dark gray (10YR3/1) to dark grayish brown (10 YR4/2) and silty clay to clay in texture. Most of the soils were moderately acidic to moderately alkaline in reaction, however few soils of Aheri range are moderate to strongly alkaline and the pH increased with depth. Soil organic carbon content varied from very low (0.12%) to very high (2.1%) and decreased with depth in all the soils.

The mean available nitrogen and phosphorous content is low in all the ranges that is less than 280 and 15 kg ha⁻¹ respectively, and it decreased with depth. The mean available potassium content varied from very low to medium and ranges from 152 to 206 kg ha⁻¹. The soils were deficient in Zinc. The soils of the division were classified as *Typic Ustorthents*, *Lithic Haplustepts*, *Typic Haplustepts* and *Typic Haplusterts*.

2.3

BASIC PEDOLOGICAL RESEARCH

Conceptual model of organic carbon stabilization as governed by the nano-size soil minerals

Indian soils in general, contain both crystalline (layered phyllosilicates, oxides and hydroxides) and non-crystalline short range ordered (amorphous aluminosilicates and ferri-aluminosilicates) nano-clay (< 100 nm) minerals, which appear to have a positive role in soil organic carbon (SOC) stabilization. The proposed conceptual model indicates that nano-sized crystalline layer silicates in soils break down at acidic pH in highly weathered humid tropical soils, resulting in the formation of nano-size non-crystalline minerals with positive charge surfaces (Fig 2.3.1). These

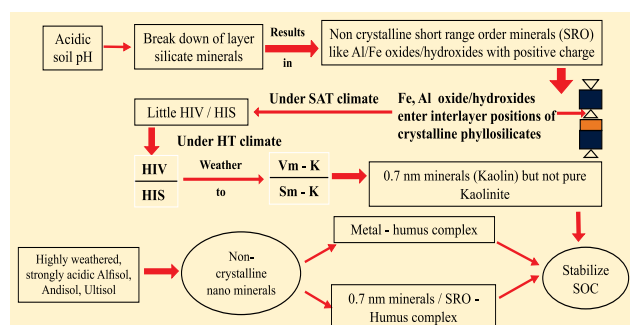


Figure 2.3.1 Conceptual model of soil organic carbon sequestration governed by the nano-size soil minerals

positively charged minerals then form complexes with metal humus, effectively sequestering SOC. Moreover, these non-crystalline minerals can trap SOC by creating hydroxy interlayering within crystalline minerals in humid tropical climates. Thus, in acidic soil reactions, hydroxy interlayered nano-sized crystalline minerals and non-crystalline clay minerals emerge as the primary substrates for SOC stabilization, contradicting the long-held notion linking SOC accumulation solely to the content of expanding crystalline clay minerals.

Relationship between mineral composition of nano-clays and forms of soil K

In Vertisols, positive and significant correlation of water soluble, exchangeable and non-exchangeable K with quantity of clay sized mica suggested the mineral as major K source (Table 2.3.1). However, nano-sized mica, kaolin and smectite are not significant source of K in soil. Also, nano-sized smectite and kaolin are non-selective in fixing K. In Ultisols, positive and significant correlation of non-exchangeable K with nano-sized hydroxy interlayered vermiculite and kaolin suggested the mineral as major K source (Table 2.3.2). Further, it has been observed that nano-mica could also fix larger amount of K as indicated by the higher degree of correlation coefficient.

Table 2.3.1. Correlation between quantity of minerals and different forms of potassium in Vertisols

Parameters	Water soluble K	Exchangeable K	Non-Exchangeable K	
			HNO ₃ extractable K	NaBPh ₄ extractable K
Clay Smectite	0.091	0.785*	0.981*	0.908*
Clay Chlorite	-0.090	-0.505	-0.141	-0.108
Clay Mica	0.837*	0.958*	0.993**	0.985*
Clay Kaolin	-0.089	-0.505	-0.159	-0.108
Nano Smectite	-0.094	-0.505	-0.145	-0.108
Nano Mica	-0.095	-0.505	-0.167	-0.108
Nano Kaolin	0.087	0.505	0.121	0.108

Table 2.3.2. Correlation between quantity of minerals and different forms of potassium in Ultisols of Meghalaya

Parameters	Water soluble K	Exchangeable K	Non-Exchangeable K	
			HNO ₃ extractable K	NaBPh ₄ extractable K
Nano Kaolin (Int with Vm)	0.245	-0.356	0.727*	0.864*
Nano HIV	0.611	0.337	0.756*	0.742*
Nano Mica	-0.637	-0.219	-0.661	-0.542
Clay HIV	0.563	0.176	0.636*	0.669*
Nano Ch	0.69	0.383	0.623	0.514
Nano Mica-Vm (Int)	0.382	-0.11	0.802*	0.965**
Nano Mica-Chl (Int)	0.528	0.029	0.856*	0.916*
Clay Mica	-0.571	-0.442	-0.418	-0.179
Clay Kaolin (Int with Vm)	-0.342	0.062	-0.714*	-0.883*
Total Mica (Nano + Total Clay)	0.408	0.073	0.786*	0.911*

Quantification of micromorphological features for climate change and its implication

Semi-quantitative estimation of weatherable index mineral particularly of olivine, pyroxene, pedogenic carbonate (PC) and iron nodules present in sub-humid moist (SHM) climate of IGP soils indicated variability from surface to subsurface soils (Fig. 2.3.2 to 2.3.3). It was observed that olivine mineral having dominant

constituents of Fe-Mg silicates and pyroxene having dominant constituents of Ca, Fe, Mg silicates and iron nodules, are in different stages of weathering, and it is supposed to be the major source of nutrient in IGP soils besides the presence of micaceous minerals in the groundmass. Their quantified value is given in the body of respective minerals and their variation is due to climate change.

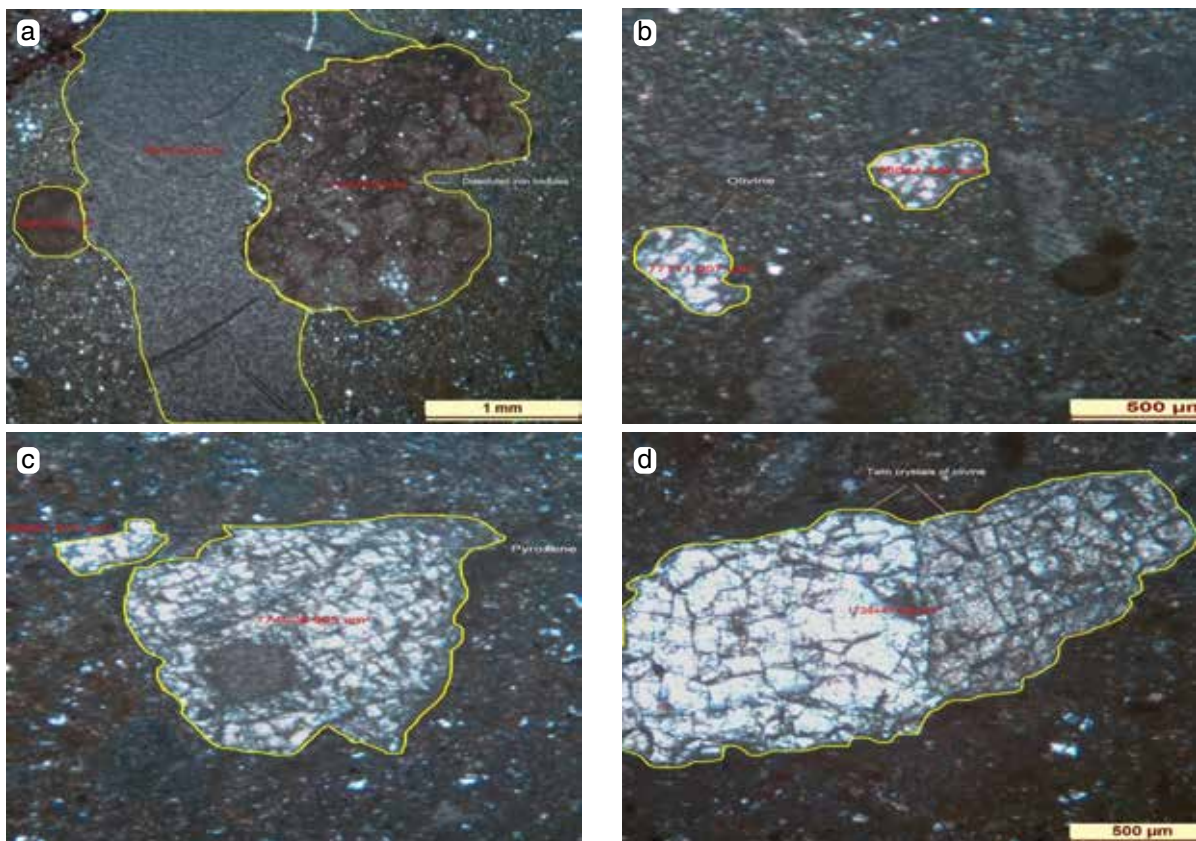


Fig. 2.3.2 Semi-quantitative estimates of micromorphological index minerals with their area in the soils of Burdwan Dist. W.B. (a) Fe-Mn nodules, 2.5x,XPL,29-37cm; (b) Olivine, 2.5x,XPL,29-37cm; (c) Pyroxene, 2.5x,XPL,76-84cm. (d) Twin crystals of olivine, 5x,XPL,76-84cm

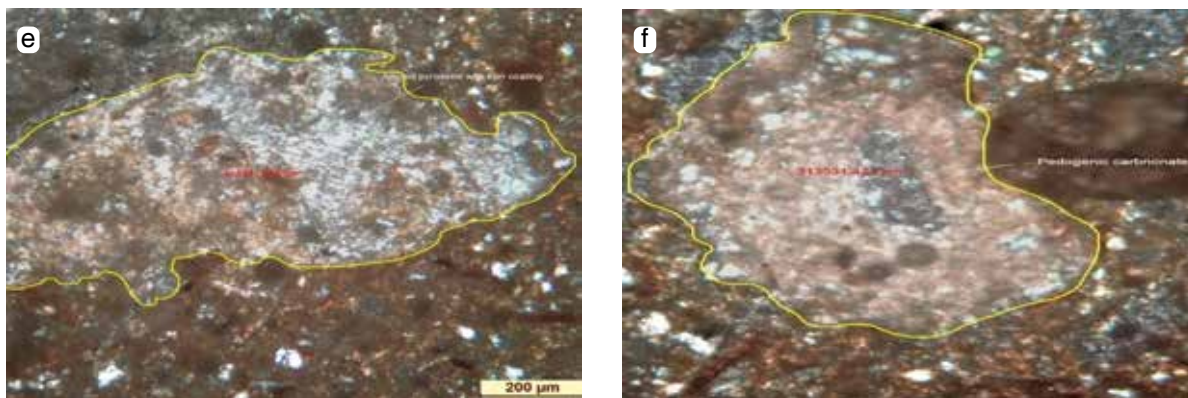


Fig. 2.3.3. Micromorphological index minerals in the soils of Mohanpur, Paschim Medinipur Dist., W.B.
(a) Altered pyroxene with iron leaching, 10x,XPL, 142-150cm; (b) PC with dissolved core, 5x,XPL, 142-150cm.

Pedodiversity of Vertisols

A study on the pedodiversity of Vertisols was initiated in 2022 and the morphological, physical, and chemical data of 454 Vertisol profiles were compiled and the variability in their depth in different Agro Ecological Regions (AERs) were analysed. During the reporting period, Vertisol legacy data of 604 profiles across the various AERs of the country were added and total profiles in the dataset is 1058. The surface horizon thickness varied from 8 to 23 cm due to variation in land use management (Fig 2.3.4). The initial depth of slickenside occurrence varied from 16 cm to 57 cm and the thickness of the slickensided horizons varied from 27 cm to >90 cm. Various types of cracking patterns viz., irregular, hexagonal, and crisscross were observed in the surface of the Vertisols. The depth of surface cracks was higher (30-52 cm) in AER 6 and

7 than the other AERs indicating the soil moisture deficit in these AERs. The width of the cracks at the surface varied from 0.5 - 11 cm. Generally, the colour of the Vertisol surface horizons varied from 10YR 3/4 to 10YR 3/3 and the subsurface horizons from 10YR 2/1 to 10YR 5/6 due to the influence of parent material and soil moisture regime. Some Red Vertisols are also found in AERs 6 with the colour hue varying from 7.5 YR to 5 YR. Few Vertisols under perennial crops in AER 19 had granular structure due to high organic matter addition and no tillage. The Vertisols of AER 6 and 7, particularly in the central Maharashtra region were mostly calcareous, sodic and showed effervescence to diluted HCl but the coastal Vertisols formed from basaltic alluvium deposits were non-calcareous and non-sodic. The coastal Vertisols in the AER 19 were very deep and exhibited well-drained conditions.

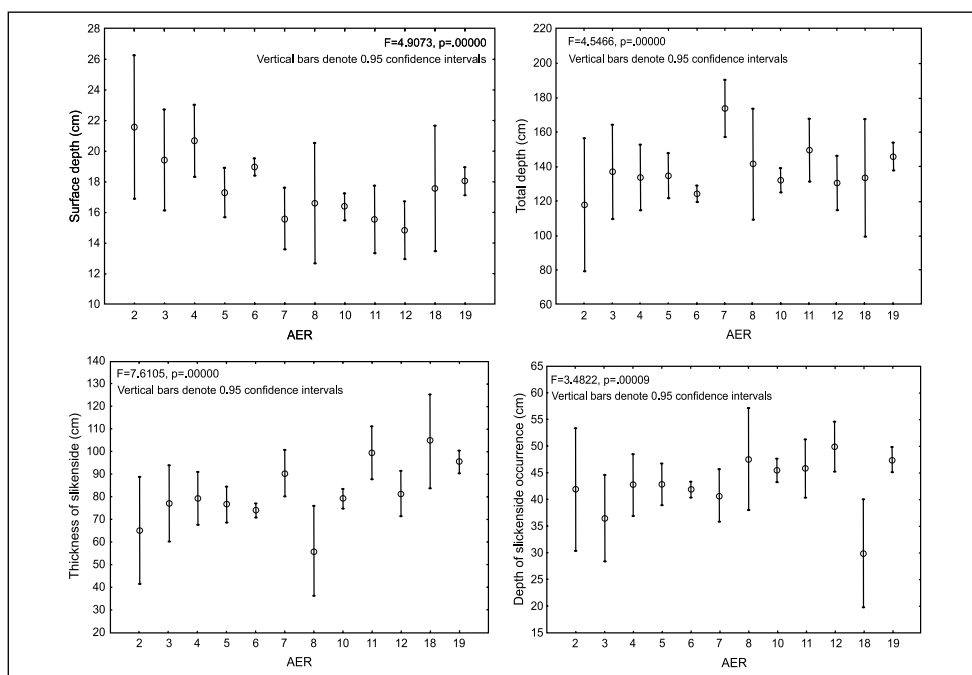


Fig 2.3.4. Variability in surface soil horizon depth, total depth, thickness of slickensides and first occurrence of slickensides in Vertisols in different AERs of India

2.4

INTERPRETATION OF SOIL SURVEY DATA

REWARD Hydrology

The inventory and documentation of spatial and temporal changes in hydrological components of Gummlapalli sub-watershed (4C3D7v) in Bagepalli taluk, Chikkaballapur district, has been undertaken for integrated planning, development, and management at the level of soil mapping units (scale 1:8000). Gummlapalli sub-watershed (Bagepalli taluk, Chikkaballapur district) is located between 13°44'20.389"N to 13°49'26.573"N latitude and 77°53'10.493"E to 77°59'55.27"E longitude, covering an area of about 5851.62 ha. Average annual rainfall (2015-2021) is 835 mm and mean potential evapotranspiration is 1659.7 mm. Hydrological outputs namely, rainfall trends, and patterns of actual evapotranspiration, runoff, soil moisture, groundwater levels, and recharge along with water balance for the SWS were estimated. The seasonal water budget (supply-demand) is estimated along with an assessment of sustainability of SWS. Water conservation interventions were recommended. The water balance of the Gummlapalli sub-watershed

was studied and as shown in Fig. 2.4.1. Based on the rainfall and AET values of the Gummlapalli sub-watershed during *kharif* and *rabi* seasons, rainfall was sufficient to fulfil the crop water demands, whereas in summer, AET was more than the rainfall, which demands to augment the groundwater to fulfil the crop water requirements.

Onsite measurement procedure for some of the water quality parameters (with particular reference to the ground water quality) for sub-watershed was calculated and mapped (Fig. 2.4.2 to 2.4.5). The pH of the Gummlapalli sub-watershed ranged between 8.08 to 8.77. The majority of groundwater EC values in the Gummlapalli sub-watershed fall into the good (0.25 to 0.75 dS m⁻¹) followed by permissible (0.75 to 2.0 dS m⁻¹), doubtful (2 to 3 dS m⁻¹), and unsuitable (>3 dS m⁻¹). The majority of the groundwater residual sodium bicarbonate (RSBC) values in the Gummlapalli sub-watershed fall between 5 to 10 (marginal) and < 5 (satisfactory). The majority of Kelly Ratio (KR) ratio in the Gummlapalli sub-watershed fall into the good (<1) followed by doubtful (1 to 2) and unsuitable (>2).

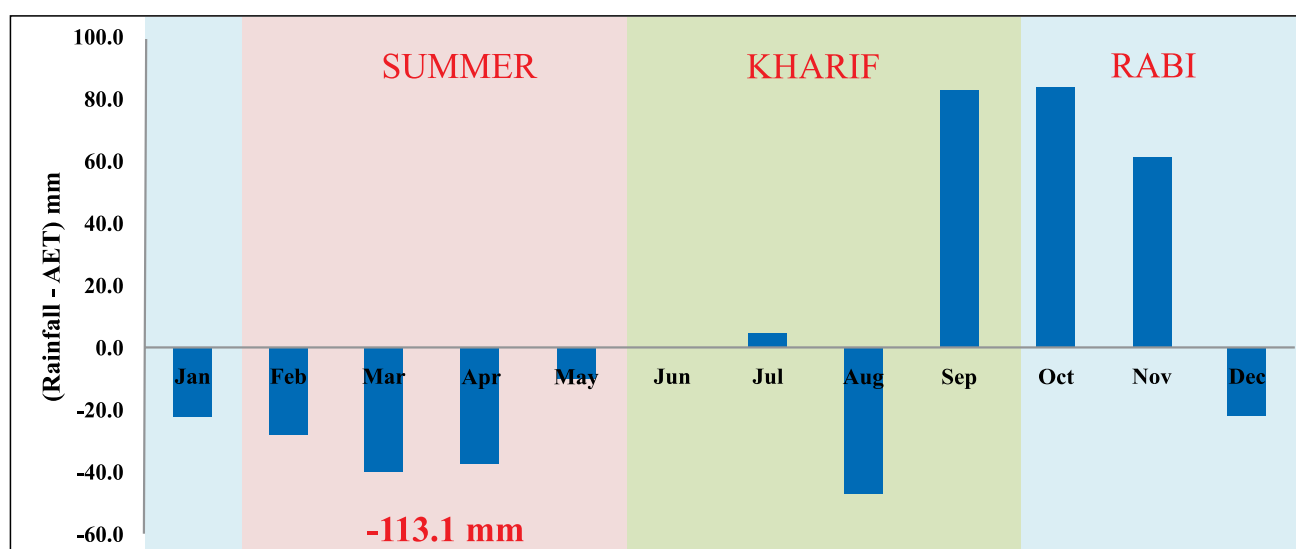


Fig. 2.4.1 Water balance map of Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

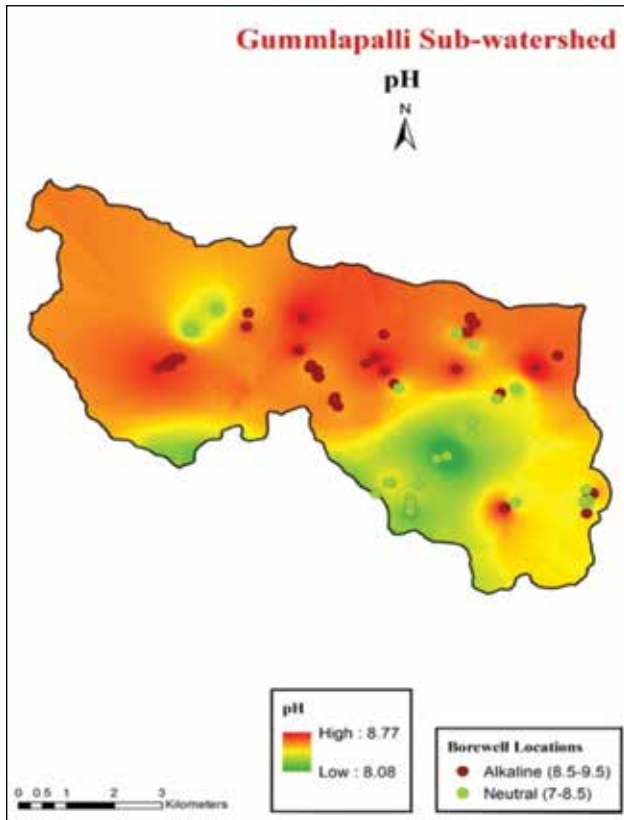


Fig. 2.4.2 pH of groundwater in Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

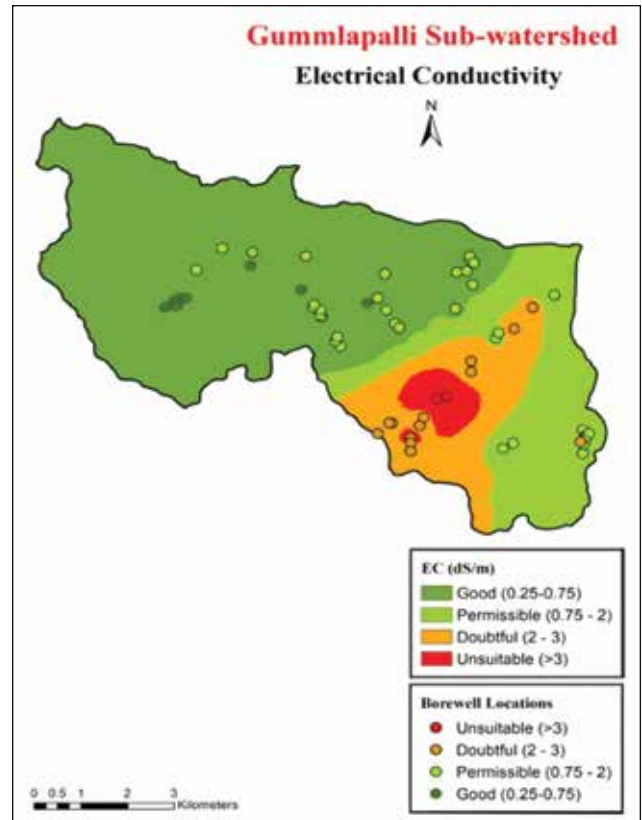


Fig. 2.4.3 EC of groundwater in Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

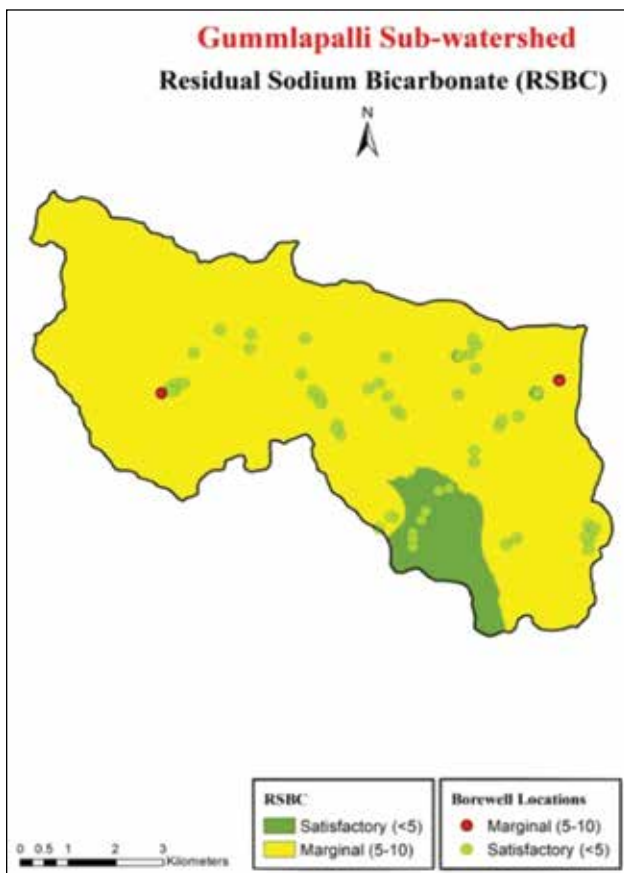


Fig. 2.4.4 RSBC of groundwater in Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

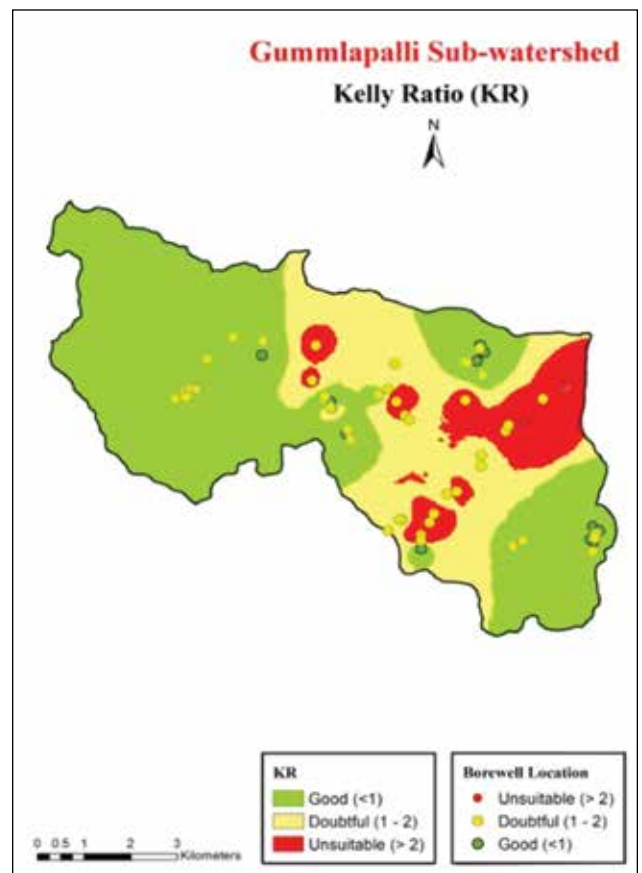


Fig. 2.4.5 KR of groundwater in Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

Soil carbon sequestration potential of mango (*Mangifera indica* L.) growing orchards under rainfed region of Karnataka

A study was conducted to characterize the soils of mango orchards and evaluate its carbon sequestration potential in the rain-fed ecosystem of Kolar (Karnataka). A total of 26 soil pedons were studied in the mango orchards for morphological, physical and chemical properties. The soil organic carbon stocks and carbon sequestration potential (CSP) of soils of mango orchards were calculated. The difference between soil organic carbon (SOC) saturation potential finer fractions (clay and silt) of soil and current soil organic carbon content is considered

as CSP. The estimated SOC stock and CSP (Fig. 2.4.6) in the soils of mango orchards ranged from 4.0 to 18.3 kg m⁻² and 10.3 to 36.2 kg m⁻², respectively. In total, about 4.67 Tg of organic carbon is stored in 50,430 ha of mango orchards in Kolar district and 43.47 Tg CO₂-equivalents could theoretically be stored in the 100 cm soil depth of these orchards.

Soil fertility Status in Chitradurga district, Karnataka

A total of 49 surface (0-20 cm) soil samples from farm lands of Hiriya and Hosadurga taluks of Chitradurga district were analysed in the laboratory and the fertility status are presented in Fig. 2.4.7

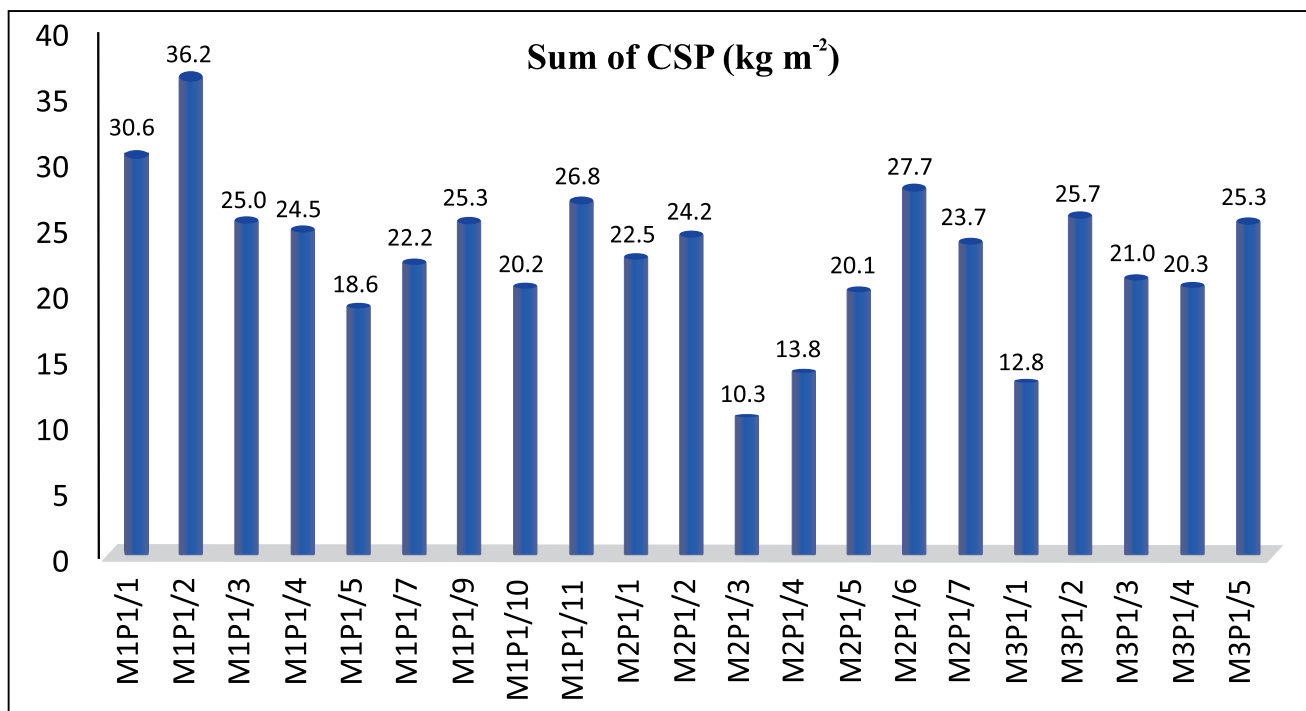
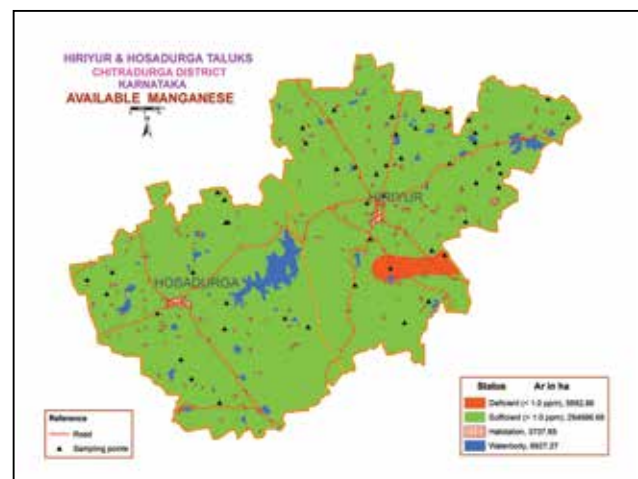
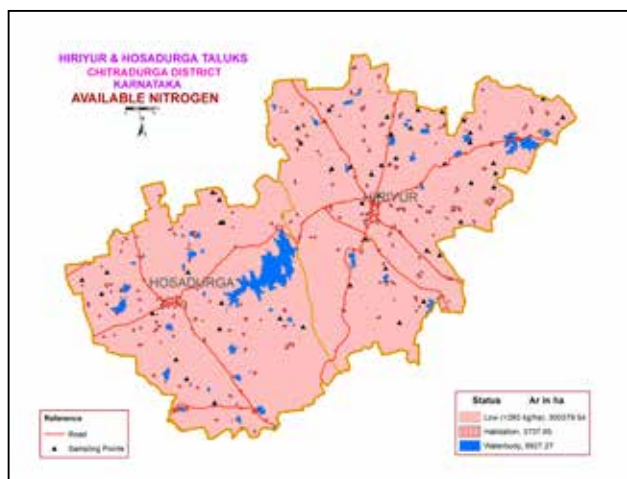


Fig. 2.4.6 Carbon sequestration potential in mango orchards in Kolar district, Karnataka



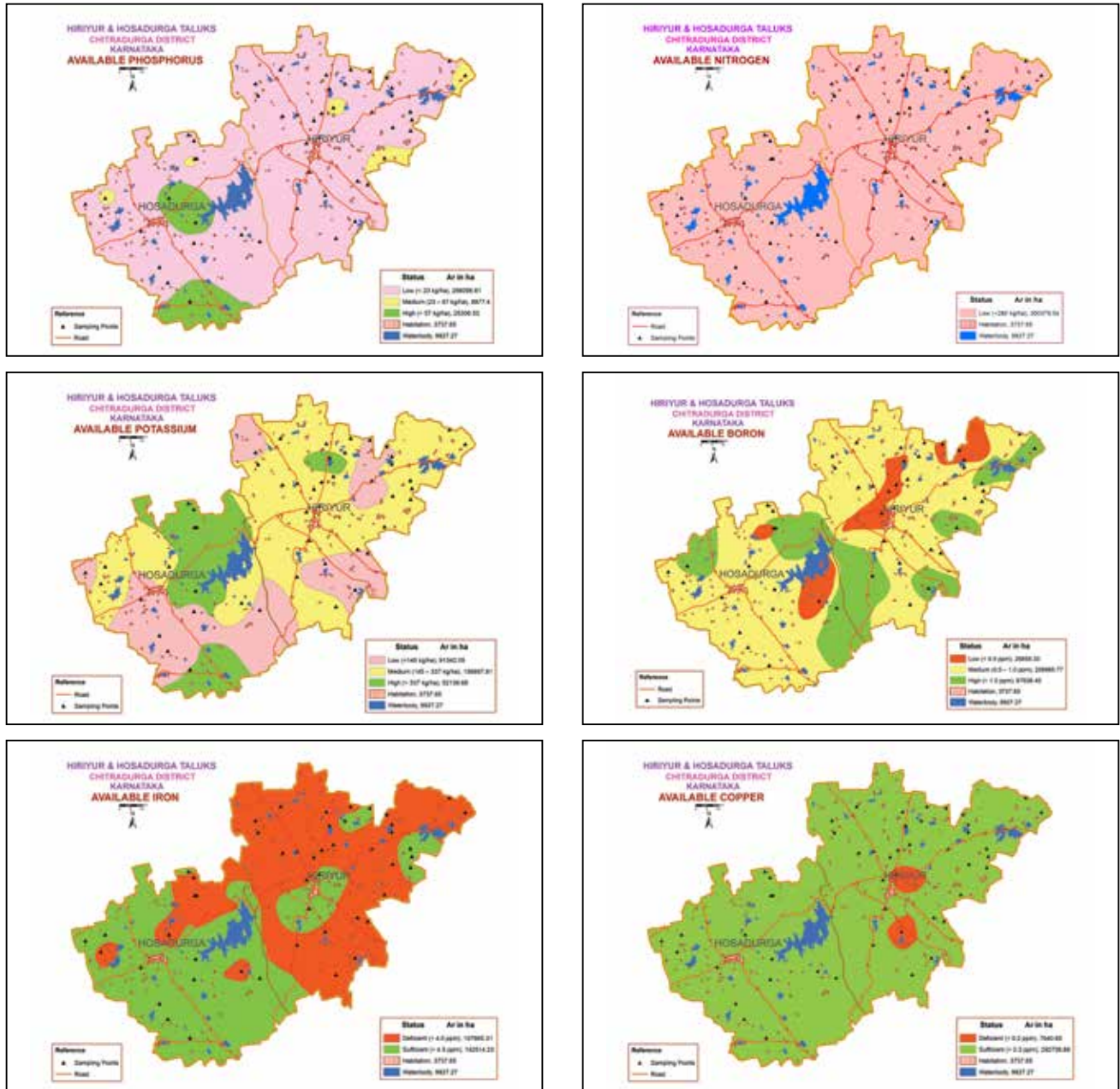


Fig. 2.4.7: Mapping of soil available nutrients including pH and organic carbon content in Hiriya and Hosadurga taluks of Chitradurga district, Karnataka

Groundwater Quality for management of Drinking and Irrigation Water in Chitradurga district, Karnataka

In order to assess the groundwater quality in Chitradurga district, 27 randomly collected bore well water samples from farm lands of different villages of Hiriya and Hosadurga taluks were analysed for pH, EC, Ca, Mg, Na, K, SO₄, CO₃, HCO₃, Cl, and B (Fig. 2.4.8).

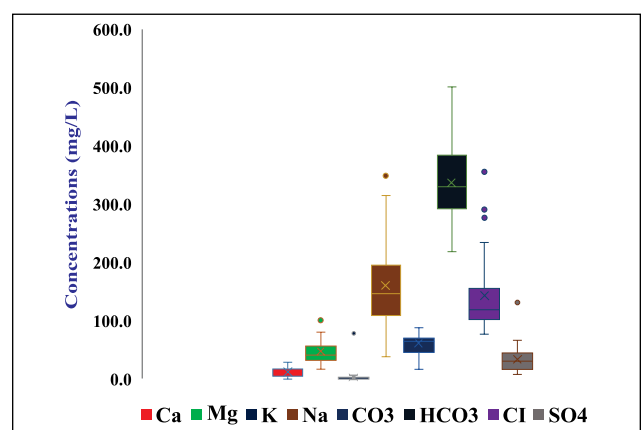


Fig. 2.4.8: Box plot showing major cation and anion concentration in ground water, Chitradurga district



Cinchona (*Cinchona* sp.) a sustainable land use practice in the Eastern Himalayas of India

Identification of a sustainable land use system (LUS) in the Eastern Himalayan region is crucial to mitigate the effects of climate change due to its high vulnerability to soil erosion-induced land degradation. Present study investigates the variability in the soil properties under cinchona, horticulture and forest land use systems (LUSs) for identifying a sustainable LUS in the study area. Different soil properties, including the total microbial count, hydrolytic enzyme activities, and different C fractions and their indices, were evaluated in soils collected from natural forest, cinchona and horticulture at two soil depths, i.e., 0–15 and 15–30 cm. The LUSs significantly influenced the clay, total nitrogen (TN), available phosphorus (AP) and available potassium (AK) contents, pH, microbial properties, and the C parameters. Labile C fractions and total organic C (TOC) were the highest in forest soil, followed by cinchona and horticulture; however, a completely reverse trend was observed in the passive C pool content (Table 2.4.1). Total bacterial count (108%), soil microbial biomass C (103%) and N (111%) of surface soil were higher in the forest compared to the other LUSs. However, the total fungal and actinomycetes counts were higher in horticulture and cinchona compared to forest. The lability index, C pool index, C management index and instability index were higher in forest followed by cinchona and horticulture (Table 2.4.2). All the C pools and microbial properties decreased from the surface to the sub-surface layers. The correlation matrix and principal component analysis (PCA) showed that soil properties, including microbial properties, are closely associated with C fractions and their indices. The biplot analysis showed that only in cinchona, both the labile and non-labile fractions of C, were evenly distributed (Fig. 2.4.9). Cinchona lies in between the forest and horticulture with respect to enzymatic activity, C fractions and C indices. Our results indicate that cinchona is the most promising and sustainable LUS for C sequestration and soil fertility enrichment in the Eastern Himalayas.

Table 2.4.1. Soil organic carbon fraction (%) under different land use systems in the surface and subsurface soil layers

SOC fractions	Depths (cm)	Forest	Cinchona	Horticulture
TOC	0–15	4.63 ^A	3.62 ^B	3.45 ^B
	15–30	2.72 ^A	2.39 ^A	2.60 ^A
VLC	0–15	1.79 ^A	1.45 ^A	0.89 ^B
	15–30	0.87 ^A	0.76 ^A	0.66 ^A
LC	0–15	1.46 ^A	0.73 ^B	1.01 ^{AB}
	15–30	0.80 ^A	0.55 ^A	0.77 ^A
LLC	0–15	0.46 ^A	0.65 ^A	0.54 ^A
	15–30	0.22 ^A	0.43 ^B	0.34 ^{AB}
NLC	0–15	0.92 ^{AB}	0.79 ^A	1.02 ^B
	15–30	0.83 ^A	0.65 ^A	0.83 ^A
KMnO ₄ -C	0–15	1.33 ^A	1.14 ^{AB}	0.95 ^B
	15–30	0.85 ^A	0.66 ^A	0.70 ^A
ACP	0–15	3.25 ^A	2.18 ^B	1.90 ^B
	15–30	1.67 ^A	1.31 ^B	1.43 ^{AB}
PCP	0–15	1.38 ^A	1.44 ^{AB}	1.55 ^B
	15–30	1.05 ^A	1.08 ^A	1.17 ^A

TOC: total organic carbon; VLC: very labile pool; LC: labile pool; LLC: less labile pool; NLC: non-labile pool; KMnO₄-C: permanganate oxidizable carbon; ACP: active carbon pool; PCP: passive carbon pool

Different letters in each row indicate significant differences ($P < 0.05$) among the land uses systems (Duncan's multiple-range test).

Table 2.4.2 Carbon indices under different land use systems in the surface and subsurface soil layers

Carbon indices	Depths (cm)	Forest	Cinchona	Horticulture
LI	0–15	1.88 ^A	1.77 ^A	1.48 ^B
	15–30	1.60 ^A	1.59 ^A	1.41 ^A
CPI	0–15	1.00 ^A	0.78 ^B	0.75 ^B
	15–30	1.00 ^A	0.88 ^A	0.96 ^A
CMI	0–15	189 ^A	139 ^B	113 ^B
	15–30	163 ^A	140 ^B	142 ^B
II	0–15	0.55 ^A	0.29 ^B	–0.01 ^C
	15–30	0.26 ^A	0.05 ^B	–0.16 ^C

LI: lability index; CPI: carbon pool index; CMI: carbon management index; II: instability index. Different letters in each row indicate significant differences ($P < 0.05$) among the land uses systems (Duncan's multiple-range test).

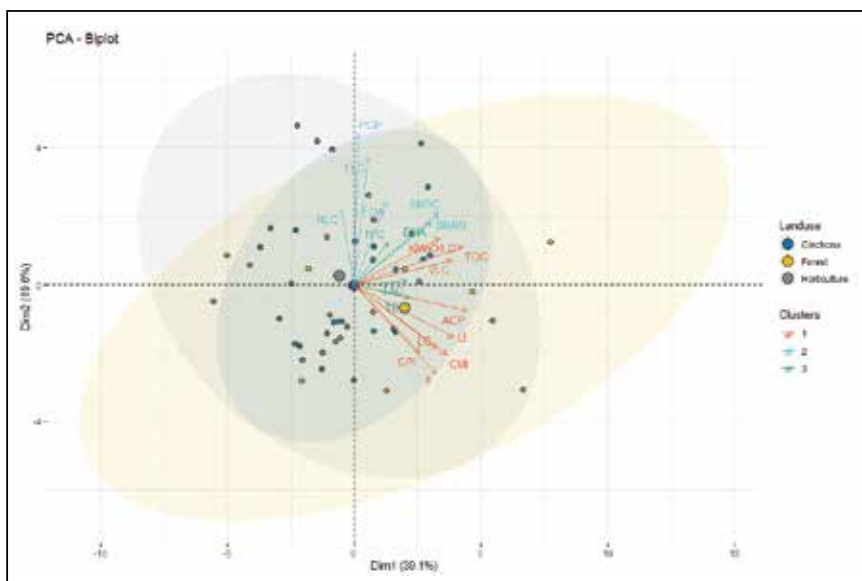


Fig. 2.4.9. PC biplot showing orientation of different land use systems across Dim 1 and Dim 2 in 0–30 cm depth in the study area.

Soil quality assessment under contrasting land use system of Anjaw district of Arunachal Pradesh

This study was aimed to identify most suitable soil quality indicators and to assess impact of four dominant land uses i.e. forest (FR), jhum cultivation (JH), plantation (PL) and agriculture (AG) on soil quality of Anjaw district of Arunachal Pradesh. Four profiles from each land use were selected, and soil physical (texture, bulk density and porosity) and chemical (pH, cation exchange capacity, base saturation, organic carbon, available N, P, K, available micronutrients Fe, Mn, Zn and Cu) parameters were analysed in surface (0-20) and subsurface (20-70 cm) soils. The weighted soil quality index (SQI) was calculated at 0-20 cm and 0-70 cm soil depths from minimum dataset (MDS) derived from principal component analysis (PCA), followed by varimax rotation algorithm (Fig. 2.4.10). Significantly ($P < 0.05$) higher values of SQI was obtained under FR land use compared to JM, PL and AG in 0-20 cm. However, at 0-70 cm soil depth SQI under AG land use was at par with FR land use. The SQI were in order of FR (0.96) > AG (0.79) $\approx$ PL (0.77) $\approx$ JH (0.74) in 0-20 cm and FR (0.76) $\approx$ AG (0.73) > PL (0.67) $\approx$ JH (0.66) in 0-70 cm soil depths. Soil organic carbon (SOC) was observed to be most influencing soil quality indicator under studied land uses and on an average OC contributed 47 % and 40% in SQI in 0-20 and 0-70 cm depths, respectively. The studied soils were rated as high quality ($SQI > 0.70$) in all four land uses in 0-20 cm and high quality under FR and AG and intermediate quality ($0.50 < SQI < 0.70$) under PL and JH in 0-70 cm soil depth.

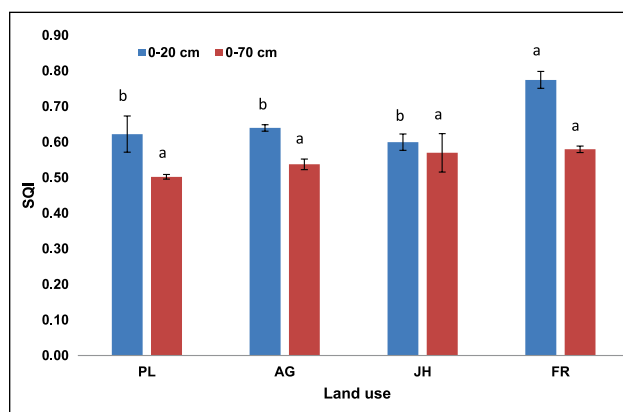


Fig. 2.4.10. Soil Quality Index (SQI) under different land uses at 0-20 and 0-70 cm soil depths in Anjaw district, Arunachal Pradesh (PL-Plantation; AG-Agriculture; JH-Jhum cultivation; FR-Forest).

Depth wise distribution of soil properties in Siang district of Arunachal Pradesh

East Siang of Arunachal Pradesh is situated in the geographic extent between 28°1'23.34" N to 28°4'15.22" N latitudes and 95°4'3.53" E to 95°33'50.52" E longitudes having total geographical area of 11,63,849 ha. Soils of the district were slightly acidic to moderately acidic in surface (pH 4.58 to 5.66) and the pH increased with depth except in the soils of low hill. Organic carbon content in the surface soils were high (1.18 to 2.94%) except in piedmont and alluvial plains (0.57%). The CEC of the soils were low to medium ranging from 3.3 to 13.9 cmol (p⁺) kg⁻¹ with mean value of 8.3 cmol (p⁺) kg⁻¹. Clay content in profiles ranged from 5.7 to 43.1% with the mean value of 23.6%. The depth wise distribution of soil properties are presented in Fig. 2.4.11.

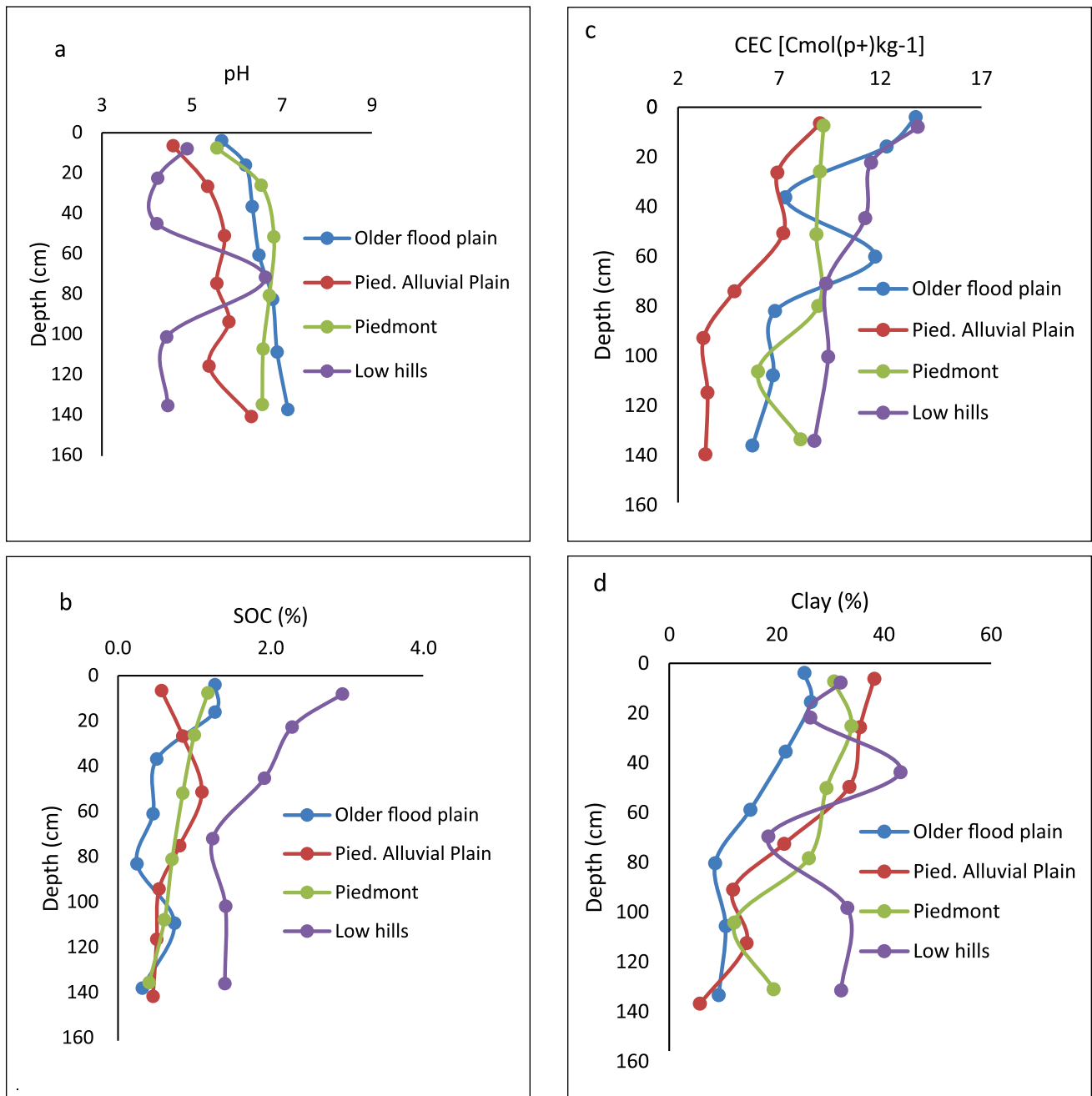


Fig. 2.4.11. Depth-wise distribution of soil properties
(a) pH; (b) SOC; (c) CEC; (d) Clay in different landforms of East Siang district, Arunachal Pradesh

Soil-landform relationship in Mandi district of Himachal Pradesh

Soils developed on five major landforms (ridge tops, side slope, fluvial valley, piedmont alluvial plains and active flood plain/ valley plain) in Mandi district were characterized and soil-landform relationship was established (Fig 2.4.12). Soils of moderately steep to steep sloping ridge tops are moderately deep to deep, well to excessively drained, loamy skeletal texture with severe to very severe erosion. They are slightly acidic to slightly alkaline in nature with medium to high soil organic carbon, low AWC and classified as

Typic Udorthents. Soils developed on side slopes are moderately deep to deep, well to excessively drained, loamy skeletal, coarse loamy and fine loamy with moderate to severe erosion. The soil are slightly acidic to slightly alkaline in nature with low to moderate SOC, low to moderate AWC. These soils were classified as *Typic Eutrochrepts*. The soils of fluvial valley are moderately deep to deep, well to excessively drained, loamy sand to sandy loam with moderate soil erosion. The soils are neutral to moderately alkaline in nature with low to medium SOC, low to moderate AWC. These soils were classified as *Udic Ustochrepts*, *Typic Udifluvents*. The soils developed on piedmont plains

are moderately deep to deep, well drained, coarse loamy with moderate to severe erosion. The soils are calcareous, slightly to moderately alkaline in nature with low to medium SOC, moderate AWC, and were classified as *Typic Ustorthents*. Soils developed on nearly level to very gently sloping active flood plains

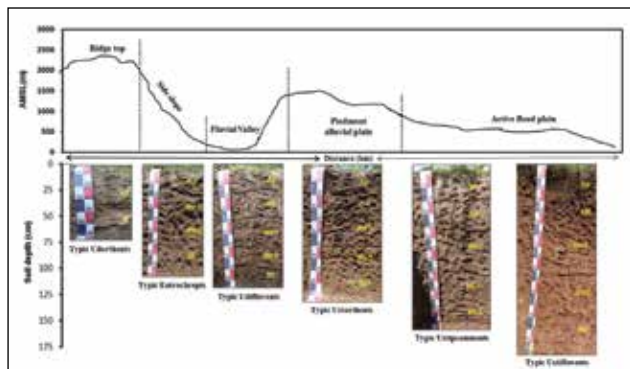


Fig. 2.4.12. Soil-landform relationship in Mandi district, Himachal Pradesh.

are deep to very deep, well drained, mostly stratified, coarse and fine loamy, slightly alkaline, medium in SOC, with slight erosion, proneness to slight to moderate flooding and slight stoniness, and were classified as *Typic Ustifluvents* and *Typic Ustipsamments*.

Depth-wise distribution of soil properties of Mandi district of Himachal Pradesh

The soils of Mandi district are very low to high in organic carbon content in surface layers and it varied from 0.16 to 1.85%. The SOC decreased with depth in all landforms except piedmont plain and active flood plain. The available N was low to medium (varied from 189 to 378 kg ha⁻¹) whereas, available P content was low to medium in surface horizons, varying from 9.9 to 23.1 kg ha⁻¹. Highest available nitrogen and phosphorus occur in surface horizon of ridge top and side slopes. The clay content was higher in piedmont plain and it varied from 10 to 20% (Fig. 2.4.13).

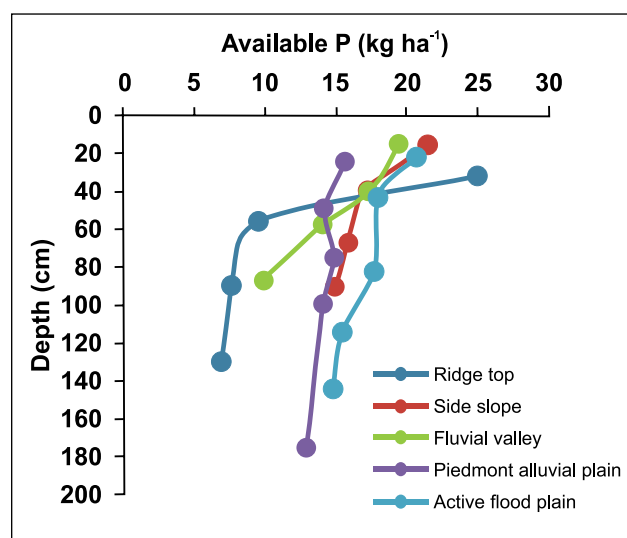
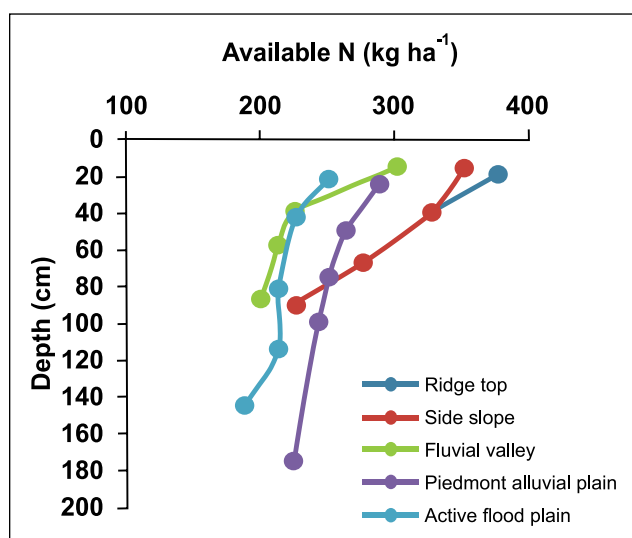
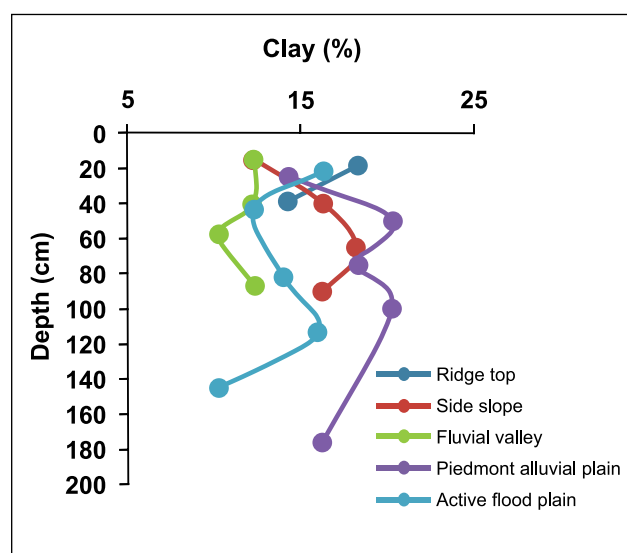
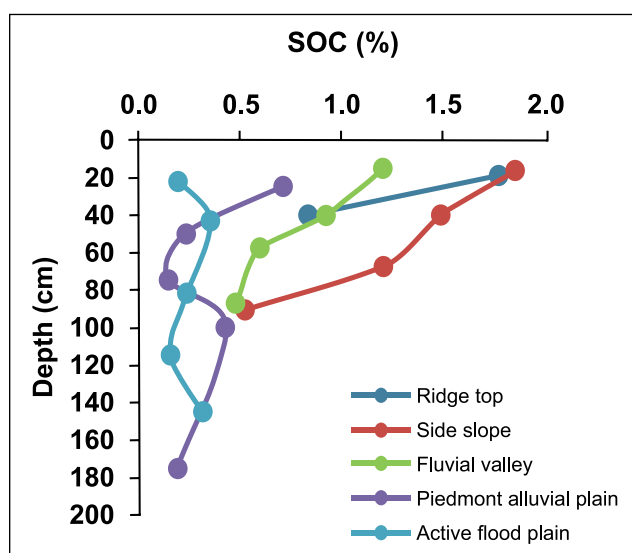


Fig.2.4.13. Different soil properties under various landforms in Mandi district, Himachal Pradesh

Soil-landform relationship in Dang District, Gujarat

The soil-landform relationship in Dang district, Gujarat is presented in Fig. 2.4.14. The soils developed on the highly dissected hills are shallow, clay loam texture with very severe water erosion, moderately acidic (pH 5.4) and classified as *Loamy skeletal, mixed, hyperthermic, Lithic Haplustepts*. The soils of plateau top are moderately shallow, silty clay to silty clay loam with severe water erosion, slightly acidic (pH 5.8) and classified as *Coarse silty, mixed, hyperthermic, Typic Haplustepts*. The soils developed on the moderately dissected hills are moderately shallow, clay loam with very severe water erosion, moderately acidic (pH 5.5) and classified as *Fine loamy, mixed, hyperthermic, Typic Haplustepts*. The soils formed on the low dissected hills are deep, clay to sandy loam with very severe water erosion, slightly acidic (pH 5.6) and classified as *Loamy, mixed, hyperthermic, Typic Haplustepts*. The soils of alluvial plain are moderately shallow, silty clay to silty clay loam with severe water erosion, moderately calcareous, slightly alkaline (pH 7.6) and classified as *Fine silty, mixed, hyperthermic, Typic Haplustepts*. The soils developed in the Intermontane valley are moderately deep, clay

loam to sandy loamy with very severe water erosion, slightly acidic (pH 6.0) and classified as *Fine loamy, mixed, hyperthermic, Typic Haplustepts*.

Depth distribution of soil properties and soil fertility

Dang district

In Dang district, eight soil series were identified through a detailed soil survey. Soil depth varied from 45 cm (Gaygothan series) to 102 cm (Bhisya series). The Mahal series has relatively low clay content than other soils (Fig. 2.4.15). Clay content increased in subsurface horizons except Mahal and Bardipada soils. The SOC content was > 1% in surface layers except Mahal series (0.65%) and decreased in subsurface layers. The soils are slightly acidic to slightly alkaline in nature. The soil pH decreased with depth except in the Bawadi soils. Chikar soils are slightly alkaline in nature due to the CaCO_3 content. The exchangeable Ca and Mg ratio varied from 1.13 to 3.0 in surface horizons and decreased with depth. The soils were non-calcareous, rich in N, P and K content but showed Zn deficiency in 15% area of the district (Fig. 2.4.16).

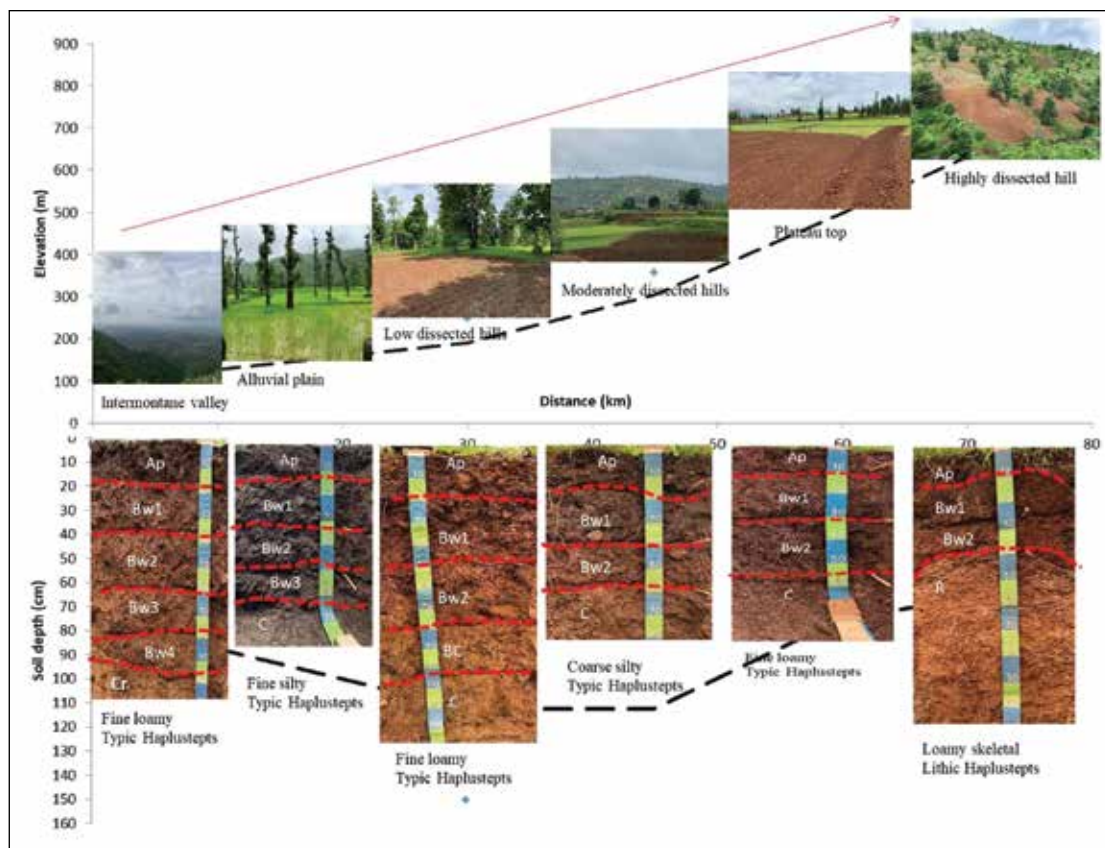


Fig. 2.4.14. Soil-landform relationship in a topo-sequence in Dang district, Gujarat

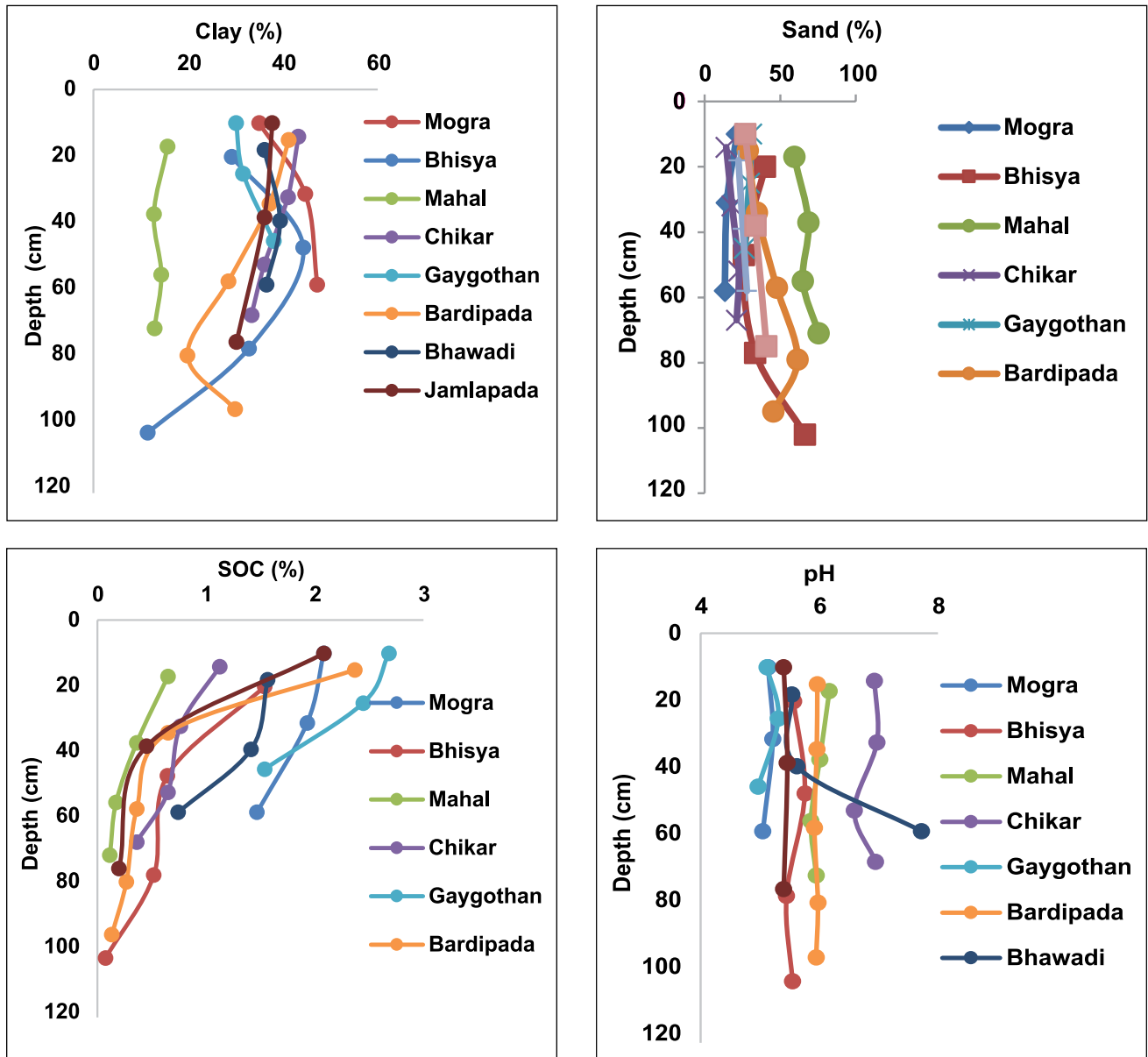


Fig. 2.4.15. Depth distribution of some soil properties in Dang district, Gujarat

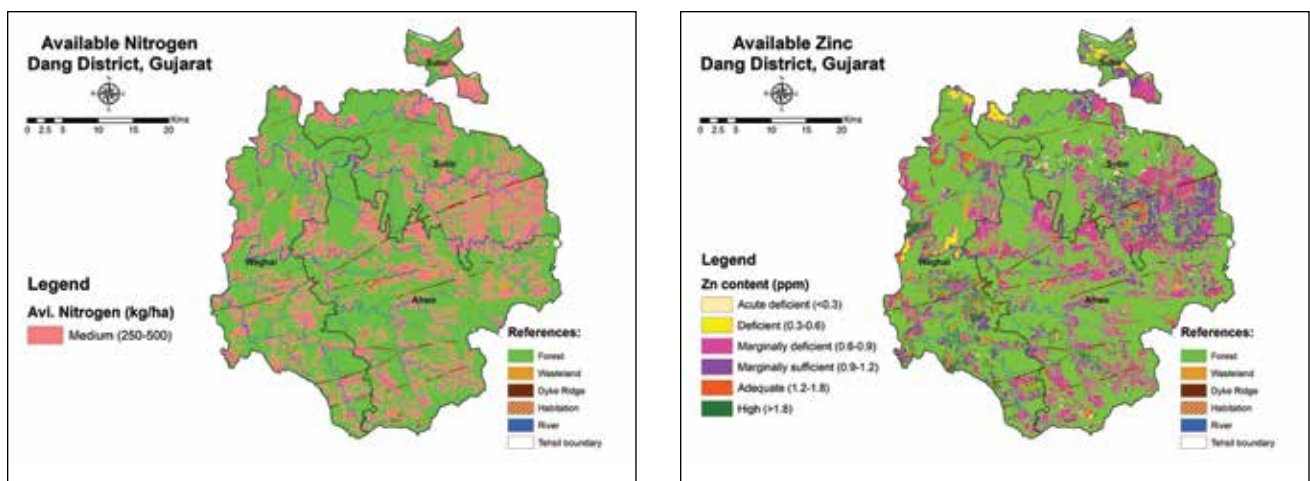


Fig. 2.4.16. Soil available nitrogen and zinc maps of Dang district, Gujarat

Amreli district

Soil depth in Amreli district varies from 20 cm (Trambakpur series) to 135 cm (Lapaliya). The clay content varies from 9.92 to 50.3 % in the surface horizons, and from 8.70 to 58.4 % in the subsurface horizons (Fig. 2.4.17). The clay content generally increases with depth, except in Dharai and Nal series. The soils are slightly to strongly alkaline in nature,

with pH varying from 7.2 to 8.7 in surface horizons and from 7.1 to 9.8 in the subsurface horizons. Soil organic carbon generally decreased with depth and it varied from 0.52 to 1.40% in surface and from 0.23 to 0.70% in the subsurface. The soil CaCO_3 varied from 3.79 to 21.3% in surface horizons and from 4.27 to 22.0% in the subsurface horizons.

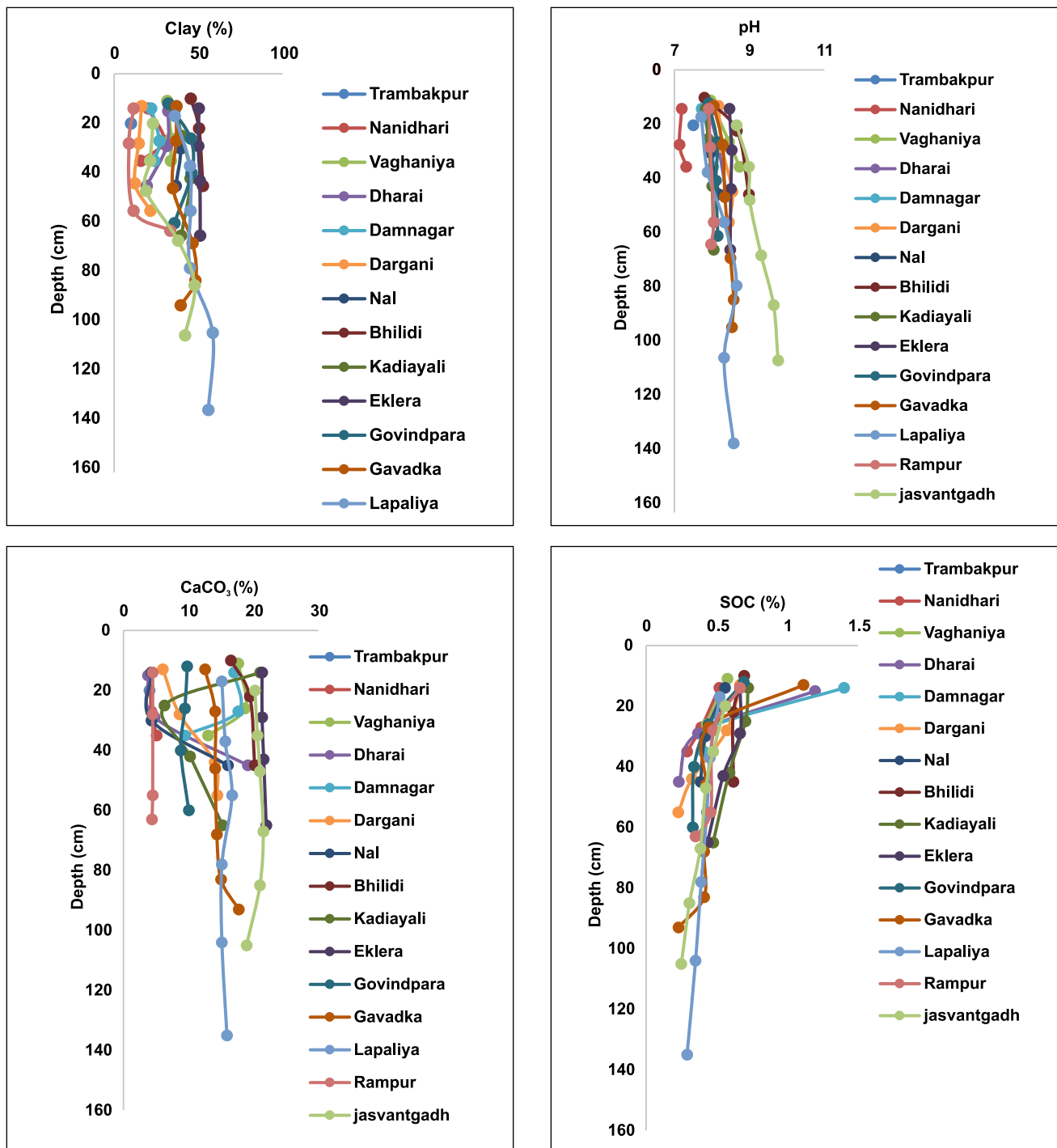


Fig. 2.4.17. Depth distribution of some soil properties in Amreli district, Gujarat

Soil–landform relationship in Tapi District, Gujarat

Soils in hill top and pediment landforms are very shallow to shallow, well drained, dark reddish brown, gravelly clay loam texture, and non-calcareous. Soils in the older alluvial plain are shallow to moderately deep, well drained, clay and clay loam texture, and slightly calcareous. Soils in younger alluvial plains are deep

to very deep, moderately well drained, clay texture and slightly calcareous. Soils in the older alluvial plain are very deep, moderately well drained, clay texture, and slightly calcareous (Fig. 2.4.18). In Vadodara district, soils in alluvial and coastal plains are very deep, moderately well to poor drained, brown to dark black in colour, and sandy loam to clay in texture (Fig. 2.4.19)

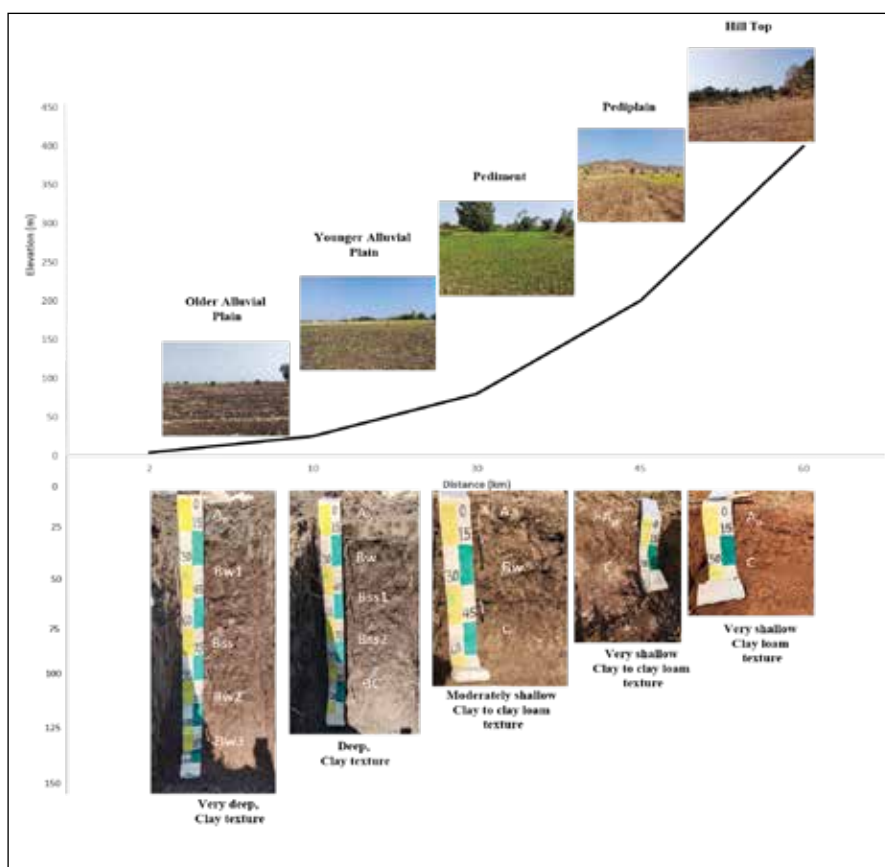


Fig. 2.4.18. Variation in soil in different landforms in Tapi district, Gujarat

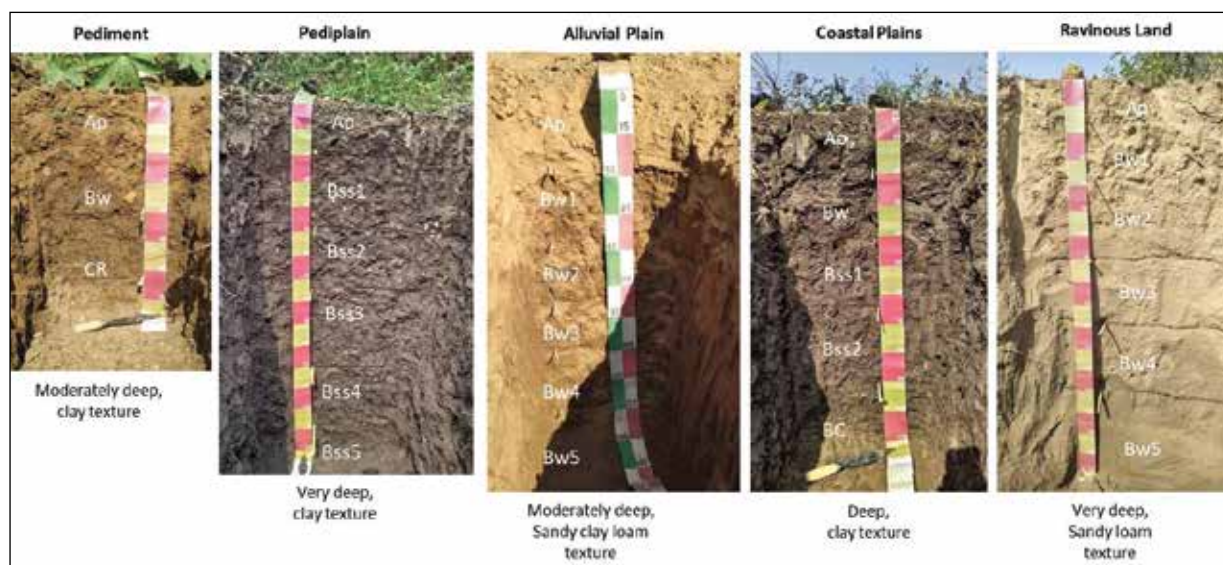


Fig. 2.4.19. Soil profile variations in different landforms in Vadodara district, Gujarat

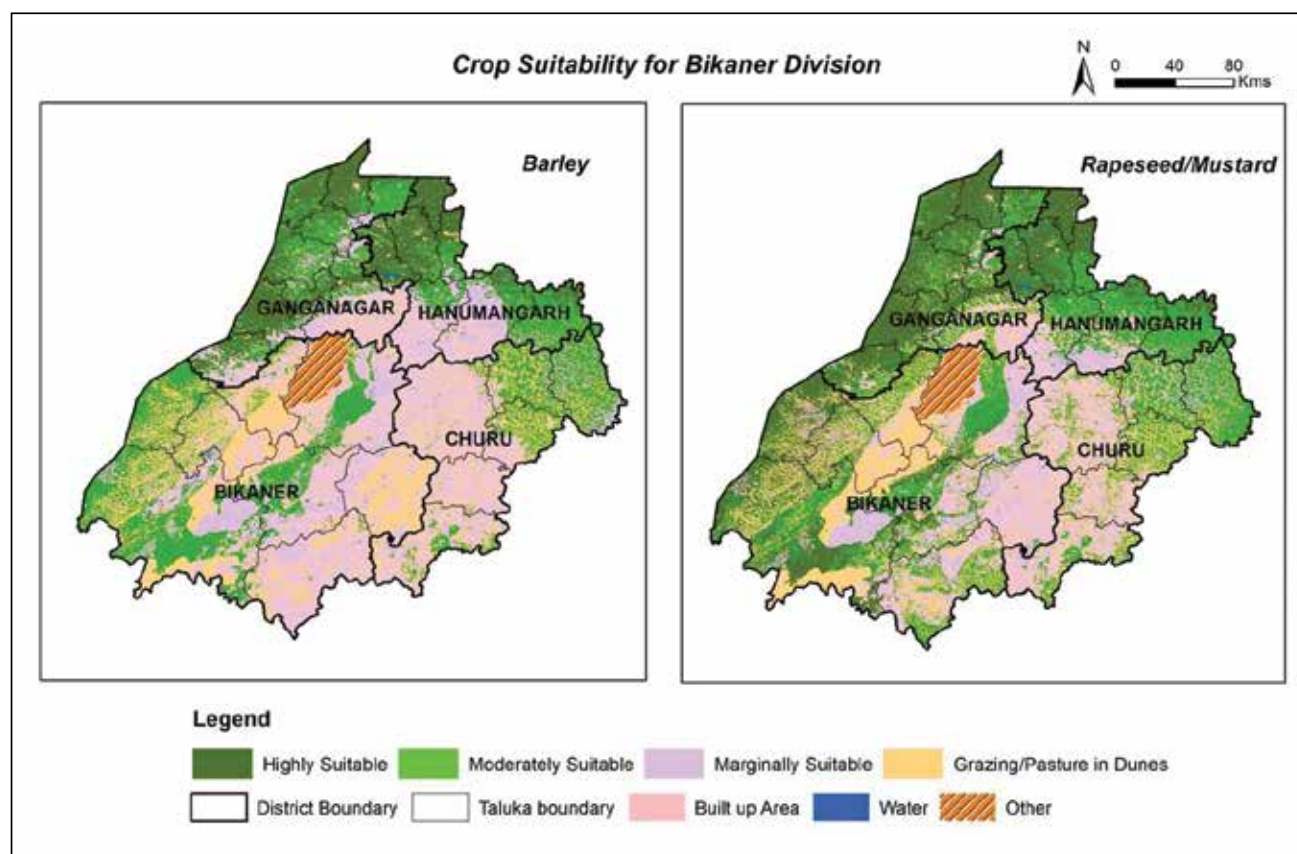
2.5

LAND EVALUATION AND LAND USE PLANNING

Mapping soil-site suitability for major crops and alternate land use plans in Bikaner division of Rajasthan using GIS-based multi-criteria decision analysis

Land resources were evaluated for suitability of major crops in the Bikaner division using the analytical hierarchical process (AHP) in the GIS environment. Major crops comprising cereals, pulses, oilseeds and fruit crops were considered for soil-site suitability analysis. The climatic, pedological, and edaphological requirements of each crop were listed and ranked using the AHP matrices with parameters such as

rainfall, soil texture, soil organic carbon, distance to canal, distance to *Ghaggar* river basin and relative slope position to develop soil-site suitability maps for the crops. The weightage and score of input parameters of respective crops were decided in consultation with experts from institutes of ICAR-CAZRI, SKRAU, Bikaner, KVK and State Department of Agriculture. District-wise land suitability maps of different crops were generated by integrating AHP weightage and score for each layer in GIS. The developed crop suitability maps for the major crops are presented in Fig. 2.5.1 and area under different suitability classes is presented in Table 2.5.1.



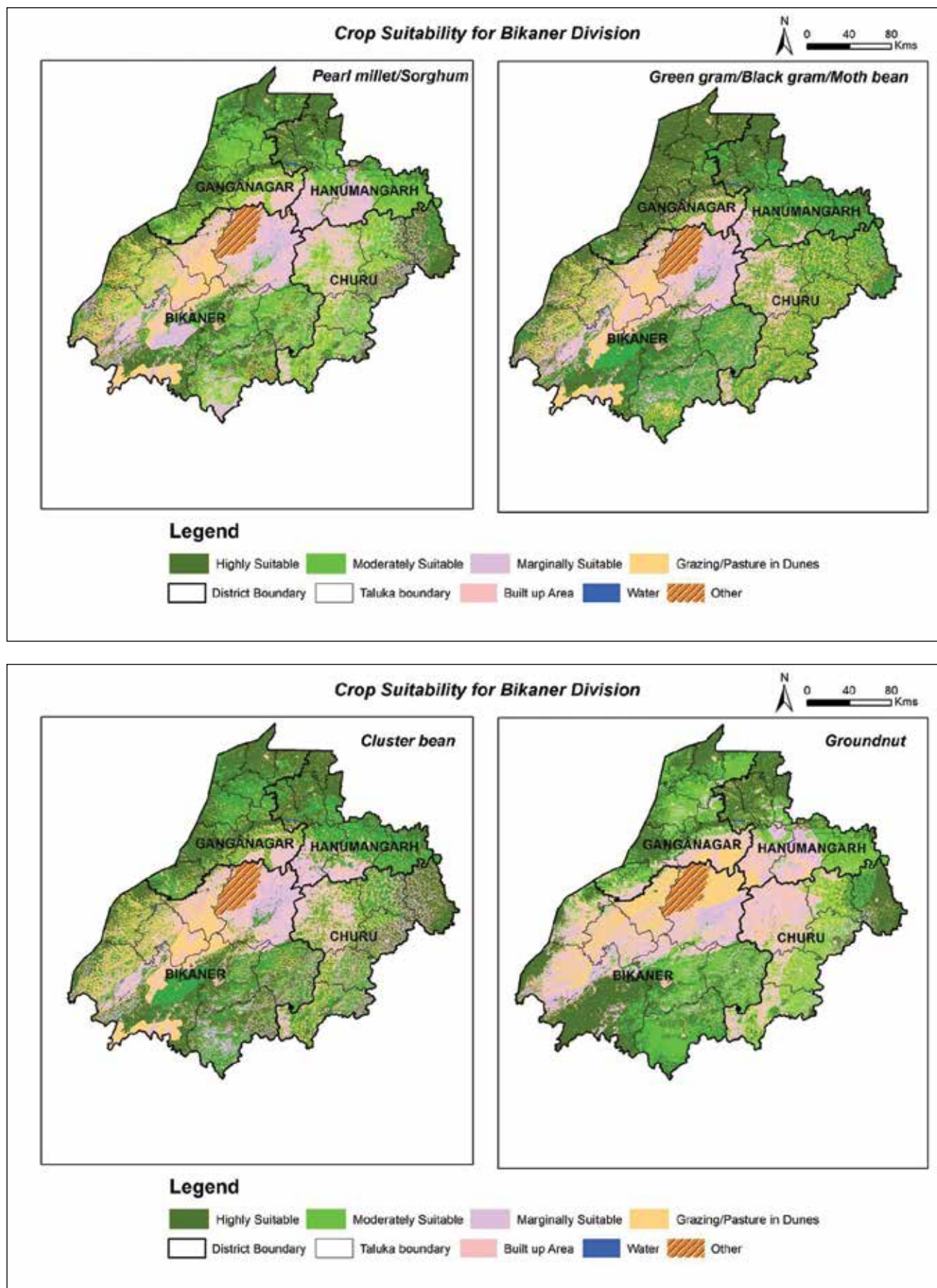


Fig. 2.5.1. Crop suitability maps for Bikaner division, Rajasthan

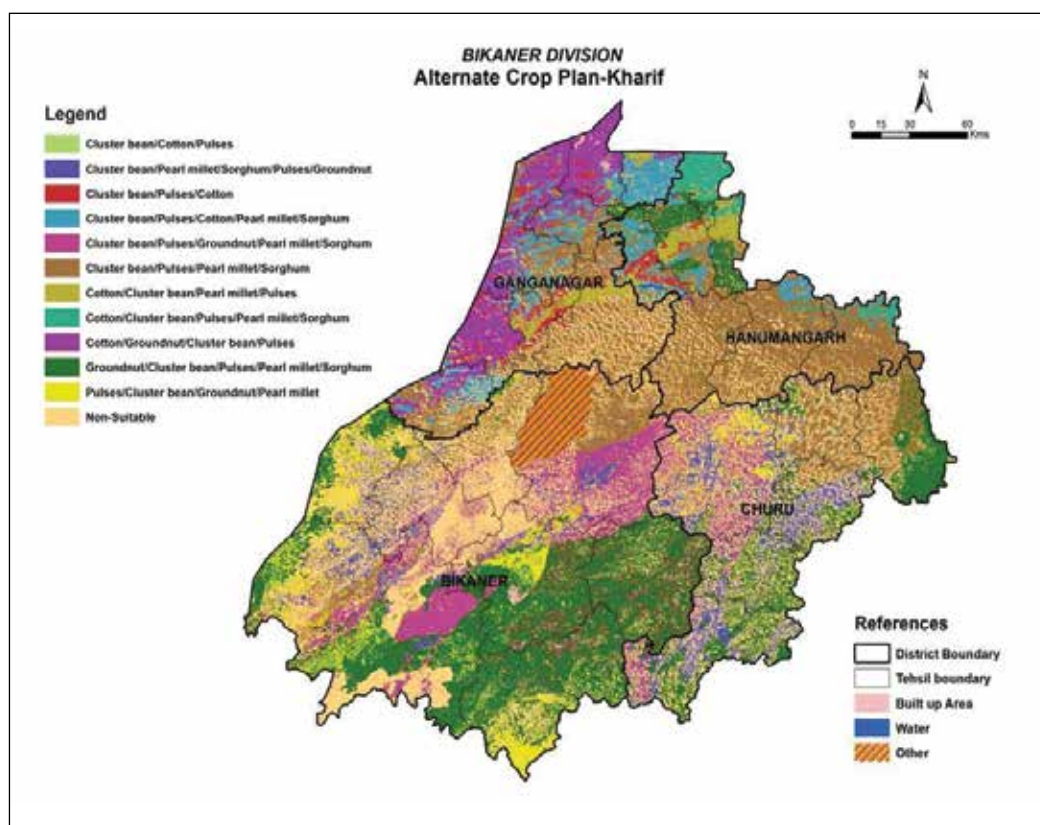
Table 2.5.1. Area (ha) under different suitability classes for major crops in Bikaner division

Crop	Highly Suitable	Moderately Suitable	Marginally Suitable	Grazing/Pasture in Dunes
Pulses	1535839	2083939	1181853	1488797
Bajra	1711381	1571835	1551477	1455735
Mustard	1334132	1845866	1583756	1526674
Barley	661136	1737151	2115206	1776935
Cluster bean	1653425	1826452	1420500	1390050
Groundnut	1827216	1540824	1633533	1478426

Alternate land use plan (ALUP) for the Bikaner division is suggested for *kharif* and *rabi* seasons. Groundnut/Cluster bean/ Pulses/Pearl millet/Sorghum for Bikaner and Churu districts whereas, Cluster bean/Pulses/Pearl millet/Sorghum and Cotton/Groundnut/Cluster bean/Pulses for Sri Ganganagar, and Cluster bean/Pulses/Pearl millet/Sorghum and Cotton/Cluster bean/Pulses/Pearl millet/Sorghum for Hanumangarh district are the suggested crops/cropping systems covering maximum area during *kharif* season (Fig. 2.5.2). For *rabi* season, Taramira/Mustard/Chickpea is proposed for Bikaner and Churu districts whereas Barley/Mustard/Oat/Vegetables and Chickpea/Taramira/Mustard/Barley are suggested for Sri Ganganagar and Hanumangarh, respectively (Fig. 2.5.3).

The non-arable land which is mostly occupied by sand dunes may be utilized for development of community

grazing or pasture land for cattle/small ruminants. Shrubs like *Capparis decidua* (Ker), *Calligonum polygonoides* (Phog), *Calotropis procera* (Aak) etc. has the potential to arrest wind erosion in desert area. Sustainable and remunerative farming systems for the division include crop production in association with animal husbandry (livestock, goat/sheep/camel rearing and backyard poultry), which would provide additional source of income to farmers of the division. Small ruminants (goat and sheep) and pseudo-ruminants (camel) can feed over xerophytes in degraded silvi-pasture of desert region. In the Bikaner division, the land under sand dunes may be brought under plantation of *Khejri* (*Prosopis cineraria*), *Babul* (*Acacia nilotica*), *sewan graass* (*Lasiurus scindicus*) and *anjan grass* (*Cenchrus ciliaris*) for fodder production or grazing of animals.

**Fig. 2.5.2.** Alternate crop plan for *kharif* season in Bikaner division, Rajasthan

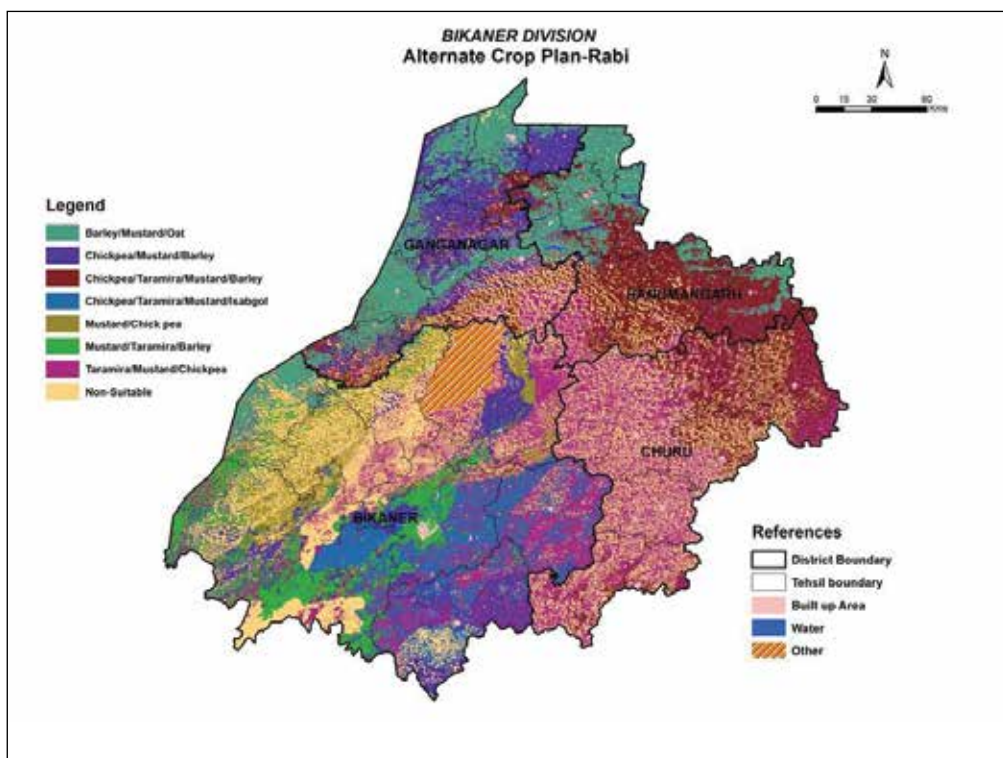


Fig. 2.5.3. Alternate crop plan for *rabi* season in Bikaner division, Rajasthan

Project on Climate-Resilient Agriculture (PoCRA) in Selected Village Clusters of Maharashtra

The Phase II of PoCRA project comprises mapping and generation of soil database for 15 districts of

Maharashtra. During 2023, data generation for eight districts of Marathwada region, namely Aurangabad, Parbhani, Beed, Hingoli, Nanded, Latur, Jalna and Osmanabad was completed. Soil depth, soil texture, available water capacity, soil organic carbon, and pH were predicted using DSM approach based on

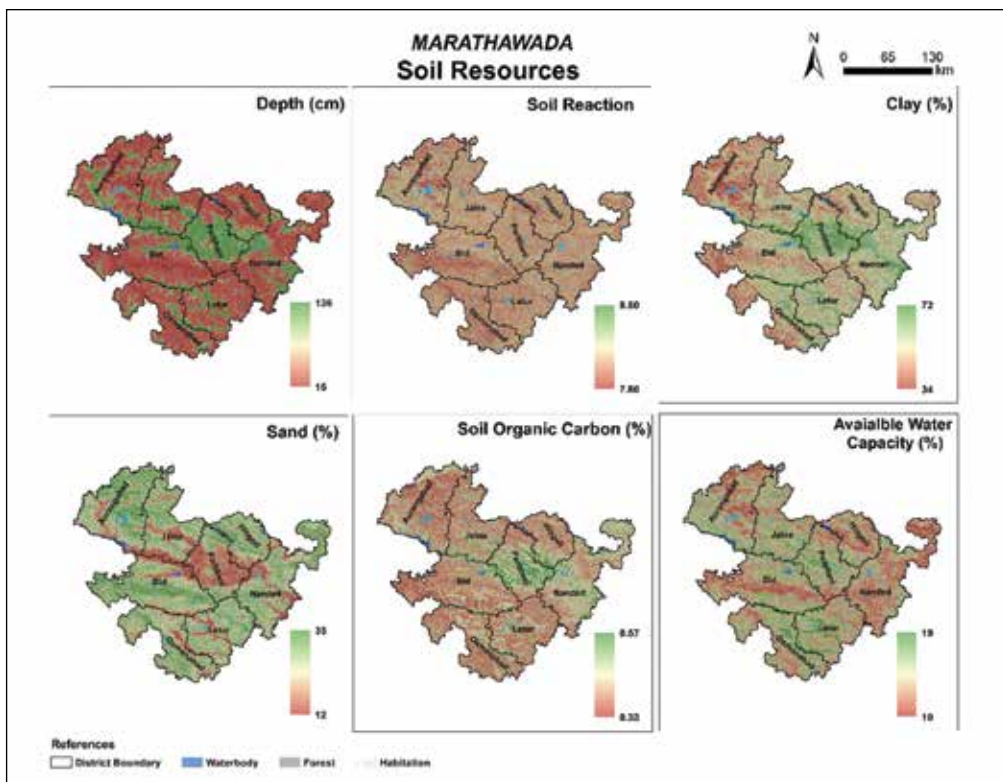


Fig. 2.5.4 Prediction maps of soil properties in the Marathwada region of Maharashtra under POCRA project

the soil data of 700 profiles and legacy soil data. The environmental covariates comprised of Landsat 8 images, Normalized difference vegetation index (NDVI), Soil adjustment vegetation index (SAVI), Enhanced vegetation index (EVI), GREEN, RED and NIR bands. The terrain parameters like elevation, slope, topographic wetness index (TWI) and topographic position index (TPI), LS factor, Multi-resolution Ridge Top Flatness (MrRTF), and Multi-resolution Index of Valley Bottom Flatness (MrVBF), Valley depth, channel network base level, vertical distance to channel network and landform features were used for prediction. Additionally, mean annual temperature and mean annual precipitations are used as climate variables derived from World climate. The soil maps for the Marathwada region are shown in Fig. 2.5.4.

Pilot project on Crop Diversification

The ICAR-Indian Institute of Farming Systems Research, Modipuram and ICAR-National Bureau of Soil Survey and Land Use Planning jointly developed a pilot project for crop diversification in 5 million ha within 5 years, for the subsequent generation of decision support system for agro-climatic regions based crop planning, linking district-wise data/information on suitability of crops, climate resilient and stress tolerant varieties, crop demonstrations/schemes and up scaling of cropping systems under changing condition under agro-climatic zones for adoption by states. An exercise was carried out to delineate the potential crop zones for 14 major crops namely rice, wheat, maize, sorghum, pearl millet, pigeon pea, chickpea, mustard, soybean, groundnut, cotton, sugarcane, onion, and potato using relative spread, yield and soil-climate suitability indices. Accordingly, areas were classified as highly potential, moderately potential, and marginally potential. Highly

potential areas are areas where a particular crop has high spread and productivity, and these areas are bio-physically suitable to the crop. Moderate potential areas have low spread but high productivity and are bio-physically suitable to a particular crop. Marginally potential areas have high spread but low productivity and are bio-physically suitable to a particular crop. Other areas are categorized as not suitable. A training programme was organized in the Binpur I block, Jhargram district, West Bengal under this project, in which 25 farmers were trained with respect to different aspects of crop diversification (Fig. 2.5.5).



Fig. 2.5.5. Farmers' training programme in Binpur-I block, Jhargram district

Revision of Soil-site suitability criteria of major crops

The datasets in relation to rainfall, temperature, soil depth, soil texture, soil pH, drainage, erosion, slope, elevation and soil CaCO_3 were collected from different locations for wheat, maize, sorghum, sugarcane, cotton, groundnut, tomato, *ashwaganda* and *davana* crops. The data were analysed and found that soil depth is more important in maize, sugarcane, cotton, tomato, pomegranate, *ashawaganda* and *davana* whereas, the productivity of sorghum, groundnut and wheat is highly influenced by the soil texture (Table 2.5.2 and 2.5.3).

Table 2.5.2. Soil-site suitability criteria for maize

Land use requirement			Rating			
Soil-site characteristics						
		Unit	Highly suitable S1	Moderately suitable S2	Marginally suitable S3	Not suitable N
Climatic regime	Mean temperature in growing season	°C	20-32	33-38 15-20	39-40 10-15	>40 <10
	Total rainfall	mm	900-1200	750-900	500-750	<500
Land quality						
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Coarse fragments	%	<15	15-35	35-55	>55

Land use requirement			Rating			
Soil-site characteristics						
		Unit	Highly suitable S1	Moderately suitable S2	Marginally suitable S3	Not suitable N
Oxygen availability to roots	Soil drainage	Class	Well	Moderately well to Imperfect	Poor/ Excessive	Very poor
Nutrient availability	Texture	Class	l, cl, scl, sil, sicl, sc,	sl, sic, c(n-s)	c (s-s), ls	cs
	pH	1:2.5	6-8	8.0-8.5 5-6	8.6-9.0 <5.0	>9.0
	OC	%	High	Medium	Low	
Soil toxicity	Salinity (ECe)	dS/m	<4	4-6	6-8	>8
	Sodicity (ESP)	%	<15	15-20	20-25	>25
Erosion hazard	Slope	%	<3	3-5	5-8	>8

Note: c(n-s)= Non swelling clay soils; c(ss)= Shrink-swell clay soils; l= loam; sil= silt loam; sl= sandy loam; scl= sandy clay loam; sic= silty clay; cl=clay loam; sicl= silt clay loam; ls=loamy sand; sc=sandy clay; Cs=coarse sand; ESP=Exchangeable Sodium Percent; ECe= Electrical Conductivity(saturation extract); OC=Organic Carbon

Table 2.5.3. Soil-site suitability criteria for Tomato

Soil-site characteristics			Rating			
		Unit	Highly suitable S1	Moderately suitable S2	Marginally suitable S3	Not suitable N
Climatic regime	Mean temperature in growing season	°C	25-28	29-32 20-24	15-19 33-36	<15 >36
	Total rainfall	mm	600-750	500-600 750-1000	400-500 1000-1500	<400 >1500
	Length of growing period	Days	>150	120-150	90-120	<90
Land quality						
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Coarse fragments	Vol %	<15	15-35	>35	
Oxygen availability to roots	Soil drainage	Class	Well	Moderate	Imperfect; Somewhat excessive	Poor; Excessive
Nutrient availability	Texture	Class	l, sl, cl, scl	sic, sicl, sc, c(m+k)	c (ss), ls	s
	pH	1:2.5	6.0-7.0	5.5-5.9; 7.1-8.5	<5.5 >8.5	
	Available nutrient status (NPK)	Fertility rating class	High	Medium	Low	
	CaCO ₃ in root zone	%	Non-calcareous	Slightly calcareous	Strong calcareous	
	OC	Class	High	Medium	Low	
Soil toxicity	Salinity (ECe)	dS/m	Non-saline	Slight	Strongly	
	Sodicity (ESP)	%	Non-sodic	Slight	Strongly	
Erosion hazard	Slope	%	1-3	3-5	5-10	>10

Note: *Irrigation is must for successful crop of improved varieties and hybrids; c(m+k) = mixed/ kaolinitic clay; c(ss)=swell-shrink clay; l= loam; sl= sandy loam; scl= sandy clay loam; sc=sandy clay; sic= silty clay; cl=clay loam; ls=loamy sand; s=sand; sicl= silty clay loam; CaCO₃= Calcium carbonate; ECe=Electrical Conductivity(saturation extract); ESP= Exchangeable Sodium Percent; OC= Organic Carbon

Delineation of potential areas for soybean cultivation in all states of India using GIS modelling techniques

In the project, initially, 15 states were selected to generate the climate and soil-based input parameters in GIS for their integration to identify the potential areas. The relevant thematic information (climate and soil) on the input parameters was generated to identify the potential areas for soybean cultivation with the help of advanced GIS techniques. The GIS-based draft modelling criteria along with weights for various input parameters has been developed and tested in the identification of potential areas for soybean in Madhya Pradesh and Maharashtra states. In the first review, it was decided to add additional parameters

in the model such as relative humidity, minimum temperature, maximum temperature and sunshine hours to standardize the GIS-based methodology to identify the potential areas for soybean in different states of India. The analysis shows that about 9.3 M ha is highly suitable 18.5 M ha is moderately suitable and 1.0 M ha is marginally suitable soybean in Madhya Pradesh. Whereas, in Maharashtra, about 16.3 M ha is highly suitable, 10.8 M ha is moderately suitable and 1.6 M ha is marginally suitable soybean in Maharashtra. The suitability maps for soybean of Madhya Pradesh and Maharashtra are shown in figure 2.5.6.

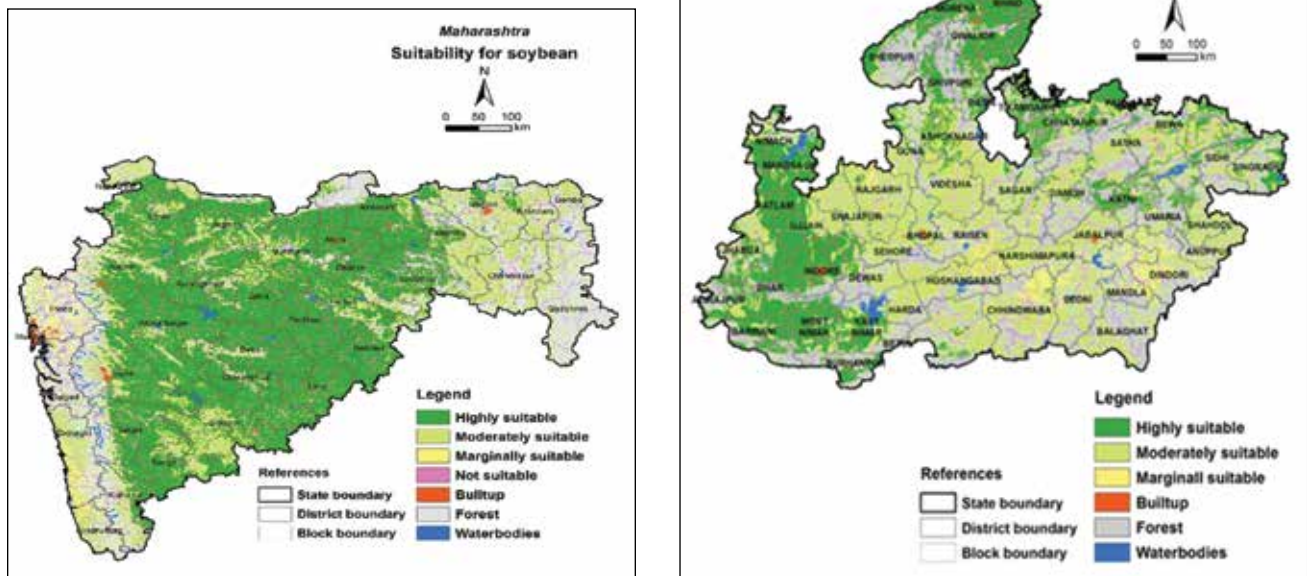


Fig.2.5.6. Suitability maps of soybean for Madhya Pradesh and Maharashtra states

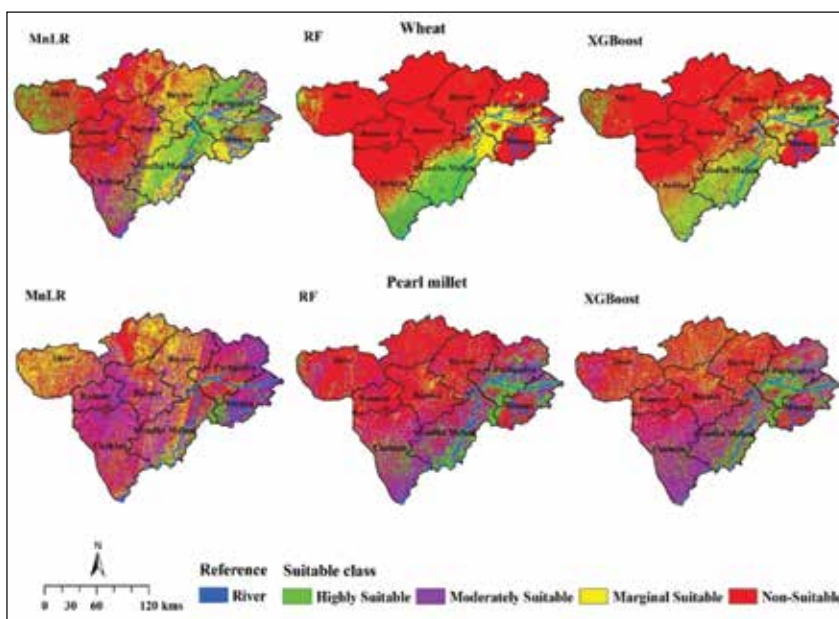


Fig. 2.5.7. Distribution of soil suitability class for wheat and pearl millet predicted by various model in the Barmer district of Rajasthan

Crop suitability prediction

Three different techniques (MnLR, RF and XGBoost) were used for the prediction of suitability for pearl millet and wheat in Barmer district of Thar Desert region. The final crop suitability map was classified into four different categories: highly suitable, moderately suitable, marginally suitable, and not-suitable. The study identified both the RF and XGBoost as effective models for classifying crop suitability class. The RF model for wheat identified 11.9% of the total area as highly suitable, 1.6% as moderately suitable, 14.9% as marginally suitable, and 71.6% as not suitable, while 15.5% of the total area is highly suitable for pearl millet (Fig. 2.5.7).

Carbon dynamics under different long term agricultural land use systems in Vertisols

The present study was undertaken in Vertisols and associated soils of Hingoli district of Marathwada region of Maharashtra to study the effect of different agricultural land use systems (ALUS) on profile distribution of carbon and its quality. The dominant ALUS in region are soybean-pigeon pea (ALUS-1), soybean-chickpea (ALUS-2), cotton+pigeon pea (ALUS-3), soybean-wheat (ALUS-4), sugarcane (ALUS-5), cotton (ALUS-6) and fallow (ALUS-7). The ALUS-4 system showed highest values of soil organic carbon (SOC) of 1.04% followed by ALUS-1 and ALUS-3. All the profiles had four horizons of different depths, therefore for simplicity depth-nomenclature was put uniformly as H₁, H₂, H₃ and H₄ from surface

downwards. The depth distribution of organic carbon was significantly affected by ALUS. Similar trend was also recorded in very labile, labile and less labile carbon fractions under different ALUS. The stratification ratio (SR), *i.e.* the ratio between surface and sub-surface organic carbon content of SOC and active carbon (POXC) was more discerning among the ALUS. Stratification ratio of SOC and POXC was greater under ALUS-7 and it ranged from 1.0 to 5.71 and 1.0 to 4.19 (Figure 2.5.8 and 2.5.9) than the other ALUS. Among the other ALUS, the soybean based ALUS showed higher values of stratification ratio than the other system. High SR of SOC and POXC (permanganate-oxidizable carbon) of surface layer to subsurface layer (H₄), >2 indicated a distinct improvement of SOC sequestration.

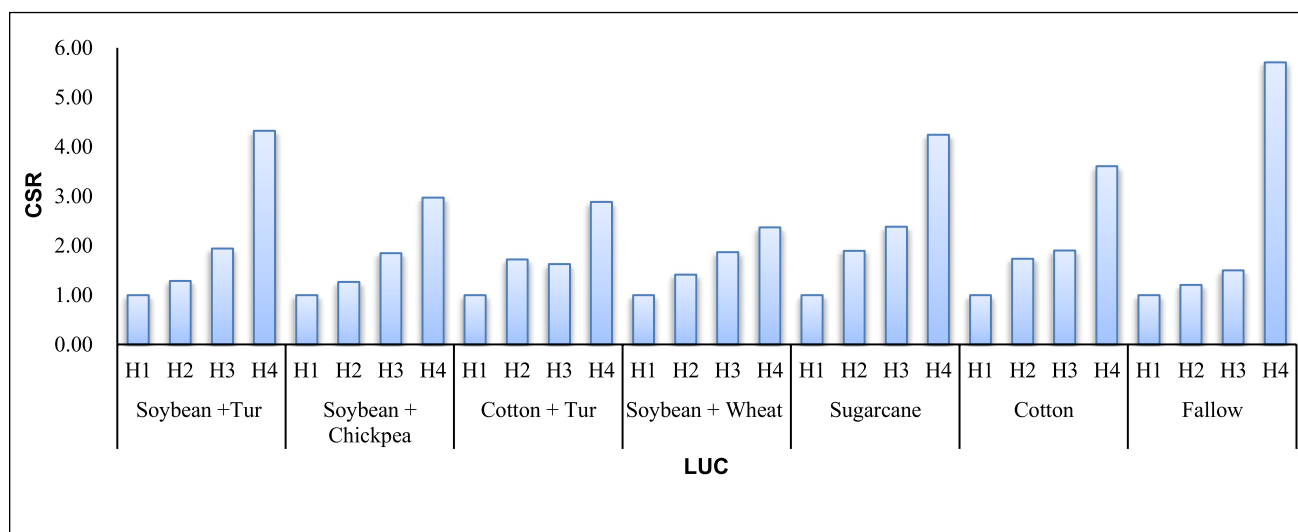


Figure 2.5.8. Soil organic carbon stratification ratio under different land use system

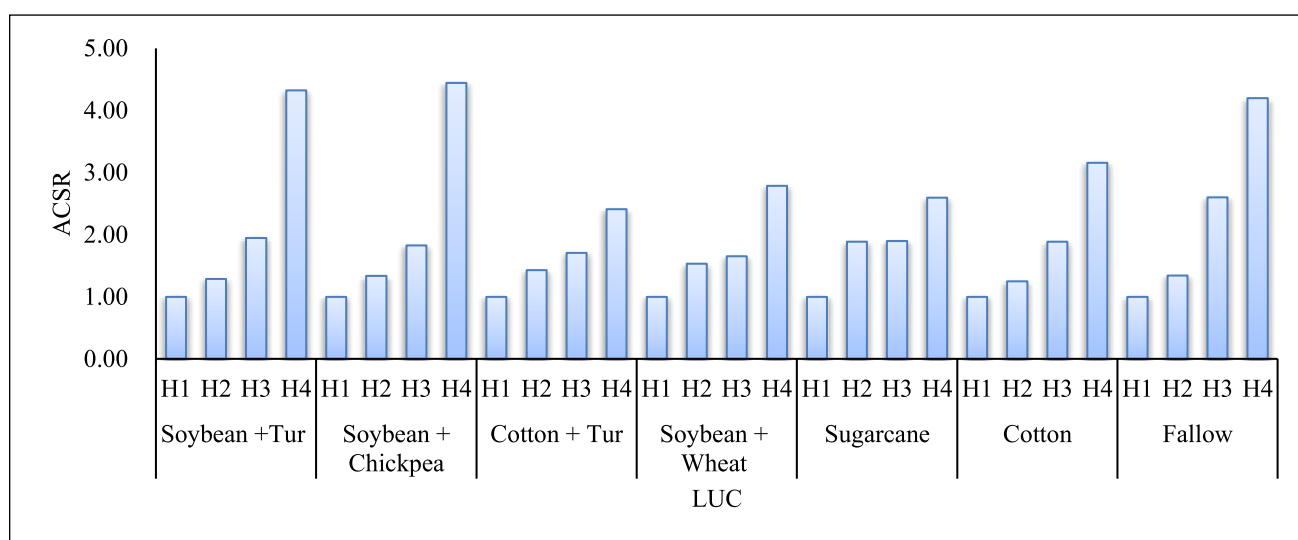


Figure 2.5.9: Active carbon stratification ratio under different land use system

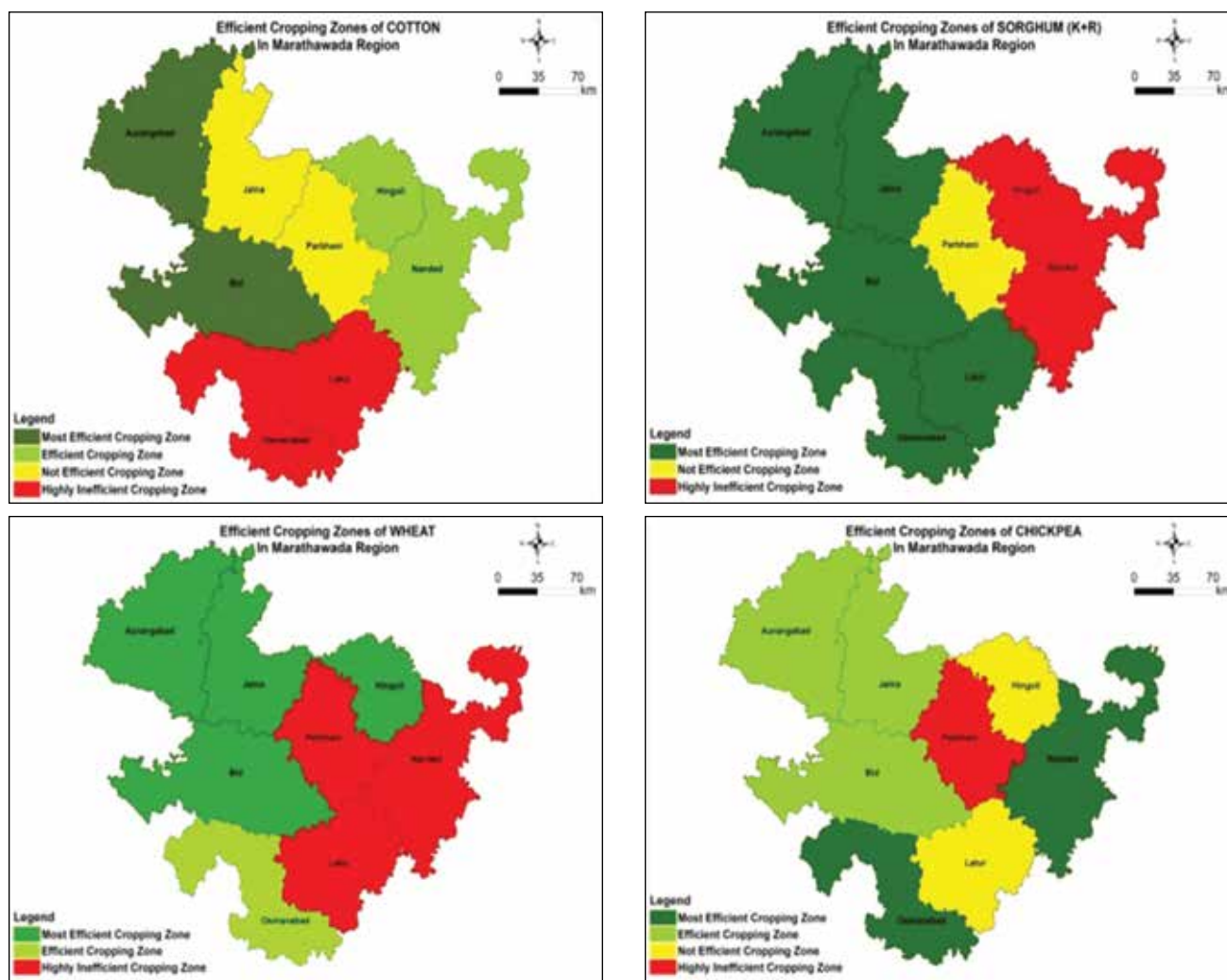


Fig. 2.5.10: Efficiency of cropping zones maps of major crops of Marathwada region

The most efficient cropping zones (MECZ) for wheat was identified in Hingoli, Beed, Jalna and Aurangabad. Five districts are under 'not efficient cropping zones' (NECZ) while Jalna, Aurangabad and Latur are efficient cropping zone (ECZ) with respect to soybean. For chickpea and pigeon pea, all the districts were identified as efficient. The maps of efficient

cropping zones are depicted in Fig. 2.5.11. The best management practices to enhance crop productivity in low yielding areas of Marathwada region are listed in Table 2.5.5 and 2.5.6, and the contingency plans developed for different situations in consultations with SAUs and eminent experts for the entire region in provided in Table 2.5.7.

Table 2.5.5. Best Management for Important Crop and suggested crops/ cropping systems

Crop	Sowing time	Seed rate (kg/acre)	Spacing (cm)	Sowing depth (cm)	High yielding Variety
Pigeonpea	II fortnight June- II fortnight July	Sole- 5-6 Inter- 2-3	Sole- BC:90-120 x 20-30 Med- 75-90 x 30	6-7	BDN-711, BDN-716, BSMR-736
Green gram	II fortnight June- II fortnight July	5-6	30 x 10 / 45 x 10-15	4-5	BM-2003-2, BM-2002-1
Ground nut	K: June- July R: Nov- Dec	Semi- 40-50 Bunchy: 50-60	Bunchy K: 30 x 10 R: 22.5 x 10 S & SS : 30 x 15 K 22.5 X 15 R	4-5	LGN-1, TLG-45
Cotton	June- II fortnight July	Hyb- 2-2.5 Desi- 4-5	Hyb: 90-120 X 45-60 Desi: 60 x 30	5-6	NH-44 BG-2
Soybean	June-July	10-12	45 x 5-10	5	MAUS-71, 158,162 &612
Chickpea	October	12-13	30- 45 x 10	7-8	BDNG-797, BDNGK-798
Wheat	Oct- Nov	40	22.5- 30 x 4-5	4-5	NIAW-301, NIAW-1994, NIAW-1415

**Table 2.5.6.** Suggested crops, and cropping systems to be adopted

Sowing date	Crops/cropping systems to be adopted
Up to 30 June (Normal sowing)	Cotton + soybean, soybean + pigeonpea, sorghum + pigeonpea, castor + soybean, bajra + pigeonpea, greengram, blackgram, sorghum, pearl millet, cotton and soybean
30 June to 15 July	Cotton + soybean, soybean + pigeonpea, castor + soybean, and bajra + pigeonpea
16 July to 30 July	Soybean + pigeonpea, bajra + pigeonpea and castor + soybean
1 August to 15 August	Soybean + pigeonpea, bajra + pigeonpea and castor + soybean (exceptional situation)

Table 2.5.7. Suggested contingency plan

Farming situation	Normal crop Normal onset of monsoon (2nd week of June)	Suggested contingency plan			
		Delay by 2 weeks (June 4th week)	Delay by 4 weeks (July 2nd week)	Delay by 6 weeks (July 4th week)	Delay by 8 weeks (August 2nd week)
1	2	3	4	5	6
Medium to deep black soils	Cotton	Cotton (PKVHY-5)	Cotton+ Pigeon pea (6:2) Pigeon pea varieties-BSMR 736, 853	Cotton+ Pigeon pea (6:2) Pigeon pea varieties-BSMR 736, 853, BDN 708, 711	Pigeon pea varieties-BDN 708, 711
	Sorghum	Sorghum (CSH-16)	Sorghum+ pigeon pea (4:2) Sorghum: CSH-9, 11, 14, 16 PVK-401, 809, Pigeon pea: BSMR-736, 853	Sorghum+ pigeon pea/ (4:2)/ Maize/ Sunflower Sorghum: CSH-9, 11, 14, 16 PVK-401, 809, Pigeon pea: BSMR-736, 853	Sorghum+Pigeonpea (4:2)/ Maize/ Sunflower Sorghum: CSH-9, 11, 14, 16 PVK-401, 809 BSMR-736, 853
	Soybean	Soybean (MAUS-81/ MAUS-725)	Sorghum + Pigeonpea (4:2)	Sorghum + Pigeonpea (4:2)	Pigeonpea / Sunflower /Sesame
	Black gram	Blackgram (TAU1, AKU-15)	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea: BSMR, 736, 853	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea:BSMR-736, 853, BDN-708, 711	Pigeonpea / Maize / Pearl Millet/ Sunflower or Plan for early rabi crops like sorghum, Chickpea and Safflower
	Pigeon pea	Pigeonpea (Vaisali)	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea: BSMR, 736, 853	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea:BSMR-736, 853,	Pigeonpea / Maize / Pearl Millet/ Sunflower or Plan for early rabi crops like sorghum, Chickpea and Safflower
	Greengram	Greengram (Taram-18, BPMR-145)	Soybean+Pigeopea (4:2) Soybean:MAUS-71, 81 Pigeonpea: BSMR-736, 853	Soybean+Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea:BSMR-736, 853	Pigeonpea/ Maize/ Pearl millet/ Sunflower (Phule Bhaskar, Bhanu) OR Plan for early rabi crops like Sorghum, Chickpea and Safflower
Shallow black soils	Cotton	Cotton (PKVhy 3, 5Bt 2)	Cotton+ Pigeon pea (6:2) PigeonpeaBDN 708, 711	Cotton+ Pigeonpea (6:2) PigeonpeaBDN 708, 711	Pigeon pea varieties-BDN 708, 711

Farming situation	Normal crop	Suggested contingency plan			
	Normal onset of monsoon (2nd week of June)	Delay by 2 weeks (June 4th week)	Delay by 4 weeks (July 2nd week)	Delay by 6 weeks (July 4th week)	Delay by 8 weeks (August 2nd week)
1	2	3	4	5	6
	Sorghu	Sorghum (CSH-16)	Sorghum+ pigeon pea (4:2) Sorghum: CSH-9, 11, 14, 16 PVK-401, 809	Sorghum+ pigeon pea/ (4:2)/ Maize/ Sorghum: CSH-9, 11, 14, 16; PVK-401, 809	Pearl millet (AHB-1200 Fe) + Pigeon pea (4:2)/ Maize/ Sunflower (Phule bhaskar, Bhanu) Pearl millet: Shradha. Saburi, Shanti, AIMP-92901,
	Soybean	Soybean (MAUS-81/ MAUS-725)	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea: BSMR-736, 853	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea: BSMR-736, 853	Pigeonpea (BDN 711, BDN 716, BSMR 736, BDN-781 (Godavari, B D N - 2 0 1 3 - 4 1) / Sunflower (Phule bhaskar, Bhanu) / Sesame- AKT-64, Punjab-1, Phule-1 and Castor- DCH-9
	Blackgram	Blackgram (TAU1, AKU-15)	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea: BSMR, 736, 853	Soybean + Pigeonpea (4:2) Soybean: MAUS-71, 81 Pigeonpea: BSMR-736, 853,	Plan for early rabi crops like sorghum, Chickpea (Phule Vikram, Vijay, Vishal, Digvijay, JG 16, JAKI 9218 and BDNG 797) & Safflower (PBNS-154)
	Pigeonpea	Pigeonpea (Vaisali)	Soybean + Pigeonpea (4:2) Sorghum: JS-335, MAUS-71, 81 Pigeonpea: BSMR, 736, 853 BDN-708, 711	Soybean + Pigeonpea (4:2) Soybean: JS-335 MAUS-71, 81 Pigeonpea: BSMR-736, 853 BDN-708, 711	Plan for early rabi crops like sorghum, Chickpea (above varieties) and Safflower

High resolution soil soil-site suitability mapping of major crops in Maharashtra state using geospatial technique

Maharashtra is the third largest state in area and second largest populated state in India. It has an area of 307,713 km² with 36 districts, 358 blocks and 43711 villages and a population of 112,372,972. Agriculture is one of the important sectors of the state economy. The land utilization statistics for 2019-20 depicts that of the total 307.58 lakh ha geographical area of the state, gross cropped area was 235.70 lakh ha while net sown area was 167.22 lakh ha (about 54.4 per cent). Cultivable waste, current fallow and other fallow land is 11% of the geographical area of the state. Gross irrigated area is 44.19 lakh ha and 80% of the area is rain fed. Therefore, there is an urgent need

to characterize, evaluate and map the soil suitability for major crops grown in Maharashtra for sustainable agriculture in order to increase production and arrest land degradation. The present study aimed to identify and delineate the potential crop zones for agriculture and horticultural crops in Maharashtra based on the potential crop zone concept for expanding and optimizing production of the different crops. The crop distribution (Kharif and Rabi) in the year 2022-23 indicated that soybean-pigeon pea and cotton-pigeon pea are the major cropping systems in kharif season covering 51 and 47% respectively, whereas rice contribute to 16% followed by sugarcane 12%. Chick pea and sorghum are the major crops in the rabi season covering 27 and 12 % area respectively, whereas wheat contributes to 10% area (Fig. 2.5.11).

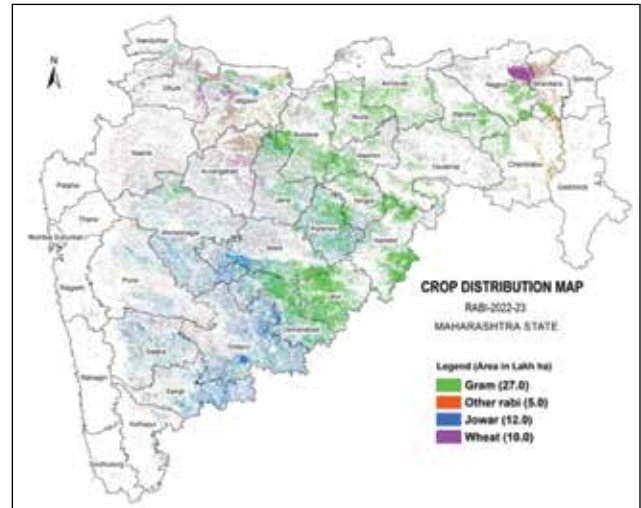
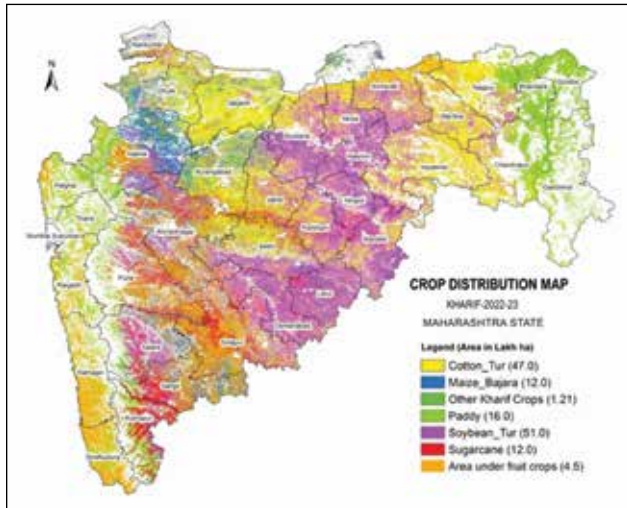


Fig. 2.5.11. Crop distribution maps of Maharashtra State 2022-23

Land capability classification of Nagathi Basapura sub-watershed, Hara Harappanahalli Taluk, Vijayanagara District, Karnataka

In the Nagathi Basapura sub-watershed, lands were grouped under four land capability classes and eight land capability subclasses (Fig. 2.5.12). About 5473 ha (60.41%) area in the sub-watershed is suitable for agriculture.

Soil and water conservation plan of Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapura district, Karnataka

The land resource inventory database generated

under REWARD project has been transformed as information through series of interpretative (thematic) maps using soil phase map as a base for preparing soil and water conservation treatment plan for Gummlapalli sub-watershed. A map showing soil and water conservation plan with different kinds of structures recommended has been generated which shows the spatial distribution and extent of area (Fig. 2.5.13).

Watershed Development to Prevent Drought (WDPD): Chikkaballapur district, Karnataka

Different thematic maps were prepared and evaluated for suitability of different crops (Fig. 2.5.14 and

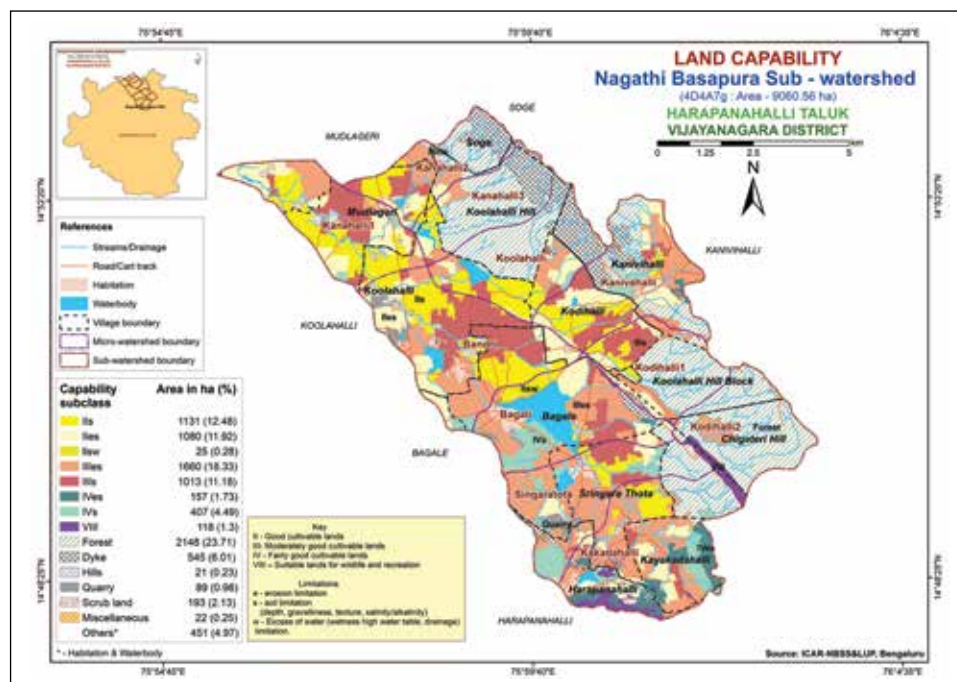


Fig. 2.5.12. Land Capability map of Nagathi Basapura sub-watershed

2.5.15) in the selected different micro-watersheds of Chikkaballapur district of Karnataka under Watershed Development to Prevent Drought (WDPD) project.

Based on the potentials and constraints of each mapping unit, drought management strategies are proposed (Table 2.5.8).

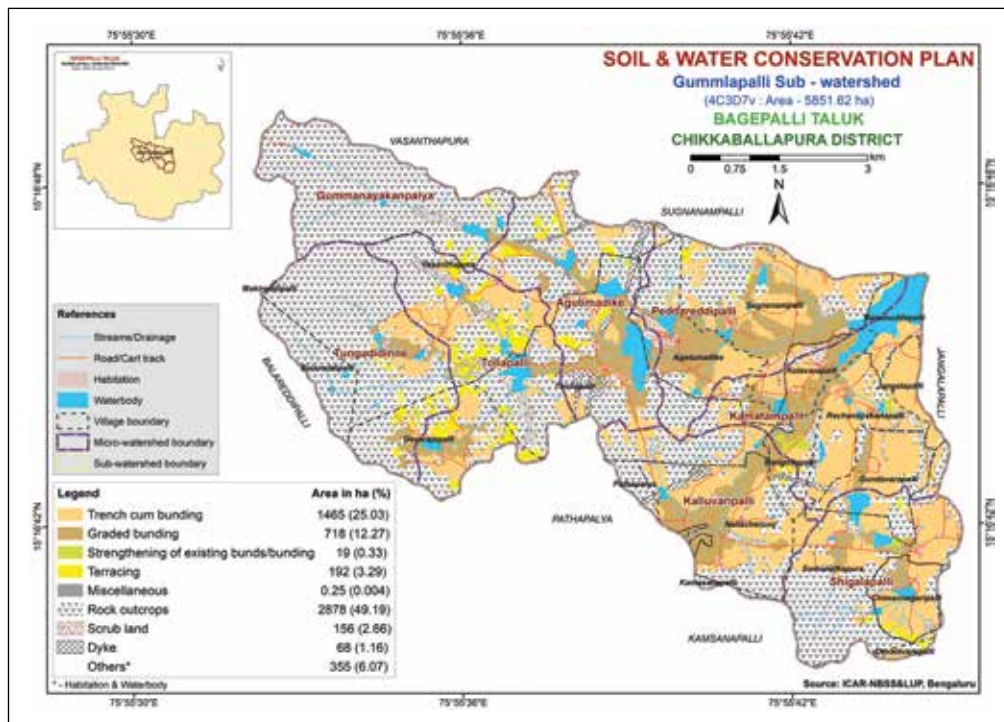


Fig. 2.5.13. Soil and water conservation plan of Gummlapalli Sub-watershed, Bagepalli Taluk, Chikkaballapur district, Karnataka Watershed Development to Prevent Drought (WDPD): Chikkaballapur district, Karnataka

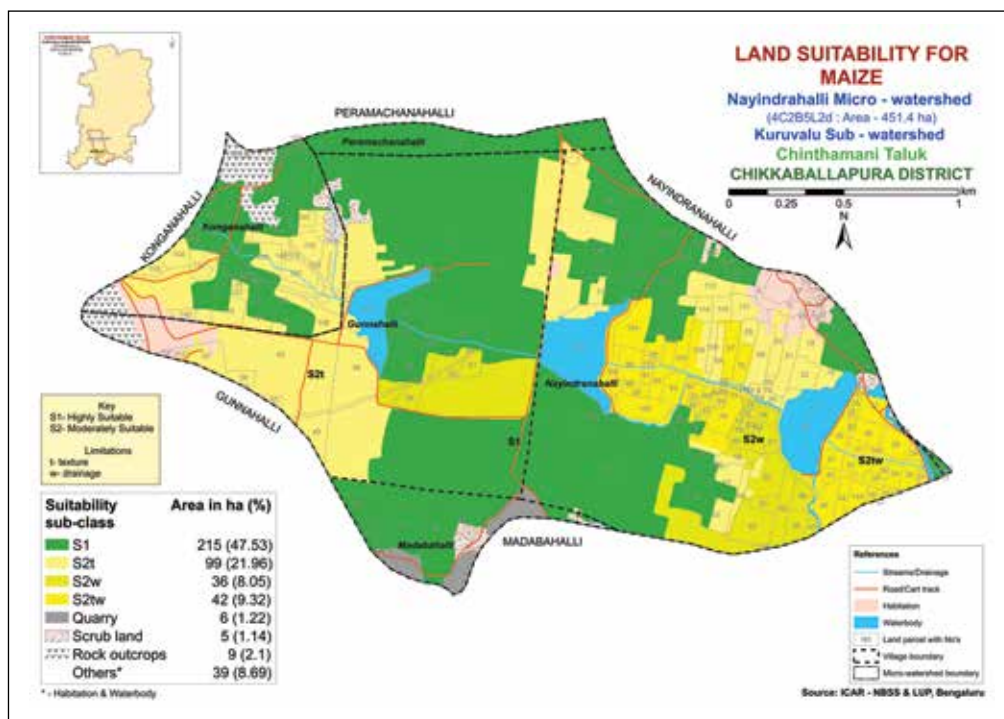


Fig. 2.5.14. Land suitability map of Nayindrahalli micro-watershed for maize.

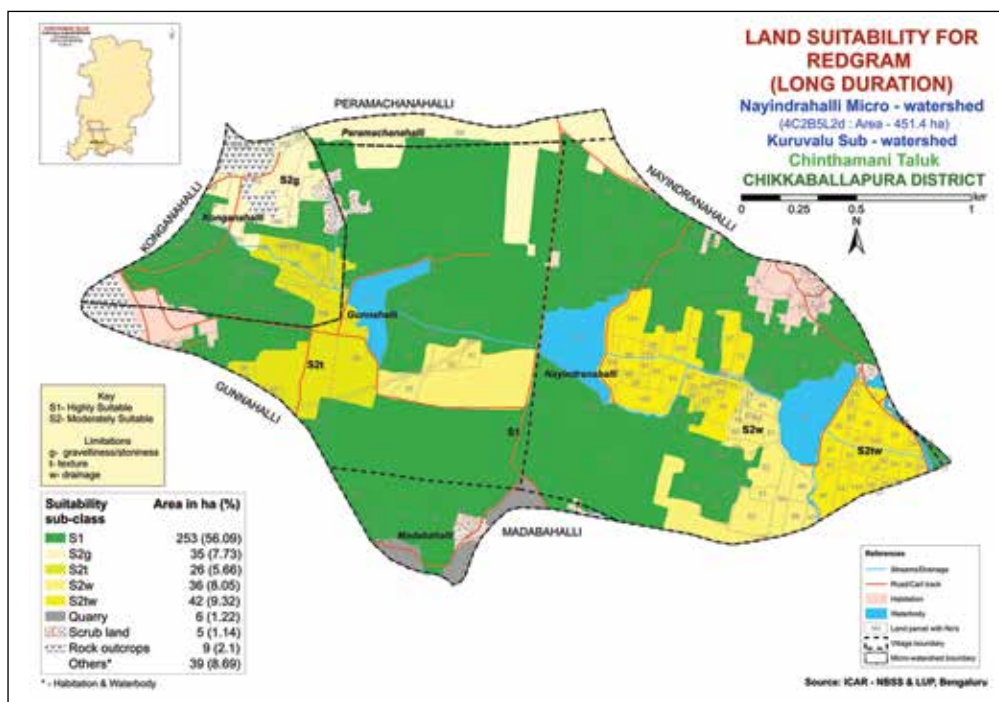


Fig 2.5.15. Land suitability map of Nayindrahalli micro-watershed for Redgram.

Table 2.5.8. Proposed Crop Plan for Nayindrahalli (4C2B5L2d) Micro-watershed

LMU No.	Soil Map Units	Village name and Survey Number	Highly Suitable crops	Moderately Suitable crops	Suitable Interventions
1	1. NSDCa1 (Deep, red gravelly sandy clay loam soils)	Peramachanahalli- 68 Nayindranahalli- 101	Field crops: Maize, ragi, field bean, green gram, black gram & horse gram Vegetables: Amaranthus, drumstick, potato, beetroot, cabbage, onion, ridge gourd, tomato, beans, carrot, chilli, bitter gourd & cucumber Flower crops: Marigold, davana & tuberose Fruit crops: Pomegranate, dragon fruit, dates & cashew	Field crops: Red gram, sorghum, groundnut, castor, sunflower, sugarcane & cotton Vegetables: Brinjal Flower crops: Rose & jasmine Fruit crops: Mango, grapes, banana, fig, papaya, guava, apple, lime, tamarind, jamun & sapota Plantations: Coconut, arecanut, sandalwood, mulberry & teak	Drip irrigation, mulching, strengthening of existing bunds, trench cum bunding and crescent bunding with catch pit for plantation and fruit crops
2	2. HLKcA1 3. RTRcA1 4. RTRcB2 5. RTRhA1 6. RTRhB2 7. RTRiA1 (very deep, sandy clay to clay soils)	Gunnahalli- 112, 45, 46, 56, 57, 59, 60 Konganahalli- 103, 104, 105, 106, 107, 108, 109, 118, 119, 124, 125, 130, 132, 133, 134, 140, 142, 146, 147, 148, 156 Madabahalli- 101, 106, 107, 69, 98 Nayindranahalli- 101, 102, 105, 106, 108, 109, 11, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 12, 122, 125, 126, 127, 128, 129, 146, 147, 148, 16, 17, 18, 19, 21, 22	Field crops: Maize, ragi, field bean, red gram, green gram, black gram, horse gram, sugarcane sunflower & cotton Vegetables: Amaranthus, drumstick, potato, beetroot, cabbage, onion, ridge gourd, tomato, beans, carrot, chilli, bitter gourd & cucumber Flower crops: Marigold, rose, jasmine, davana & tuberose Fruit crops: Mango, lime, fig, banana, guava, tamarind, jamun & sapota Plantations: Coconut, arecanut & mulberry	Field crops: Sorghum, ground nut, castor, lowland paddy & bengal gram Vegetables: Brinjal Fruit crops: Pomegranate, grapes, apple, papaya, dragon fruit & strawberry & cashew Plantations: sandalwood & teak	Drip irrigation, mulching, strengthening of existing bunds, trench cum bunding, crescent bunding with catch pit for fruit and plantation crops

Evaluation of effectiveness of LRI in watershed development and its impact on agro ecosystem services and livelihood in Chamarajanagar district, Karnataka.

Provision services from land resources include the products/raw materials like food, water, medicines, and other resources from ecosystems. The economic value of the cereals (maize, sorghum and ragi), pulses (horse gram and cow pea) commercial (cotton) and horticultural (banana, coconut, and tomato) crops were estimated across upstream, midstream and downstream in Harve sub watershed covering 5823 ha of land distributed in 10 micro watersheds covering 10631 farm households. The socio-economic survey data on crop yields and prevailing market information is used for estimation of economic value (Fig. 2.5.16).

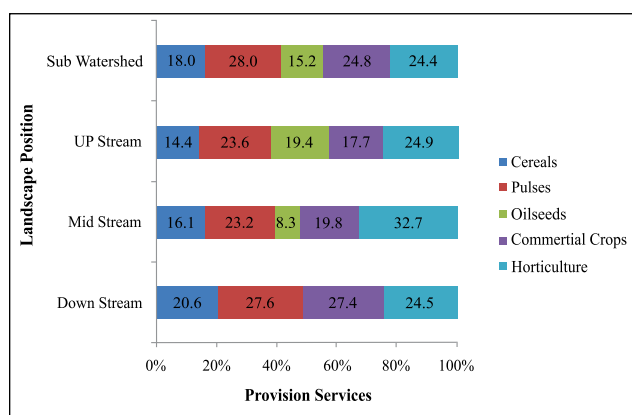


Fig. 2.5.16. Economic valuation of provision ecosystem services

Land Suitability Assessment under REWARD-Odisha project

As per the land suitability assessment of crops, cashew was found highly suitable in 27.4% of TGA and moderately suitable in 19.6% of TGA, whereas, millets were found highly suitable in 7.7% of TGA and moderately suitable in 35.9% of TGA, respectively in Publiguda microwatershed (Fig. 2.5.17).

Soil site suitability evaluation for major crops in Arunachal Pradesh

Lohit district

The soils of the district were evaluated for suitability for paddy, maize, mustard, citrus, tea, and cardamom. The results showed that 0.5% of TGA is highly suitable, and 12.9% and 22.1% of TGA as moderately suitable and marginally suitable, respectively, for the mustard crop. The limitations were due to the steep slope, low soil fertility, and coarse texture. About 20.9% of TGA in the district is highly suitable for maize, 13.2% is moderately suitable, and 11.0% is marginally suitable due to limitations caused by topography and soil fertility. About 7.13% of the area in the district is highly suitable for tea, 14.45% area is moderately suitable, and 14.0% area is marginally suitable due to limitations of soil fertility.

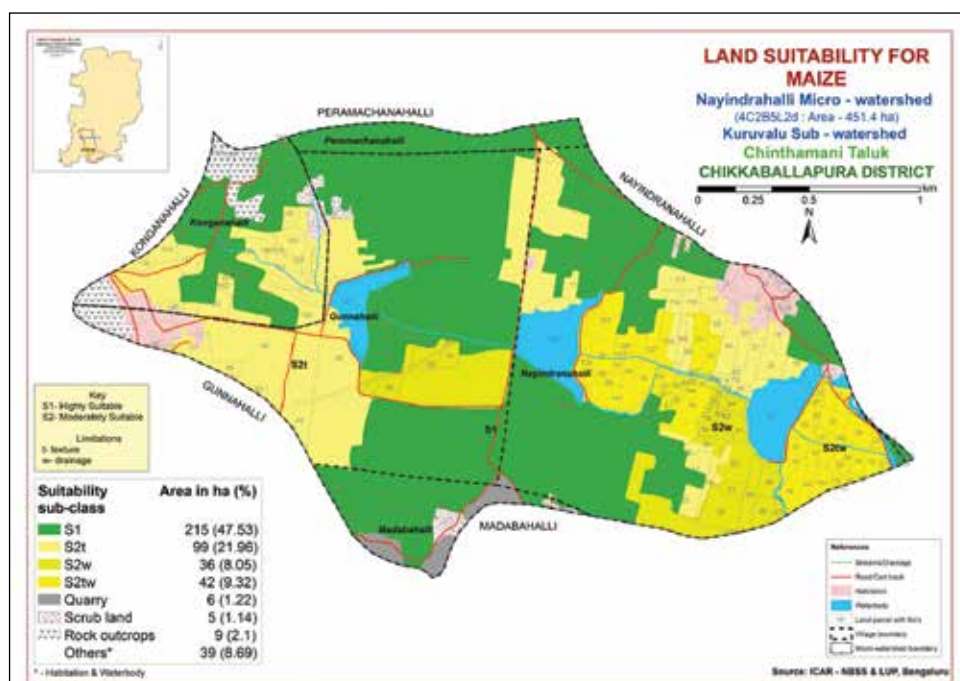


Fig. 2.5.17. Land Suitability for Millets in Publiguda Micro-Watershed

Changlang district

The land capability classification indicates that topography (steep slope) and soil fertility were major limitations. Land capability analysis resulted in twelve land capability classes in Changlang district. The class VII covers 20.25% of the total geographic area. The soil site suitability evaluation indicates that only 3.15% of TGA is moderately suitable for paddy and 0.90% of area is marginally suitable with the limitations of soil physical properties and steep slope. For maize, 9.43% of the area is moderately suitable, and 10.5% of the TGA is marginally suitable due to fertility and topography imitation. About 3.87% of the area is moderately suitable, and 3.93% is marginally suitable for millets.

Agricultural Land Use Planning of Mathura District, Uttar Pradesh

The soil suitability for fruits (mango, citrus, guava, and papaya) was evaluated in terms of current and potential soil suitability to suggest alternate land use options for crop diversification and livelihood security. Current soil suitability evaluated 68.8% area as moderately suitable (S2) for guava cultivation (Fig. 2.5.18), whereas, for other fruit crops maximum area found to be marginally suitable (S3) in the following order papaya (79.8%), mango (63.6%), and citrus (55.6%). Potential suitability for guava cultivation revealed 13.2% area found to be class S1 whereas, 55.6% areas under class S2 and 11.0% area as class S3, and 17.2% area as class N2 (Fig.2.5.2).

Assessment of heavy metal contamination in soil, water and vegetables at selected hotspots in Purna river basin, Maharashtra

This study investigated the accumulation and contamination of soil, water and vegetables with heavy metals (Fe, Mn, Cu, Zn, Ni, Cr, Co and Cd) and the associated health risks in peri-urban areas of Amravati district of Maharashtra. Five sites across or along the Amba nala drainage channel were selected for sampling of water, soil, and vegetable samples (Spinach, Cabbage, Brinjal and Fenugreek), where sewage wastewater is being used to irrigate vegetables and three tube-well water irrigated sites were selected as the control sites. A total of 40 soil samples, 30 vegetables samples and 08 water samples were collected and analysed for heavy metal content. The heavy metals were found in order Fe> Mn> Cu> Cr> Ni> Co>Zn in the soil and water samples and were below permissible limit except Cd

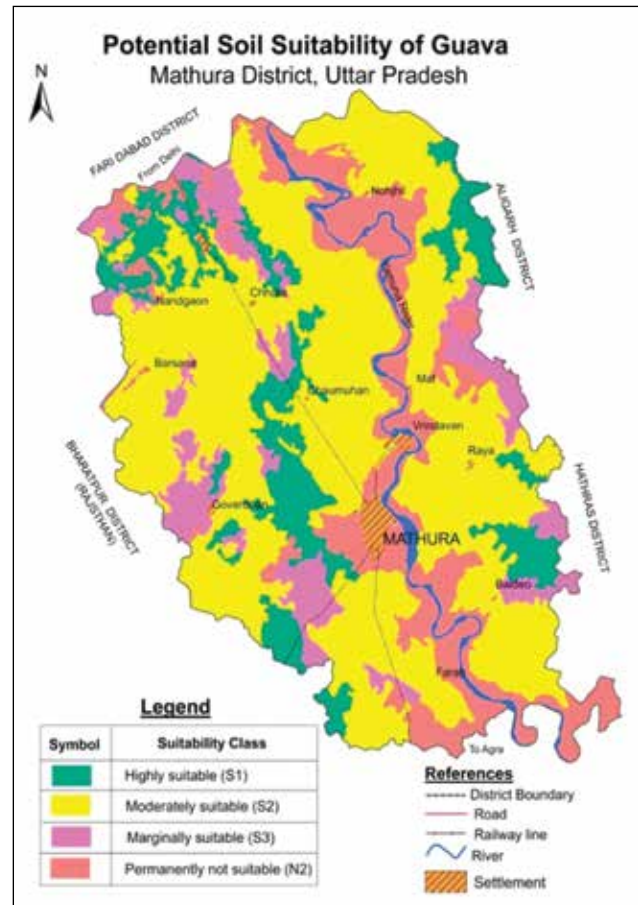


Fig.2.5.18. Potential soil suitability of Guava

and Cr in few water samples (Table 2.5.9). The heavy metal content in vegetables samples were found as Fe> Mn> Cu> Zn> Cr> Ni> Cd and below permissible limit except Cr and Cd in few samples (Table 2.5.10). Bio-Concentration Factor (BCF) values shows higher uptake of Fe, Ni in Spinach and Fe in Fenugreek. The Hazard quotient (HQ) and health risk index (HRI) indicate that the level of health risk due to contaminated vegetable consumption is acceptable and do not cause any carcinogenic health effects.

Livelihood improvement of SC community through the integrated approaches of natural resource management in South-eastern region of Rajasthan (SCSP)

A cluster of four villages (Jhadol, Bassi, Dhingri and Ghatod) near Jaisamand lake of Udaipur district were selected under SCSP scheme. Participatory rural appraisal approach was adopted to understand the current problems and possible solutions in agricultural sector in these villages and problem-based solutions were provided. Salt tolerant green gram variety was suggested and seeds were distributed to the farmers (Fig. 2.5.19) which resulted in good yield in the soils affected with surface salinity.

Table 2.5.9. Mean values of physicochemical parameters and total heavy metal concentration (mg kg⁻¹) of soil samples

Sites	pH	EC (dsm ⁻¹)	OC (%)	Fe mg kg ⁻¹	Mn mg kg ⁻¹	Zn mg kg ⁻¹	Cu mg kg ⁻¹	Ni mg kg ⁻¹	Cr mg kg ⁻¹	Co mg kg ⁻¹	Cd mg kg ⁻¹
Control	9.14 ± 0.22	0.16 ± 0.03	0.57 ± 0.15	22.88 ± 0.04	22.4 ± 0.02	1.40 ± 0.03	6.87 ± 0.35	1.91 ± 0.13	2.68 ± 0.09	1.13 ± 0.02	BDL
Contaminated 1	8.57 ± 0.25	0.37 ± 0.15	0.79 ± 0.37	23.30 ± 0.03	22.70 ± 0.03	1.55 ± 0.03	12.21 ± 0.72	1.96 ± 0.03	2.96 ± 0.14	1.52 ± 0.03	BDL
Contaminated 2	8.44 ± 0.31	0.26 ± 0.07	0.73 ± 0.41	24.44 ± 0.07	23.61 ± 0.05	1.63 ± 0.03	10.67 ± 0.65	2.41 ± 0.03	4.43 ± 0.05	1.83 ± 0.02	BDL
Contaminated 3	8.58 ± 0.22	0.32 ± 0.12	1.00 ± 0.28	23.5 ± 0.02	23.13 ± 0.01	1.58 ± 0.04	10.52 ± 0.40	2.08 ± 0.04	2.90 ± 0.05	1.41 ± 0.04	BDL
Contaminated 4	8.73 ± 0.17	0.24 ± 0.03	0.84 ± 0.20	25.43 ± 0.01	22.05 ± 0.01	1.84 ± 0.05	11.02 ± 0.34	2.77 ± 0.06	3.55 ± 0.12	1.64 ± 0.09	BDL
Contaminated 5	8.72 ± 0.29	0.28 ± 0.02	0.70 ± 0.22	22.97 ± 0.05	25.04 ± 0.06	1.48 ± 0.04	9.99 ± 0.21	2.23 ± 0.08	3.76 ± 0.10	1.23 ± 0.07	BDL
USEPA (2002) ^a				-	-	1100	270	72	-	-	-
Standards limits ^b						300-600	135-270	75-150			3-6

a is the standards reference value for heavy metals in agricultural soils.

b Indian standards (1983) and Awashthi (2000) (mg/kg⁻¹) *BDL – Below Detectable Limit

Table 2.5.10. Mean concentration of total heavy metals in vegetable samples at different selected sites

Vegetable	Site	Fe	Mn	Zn	Cu	Ni	Cr	Co	Cd
Spinach	Control	39.57 ± 4.71 ^c	1.76 ± 0.08 ^e	0.40 ± 0.22 ^{abcdef}	1.13 ± 0.08 ^{ghi}	0.02 ± 0.02 ^d	0.44 ± 0.06 ^{ij}	BDL	BDL
	Contaminated 1	55.87 ± 7.02 ^{ab}	5.03 ± 0.17 ^c	0.44 ± 0.11 ^{abcdef}	4.08 ± 0.19 ^c	5.01 ± 0.14 ^a	0.60 ± 0.05 ^{hi}	1.57 ± 0.16 ^a	2.13 ± 0.05 ^a
	Contaminated 2	43.76 ± 6.12 ^{bc}	5.95 ± 0.09 ^b	0.26 ± 0.12 ^{ef}	4.48 ± 0.18 ^c	0.07 ± 0.05 ^d	0.46 ± 0.06 ^{ij}	0.03 ± 0.06 ^{de}	0.18 ± 0.04 ^d
	Contaminated 3	56.63 ± 6.16 ^{ab}	6.50 ± 0.11 ^a	0.48 ± 0.09 ^{abcde}	6.39 ± 0.16 ^a	0.14 ± 0.04 ^d	0.88 ± 0.08 ^{def}	0.26 ± 0.11 ^{cd}	0.05 ± 0.05 ^{de}
	Contaminated 4	59.90 ± 5.04 ^a	6.64 ± 0.38 ^a	0.52 ± 0.08 ^{abcd}	6.44 ± 0.10 ^a	0.06 ± 0.07 ^d	1.02 ± 0.05 ^{de}	0.34 ± 0.09 ^c	0.59 ± 0.08 ^c
	Contaminated 5	64.56 ± 5.40 ^a	4.81 ± 0.20 ^c	0.56 ± 0.12 ^{ab}	5.57 ± 0.09 ^b	1.67 ± 0.17 ^b	1.12 ± 0.07 ^d	0.87 ± 0.14 ^b	1.01 ± 0.11 ^b
Cabbage	Control	5.41 ± 0.20 ^e	0.48 ± 0.08 ^{ijk}	0.21 ± 0.04 ^f	0.58 ± 0.13 ^k	BDL	0.03 ± 0.06 ^k	BDL	BDL
	Contaminated 1	15.35 ± 4.50 ^e	0.76 ± 0.08 ^{hij}	0.56 ± 0.09 ^{ab}	1.36 ± 0.18 ^{fgh}	0.48 ± 0.14 ^c	1.91 ± 0.05 ^{ab}	BDL	BDL
	Contaminated 2	18.84 ± 3.55 ^{de}	0.78 ± 0.06 ^{hij}	0.22 ± 0.02 ^f	0.84 ± 0.12 ^{ijk}	BDL	0.54 ± 0.06 ^{hi}	BDL	BDL
	Contaminated 3	14.82 ± 3.03 ^e	0.76 ± 0.05 ^{hij}	0.52 ± 0.05 ^{abcd}	0.82 ± 0.09 ^{ijk}	0.03 ± 0.04 ^d	1.70 ± 0.08 ^{bc}	BDL	BDL
	Contaminated 4	18.85 ± 3.24 ^{de}	0.86 ± 0.06 ^{ghi}	0.44 ± 0.06 ^{abcdef}	1.14 ± 0.13 ^{ghi}	0.34 ± 0.07 ^c	1.54 ± 0.03 ^c	BDL	BDL
	Contaminated 5	12.7 ± 2.40 ^e	0.65 ± 0.11 ^{hijk}	0.20 ± 0.04 ^f	0.67 ± 0.12 ^{jk}	BDL	0.28 ± 0.07 ^{jk}	BDL	BDL
Brinjal	Control	4.23 ± 0.55 ^e	0.37 ± 0.03 ^k	0.30 ± 0.03 ^{cdef}	1.64 ± 0.1 ^f	0.02 ± 0.02 ^d	0.74 ± 0.09 ^{gh}	BDL	BDL
	Contaminated 1	12.34 ± 1.80 ^e	0.61 ± 0.10 ^{hij}	0.35 ± 0.04 ^{abcdef}	3.40 ± 0.38 ^d	0.02 ± 0.01 ^d	0.99 ± 0.11 ^{de}	BDL	BDL
	Contaminated 2	16.69 ± 2.14 ^{de}	0.50 ± 0.05 ^{hijk}	0.54 ± 0.05 ^{abc}	1.73 ± 0.17 ⁱ	0.04 ± 0.02 ^d	1.96 ± 0.15 ^a	BDL	BDL

Vegetable	Site	Fe	Mn	Zn	Cu	Ni	Cr	Co	Cd
Fenugreek	Contaminated 3	12.47 ± 1.28 ^e	0.74 ± 0.08 ^{hijk}	0.32 ± 0.03 ^{abcdef}	1.40 ± 0.09 ^{fg}	0.04 ± 0.01 ^d	1.55 ± 0.08 ^c	BDL	BDL
	Contaminated 4	15.61 ± 1.82 ^e	0.40 ± 0.05 ^{jk}	0.57 ± 0.06 ^a	2.89 ± 0.12 ^e	0.05 ± 0.02 ^d	2.05 ± 0.08 ^a	BDL	BDL
	Contaminated 5	10.71 ± 0.89 ^e	0.49 ± 0.05 ^{ijk}	0.48 ± 0.03 ^{abcde}	2.74 ± 0.06 ^e	0.03 ± 0.02 ^d	0.95 ± 0.07 ^{def}	BDL	BDL
	Control	32.19 ± 3.95 ^{cd}	0.97 ± 0.10	0.24 ± 0.05 ^{ef}	0.71 ± 0.10 ^{ijk}	0.01 ± 0.01 ^d	0.40 ± 0.05 ^{ij}	BDL	BDL
	Contaminated 1	57.63 ± 7.46 ^{ab}	1.76 ± 0.14 ^e	0.31 ± 0.08 ^{bcd}	0.75 ± 0.12 ^{ijk}	0.02 ± 0.01 ^d	0.86 ± 0.12	0.03 ± 0.01 ^e	BDL
	Contaminated 2	69.32 ± 9.39 ^a	2.37 ± 0.11 ^d	0.35 ± 0.06 ^{abc}	2.88 ± 0.13 ^e	0.02 ± 0.01 ^d	0.74 ± 0.06 ^{gh}	0.03 ± 0.01 ^e	BDL
	Contaminated 3	42.20 ± 8.24 ^{bc}	1.40 ± 0.07 ^{ef}	0.24 ± 0.05 ^{ef}	0.74 ± 0.14 ^{ijk}	0.01 ± 0.01 ^d	0.49 ± 0.08 ^{ij}	0.02 ± 0.01 ^e	BDL
	Contaminated 4	62.45 ± 8.04 ^a	1.67 ± 0.10 ^e	0.34 ± 0.07 ^{abc}	0.92 ± 0.10 ^{hijk}	0.03 ± 0.02 ^d	0.89 ± 0.12 ^{def}	0.03 ± 0.02 ^e	BDL
	Contaminated 5	35.41 ± 5.51 ^c	1.24 ± 0.08 ^{fg}	0.28 ± 0.04 ^{def}	1.11 ± 0.07 ^{ghij}	0.02 ± 0.02 ^d	0.62 ± 0.07 ^{ghi}	0.05 ± 0.02 ^{de}	BDL
Allowable limit			500	50	10-40	10	1.3	50	0.05–0.2

Allowable heavy metals limit (mg/kg dw) in vegetables as described by Gebeyehu and Bayissa, 2020. *BDL – Below Detectable Limit



Fig. 2.5.19. Distribution of green gram seeds of saline tolerant variety to farmers and crop performance in saline soils

Vegetable seeds viz., okra (20 kg), cowpea (10 kg), dolich bean (2 kg), tomato (1 kg), chilli (1 kg) and brinjal (1 kg) were distributed to farmers to encourage vegetable cultivation to earn continuous income for the household and farmers earned about Rs. 10000 per month by adopting vegetable cultivation.

A 15 days residential skill development training was given to the 30 women from landless community on “cutting and tailoring” in collaboration to MPUAT, Udaipur, and 30 sewing machines along with kit and

sitting stool were distributed to increase the household income for livelihood security.

Socio Economic Impact of Land Use/ Land Cover Changes in Selected Districts of Eastern Vidarbha Region in India

Bhandara, Chandrapur, Gadchiroli and Gondia are under high rainfall zone, as the rainfall varies from 1,250 to 1,700 mm. More than 50% of the area is under forest and paddy is the major crop in these districts. In all the districts, forest lands, fallow lands and water bodies increased by 0.6 to 1.3 percentage during 2001 to 2016. However, no significant change in croplands was noticed during the study period. Due to the industrialization in surrounding areas, farm labourers are migrating in a peak period. Therefore, availability of farm labours is the major constraint in study area.

Soil and water management strategies for enhancing agricultural productivity in TSP/ SCSP villages of Nagpur district through SCSP

Need based interventions were introduced in identified villages to improve the livelihood and socio-economic conditions of small and marginal Scheduled Caste farmers from selected clusters of Nagpur district. The interventions were (i) micro-irrigation-based vegetable farming for 200 farmers; (ii) animal feed to 200 farmers to improve the livestock health and enhance the milk yield.

2.6

IT ENABLED EXTENSION PROGRAMME

Development of Land Resource Inventory Cards for farmers

A novel extension method to disseminate Land Resource information through LRI Cards (Fig. 2.6.1 (a) and (b)) derived from LRI database was developed

2018 were processed for ICAR-KRISHI Geoportal. API services were created to provide WMS using programming languages and deployed on the central Geoportal server to access the provided services. The proto-type interoperable platform developed on BHOOMI Geoportal needs to be deployed on ICAR-

Laboratory Name and Address:		National Bureau of Soil Survey and Land Use Planning, Regional centre,Hebbal, Bangalore -560 024.			
Soil Test Results					
Sl.no	Parameter	Test value	Unit	Rating	
01	Soil reaction (pH)	5.5-6.0	-	Moderately acid	
02	Electrical Conductivity (EC)	<2	dSm ⁻¹	Non saline	
03	Organic Carbon (OC)	0.25-0.5	%	Low	
04	Available Nitrogen (N)	<140	Kg/ha	Very Low	
05	Available phosphorus (P ₂ O ₅)	<11.5	Kg/ha	Very Low	
06	Available Potassium (K ₂ O)	<72	Kg/ha	Very Low	
07	Available Sulphur (S)	10-20	P.P.M	Medium	
08	Available Zinc (Zn)	<0.6	P.P.M	Deficient	
09	Available Boron (B)	<0.5	P.P.M	Low	
10	Available Iron (Fe)	>4.5	P.P.M	Sufficient	
11	Available Manganese (Mn)	>1.0	P.P.M	Sufficient	
12	Available Copper (Cu)	>0.2	P.P.M	Sufficient	
Note: Fertility data obtained from 320 meters, and may not match the actual value. Properties indicated correspond to the maximum area covered in the survey number. For complete details please refer the LRI reports /atlases of the watershed area.					
Colour Code:	 Dark Green : Very High Rating	 Green: High Rating	 Yellow: Medium Rating	 Orange : Low Rating	 Red : Very Low Rating
Secondary and Micronutrients Recommendation for Deficient Soil					
Sl.no	Parameter	Fertilizer	Micronutrient fertilizers May be applied in consultation with scientists of KVK and RSK since the recommendation varies from crop to crop		
1	Sulphur (S)	Gypsum			
2	Boran (B)	Borax			
3	Zinc(Zn)	Zinc Sulphate			
4	Iron(Fe)	Ferrous Sulphate			
5	Manganese(Mn)	Manganese Sulphate			
6	Conner(Cu)	Copper Sulphate			

Soil Nutrient Classification					
Based on the soil test results the soil is classified as Low, Medium and High in the below table.					
Nutrient	Very Low	Low	Medium	High	Very High
Organic Carbon (%)	<0.25	0.25-0.5	0.5-0.75	0.75-1.00	>1.00
Available Nitrogen (Kg/ha)	< 140	140-280	280-560	560-700	>700
Available phosphorus (Kg/ha)	< 11.5	11.5-23	23-57	57-91	>91
Available Potassium (Kg/ha)	< 72	72- 145	145-337	337-675	> 675
Available Sulphur (P.P.M)	-	<10	10-20	>20	-
Micronutrients		Deficient	Sufficient		
Available Zinc (P.P.M)	-	<0.6	>0.6	-	-
Available Iron (P.P.M)	-	<4.5	>4.5	-	-
Available Copper (P.P.M)	-	<0.2	>0.2	-	-
Available Manganese (P.P.M)	-	<1.0	>1.0	-	-
Micronutrient		Low	Medium	High	
Available Boron (P.P.M)	-	< 0.5	0.5-1.0	> 1.0	-

Suggested Crop Plan Based on Land Resource Information			
Suitability	Suitable Crops	Limitations	Suggested Interventions
Highly suitable	-	-	Use of short duration varieties, Drought resistant crops, sowing across the slope. Land leveling without exposing parent material.
Moderately suitable	-	-	
Marginally suitable	Beetroot, Field Bean, Chrysanthemum, Marigold, Onion, Tomato, Brinjal, Cowpea, Groundnut, Maize, Carrot, Bheema Bamboo, Cauliflower, Ragi	Rooting conditions	
	Lowland Paddy	Rooting and Graveliness conditions	
Not suitable	Guava, Mango, Papaya, Teak, Silver oak, MalabarNeem, Red gram, Sunflower	Rooting conditions	-

Note: Horticultural crops subjected to availability of good quality irrigation water

Issued Month & Year: November 2023

Fig. 2.6.1(a). LRI Card (inner side)

and used for site-specific farm resource management in watersheds as part of the World Bank-funded REWARD project. Data on climate, soil fertility status, site-specific crops, and suitable technologies are suggested in the cards for enhancing productivity and for conserving soil and water.

ICAR Research Data Repository for Knowledge Management-Agricultural Knowledge Resources and Information System Hub for Innovations (KRISHI)

The 16-day composites of MODIS satellite data-based NDVI and VCI products of India for the years 2000 to

KRISHI Geoportal to access the API services from other Geoportals. This mechanism enables the data-providing institutes to update the services and share them through APIs. Provided API services for various soil parameters on 1:1m scale, land degradation and grapes suitability for two states deployed on ICAR-KRISHI Geoportal.

Development of the Indian National Soil Grid

ICAR-NBSS&LUP is engaged in preparing predicted soil properties maps at various resolutions using digital soil mapping (DSM) techniques. A sub-module a soil grid Geoportal on the BHOOMI Geoportal

How to use Land Resource Inventory Card

- Depth** : Shallow soils are to be used for growing short duration & shallow rooted crops. Digging deep/bigger than recommended size pits & filling with good quality loamy soils from outside for planting Horticultural crops suggested.
- Texture** : Clayey soils are to be moderated by adding sandy soils or weathered parent material. Quantity of material to be added depends on the local crops requirements. For sandy soil addition of tank silt or black clayey soils provides better soil air-water relationship environment.
- Gravelliness** : Addition of tank silt or black clayey soils to increase soil volume is better. This helps in increasing soil available water & nutrient holding capacity.
- Slope** : By following appropriate suggested conservation measures like trench cum bunding, graded bunding, strengthening of existing bunds or sowing crops across the slope, better management of lands can be achieved. Bunds Strengthening has to be done every year.
- Soil Erosion** : Reducing the slope by appropriate bunding, levelling, planting across the slope, growing cover crops & mulching are suggested.
- Available Water Capacity**: By addition of organic matter, in-situ moisture conservation, addition of clayey materials to sandy soils shall help to improve the AWC to some extent.
- Soil and Water Conservation Plan**: The recommended soil and water conservation and drainage line treatment plans are to be followed. Proper maintenance is most essential.
- Always apply recommended level of FYM/compost before crop sowing.
- There is no need of adding amendment (lime of gypsum) if the Soil pH is neutral (pH6.5-7.5)
- Application of required quantity of burnt lime is recommended if the soil pH is <6.5. Repeat the soil test after two years and correct based on the soil pH values.
- In Sodic soils (pH >8.5) apply recommended dose of Gypsum & drain out the excess salts with good quality irrigation water.
- Apply 25 percent extra RDF if the soil is low in major nutrients and reduce 25 percent from RDF if the soil has high NPK content. For example if the soil is deficient in nitrogen, application of 125kg RDF nitrogen is recommended in place of 100 kg N. The same needs to be followed for P & K also.
- Incorporation of bio-fertilizers like Rhizobium, Azotobacter, Azospirillum, Phosphate Solubilizing Bacteria and Mycorrhiza will enhance availability of major & micro nutrients to the plants & also reduces the cost of cultivation.

While applying, soil moisture condition should be good.

- It is recommended to go for soil test at every 2 years interval.

For More Informations Please refer Sujala Website (Sujala3lri.karnataka.gov.in)

Farmers Helpline Centers: Agricultural Problems-1800-425-3553, Varuna Mitra-92433 45433, Horticulture Helpline-1800-4257910 and Krishi marata vahini-1800-425-1552



Govt. of Karnataka

THE WORLD BANK

ICAR-NBSS&LUP

REWARD

Watershed Development Department Kaveri Bhavana,
Bengaluru-560 009

And
ICAR - National Bureau of Soil Survey and Land Use Planning,
Regional centre, Hebhal, Bangalore -560 024

Contact: E-Mail: nbssgis@gmail.com

Land Resource Inventory Card

Farmer's Name	D Sugunamma
Gender: Male/Female	Female
Microwatershed Name	Kamatampalli (4C3D7V01)
Address	Agutamadike Village Bagepalli Taluk, Chikkaballapura District
Soil sampling year	2023
Survey/Hissa No	46/3
Area in (Acre/Gunta)	1.6
Annual Rainfall (mm)	835
*Note: Survey Number total area	

Details Of Land Surface And Soil Properties	
Soil Depth	Shallow (25-50 cm)
Soil Texture	Loamy sand
Soil Gravelliness (%)	Very gravelly (35-60 %)
Soil Slope (%)	Gently sloping (3-5%)
Soil Erosion	Severe Erosion
Land Capability Classes	Moderately good cultivable lands with erosion and soil limitations
Soil Water Holding Capacity	Very low (<50 mm/m)
Soil & Water Conservation Plan	Trench cum bunding
Traditional Soil Name	Shallow Red gravelly Loamy soil

Fig. 2.6.1(b). LRI card (outer side)

platform has been developed with the help of HTML, JavaScript, CSS, php web service, MySQL database and GeoServer to disseminate the generated data (Fig. 2.6.2). The portal allows the user to select the region, soil physical and chemical properties, resolutions and depths. The standard depths available are (0-5cm, 5-15cm, 15-30 cm, 30-60 cm, 60-100 cm, and 100-200 cm). Some layers are available for a limited depth of 0-30 cm too. The user can create a graph of the variation in a soil property along with depth by clicking on any pixel. The user can also visualize the uncertainty map in a separate window synchronous with the soil property map. An android app has been developed using JAVA and Android SDK to replicate



Fig.2.6.2. Front page Indian National Soil Grid.

the geoportal in the android mobiles. In the updated version, Bikaner region and Jalpaiguri district's DSM products were uploaded to the portal.

Development of the Indian National Soils Archive

ICAR-NBSS&LUP has collected a large volume of soil samples across the country in the past under various projects on different scales with precise locations. This has helped the establishment of an Indian National Soil Archive (INSA) with the help of HTML, JavaScript, CSS, php, MySQL and GeoServer, which will be helpful in studies related to digital soil mapping, soil spectroscopy, temporal assessment of soil properties, and other studies. The Indian National Soil Archive consists of: (i) a soil sample storage room where soil samples are kept with QR codes, (ii) a web application to create and update database on the soils and generation of QR codes and reports, (iii) an android mobile application to scan the QR code to generate reports of a particular sample. The INSA shows the user the availability of soil samples and databases in a particular region on spatial maps (Fig. 2.6.3). More than 1000 soil samples have been stored and the database has been updated in the system. The system has been tested and validated with all the soil samples.



Fig. 2.6.3: Front view of Indian National soils archive

Advanced BHOOMI Geoportal Platform for the robust management of land resources database of India

Various thematic layers developed for Bundelkhand and Vidarbha regions have been processed and deployed on the BHOOMI Geoportal to visualize and query at the region and district level. Soil information at 1:10,000 scale for 10 blocks were processed and deployed on the BHOOMI Geoportal platform. A dedicated dashboard has been developed to visualize various thematic information at the state level (Fig. 2.6.4). The Geoportal Interoperable Platform' developed on BHOOMI Geoportal was tested with additional vector and raster datasets derived through API's from KRISHI. The database system of the Mobile App of Soil Survey Data Collection and Management System (SDCMS) has been integrated with BHOOMI

Geoportal to visualize the status of soil data collection during the field surveys. During the reporting period 53,052 viewers visited the BHOOMI Geoportal.

National Soil Spectral Library

A system is designed and developed with html, php, and CSS for the front end, java script for the back end and MySQL for the database, that will host spectral libraries of different types of soils of India with large sample sizes. The spectra of 1900 soil samples were generated under the National Soil Spectral Library. The user can visualize the spatial distribution of the samples and can select them based on administrative and AER/AESR boundaries. User-friendly options for zooming a part of the spectra and taking snaps of it are provided. The soil properties can be visualized by clicking on the legend in the plot (Fig.2.6.5).

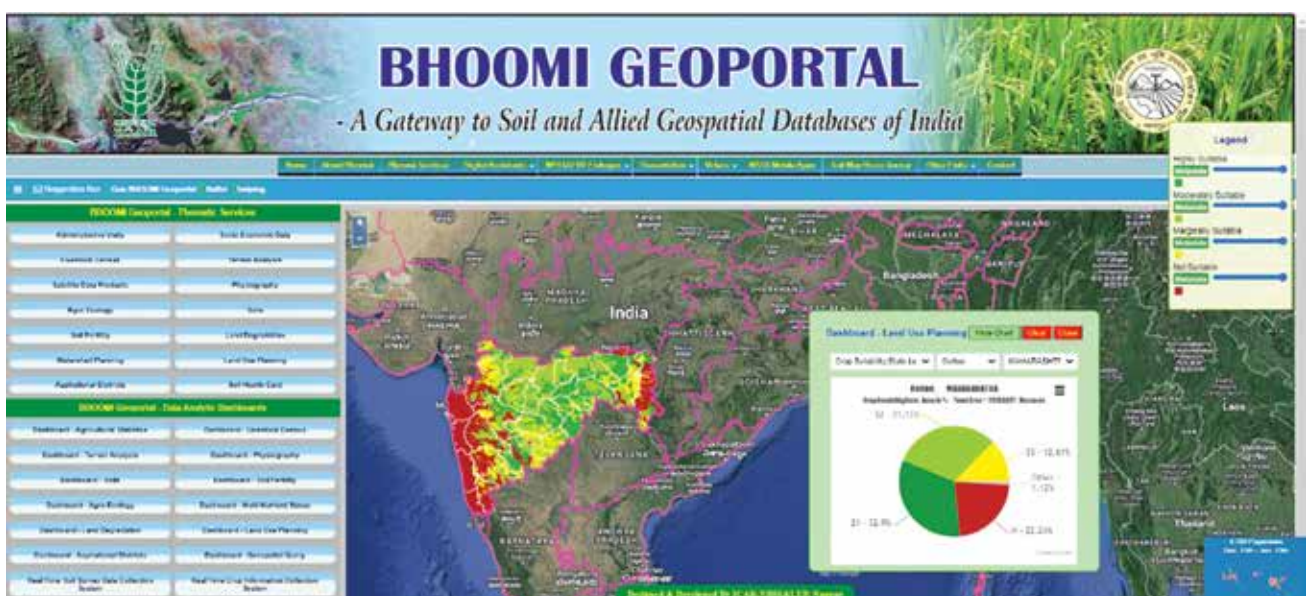


Fig.2.6.4. Query thematic information through modules developed on BHOOMI Geoportal platforms

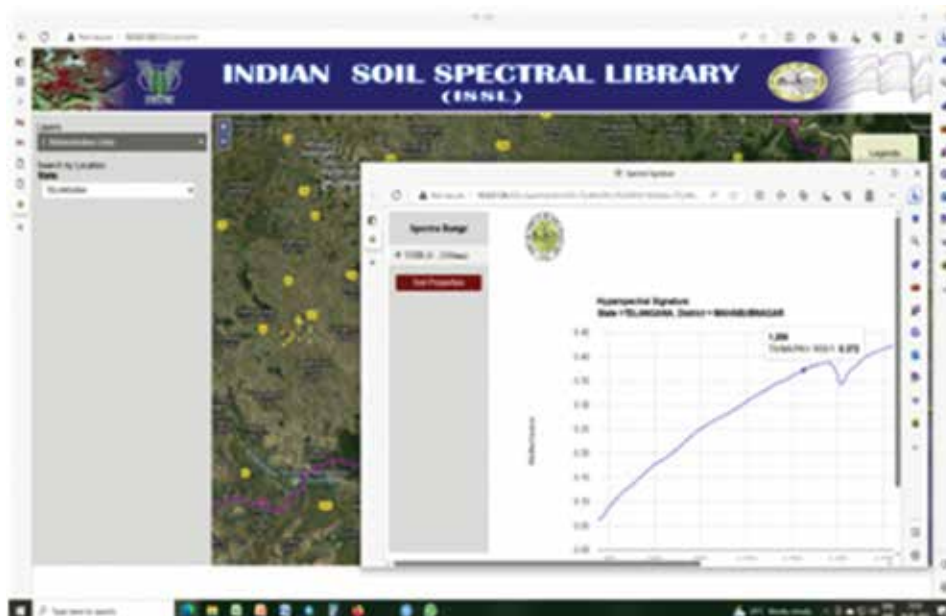


Fig. 2.6.5. Front-page of Indian soil spectral library developed.

Design and development of MobileApp on 'Soil Survey Data Collection and Management System (SDCMS)'

To ensure real-time soil survey data collection and not to lose any data in the form of profile sheets, profile photographs, etc. various additional features have been added in the Android Mobile app developed on 'Soil Survey Data Collection and Management System (SDCMS)' to be used by the soil survey field parties during the soil survey (Fig. 2.6.6). Log-in credentials are provided to the users and on logging in he/she can visualize only the samples assigned to him/her. It has capabilities of providing directions with Google Maps to reach the sampling site, fetching current location, and adding and updating soil site characteristics, number of horizons, profile photographs, and morphological properties.

Development of R package: SpatGRID: Spatial Grid Generation from Longitude and Latitude List

Developed R package: SpatGRID for Spatial Grid Generation from Longitude and Latitude List (Fig. 2.6.7). The developed function can be used to create spatial grids using user-specified latitude and longitude coordinates. To make sure the input longitude and latitude values are within the proper geographic ranges, the function first verifies their validity. The appropriate Universal Transverse Mercator (UTM) zone is then identified using the provided hemisphere and longitude values, after which a polygon is constructed from the coordinates. Subsequently, it transforms the input shapefile to the UTM projection when necessary. Finally, a spatial grid is generated with the specified interval and saved as a shapefile. The function takes into account crucial parameters such as the hemisphere (north or south), desired grid interval, and the output shapefile path. The developed function is an efficient tool, simplifying the process of empty spatial grid generation for applications such as, geostatistical analysis, digital soil mapping product generation, etc.

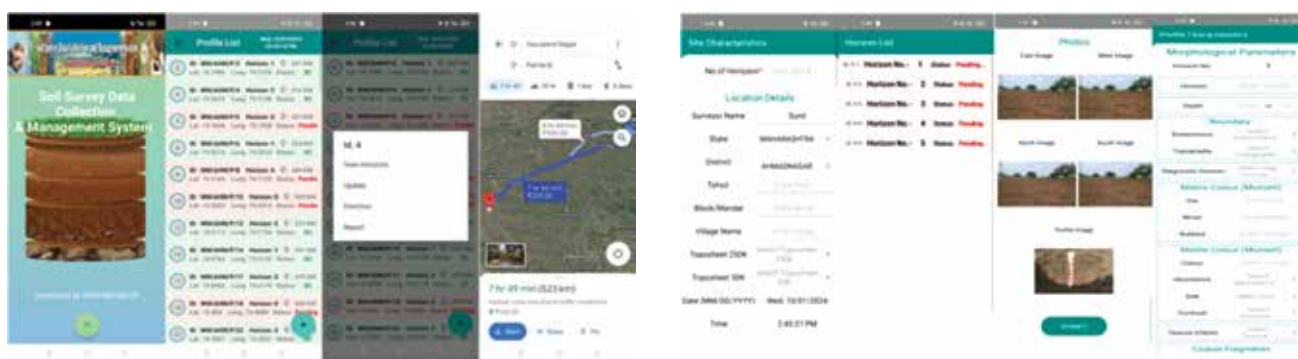


Fig. 2.6.6. Workflow of MobileApp on 'Soil Survey Data Collection and Management System (SDCMS)

The function takes into account crucial parameters such as the hemisphere (north or south), desired grid interval, and the output shapefile path. The developed function is an efficient tool, simplifying the process of

empty spatial grid generation for applications such as, geostatistical analysis, digital soil mapping product generation, etc.

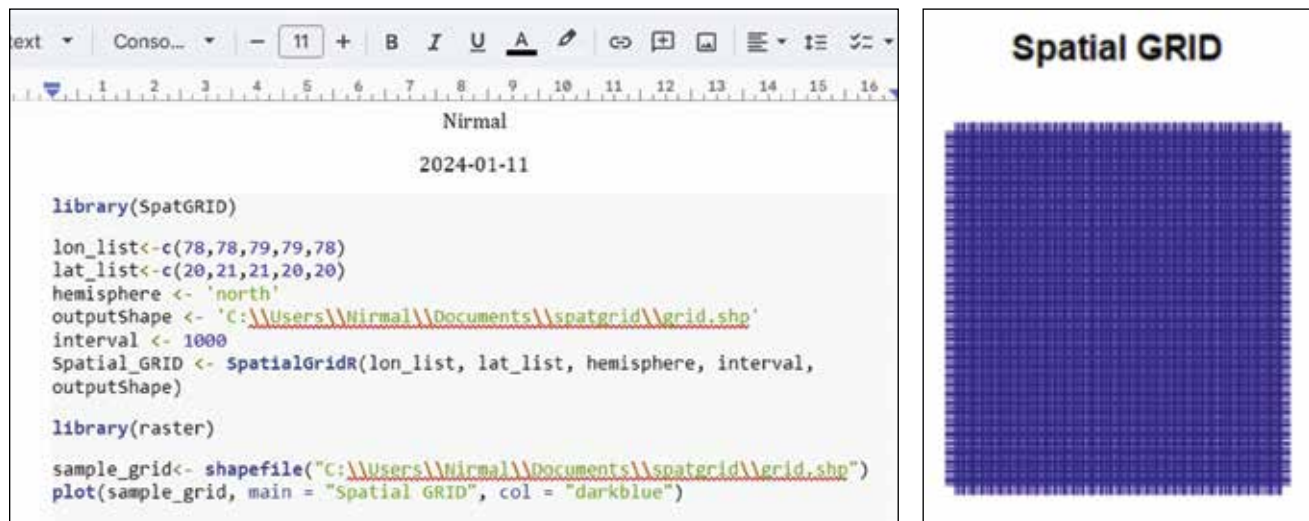


Fig. 2.6.7. Source code and grid output of SpatGRID R-package

INSTITUTE PROJECTS (ONGOING)**Inventorying Natural Resource****LAND RESOURCE INVENTORY (LRI)**

S. No.	Project Title	Principal Investigator
1	LRI and LUP of Hassan and Mandya districts, Karnataka using high resolution satellite data	R. Srinivasan
2	LRI and LUP of Koppal and Bellari districts, Karnataka using high resolution satellite data	B. Kalaiselvi
3	LRI and LUP of Chitradurga and Chikkamagaluru districts, Karnataka using high resolution satellite data	M. Chandrakala
4	LRI and LUP of Tumkur and Ramanagara districts, Karnataka using high resolution satellite data	K. S. Karthika
5	LRI and LUP of Yadgir district, Karnataka using high resolution satellite images	K. S. Anil Kumar
6	LRI and LUP of Davanagere and Shivamogga districts, Karnataka using high resolution satellite data	S. P. Maske
7	LRI and LUP of Chamarajnagar and Mysuru districts, Karnataka using high resolution satellite data	M. Lalitha
8	LRI and LUP of Kolar, Chikkaballapur and Bangalore Rural districts, Karnataka using high resolution satellite data	R. Vasundhara
9	Land resource inventory of Nadia district, West Bengal at 1: 10000 scale using geospatial techniques.	S. Gupta Choudhury
10	Land resource inventory of Murshidabad district, West Bengal at 1:10,000 scale using geospatial techniques.	B. N. Ghosh
11	Land resource inventory of Birbhum district, West Bengal at 1:10000 scale using new SOP methods.	S. Gupta Choudhury
12	Land resource inventory of Tirap district of Arunachal Pradesh at 1:10000 scale for agricultural land use planning using geo-spatial techniques.	S. Bandyopadhyay
13	Land resource inventory of Longding district of Arunachal Pradesh at 1:10000 scale for agricultural land use planning using geo-spatial techniques.	S.K. Reza
14	Land resource inventory of Kangra Region of Himachal Pradesh using geo-spatial techniques for sustainable land use planning	Ashok Kumar
15	Land resource inventory of Patiala district, Punjab on 1:10000 scale for agricultural land use planning	Sunil Kumar
16	Land resource inventory of Mandi region, Himachal Pradesh for agricultural land use planning using geospatial techniques	Sunil Kumar
17	Land resource inventory of SBS Nagar district, Punjab on 1:10000 scale for agricultural land use planning	R. K. Meena
18	Land resource inventory (1:10000 scale) of Pangi block of Chamba district, Himachal Pradesh for development of soil health cards and agricultural planning	R. K. Meena

S. No.	Project Title	Principal Investigator
19	Land resource inventory of Bhimtal block of Nainital district, Uttarakhand on 1:10000 scale for agricultural land use planning	Vikas Joon
20	Land resource inventory of upper Bramhaputra valley region of Assam for optimal agricultural land use planning	R. S. Meena
21	Land resource inventory of Morena district, Madhya Pradesh on 1:10000 scale for optimal agricultural land use planning, using geo-spatial techniques.	R. P. Sharma
22	Land resource inventory (1:10000 scale) of Amreli district, Gujarat using the new SOP for optimal agricultural land use planning.	Mahaveer Nogiya
23	Land resource inventory (1:10000 scale) of Narmada district, Gujarat for optimal agricultural land use planning using geospatial techniques.	R. L. Meena
24	Land resource inventory (1:10000 scale) of Dahod district, Gujarat for optimal agricultural land use planning using geospatial techniques	R. L. Meena
25	Land resource inventory of Tapi district, Gujarat using the New SOP for optimal agricultural land use planning.	L. C. Malav
26	Land Resource Inventory of Vadodara district, Gujarat using the new SOP for optimal agricultural land use planning.	Brijesh Yadav
27	Land Resource Inventory of Anand district, Gujarat Using the New SOP for Optimal Agricultural Land Use Planning.	B. L. Mina
28	Land Resource Inventory of Ahmednagar district, Maharashtra on 1:10000 scale using geo-spatial technique	Ranjan Paul
29	Land Resource Inventory of Wardha district of Maharashtra at 1:10000 scale using geo-spatial technique for agricultural land use planning	K. Karthikeyan
30	Land resource inventory and land use planning of Osmanabad district of Maharashtra using geospatial techniques	U.K. Maurya
31	Land resource inventory of Bemetara block, Bemetara district, Chhattisgarh state (AESR 11) on 1:10000 scale for optimal agricultural land use planning, using geo-spatial techniques	K. Karthikeyan
32	Land Resource Inventory of Washim district, Maharashtra at 1:10000 scale for optimal agricultural land use planning	P. C. Moharana
33	Land Resource Inventory of Gadchiroli district of Maharashtra on 1:10000 scale using geoinformatics	R. K. Naitam
34	Land Resource Inventory of Yavatmal district of Maharashtra on 1:10000 scale using remote sensing and GIS technique	R.K. Naitam
REMOTE SENSING AND GIS APPLICATIONS		
35	Hydrology integration and development of spectral library	S. Dharumarajan
36	High resolution (90 m) digital soil mapping of key soil properties of Eastern Region of India (Phase I: West Bengal)	S. Chattaraj
37	Development of GIS based digital library and data analysis	S. Srinivas
38	High Resolution soil mapping using DSM techniques in Marathwada region of Maharashtra	S. Chattaraj
39	Digital mapping of soil attributes in Central Brahmaputra valley region of Assam.	Arijit Barman
40	High resolution soil mapping using digital soil mapping techniques in Central region of Gujarat	Brijesh Yadav
41	High resolution soil mapping of Barmer district, Rajasthan for optimal agricultural land use planning using digital soil mapping techniques	P. C. Moharana
42	Development of soil grid portal of India	Nirmal Kumar



S. No.	Project Title	Principal Investigator
43	High resolution soil attributes mapping in central Chhattisgarh state using digital soil mapping techniques.	Sunil B. H.
44	Advance Bhoomi Geoportal platform for the robust management of land resources database of India	G.P. Obi Reddy
45	Development of Indian National Soils Archive	Nirmal Kumar
46	Spatial modelling for delineation of agro-ecological zones (AEZs) of India for smart agricultural planning using earth observation time-series data.	G.P. Obi Reddy
47	Hyperspectral characterization of soils of Indian soils and development of soil spectral library and models for quick assessment of soil properties	H. Biswas
48	High resolution soil attributes modeling using digital soil mapping techniques in Western region of Maharashtra	Nirmal Kumar
49	High resolution soil attributes modeling using digital soil mapping techniques in Konkan region of Maharashtra	H. Biswas
50	High resolution soil attributes modeling using digital soil mapping techniques in Khandesh region of Maharashtra	B. H. Sunil
51	Digital Terrain Analysis and Characterization of Landforms for Soil-Landscape Modelling in Maharashtra Using Remote Sensing Data, DEM and GIS	G.P. Obi Reddy
LAND EVALUATION AND AGRICULTURAL LAND USE PLANNING		
52	Evaluation of effectiveness of land resources inventory in watershed development and its impact on agro-ecosystem services and Nugehalli livelihood in Chamarajanagar district, Karnataka	S. C. Ramesh Kumar
53	Revision of soil site suitability criteria for major crops	V. Ramamurthy
54	Agricultural land use planning for Indo-Gangetic plain regions of India towards sustainable crop production and livelihood security- A case study in Mathura district of Uttar Pradesh	Ashok Kumar
55	Heavy metal contamination and ecological health risk evaluation in peri-urban wastewater irrigated soils of Nagpur city	Amrita Daripa
56	Assessment of ecosystem service value in response to LULC changes in different agro-climatic zones of Rajasthan using geospatial techniques	L. C. Malav
57	High resolution soil soil-site suitability mapping for major crops in Maharashtra state using geospatial technique	R.K. Naitam
58	Energy budgeting and carbon footprint of major crops in Hingoli district of Marathwada region for optimizing land use plan	A.O. Shirale
59	Land resource inventory of Rahuri taluka, Ahmednagar district, Maharashtra State on 1:10000 scale for optimal agricultural land use planning, using geo-spatial techniques	R.K. Naitam
60	Land Resource Inventory of Seloo and Samudrapur tehsils of Wardha district Maharashtra on 1:10000 Scale using Geo-spatial Techniques for Optimal Agricultural Land Use Planning.	R.K. Naitam
61	Evaluating and mapping soil-site suitability for major crops in Central India using GIS based multi criteria decision analysis	M. S. Raghuvanshi
62	Socio Economic Impact of Land Use Land Cover Change in Selected districts of Eastern Vidarbha Zone in India	H. L. Kharbikar
INTERPRETATION OF SOIL SURVEY DATA		
63	Soil loss evaluation using morphometric parameters in Harve micro-watershed.	S. P. Maske
64	Development of an objective technique for land degradation assessment.	S. Dharumarajan

S. No.	Project Title	Principal Investigator
65	Assessment of land-soil-water continuum in multi-functional peri-urban landscape of East Kolkata wetlands for sustainable land use planning.	Tapati Banerjee
66	Development of land resource inventory based long-term soil organic carbon restorative land use plan in humid sub-tropical region of Eastern India (Jalpaiguri district).	B. N. Ghosh
67	Sensor based surface and deep soil carbon modeling for predicting active and passive pools of carbon in different landforms of Arunachal Pradesh.	K. K. Mourya
SCSP PROGRAMME		
68	Livelihood improvement of SC communities of selected villages of Kolar district through integrated land use planning	R. Vasundhara
69	Agricultural land use planning to enhance productivity and livelihood security of farming community of Majherpara village of Canning-II block, South 24 Parganas district, West Bengal	S. Bandyopadhyay
BASIC PEDOLOGICAL RESEARCH		
70	Pedo-diversity of Vertisols in different agro-ecological regions of India	D. Vasu
71	Quantification of micro-morphological features for climate change and its implication	U.K. Maurya
72	Nature and composition of nano-clays of major soil groups of India (Vertisols, Alfisols and Ultisols) and their implications in managing nutrients	Ranjan Paul
73	Genesis and Classification of Soils in Bemetara Block, Bemetara district, Chhattisgarh	K. Karthikeyan
EXTERNALLY FUNDED PROJECTS (ONGOING)		
74	Project on Climate Resilient Agriculture (PoCRA-2) Funding/Sponsored by Government of Maharashtra	Nitin G. Patil All Scientists of HQrs
75	An algorithm to predict soil depths and engineering properties Funding/Sponsored by Adani Transmission Limited	Nitin G. Patil
76	Land Resource Inventory of FDCM Divisions Using High Resolution Geo-spatial Technique. Funding/Sponsored by Forest Development Corporation of Maharashtra	R.K. Naitam
77	ICAR Research Data Repository for Knowledge Management (KRISHI) Funding/Sponsored by ICAR	G.P. Obi Reddy
78	REWARD-Karnataka, Watershed Development Department (WDD), Government of Karnataka	Rajendra Hegde
79	REWARD Project Directorate of Soil Conservation & Watershed Development, (DSC & WD), Odisha, Govt. of Odisha	S. Bandyopadhyay
80	Karnataka Watershed Development for drought prevention Department (KWDPD), Bengaluru, Government of Karnataka	V. Ramamurthy
81	Identification, Mapping and Characterization of Fallow land for Conversion to productive lands in Tamil Nadu using Remote Sensing and GIS tools TNSLURB	R. Srinivasan
82	Land Resource Inventory of Pench National park for ecological restoration Govt. of Madhya Pradesh	K. Karthikeyan
83	Land Resource Inventory of NACIN, Palasamudaram, Andhra Pradesh National Academy of Customer, Indirect Taxes & Narcotics (NACIN) Ministry of Finance, Govt. of India	K. Karthikeyan
84	Development of spatial soil management zones as an agri-technology implementation in Eastern Himalayan foothills of Jalpaiguri district, West Bengal C-DAC	S. Chattaraj
85	Land resource inventory of Tripura state at large scale for agricultural land use planning using geo-spatial techniques Govt. of Tripura	S. K. Reza



S. No.	Project Title	Principal Investigator
86	Land resource inventory of Arunachal Pradesh at large scale for agricultural land use planning using geo-spatial techniques. Govt. of Arunachal Pradesh	S.K. Ray U.S. Saikia
87	Land resource inventory of four selected watersheds in Bihar using geo-spatial techniques (Under PMKSY 2.0) Bihar Watershed Development Society (BWDS) (SLNA), Govt. of Bihar	S.K. Reza
88	Land resource inventory of Cinchona and other medicinal plants growing area of Darjeeling district on larger scale using geo-spatial techniques Dept. of Cinchona and Aromatic plants Govt. of West Bengal	S. K. Reza
89	Hyperspectral reflectance and multi-nutrient extractant based rapid assessment of soil properties for sustainable soil health in India ICAR (NASF)Lead Institute: ICAR-CAZRI Cooperating Institute: ICAR-NBSS&LUP	Nirmal Kumar
90	Pilot project on "Crop Diversification". (funded by Ministry of Agriculture and Farmers Welfare)	V. Ramamurthy
91	Development of an objective technique for land degradation assessment (funded by Dept. of Space, Govt. of India)	S. Dharumarajan
INSTITUTE PROJECTS (COMPLETED)		
1	Land resource inventory of Mandapam block of Ramanathapuram district, Tamil Nadu for optimal land use planning.	S. Dharumarajan
2	Digital soil mapping of India (Indian Soil Grids) project	S. Dharumarajan
3	Land resource inventory of Nuggehalli block (Part) of Channarayapatna taluk, Hassan district, Karnataka on 1:10K scale for optimal agricultural planning using geo-spatial techniques.	R. Srinivasan
4	Land resource inventory of Maldah district, West Bengal at 1: 10000 scale using geospatial techniques.	S. Gupta Choudhury
5	Landform identification and mapping of Aspirational districts of Eastern India.	S. Mukhopadhyay
6	LRI of Chamba Block, Tehri Garhwal District of Uttarakhand for agricultural land use planning	Vikas Joon
7	Land resource inventory of Rangjuli block, Goalpara district, Assam (at 1:10000 scale) for optimal agricultural land use planning using geo-spatial techniques	Surabhi Hota
8	Land resource inventory of Lohit district of Arunachal Pradesh at large scale for agricultural land use planning using geo-spatial techniques.	Surabhi Hota
9	Assessment of heavy metal contamination in soil, water and vegetables at selected hotspots in Purna river basin, Maharashtra	L. C. Malav
10	Land resource inventory of the Dangs district, Gujarat (1:10000 scale) using the new SOP for optimal agricultural land use planning.	Mahaveer Nogiya
11	Delineation of potential areas for Pomegranate cultivation in India using Remote Sensing and GIS modelling (Inter-institutional collaborative project of ICAR-NBSS&LUP and ICAR-NRCP).	G.P. Obi Reddy R.A. Marathe D.T. Meshram
EXTERNALLY FUNDED PROJECT (COMPLETED)		
1	Spatial Crop Planning for Sustainable Resource Use and Conservation of Ecological Resources under GoI-GEF-UNDP IHRML project.	S. Dharumarajan
2	Accompanying the adaptation of irrigated agriculture to climate change (ATCHA project)	S. Dharumarajan
3	Development of standard protocols for assessment of cropped area, crop monitoring and precision orchards management in mango.	R. Vasundhara
4	Role of crystalline and non-crystalline nano-clays for carbon stabilization in pedo-genetically important soil orders of tropical India (DST)	Ranjan Paul
5	Development of spectral models for prediction of soil properties in soils of Maharashtra using hyperspectral remote sensing (A collaborative project with Neoperk Technologies Pvt. Ltd., Mumbai).	M.S.S. Nagaraju

Research Papers

1. Daripa, A., Chattaraj, S., Malav, L.C., Sharma, R.P., Naitam, R.K., Mohekar, D.S., and Ramamurthy, V. 2023. Land use-based distribution pattern, fractionation forms and health risk assessment of heavy metals in mining-affected soils of western Ghat of Goa, India. *International Journal of Plant & Soil Science*. **34**(23), 838-854. (NAAS 5.07)
2. Daripa, A., Chattaraj, S., Malav, L.C., Ray, P., Sharma, R.P., Mohekar, D.S., Ramamurthy V., Raghuvanshi, M.S. and Patil, N.G. 2023. Risk assessment of agricultural soils surrounding an iron ore mining: a field study from Western Ghat of Goa, India. *Soil and Sediments Contamination – An International Journal*, **32**(5), 570-590. DOI: <https://doi.org/10.1080/15320383.2022.2111403>. (NAAS 9.06)
3. Gupta Choudhury, S. and Banerjee, T. 2023. Land Resource Inventory: A primary tool for sustainable integrated watershed management. *International Journal of Environmental & Agriculture Research*, **9**(2), 13-16.
4. Kumar, Sunil., Phogat, V.K., Dahiya, Rita., Yadav, Vikas., Meena, R.L., Nogiya, Mahaveer., Yadav, Lalu Prasad., Priya, Himani., Yadav, Sunil Kumar., Tiwari, Shalini and Surya, Jaya N. 2023. Assessment of poor-quality irrigation water under different cropping systems in Arid and Semi-Arid region, India. *Agricultural Mechanization in Asia Africa and Latin America*, **54**(08), 15359-15367. (NAAS 6.29)
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 28. Srinivasan, R., Maske, S.P., Maddileti, N., Ramamurthy, V. and Kalaivanan, D. 2023. Deforestation - Major Cause for Soil Erosion in Hilly Regions of Karnataka. *Agro India*, April, 21-22.
 29. Srinivasan, R., Maske, S.P., Maddileti, N., Ramamurthy, V. and Kasthuri Thilagam, V. 2023. Nitrogen Deficiency in Arecanut: Causes and Management. *Trends in Agriculture Science* 2(4), 563-566.
 30. Srinivasan, R., Maddileti, N., Ramamurthy, V. and Kalaivanan, D. 2023. Ginger Productivity Is high in Red Gravelly Soils of Karnataka. *Agro India*, July, 33-34.
 31. Vasundhara R, Dharumarajan S, Rajendra Hegde, 2023. Mango cultivation: soil and climate is more suitable for mango orchards cultivation in kolar district of Karnataka, *Agro India*, October, 15-17
 32. मनीष ओलानिया, जयानिरांजने सूर्या, सुनिल कुमार, दिलिप कुमार कटियार मिलेट् रूगुण्वत्ता का परिचय इंटरनेशनल ईयर आफ मिलेट्स के प्ररिपेक्ष में: Dharti Patrika, 2022-23, NBSS&LUP.

Seminar / Symposium / Conference/ Workshop /Abstracts/Poster/Presentation

Papers Presented in the Seminars

International Conference on “Sustainable &



Resilient Environment development -2023 (ICSRED – 23)” at NEERI, Nagpur during 17-18 February, 2023

1. Naitam, RK (2023). Delivered a lead talk on “Soil quality and Agricultural Land Use Planning” in **National Seminar on Developments in Soil Science-2023 during 87th Annual convention of the Indian Society of Soil Science on 3-6th October at IISS, Bhopal, India.**

1. Nirmal Kumar 2023 Spectral libraries of Indian soils and system for On-line soil spectroscopy”
2. Srinivasan, R., Ramamurthy, V., Lalitha, M., Kalaiselvi, B., Vasundhara, R., Karthika, K.S., Vivek, M. S., Nichitha, C.V., Sharath Babu, C., Charankumar, G.R., Patil, N.G. 2023. Land Capability and Crop suitability assessment using LRI data to mitigate Drought in Watershed scale.

International Conference on Biodiversity, food security and climate change organised at Assam Agricultural University, Jorhat, Assam.

1. Hota, S. Suna, T., Mourya, K. K., Barman, A., Meena, R. S., Chutia, D. and Saikia, U. S. 2023. Exploring machine learning techniques for prediction of irrigation water quality of lower Brahmaputra valley of North-eastern India.
2. Mourya, K. K., Hota, S., Barman, A., Meena, R. S. and Saikia, U. S. 2023. Soil characterization and land suitability evaluation for land use planning using geospatial techniques in the lower Brahmaputra valley zone of Assam.
3. Barman, A., Srivastava, R., Mourya, K. K., Hota, S., Meena, R. S. and Saikia, U. S. 2023. Spectral Properties of Sodium Salt Dominated Soils and Development of Soil Reflectance Library.
4. Sumantra Arya, Awtar Singh, Arijit Barman, Dinesh, R.S. Garhwal 2023. Spatial variability assessment of soils and water quality in the Basin of Hindon River. In: International Conference on Strategies for Global Food and Nutritional Security, Sustainability and Wellness (NUTRI-2023), Abstract, December 04-06, CCS HAU, Hisar, India.

Asian Citrus Congres-2023 on “Advancing Citriculture Agro-economic Prosperity” at CCRI, Nagpur during 28-30 October, 2023.

1. Ravindra Naitam, Preeti Deshmukh, Abhay Shirale and Nitin Patil (2023) Dynamics of Soil Organic Carbon Stock under Citrus, Cotton and Forest systems in black cotton soils of the Nagpur District, Maharashtra, India.

5th International Conference on Sustainable Natural Resources Management under Global Climate Change organized by SCSi at New Delhi during November 7-10, 2023.

1. Meena, R.K., Joon, V. and Surya, Jaya N. 2023. “Characterization of Soil Resources using Geospatial technologies for Sustainable Agricultural Land Use Planning: a case study from intensively cultivated Trans Indo-Gangetic plains” published In: S. Mannivannan, TBS Rajput, Sanjay Arora, V. Kasturi Thilagam, Nandlal Kushwaha, Mukar Kumar, RAS Patel, Manjushree Singh (Eds)
2. Malav, L. C., Daripa, A., Jangir, A., Yadav, B., Nogiya, M., Meena, R. L., Sharma, R. P. and Mina, B. L. 2023. Heavy Metal Contamination in Soil and Vegetables and Their Health Risk to Human Health in Peri-Urban Agriculture of Central India.
3. Malav, L. C., Daripa, A., Yadav, B., Jangir, A., Nogiya, M., Meena, R. L., Sharma, R. P. and Mina, B. L. 2023. Heavy metal contamination in soil and vegetables and their health risk to human health in peri-urban agriculture of central India.
4. Meena, R. L., Moharana, P. C., Nogiya, M., Meena, R. S., Malav, L. C., Yadav, Brijesh., Kumar, Sunil., Sharma, R. P. and Mina, B. L. 2023. Large Scale Soil Mapping Using Geospatial Techniques-A Case Study of Dahod District, Gujarat.
5. Nogiya, M., Moharana, P. C., Meena, R. L., Yadav, Brijesh., Malav, L. C., Sharma, R. P., Kumar, Sunil., Mina, B. L. and Patil, N. G. 2023. Predictive Soil Mapping of Soil organic Carbon in Hill Ranges of South Gujarat of India.
6. Yadav, B., Malav, L. C., Nogiya, M., Meena, R. L., Sharma, R. P. and Mina, B. L. 2023. Land Degradation Vulnerability Mapping in Arid Ecosystem of Rajasthan Using Geospatial Techniques and Analytical Hierarchy Process.
7. Chandrakala M., Chakraborty, R., Parvathy, S., Sunil P. Maske, Karthika K.S., Srinivasan, R., Bhaskar, B.P., Ramamurthy, V., Ramesh Kumar S.C., Nirmal Kumar, Obi Reddy G. P. and Patil N.G. 2023. Assessment of Groundwater Quality for Management of Drinking and Irrigation Water on Sustainable basis in Chitradurga district, Karnataka, India.
8. Dharumarajan, S., Vasundhara, R., Hegde, R., Lalitha, M., Kalaiselvi, B., and Ramamurthy, V. 2023. Karnataka Soil Spectral Library: A tool for Rapid Soil Testing Based on Reflectance Properties of the Soils in Karnataka.

9. Karthika, K.S., Anil Kumar, K.S., Srinivasan, R., Chandrakala, M., and Lalitha, M. 2023. Land suitability assessment for the cultivation of rice in a semi-arid ecosystem in Telangana, India.
10. Srinivasan, R., Ramamurthy, V., Lalitha, M., Anuja Hiregoudar and Sudha Ramen. 2023. Assessment and Mapping of the Fallow land in Tamil Nadu using Landsat imageries for increasing crop productivity and minimizing land degradation. pp, 88.
11. Srinivasan, R., Ramamurthy, V., Lalitha, M., Kalaiselvi, B., Vasundhara, R., Karthika, K.S., Vivek, MS., Nichitha, C.V., SharathBabu, C., Charankumar, G.R., Patil, N.G. 2023. Land Resources Inventory is Key Component for Drought Mitigation: A Case Study in Kudumalakunte Sub-Watershed, Karnataka., pp, 50.
12. Vasundhara, R., Dharumarajan, S., Hegde, R., Ramamurthy, V. and Patil, N.G. 2023. Soil Carbon Sequestration Potential of Mango (*Mangifera indica* L.) Growing Orchards under Rainfed Region of Karnataka.

XXII Biennial National Symposium of Indian Society of Agronomy, 22–24 November, 2023 at ICAR-CCARI, Ela, Goa.

1. Kumar, Ashok., Vikas, Nagdev, R., and Surya, Jaya. N. 2023. Evaluation of soil suitability for pearl millet as an alternate land use option towards achieving food and nutritional security and climate resilience -A case study in IGP. p. 368-369.
2. Meena, R. L., Moharana, P. C., Nogiya, Mahaveer., Kumar, Sunil., Meena, R. S., Malav, L. C., Yadav, Brijesh., Sharma, R. P. and Mina, B. L. 2023. Suitability Assessment of Wheat (*Triticum aestivum* L.) under Land Management Units of Arid Western Plain of Gujarat, India.
3. Meena, R. L., Moharana, P. C., Nogiya, Mahaveer., Kumar, Sunil., Meena, R. S., Malav, L. C., Yadav, Brijesh., Sharma, R. P. and Mina, B. L. 2023. Suitability Assessment of Wheat (*Triticum aestivum* L.) under Land Management Units of Arid Western Plain of Gujarat, India.

National Conference on Natural Resource Conservation and Management for Agricultural and Environmental Sustainability, Academy of Natural Resource Conservation and Management organized during December 8-9, 2023 at Lucknow.

1. Sharma R.P., Yadav, B and Malav, L.C. 2023. Digital soil mapping in India: Current progress and ways forward. Published in Souvenir cum abstracts, (Edited by Arora, Sanjay, Singh, A.K.,

Ammal B.U., Chopra, I., Sarmah, A.K., Sharma, N. and Ojha, R.P.), Pp 6-13.

International Conference on Feeding the Future through Sustainable Eco-friendly Innovations in Rangeland, Forages and Animal Sciences” held at University of Agricultural Sciences, Bangalore during 2-4 December.

1. Chandrakala M., Chakraborty, R., Parvathy, S., Maske, S.P., Karthika K.S., Bhaskar, B.P., Ramamurthy, V., Ramesh Kumar S.C., Nirmal Kumar, Obi Reddy G. P. and Patil N.G. 2023. ‘Assessment of Soil fertility Status and Soil Health Management for Sustainability in Chitradurga district, Karnataka, India

Seminar/Conference/Workshop Attended

1. Dr. Nirmal Kumar attended International Conclave on Futuristic Farming organized by MPKV, Rahuri from 20- 21st December, 2023.
2. Dr. Arijit Barman, Dr. K. K. Mourya, and Dr. Surabhi Hota attended 3rd International Conference on Biodiversity, food security and climate change organised at Assam Agricultural University, Jorhat, Assam during 25-28 April, 2023.
3. Dr. Jaya N. Surya & Dr. Ashok Kumar attended Stakeholder Dialogue on Enhancing Fertilizer Use Efficiency for Sustainable Soil Health” organized by TAAS, New Delhi on 28-29 September, 2023, at NASC Complex, New Delhi.
4. Dr Sunil Kumar attended 5th International Conference on Sustainable Natural Resources Management under Global Climate Change organized by Soil Conservation Society of India from 07-10 November, 2023 at NASC-Complex, New Delhi, India.
5. Dr. Jaya N. Surya, Dr. Sunil Kumar and Sh. Sabu Samuel attended International Conference on Blending Learning Ecosystem for Higher Education in Agriculture” scheduled from March 21-23, 2023, at NASC complex, New Delhi.

Lectures Delivered

1. G.P. Obi Reddy delivered a lecture on “Advances in geospatial technologies for land resource inventory” on 6th January 2023 in 21 days training program on “Soil Survey and Land Use Planning” for soil survey officers sponsored by the Directorate of Soil Survey and Soil Conservation, Thiruvananthapuram, Kerala from 03rd to 23rd January 2023.



2. Nirmal Kumar delivered a lecture on “R for spectral data visualization and modelling for soil and plant studies” on 19th January 2023 in “Air borne hyperspectral remote sensing for agriculture” held at ICAR-IARI, New Delhi during 16-25 January, 2023.
3. Nirmal Kumar delivered a lecture on “remote sensing techniques for soil characterization” on 14th October 2023 in “Season long training programme on cotton” held at ICAR-RCIPMC, Nagpur during 27th September to 26th October, 2023.
4. Nirmal Kumar delivered a lecture on ‘Digital soil mapping’ on 12th December 2023 in “Remote Sensing for Agricultural Applications for BIMSTEC Participants” held at ICAR-IARI, New Delhi during 4-15 December, 2023.
6. Dr. R. P. Sharma, Scientist delivered a lecture on “Bhumi Suposhan” in a 15 days CAFT training programme on “Natural Farming: Present status and future prospectus” organized by Centre for Advanced Faculty Training on Organic Farming, MPUAT, Udaipur on 08th September 2023.
7. Dr. R. P. Sharma, Sr. Sci. delivered a lecture on “Soils of Rajasthan” to 46 trainees of fertilizer input dealers, MPUAT on 15th September 2023.
8. Dr. R. P. Sharma, Sr. Sci. delivered a lecture on “Plant nutrient management” to 46 trainees of fertilizer input dealers, MPUAT on 15 September 2023.
9. Dr. Mahaveer Nogiya, Sci. delivered a lecture on “Analysis of chemical properties of soil and water” to 46 trainees of fertilizer input dealers, MPUAT on 15th September 2023.

Lectures Delivered

Teaching:

1. Dr. Mahaveer Nogiya, Scientist, taught a course “Soil-509-Remote sensing and GIS technique for soil and crop studies (2+1)” in M.Sc. (Ag.) courses II semester at Department of Soil Science and Agricultural Chemistry, Rajasthan College of Agriculture (MPUAT), Udaipur- (Academic session 2022-23).
2. Dr. R. L. Meena, Scientist, taught a course “Agron-502-Principal and Practices of Soil Fertility and Nutrient Management (2+1)” in M.Sc. (Ag.) courses, semester-I at Department of Agronomy, Rajasthan College of Agriculture (MPUAT), Udaipur- (Academic session 2023-24).
3. Dr. R. K. Naitam, Scientist delivered guest lectures on “Soil Health and Agricultural Land Use Planning” in five days orientation training programme on the “IPM Programme under Human Resource Development Rabi 2022-23” organized by RCIPMC, Nagpur during 16-20 Jan, 2023.
4. Dr. R. K. Naitam, Scientist delivered guest lectures on “Importance of soil testing and soil health card” in Long training programme on the “IPM Cotton” organized by RCIPMC, Nagpur during 27.09 to 26.10, 2023.
5. Dr. R. P. Sharma, Sr. Scientist delivered a lecture on “One Health Concept” in a 15 days CAFT training programme on “Natural Farming: Present status and future prospectus” organized by Centre for Advanced Faculty Training on Organic Farming, MPUAT, Udaipur on 04th September 2023.
10. Dr. Brijesh Yadav, Sci. delivered a lecture on “Soil physical properties” to 46 trainees of fertilizer input dealers, MPUAT on 15th September 2023.
11. Dr. R. L. Meena, Sci. delivered a lecture on “Best management practices in agriculture with respect to fertilizers application” to the trainees of 15 days training programme on “Retail Fertilizer Dealer Certificate Course” at MPUAT on 13th December 2023.
12. Dr. Lal Chand Malav, Sci. delivered a lecture on “Methods of micronutrients and physical properties analysis of soil and water” to the trainees of 15 days training programme on “Retail Fertilizer Dealer Certificate Course” at MPUAT on 13th December 2023.
13. Dr. Mahaveer Nogiya, Sci. delivered a lecture on “Methods of chemical analysis of soil and water” to the trainees of 15 days training programme on “Retail Fertilizer Dealer Certificate Course” at MPUAT on 13th December 2023.
14. Dr. U.K. Maurya, Pr. Sci. delivered a talk on “Different aspects of PIDPI and Preventive vigilance” at Gumthi village, Nagpur on 26.09.2023.
15. Dr. U.K. Maurya, Pr. Sci. delivered a talk on “Different aspects of Preventive vigilance” at Sillori village of Kamleswar Tehsil, Nagpur District on 03.11.2023.
16. Dr. D. Vasu, Sr. Sci. delivered a lecture on “Soil organic carbon as a tool to achieve land degradation neutrality” at the sensitization workshop on sustainable land management for combating degradation and collaborative development of training modules at Centre of

- Excellence on Sustainable Land management, ICFRE, Dehradun during 11-12 September, 2023.
17. Dr. D. Vasu, Sr. Sci. delivered an online lecture on "Land degradation neutrality as a mean to achieve sustainable development goals" on 18 December 2023 at the three days training programme on Sustainable land management through Adaptive and Climate Resilient Interventions at Centre of Excellence on Sustainable Land management, ICFRE, Dehradun.
 18. Dr. D. Vasu Sr. Sci. delivered an online lecture on "soil survey techniques for large scale soil mapping" to UG students of TNAU, Coimbatore on 31 July, 2023.
 19. Dr. Ranjan Paul Sci. presented a talk on "Characteristics and Edaphological Significance of Nano Size Smectites of Cracking Clay Soils (Vertisols) of Tropical India" in the AIPEA Early Career Clay Scientist Network's Bi-monthly Webinar series of Indian Clay Group during 24 March 2023.
 20. Dr. Ranjan Paul Sci. delivered a lecture on "Application of Nano Science in Soil Research" as Expert Scientist in the "Training Programme on Soil Health Management" of Vasantrao Naik State Agriculture Extension Management Training Institute (VANAMATI), Nagpur on 11 May 2023.
 21. Dr. Ranjan Paul Sci. delivered an online talk on "Application of Nanoscience in Soil Research" at an international virtual seminar of the School of Agricultural Innovations and Advanced Learning (VAIAL), Vellore Institute of Technology (VIT), Vellore on 30 Sept 2023.
 22. Dr. Arijit Barman Sci. delivered a lecture on 24/05/23 entitled "Use of Geo-Informatics and Sensor-based technologies in Precision Farming" in the Collaborative Training Program (ONLINE) On "ICTs for Agricultural Extension-New Concepts: IoT in Agriculture; GIS & AI" organized by Institute on Management of Agricultural Extension (IMAGE), Siripur, Bhubaneswar -751 003, Odisha during May 23-25, 2023.
 23. Dr. U. S. Saikia Pr. Sci. and Head (Act.) attended as Resource person in the Earth Day celebration of J B College, Jorhat on 06-05-2023 and delivered a lecture on the theme 'Invest in Our Planet'.
 24. Dr. Jaya Surya Pr. Sci. and Head delivered lecture on "Importance of Soil Health Management for Sustainable Land Use Planning for crop productivity" the occasion of Celebration of World Soil Day as a Chief Guest at SLUSI, M/O A&FW, Noida on the on 05.12. 2023
 25. Dr. Ashok Kumar Sr. Sci. delivered a lecture (virtual mode) on "Improving land and agricultural productivity through sustainable agricultural land use planning" in ICAR (HRM Division) sponsored training programme on "Good Agricultural Practices (GAPs) for enhancing resource-use efficiency and farm productivity" on 25.01.2023.
 26. Sh. Vikas Joon Sci. delivered a lecture on "Benefits of cleanliness" on 18.12.2023 at Shaheed Captain Amit Verma Government Co-Ed. Sarvodaya Vidhyalaya, Inderpuri, New Delhi, during Vigilance Awareness Week 2023 at ICAR-NBSS&LUP, RC, Delhi.
 27. Sh. Vikas Joon Sci. delivered a lecture on "Method of preparing vermicompost from farm residues" on 20.12.2023 in Tiggipur village of New Delhi during Swachhta Pakhwada 2023 celebration by ICAR-NBSS&LUP, RC, Delhi.
 28. Sh. Vikas Joon Sci. delivered a lecture on "Farm Waste to Wealth" on 23.12.2023 in Issapur village of New Delhi during Swachhta Pakhwada 2023 and Farmer day celebration by ICAR-NBSS&LUP, RC, Delhi.
 29. Dr. Sunil Kumar Sci. delivered lecture on "Soil Health and Nutrients Managements" during "World Soil Day" celebration at Krishi Vigyan Kendra (KVK) Shamli district, Uttar Pradesh on 05.12 2023.

Training Manual

1. Raghuvanshi, M.S., Kharbikar, H.L., Naitam, R.K., Shirale, Abhay, O., Moharana, P.C., and Patil, N.G. (2023) *Mrida Swasthya card: Mitti aur fasal utpadakta hetu ek sadhak*. In Training Manual on 3-days on *Mrida Swasthya card: Mitti aur fasal utpadakta hetu ek sadhak* ICAR-NBSS&LUP Publication No.-1172 held at ICAR-NBSS&LUP, Nagpur: 1-72 pp.

E-Publications

1. Haokip, I. C., Homeshwari Devi, M., Dey, P., Lenka, N. K., & Sunil, B. H. (2022). Potassium in agriculture and strategies to improve use efficiency. *Harit Dhara E-Magazine*, 5(2), 20-24.
2. Chandrakala, M., Maske, S.P., Srinivasan R. and Karthika K.S., Evaluation of Coconut suitability in soils of Semi- Arid Land, South Telangana Plateau, Andhra Pradesh, India, 2023, *Indian Coconut Journal*, 66(3), 24-26.
3. Gangopadhyay, S.K., Bandyopadhyay, S. and



- Maitra, A.K. 2023. Management of calcareous soils of Ushar lands of North Bihar plain. *Indian Farming* 73 (10):03-07; October 2023.
4. Choudhury, S.G., Banerjee, T., Mukhopadhyay, S. and Ghosh, B. N. 2023. Makhana Cultivation: A New Avenue of Agriculture in Malda District, West Bengal. E-publication: <https://www.scribd.com/document/639813395/makhana-2023>.
 5. Banerjee, T. and Choudhury, S.G. 2023. Suitability Assessment of Sabai Grass using Analytic Hierarchy Process (AHP). E-publication: <https://www.scribd.com/document/639973094/Suitability-Assessment-Using-Analytic-Hierarchy-Process>.
 6. Bandyopadhyay, S., Reza, S.K., Maitra, A.K., Sahu, N.C. and Rahman, F.H. 2023. Doubling Farmers' Income through Natural Resource Inventory based Agro-Technology Transfer – A Success Story in Lower Gangetic Deltaic Region of West Bengal. *Indian Society of Soil Science (Kolkata Chapter)*. Vol- VI, January, 2024.
 7. Neenu, S., Karthika, K.S., Anil Kumar, K.S., Rashmi, I and Bhagya Vijayan. 2022. Elucidating the role of sodium in soils and plants: A boon or a bane. *Harit Dhara* 5(2), 16-19.

Institute Research Council (IRC)

Institute Research Council (IRC-2023) meeting was held during 12-15 June, 2023 at ICAR-NBSS&LUP, Nagpur. Dr. N. G. Patil, Director and Chairman, IRC, Dr. Hrittick Biswas, Member Secretary, IRC, all the Heads of Regional Centre and Divisions and Scientists of the Bureau participated in the meeting.



IRC meeting at Head Quarters, Nagpur

Institute Management Committee (IMC)

Institute Management Committee (IMC) meeting of ICAR-NBSS&LUP was held on 27 September 2023 at Hqrs. Nagpur. Dr.N.G. Patil, Director and Chairman of IMC, Dr. Rajendra Sable, Joint Director of Agriculture Govt. of maharashtra, Dr.R. P. Mishra,



Institute Management Committee (IMC-2023) at Nagpur

Pri. Scientist, ICAR-IIFSR, Modipuram (UP) and Dr. A. Murkute, Director, Mahatma Gandhi Institute for Rural Industrialization (MGIRI), Wardha participated in the meeting.

Interactive meeting with Scientists of ICAR-NISAM-Baramati

An interactive meeting between the Scientists of ICAR-NBSS&LUP and ICAR-NISAM, Baramati was organized on 7th July, 2023 to discuss possible collaboration. Dr. N. G. Patil, Director, ICAR-NBSS&LUP, Nagpur and Dr. K. Sami Reddy, Director ICAR-NISAM, Baramati and Scientists participated in the meeting and agreed to develop a project proposal on abiotic stress mapping of western Maharashtra.



6

MAJOR EVENTS

47th Foundation Day of ICAR-NBSS&LUP

On September 1, 2023, ICAR—National Bureau of Soil Survey and Land Use Planning, Nagpur—celebrated its 47th Foundation Day. Honourable Dr S. K. Chaudhari, Deputy Director General (NRM), ICAR, New Delhi was the chief guest and Dr. Niteen V. Patil Vice-chancellor, MAFSU, Nagpur and Sh. Sanjay B. Patil, Deputy Inspector General, Gadchiroli were the guest of honours. As a special invitee, Dr. Brahma Swarup Dwivedi, Member, ASRB, New Delhi, took part in this event.



47th Foundation Day celebration at ICAR-NBSS&LUP, Nagpur

World soil day

World soil day was celebrated on 5th December 2023 at Head Quarter Nagpur and all regional Centres with the theme “Soil and Water: A Source of Life”.



World soil day celebrated at ICAR-NBSS&LUP, Nagpur. Dr. P.R. Kadu, Dean, College of Agriculture was the Guest speaker.



World Soil Day at RC, Udaipur with more than 150 student participants of Central Academy Senior Secondary School Udaipur



World Soil Day at Regional Centre, Kolkata



World Soil Day at Regional Centre, Jorhat at farmers field in Charaibahi village Jorhat

Kisan Diwas

On the birth centenary of Choudhary Charan Singh Former Prime Minister of India, Kisan Diwas was celebrated on 23.12. 2023 at ICAR-NBSS&LUP, Nagpur and all the regional Centres. Programmes were organized to spread awareness among the farmers regarding various schemes.



Kisan Diwas at Ishapur Farm, Ishapur Village, New Delhi



Kisan Diwas at village - Jhadol, Tehsil - Sarada, District - Udaipur (Rajasthan)

World Environment Day, 2023

World Environment Day was celebrated in ICAR- NBSS & LUP, Nagpur and its Regional Centres on 5th June 2023. Dr. T. S. Channesh, Director, Centre for Public Understanding of Sciences delivered guest lecture at Regional Centre, Bangalore. A special lecture was delivered by Prof. (Dr.) Aniruddha Mukhopadhyay, Head, Dept. of Environmental Science, University of Calcutta at Regional Centre, Kolkata. Plantation programme, awareness programme, etc. were organized to celebrate World Environment Day.



World Environment Day was celebration at Regional Centre, Kolkata



Tree planting at ICAR-NBSS&LUP, Bangalore



Dr. T. S. Channesh, Director, Centre for Public Understanding of Sciences delivered guest lecture at Regional Centre, Bangalore

Organized World GIS-Day-2023 on 15th November, 2023 at ICAR-NBSS&LUP, Nagpur

World GIS-Day-2023 was celebrated on 15th November 2023 at ICAR-NBSS&LUP, Nagpur. Dr. Suresh Kumar, Scientist-G & Group Head, Agriculture, Forestry & Ecology Group, ISRO-IIRS Dehradun delivered the invited talk.

World GIS Day 2023



Kisan Mela



Technology dissemination and interaction with students during Pusa Krishi Vigyan Meladuring 02-04 March, 2023 at ICAR-IARI, New Delhi



Sashya Shyamala Krishi Vigyan Kendra, RKMVERI, Arapanch, South 24 Parganas, West Bengal- 700150, during 14-16 February, 2023



Farmer's Fair organized by Sugarcane Research Station, AAU, Golaghat on 04-12-2023



Participation in Indian Science Congress, RSTMU, Nagpur on 03.01.2023



Participation in AgroVision Meet on 24-27 November 2023

Vigilance Awareness Campaign-2023

ICAR-NBSS&LUP, Nagpur and all the Regional Centres organised Vigilance awareness campaign programmes from 16 August-15 November 2023 with the theme on PIDPI Resolution and Capacity Building. Number of Talks/seminars/public interactions/gram sabhas were conducted explaining the provisions of PIDPI resolution, correct procedure of filing PIDPI

complaint and common pitfalls / mistakes made while filing PIDPI complaints. Different media like Banners, News papers, WhatsApp messages, e-pledge, Debate, Quiz were used to disseminate PIDPI Resolution. The campaign period also witnessed the Vigilance Awareness Week-2023 from 30th October to 5th November, 2023 by taking of the integrity pledge by all the employees of Bureau at HQs Nagpur with theme on "Say no to corruption; commit to the Nation".



Shri Somnath, Under Secretary (Vig-I), ICAR, New Delhi delivering online lecture on "PIDPI Resolution"



Shri Manoj Kumar Maurya, CVO, GSI/MECL/IBM, Ministry of Mines, Govt. of India, Kolkata, delivering a lecture on "Ethics and Good Governance"



Gram Shabha programme at Sillori village, Nagpur



Integrity pledge taken by staff of RC Delhi



Vigilance Awareness Week observed at ICAR – NBSS & LUP, regional centre, Kolkata



Vigilance Awareness Week observed at ICAR – NBSS & LUP, regional centre, Udaipur



Integrity pledge by the staff at RC, Jorhat



Awareness Gram Shabha programme at Sillori village, Nagpur



Awareness Gram Shabha programme at Gumthi village, Nagpur and their media coverage in Lokmat.

Farmers awareness campaign under SCSP programme

The ICAR-NBSS&LUP, Nagpur and its Regional Centre team organized the farmer awareness programme under Scheduled Castes Sub Plan (SCSP) scheme. The importance of soil health and soil health card scheme were discussed and correct method of collection of representative soil sample from field was also demonstrated.



Exposure Visit for SCSP farmers at ICAR-CICR, Nagpur on 11.03.2023



Exposure Visit for SCSP farmers at the Bureau on 10.03.2023



Awareness programme on 25/07/23 under SCSP scheme at Koliapani Chapori village of Jorhat district



Verification of SC household and identification of input requirements on 24/08/23 under SCSP scheme at Koliapani Chapori village of Jorhat



Visit of SCSP village for distributed machine and their working status at Sillori village, Kalmeshwar Block, Nagpur



Hindi Saptah

ICAR-NBSS&LUP, Nagpur and its regional centres organised Hindi Saptah. During this various competitions such as Translation, Story writing, debate, quiz, etc. were conducted.



Sh. Milind Wadodkar (CSSO, SLUSI, Delhi) at Regional Centre, Delhi as Chief guest



Hindi Week celebration at Regional Centre, Kolkata



Hindi Week celebration at Regional Centre, Jorhat



Hindi Week celebration at Regional Centre, Udaipur

Swachhta Pakhwada 2023

Swachhta Pakhwada was celebrated at ICAR-NBSS&LUP and its Regional Centres. Various activities such as cleaning, interaction with the students, farmers etc. were carried during *Swachhta Pakhwada*, 2023. Regional Centre, Delhi organized a talk on “Agri-residue Management for Environmental Sustainability” delivered by Dr. Livleen Shukla, Principal Scientist, Division of Microbiology, ICAR-IARI, New Delhi.



Swachhta Pakhwada at Regional Centre, Delhi



Swachhta Pakhwada at Regional Centre, Kolkata



Swachhta Pakhwada at Regional Centre, Udaipur

National Science Day, 2023

National Science Day was observed in ICAR- NBSS&LUP, Regional Centre Kolkata on 28th February, 2023. Prof. S.K. Sanyal, Former Hon'ble Vice Chancellor, BCKV was the Chief Guest in the programme.



Prof. S.K. Sanyal, Former Vice Chancellor, BCKV delivering his Chief Guest lecture

Mission Lifestyle for Awareness, 2023

ICAR- NBSS&LUP, RC Kolkata organized various events and activities about Mission Lifestyle for Awareness such as Circulation of posters to sensitize about minimizing food waste on 19.05.23 and Quiz Competition on 26.05.23.



Mission Lifestyle for Awareness, 2023 at Regional Centre, Kolkata

International Day of Yoga, 2023

International Day of Yoga was celebrated on 21.06.2023 at ICAR NBSS&LUP, Nagpur and its Regional Centres. All the staff members actively participated in the programme.



International Day of Yoga at ICAR-NBSS&LUP, Nagpur and its Regional Centres

Global Fertilizer Day, 2023

Global Fertilizer Day was observed by ICAR- NBSS&LUP, Kolkata in collaboration with Society for Fertilizers & Environment and Krishi Vigyan Kendra, Hooghly on 13.10.23. Dr. F.H. Rahman, Principal Scientist & Head and Dr. S. Bandyopadhyay, Sr. Scientist delivered lecture in the programme.



Global Fertilizer Day at ICAR- NBSS&LUP, Kolkata

MoU with Amity University

An MoU was signed between ICAR- NBSS&LUP and Amity University, Kolkata on 09.01.2023 for collaboration in research, teaching, training and other activities including organizing seminar, symposia, etc.



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MoU Signed with Bihar Watershed Development Society (BWDS) (SLNA), Govt. of Bihar

(i) LRI-PMKSY 2.0 –Bihar

A Memorandum of Understanding (MoU) was signed on 17.08.2023 between ICAR-NBSS&LUP and Bihar Watershed Development Society (BWDS) (SLNA), Govt. of Bihar in the chamber of Chief Executive Officer (CEO), BWDS (SLNS), Krishi Bhawan, Patna for the project “Land resource inventory of four selected watersheds in Bihar using geo-spatial techniques” under PMKSY 2.0 for holistic development of watershed using LRI, hydrology, socio-economic database and maps.

MoU with SAIARD

An MoU was signed between ICAR- NBSS&LUP and South Asian Institute of Advanced Research and Development (SAIARD), Kolkata on 13.01.2023 at the premises of ICAR- NBSS&LUP, Regional Centre Kolkata for collaboration in research, teaching, training and other activities including organizing seminar, symposia.



An MoU signed between ICAR- NBSS&LUP and Bihar Watershed Development Society (BWDS) (SLNA), Govt. of Bihar

MoU with The Neotia University

An MoU was signed between ICAR- NBSS&LUP and School of Agriculture and Allied Science, The Neotia University, South 24 Pgs., West Bengal on 17.01.2023 at the premises of The Neotia University, Sarisha, Diamond Harbour Road for collaboration

(ii) GIS based Fallow Land Mapping of Bihar State

A Memorandum of Understanding (MoU) was signed on 19.09.2023 between ICAR-NBSS&LUP and Bihar Watershed Development Society (BWDS) (SLNA),



Signing of Mou for Project on GIS based fallow land mapping of Bihar state

Govt. of Bihar in the chamber of Chief Executive Officer (CEO), BWDS (SLNS), Krishi Bhawan, Patna for the project “GIS based Fallow Land Mapping of Bihar”.

MoU with Department of Agriculture, Government of Tripura

A Memorandum of Understanding (MoU) was signed between ICAR- National Bureau of Soil Survey and Land Use Planning & Department of Agriculture, Government of Tripura on 16.10.2023 for Land Resource Inventory project of two districts of Tripura state at large scale for agricultural land use planning using geo-spatial techniques.



An MoU signed between ICAR- NBSS&LUP and Department of Agriculture, Government of Tripura

Memorandum of Understanding (MOU) Signed with V.N.M.K.V., Parbhani

The MoU signed between ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, and the Department of Soil Science and Agricultural Chemistry College of Agriculture, V.N.M.K.V., Parbhani to strengthen the collaboration in research, education and capacity building



An MoU signed between ICAR- NBSS&LUP and VNMKV, Parbhani

Memorandum of Understanding (MOU) Signed with VSI, Pune

The MoU signed between ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur, and Vasantdada Sugar Institute, Pune to strengthen the research for sustainable sugarcane cultivation 16th January 2023 to strengthen the research collaboration for sustainable sugarcane cultivation in India. Both organizations can jointly work in the application of remote sensing and GIS in mapping and characterization of soils and identification of suitable areas for sugarcane cultivated areas.



Linkages with State Government and other Institutes

State Departments of Agriculture	
Department of Agriculture, Govt. of West Bengal	Collaboration in LRI at district & block level and Soil Correlation activities
Department of Agriculture, Govt. of Telangana	Execution of Land Resource Inventory of 3 blocks of Telanganastate
Watershed Development Department (WDD), Govt. of Karnataka	Land resource inventory programme of selected microwatersheds of backward districts (Sujala-III Project)
Department of Agriculture, Govt. of Tripura	Initiated land resource inventory programme on 1:10000 scale
Directorate of Cinchona and other Medicinal Plants, G.T.A., Govt. of West Bengal, Mungpoo, Darjeeling	Land resource inventory of Cinchona and other medicinal plants growing area of Darjeeling district in large scale using geo-spatial techniques
(POCRA), Govt. of Maharashtra	Land Resource Inventory for Climate-Resilient Agriculture in Selected Clusters in Maharashtra
Karnataka Watershed Development Department (KWDD), Bengaluru	LRI for watershed development to prevent drought (WDPD)
Watershed, Development Department, WDD, Government of Karnataka (REWARD Project)	Land Resources Inventory in 100 project taluks and in collaboration with SAU partners
REWARD Project Directorate of Soil Conservation & Watershed Development, (DSC & WD), Govt. of Odisha,	Land Resources Inventory of selected clusters of micro watersheds of Koraput & Sambalpur districts of Odisha
Land resource inventory of Arunachal Pradesh in large scale for agricultural land use planning using geo-spatial techniques	LRI of 22 Districts of Arunachal Pradesh
MoU Signed with TNSLURB (Tamil Nadu)	An agreement for mapping of fallow lands in Tamil Nadu
Signed an agreement with Govt. of Karnataka in collaboration with GSI.	For preparation of district resource maps of Karnataka and Goa.

Central Govt./ ICAR organizations

National Remote Sensing Centre (NRSC), Deptt. of Space, GOI, Hyderabad	Collaboration for sharing of satellite data for land resource inventory programme
Regional Remote Sensing Centre (RRSSC), Nagpur	Collaboration for sharing of satellite data for land resource inventory programme
Space Application Centre (SAC), Ahmedabad	Collaborative project on desertification status mapping of India
National Informatics Centre (NIC), Govt. of India.	Collaboration in development of Web based farmers advisory.
Department of Science & Technology (DST)	Financial assistance for research projects on spectral reflectance of soil
ICAR-Indian Institute of Soil and Water Conservation (IISWC), Dehradun	Land Degradation Status/Assessment
ICAR-Central (CSSRI) Soil Salinity Research Institute, Karnal	Land Degradation Status/Assessment
ICAR-CIFRI, Barrackpore, West Bengal	Research Consultancy/ Cooperation
ICAR-Indian Institute of Soil Science (IISS), Bhopal	Soil Fertility Status and organic carbon mapping
ICAR- Central Islands Agricultural Research Institute, Port Blair and KVK, North Andaman, A&N Islands.	Collaboration in LRI of Arable lands of North & Middle Andaman district, A&N Islands.
Sashya Shyamala Krishi Vigyan Kendra, RKMVERI, South 24 Pgs.	Collaboration in SCSP Project in South 24 Pgs. District, West Bengal
Geological Survey of India	Research Cooperation
SLUSI, DAC, M/o A&FW, New Delhi	Research Cooperation



IARI, New Delhi	Research Cooperation
IGFRI, Jhansi,	Research Cooperation
ICAR-CAFRI, Jhansi,	Research Cooperation

State Agriculture Universities (SAUs)

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia.	Research, Teaching and Training programme.
Dr. PDKV, Akola, Maharashtra	Post Graduate education and research leading to Masters and Doctoral degree
Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan	Post Graduate education and research leading to Masters and Doctoral degree
Indira Gandhi Krishi Vishwavidyalaya, Raipur	Post Graduate education and research leading to Masters and Doctoral degree
CCS Haryana Agricultural University, Hisar	Post Graduate education and research leading to Masters and Doctoral degree
TNAU, Coimbatore	Post Graduate education and research leading to Masters and Doctoral degree
GKVK, Bangalore	Post Graduate education and research leading to Masters and Doctoral degree
Mahatma Phule Krishi Vidyapeeth, Rahuri	Knowledge partners
Maharashtra Animal and Fishery Science University, Nagpur	Knowledge partners
Professor Jayashankar Telangana State Agricultural University (PJTSAU), Hyderabad	Collaborative research
SKN Agriculture University, Jobner	Post Graduate education and research leading to Masters and Doctoral degree
Institute of Agricultural Science, University of Calcutta	Research & Academic collaboration
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani	Research Collaboration

Private Institutions/ NGOs

Sterlite Technologies Ltd., Mumbai	For assistance in optical fibre cable laying program
KEC International Ltd., Mumbai	For assistance in tower laying program
Adani Transmission Ltd., Ahmedabad	Provide soil data for prospecting location for laying of transmission tower in India.
Neopark Technologies, Mumbai	Development of Hyper spectral model in Maharashtra

Linkages with foreign Country

Institut National de la Recherche Agronomique (INRA), France	Accompanying the adaption of irrigated agriculture to change (ATCHA Project)
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Trainings conducted

Date	Training details &venue
January 03-23	21 days Kerala soil survey department sponsored training programme on Soil Survey and Land Use Planning for 12 Soil Survey Officers of Directorate of Soil Survey and Soil Conservation, Thiruvananthapuram, Kerala at ICAR-NBSS&LUP Regional Centre, Bangalore (Course Directors : Dr. M. Lalitha, Dr. B. Kalaiselvi, Dr. S. Dharumarajan, Dr. R. Srinivasan)
March 9-11	3-days Training on Soil Health Card: A tool for ensuring sustainable soil and crop productivity at the Bureau involving farming community of adopted SCSP villages of Nagpur district (<i>Coordinators- Drs. M.S. Raghuvanshi, H. L. Kharbikar, R.K. Naitam, A.O. Shirale, P.C. Moharana, and K.Kartikeyan</i>)
March 13-27	15 days training programme for SC women of Udaipur region on “Cutting and Tailoring” under Scheduled Caste Sub Plan Glimpses of skill development programme on “cutting and tailoring”



Date	Training details &venue
March 15-20	A 6 days training on “Food, Nutritional and Livelihood Security through sustainable Land Use Planning” was organized for 80 SC beneficiaries by a team of scientists (Dr. Ashok Kumar, Senior Scientist and training coordinator, Dr. R. K. Meena, and Sh. Vikas, Scientists and training Co-coordinators) of the ICAR-NBSS&LUP, Regional Centre, Delhi. During the training some easily adoptable scientific interventions viz., distribution of quality seeds (pearl millet, sorghum, green gram, and vegetable kits), demonstration on soil sample collection for testing also employed to improve the crop productivity, animal fodder productivity and availability. Training programme and demonstration of soil sample collection under SCSP at Pinjauri Village, Yamunanagar, Haryana
March, 22-23	Two days Training –cum-Farmers Awareness Programme on Enhancing Production in Jute based Cropping System through Efficient Nutrient Management for SC- Community Farmers of North 24 Parganas District, West Bengal under SCSP in Collaboration with ICAR-CRIJAF at ICAR-CRIJAF, Barrackpore Training –cum-Farmers Awareness Programme on Enhancing Production in Jute based Cropping System through Efficient Nutrient Management
March 29-30	Training on Land Resource Inventory (LRI) Atlas preparation and LRI Card generation at College of Horticulture, Bidar – UHS Bagalkot
April 17– 18	Training on Land Resource Inventory (LRI) Atlas preparation and LRI Card generation at UAS, Raichur
April 17-18	Training on Land Resource Inventory (LRI) Atlas preparation and LRI Card generation UAS, Dharwad & UAS (GKVK), Bangalore





Date	Training details &venue
November 02-03	A Farmers' training cum Capacity building programme under the Pilot Project on Crop Diversification of Jhargram, West Bengal at KVK, Jhargram, West Bengal
December 13-15	Training on three days training on Pension and NPS

Trainings attended

Date	Training Details & Venue	Participants
January 16-25, (Online)	NAHEP CAAST sponsored Training cum Workshop on Airborne Hyperspectral Remote Sensing for Agriculture" organized by CAAST and Division of Agricultural Physics, ICAR Indian Agricultural Research Institute, New Delhi	Dr A.O.Shirale Dr. Arijit Barman
February 13-17	Training on "Modelling and Mapping Soil Nutrients and associated Soil Properties" in the framework of Phase I of the Global Soil Nutrient and Soil Nutrient Budget Maps (GSNmap), virtually by FAO, Rome.	Dr. G.P. Obi Reddy
March 01-08	"Data Visualization using R" organized by ICAR-NAARM, Hyderabad.	Dr. Arijit Barman
May 08-12	ESRI India training programme on Arc GIS Pro foundation	Dr. Sunil Kumar, Sh. Manish Olaniya, Sh. S. Sabu Sh. Rajneesh Kumar
March 20-27	Training Programme on "Multivariate Data Analysis" (Online Mode) organized by ICAR-NAARM, Hyderabad	Dr. R. K. Naitam Dr A. O. Shirale Dr. D. S. Mohekar Sh. Pravin Butte
15 May-07 July, 2023	54 days training programme at ISRO-IIRS Dehradun on RS & GIS applications in agriculture and soils.	Dr. R. L. Meena
May 22-27	Training on "Hydrological Modelling Using SWAT+" at National Institute of Technology, Roorkee	B. Dash
June 05-09	ESRI India training programme on Arc GIS Pro foundation	Dr. S. Bandyopadhyay Dr. J. Mukhopadhyay Smt. Soma Saha Sh. Bachaspati Das
August 10-12	Training on "Natural Farming" organized by MANAGE, Hyderabad in collaboration with CNFSA in Online mode.	Dr. R. S. Meena
August 10	01-day workshop program on 'Evaluating soil site suitability' held at ICAR-NBSS&LUP, Nagpur	Dr. Sunil B. H.
October 09- 20	10-days training on "Remote Sensing and GIS in Predictive Soil Mapping" at Indian Institute of Remote Sensing (ISRO-IIRS), Dehradun	Dr. Sunil B.H. Dr. D.S. Mohekar Dr. Ajit Kumar Meena Dr. Gopal Tiwary



Date	Training Details & Venue	Participants
October 10-20	Two week special course on “Remote Sensing & GIS in Predictive Soil Mapping” at ISRO-IIRS, Dehradun	Dr. Rajesh Kumar Meena, Dr. Sunil Kumar Sh. Manish Olaniya
Oct. 30 – Nov. 03	“Innovative Extension Strategies for Sustainable Natural Resource Management in Rainfed Agriculture” organized by ICAR-CRIDA & MANAGE, Hyderabad in collaboration in Online mode.	Dr. U. S. Saikia Dr. R. S. Meena
November 01-10	10 days training on “Remote Sensing and GIS in Digital Soil Mapping” organized by RSA Division, ICAR-NBSS&LUP, Nagpur	Dr. Arijit Barman Dr. R. L. Meena Dr. Mahaveer Nogiya Dr. L. C. Malav Dr. Brijesh Yadav Dr. Sunil B. H.
	Training on “Level 1 online course on “Emerging Technologies in iGoT” at Karmayogi Bharat.	Dr. Vasu D. Dr. Ranjan Paul Sh. Pravin Butte Dr. A. P. Nagar Dr. S. S. Nimkhedkar

PAT Training

- Dr. Nabin Chandra Paul, Scientist of ICAR-NISAM, Baramati undergone PAT training programme of NAARM, Hyderabad on Mapping and Assessment of Abiotic Stresses in Pune District, Maharashtra using Geospatial Techniques from October, 19, 2023 to 17th January, 2024.
- Ms. Ashwini Suryawanshi, Scientist of ICAR Research Complex for NEH Region, Umiam undergone PAT training programme of NAARM, Hyderabad on Geospatial analysis of Soil Loss Assessment using Geoinformatics in Kabini River Basin, part of Karnataka state, Southern India” submitted to the Journal of the Indian Society of Soil Science from October, 19, 2023 to 17th January, 2024.

PG / Ph.D. Programme

- Dr. N. G. Patil acted as Co-Major Advisor for Ph.D. student of Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh.
- Dr. Mahaveer Nogiya taught a course “Soil-509-Remote sensing and GIS technique for soil and crop studies (2+1)” in M.Sc. (Ag.) courses II semester at Department of Soil Science and Agricultural Chemistry, Rajasthan College of Agriculture (MPUAT), Udaipur- (Academic session 2022-23).
- Dr. R. L. Meena taught a course “Agron-502-Principal and Practices of Soil Fertility and

Nutrient Management (2+1)” in M.Sc. (Ag.) courses, semester-I at Department of Agronomy, Rajasthan College of Agriculture (MPUAT), Udaipur- (Academic session 2023-24).

- Dr. F. H. Rahman, Principal Scientist & Head acted as a Resource Person in DAESI Course at UBKV, Cooch Behar on 20.07.2023.
- Dr. S. K. Reza, Sr. Scientist acted as an invigilator at Assam Agricultural University to conduct the viva-voce exam of a PhD Student during 13-14 July, 2023.
- Dr. S. Chattaraj acted as Chairperson/ major guide for two students of Sangam University, Vilwara, Rajasthan for six months MSc. thesis internship in Geoinformatics (2023).

Human Resource Development/ Capacity Building / Skill Development : National level priority work

A school level programme “Engaging school students in Soil testing & generation of Soil Labs in Schools” for creating awareness on Soil Health through school students was conducted by selecting 20 Schools (10 Kendriya Vidyalayas & 10 Navodaya Vidyalayas) of 13 States of India, Dr. Jaya N Surya participated in various meetings (4 physical meetings & 16 VCs’) as an executive committee member on pilot project in association with M/o A&FW, & M/o Education (DS&L), GOI. **SOP prepared for soil sample collection** for its testing and training and submitted for distribution as guidelines to 20 Nodal identified schools

21st Dr. R.S. Murthy Memorial lecture

21st Dr. R.S. Murthy Memorial lecture was organized by Indian Society of Soil Science in collaboration with ICAR- NBSS&LUP, RC Kolkata and ICAR- CRIJAF at ICAR- CRIJAF, Barrackpore on 18.08.2023.



21st Dr. R.S. Murthy Memorial Lecture

Farmers' Awareness Programme

One day farmers' awareness programme on "Digital Soil Health Information of Jalpaiguri district and its utility in crop management" was organized by ICAR- NBSS&LUP, Kolkata under C-DAC funded project on 05.10.23 at KVK, Jalpaiguri wherein Hon'ble Member of Parliament Dr. Jayanta Kumar Roy graced the occasion as Chief Guest along with officials from State Agriculture University and line departments. Total 100 farmers including input dealers, FPO/FPC members were participated and made aware of recent developments about soil information based crop planning by Dr. S. Chattaraj, PI and Sr. Scientist, Dr. S.K. Reza, Sr. Scientist and Dr. F.H. Rahman, Pr. Scientist & Head, ICAR- NBSS&LUP, RC, Kolkata.

Seminar on "e-Governance

Organised a seminar on "e-Governance: A tool for fighting corruption" at ICAR-NBSS&LUP, RC, Jorhat, on 19-10-23 for office staffs (Speaker: Dr. Rana Sharma, Administrative Officer, National Institute of Electronics and Information Technology (NIELIT) Jorhat).

Special Lecture of the Indian Society of Soil Science Kolkata Chapter

ICAR-NBSS&LUP, RC., Kolkata has Organized Special Lecture of the Indian Society of Soil Science Kolkata Chapter on March 16, 2023 in collaboration with ICAR-CRIJAF, Barrackpore at ICAR-NBSS&LUP, RC., Kolkata. A total of 65 participants were present in offline mode & 25 on online mode. Dr. Tapas Biswas, Sr. Scientist, CSIRO, Australia delivered the lecture on the topic "Non-conventional water resources use for modern agriculture". Prof. S.K. Sanyal, former Vice Chancellor, BCKV, Nadia graced the occasion as Chief Guest of the session.

Special Lecture on Biochar

ICAR- NBSS&LUP, RC Kolkata organized a special lecture (in virtual mode) on Biochar: Management of Agriculture Waste for Sustainable Rural Lifestyle and Circular Economy delivered by Dr. Manish Kumar, Principal Scientist, CSIR, Institute of Minerals and Materials Technology, Bhubaneswar, Odisha on 23.05.23 under Mission Lifestyle for Awareness programme to celebrate the World Environment Day 2023.

Organized Training-cum-Workshop on 'ICAR-KRISHI Portal-National Geospatial Policy-2022' during 20-21st March, 2023

The National Training-cum-Workshop on ICAR-KRISHI Portal-National Geospatial Policy-2022 was organized by ICAR-NBSS&LUP, Nagpur on 20-21st March, 2023. Dr. A.K. Joshi, Director, Maharashtra State Remote Sensing Application Centre (MRSAC),



Nagpur and Chief Guest of the inaugural session appreciated the efforts made by ICAR-NBSS&LUP, Nagpur in organizing such a useful workshop to deliberate the important topics like ICAR-KRISHI Portal and its enrichment for sustainable Indian agriculture.

Workshop-cum-Stakeholders Meeting on Developing National One Soil Unified Information System (NOSUIS) 28th April, 2023

The Workshop-cum-Stakeholders' meeting on 'Developing National One Soil Unified Information System (NOSUIS)' was organized at ICAR-NBSS&LUP, Nagpur on 28.04.2023. In his introductory remarks, Dr. S.K. Chaudhari, Hon'ble DDG (NRM), ICAR, New Delhi and Member, Steering Committee urged the stakeholders to understand each other's strength, develop the convergence in soil and allied resources database, data compilation, management and dissemination to the stakeholders and users. Chairman of the workshop, Dr. A. Velmurugan, ADG (SWM) emphasized the importance of data convergence and urged to develop an interoperability mechanism to integrate all the stakeholders and the agencies engaged in generating soil information.



Interactive workshop on Evaluating soil site suitability for major crops

- Organized One- day Interactive workshop on Evaluating soil site suitability for major crops in Marathwada Region using GIS-based multi-criteria decision analysis at ICAR-NBSS&LUP, Nagpur on August 10, 2023. Scientists from State Agricultural University (SAU) VNMKV, Parbhani and KVKs including all the regional Centres of the Bureau participated in the virtual workshop. (Coordinators- Drs. M.S. Raghuvanshi, H. L. Kharbikar, R.K. Naitam, A.O. Shirale, P.C. Moharana, and Nirmal Kumar)



Workshops on Evaluating soil site suitability for major crops in Marathwada region using GIS-based multi-criteria decision analysis

Organized One-day Interactive workshop on Evaluating soil site suitability for major crops in Khandesh Region using GIS-based multi-criteria decision analysis at ICAR-NBSS&LUP, Nagpur on November 23, 2023. Scientists from State Agricultural University (SAU) MPKV, Rahuri and KVKs including all the regional Centres of the Bureau participated

in the virtual workshop. (Coordinators- Drs. Nirmal Kumar, M.S. Raghuvanshi, H. L. Kharbikar, R.K. Naitam, A.O. Shirale, and P.C. Moharana)

Organized PoCRA workshop on 27.04.2023 at the Bureau involving VNMKV, Parbhani and PDKV, Akola (Coordinators- Drs. M.S. Raghuvanshi and R.K. Naitam)



One day Interactive workshop on Khandesh Region a Interactive workshop on Evaluating soil site suitability for major crops in Marathwada region using GIS-based multi-criteria decision analysis was convened on 10th August, 2023



PoCRA Workshop held on 27.04.2023

Other

Date	Topic
November 30	Launching workshop of LRI, Bihar under PMKSY 2.0 and Fallow Land Mapping of Bihar State at Krishi Bhawan, Patna
December 5-6	Two days' Workshop – cum- Capacity Building Programme on Sustainable Agricultural Land Use Planning for Livelihood Improvement of Farming Community under SCSP Programme at ICAR-NBSS&LUP, RC Kolkata
December 26-27	Concluding Workshop cum Farmers' Awareness programme on "Digital Soil Health Information of Jalpaiguri District & its utility in crop management" under C-DAC Project at KVK, Ramsahi, Jalpaiguri, West Bengal

Date	Topic
24.03.2023	Dr Ranjan Paul Organized AIPEA Early Career Clay Scientist Network's Bi-monthly Webinar series by Indian Clay Group (Virtual mode -Zoom platform).
09.10.2023	Dr. UK Maurya Organized a Webinar during Vigilance Awareness Campaign-2023 on "Provisions of PIDPI resolution, procedures of filing PIDPI complaints and common pitfalls/mistakes made while filing a complaints" and it was delivered by Shri Somnath, Under Secretary (Vig-I), ICAR, New Delhi. at ICAR-NBSS&LUP, HQs., Nagpur
13.10.2023	Dr. UK Maurya Organized a Webinar during Vigilance Awareness Campaign-2023 in offline and online mode on "Ethics and Good Governance" and it was delivered by Shri Manoj Kumar Maurya, Chief Vigilance Officer, GSI, IBM & MECL, Ministry of Mines, Govt. of India, Kolkata. at ICAR-NBSS&LUP, HQs., Nagpur



Seminars/Conferences/Workshop attended

24.11.2023	National workshop on “Integrated nutrient management key to soil health-Role of fertilizer policy” organized by The Fertilizer Association of India, Southern Region at ICAR-NBSS&LUP, Regional Centre, Bangalore	Dr. Kalaiselvi. B Dr.Vaundhara.R Dr. Chandrakala M
02.10.2023- 05.10.2023	Global Symposium on Soils and Water, organised in Hybrid format at Food and Agriculture Organisations (FAO) of the United Nations	Dr. Chandrakala M.
6.3.2023	National workshop on National Aquifer mapping organized by Central Ground Water board at Bangalore	Dr Rajendra Hegde
19.10.2023- 21.10.2023	International workshop on Heat waves: Forestry and Agriculture under pressure-a remote sensing perspective organized by jointly by UAS-Dharwad and Institute of Bio-Geo sciences, Agrosphere, Julich, Germany as invited speaker. Gave a talk on Remote sensing applications in Land resources inventory data generation	Dr Rajendra Hegde
20.12.2023- 21.12.2023	International Symposium AI & Hyperspectral Imaging, (International Conclave On Futuristic Farming) during 20-21 December 2023 at Pune, Maharashtra	Dr. S. Dharumarajan
April 28	Workshop- cum- Stakeholder Meet on Developing National One Soil Unified Information System (NOSUIS), Partners: SLUSI, ISRO, NRSC, SAC, TNAU, ICAR Institutes and others.	Dr UK Maurya
3-6 October, 2023	87 th Annual Convention and National Seminar on ‘Developments in Soil Science-2023 organized by Bhopal Chapter of Indian Society of Soil Science, at ICAR-Indian Institute of Soil Science, Bhopal	Dr A.O.Shirale
22-23 August, 2023	National Seminar on “Abiotic Stress Management for Sustainable Millet based Production Systems” at ICAR-NIASM, Baramati	Dr R.K. Naitam
17-18 February, 2023.	International Conference on “Sustainable & Resilient Environment development -2023 (ICSRED – 23)” at NEERI, Nagpur	Dr R.K. Naitam
28-30 October, 2023	Asian Citrus Congress-2023 on “Advancing Citriculture Agro-economic Prosperity” at CCRI, Nagpur	Dr R.K. Naitam

Meetings attended

Date	Details of the program	Participants
23.4.2023	Interaction meeting with Smt. Niramala Seetharaman, Union Minister of Finance on Current economic situation organized by Thinker Forum, Peenya, Bangalore	Dr Rajendra Hegde
5.7.2023	Meeting with officials of BEL, Bangalore on development of mobile applications of the soil data for precision farming. Meeting held at regional centre, NBSS&LUP	Dr Rajendra Hegde
2.08.2023	Meeting with scientists of ART pack, Indian Institute of Science, Bangalore on the use of Artificial intelligence, Robotics technology for fast forwarding of LRI field and related works. Shared the LRI atlases of Sujala project	Dr Rajendra Hegde
05.06.23	meeting under the joint Chairmanship of Secretary (DA&FW) & Secretary (DSE&L) at Shastri Bhawan, New Delhi on 05.06.2023 regarding Pilot Project on School Soil Health Program and Engaging of Schools having science labs as soil testing labs to create awareness on soil health.	Dr Jaya N Surya
03.07.23	Meeting on 03.07.2023 (virtual mode) to Discuss the Implementation of Soil Testing Projects in Schools, along with 20 representatives of Kendriya Vidyalaya & Navododya Vidyalaya/ school teachers under the Chairpersonship of Joint Secretary, INM, D/O A & FW and identify 30 Schools’ Principal.	Dr. Jaya N Surya
17.07.2023	Meeting on at ICAR, Krishi Bhawan, New Delhi under the Chairmanship of Secretary (A&FW) to review National One soil Unified information System (NOSUIS).	Dr. Jaya N Surya

Programmes/ Activities organized under SCSP schemes and Institutional activities

(Coordinators- Drs. M.S. Raghuvanshi, H. L. Kharbikar, R.K. Naitam, A.O. Shirale, P.C. Moharana, Hrittick Biswas, K. Kartikeyan)

S. N.	Item/Activity	Unit	Targets/ Achievement		No. of Beneficiaries	
			Annual targets	Achievements	Annual targets	Achievements
1	Trainings (capacity building/skill Develop etc.)					
	Three days training programme on “MridaSwasthya card: Mittiaurfasalutpadaktahetueksadhak” for farmers during 9-11 March 2023 with two exposure visits	No	01	01	55	55
	National Campaign on Soil Health Management (Nutrient Use Efficiency and Soil Organic Carbon Management) on 22.05.2023 at Sawdikhurd village. About 50 farmers benefitted	No	01	01	30	30
2	Technology dissemination and extension activities					
	Showcase of research activities in Indian Science Congress at Nagpur University Campus during 3-7 January, 2023	No	01	01	500	500
	Showcased institute's research activities in AGRO-VISION SUMMIT-2023 being organised at PDKV Ground Dabha, Nagpur from 24-27 November 2023	No	01	01	500	500
	World Environment Day during 01 to 02 June, 2023 at Sillori, Sawdikhurd and Sawarmendha villages	No	01	01	50	50
3	Awareness camps exposure visits etc.					
	Exposure visits of farmers at ICAR-CICR, Nagpur during three days training programme on 10 th and 11 th March 2023.	No	01	01	55	55
	Awareness Campaign Programs on Mission Lifestyle for Environment (LiFE) on 06/06/2023 at SCSP villages.	No	01	01	50	50
	Awareness programmes and campaigns on International Millets Year during 2023 at various SCSP villages.	No	01	01	50	50
	Exposure visits of farmers at ICAR-NBSS&LUP, Nagpur during during 47 th Foundation day of ICAR-NBSS&LUP on 1st September 2023.	No	01	01	35	35
	Swachhata Oath and cleanliness programme at institute, SCSP villages and highways during Gandhi Jayanti and Swachhata Pakhwada Drive from 02 nd to 31 st October	No	03	03	60	60
	Awareness Campaign under Swachhata Hi Seva programme at Gumthi village on 26 th September 2023	No	01	01	50	50
	Swachhata Hi Seva and cleanliness programmes at SCSP villages and in institute during 16 th to 31 st December 2023	No	04	04	60	60
	Organized programmes at institute and SCSP villages under Vigilance Awareness Programme during 16 th August to 15 th November 2023.	No	04	04	60	60
	Vigilance Awareness Gram Sabha at Gumthi village under Vigilance Awareness Week on 26 th September 2023	No	01	01	50	50
	Vigilance Awareness Gram Sabha at Sillori village under Vigilance Awareness Week on 3 rd November 2023	No	01	01	50	50
	Farmer's Scientist Interface meetings has been conducted in ICAR-NBSS&LUP, Nagpur during Foundation Day, Gandhi jayanti and Constitution day and more than 100 farmers and farm women from Sawarmendha, Pipla, Shedeshwar, GumthiSawangi, Manori villages has been participated	No	03	03	100	100
	Off campus and on campus activities	No	02	02	50	50
	Tree plantation programmes at institute and SCSP villages during Constitution day, Gandhi Jayanti programme, vigilance awareness week and cleanliness week	No	04	04	100	100



S. N.	Item/Activity	Unit	Targets/Achievement		No. of Beneficiaries	
			Annual targets	Achievements	Annual targets	Achievements
4	Input Distribution					
	Vegetable seed kits during 2023	kg	200	200	200	200
	NPK and secondary fertilizer	ton	10	10	200	200
	Micronutrients	kg	200	200	200	200
	FYM/Vermicompost	kg	200	200	200	200
	Plant growth promoter	kg	100	100	200	200
	Planting materials (Mango, Guava, Citrus, Gooseberry, Jackfruit, Dragon-fruit etc.)	No	450	450	100	100
	Water cooler in SCSP village school.	No	01	01	01	01
	Medium equipments/ machineries	No	09	09	09	09
	Large equipments/machinery	No	13	13	13	13
	Cotton bed sheets	No	200	200	200	200
5	Agri-entrepreneurship through formulation of Self-Help Groups	No	02	02	40	40
6	Created market links of Self-Help Groups	No	02	02	40	40
7	Distributed institute Literatures to farmers in various on campus and off campus programmes organized by institute (leaflets and reading materials etc.)	No	200	200	200	200
8	Employment generated for livelihood	No	02	02	02	02
9	Area oriented R&D Activity/Project addressing the problems of agro, sector faced by the SC/STs and benefit directly, which is measurable and identifiable) (SCSP Project)	No	01	01	200	200

Awards

- Dr. G.P. Obi Reddy, Principal Scientist receives the prestigious Fellowship of National Academy of Agricultural Sciences (NAAS), New Delhi with effective from 1st January, 2023.
- Dr. S. Chattaraj, Sr. Scientist received Grand Challenge Award of AgriEnlcs 2022 at International Conference on Systems and Technologies for Smart Agriculture (ICSTA 2023) during 19.12.23 to 20.12.23 sponsored by C-DAC & Ministry of Electronics and Information Technology, Govt. of India.
- Dr. S. Chattaraj received Best Paper Presentation award (1st Position) during ISCTA 2023 International conference at Biswa Bangla Convention Centre, Kolkata on 19 to 20-12-2023 by C-DAC, Kolkata, MeitY, GOI and Springer Publisher.
- Dr. R. Srinivasan was selected for Prof. J.S. BALI Award- 2023 by Soil Conservation Society of India (SCSI), New Delhi during in 5th International Conference on "Sustainable Natural Resource Management under Global Climate Change" during November 7-10, 2023 at National Agricultural Science Complex (NASC), New Delhi, India.
- Dr. Sunil Kumar, received "Young Scientist Award" for outstanding contribution and recognition in the field of Soil Science & Agri. Chemistry on the occasion of National Conference "*Drone A Boom for Agriculture*" organized by SAAST, CSJM University Kanpur 27-29 January, 2023.
- Dr. Rajesh Kumar Meena, received 'Best Oral Presentation award' for the paper presentation on "Characterization of Soil Resources using Geospatial technologies for Sustainable Agricultural Land Use Planning: a case study from intensively cultivated Trans Indo-Gangetic plains" during 5th International Conference on Sustainable Natural Resources Management under Global Climate Change organized by Soil Conservation Society of India (SCSI) at New Delhi during November 7-10, 2023.
- Dr. Ranjan Paul has received the 'Outstanding Young Scientist Award' of ICAR-NBSS & LUP during 47th Foundation day of the Institute.
- Dr. Lal Chand Malav received outstanding Young Scientist Award of 2022-23 on 47th Foundation Day of by ICAR NBSS&LUP, Nagpur.
- Dr. B. L. Tailor received Best Technical Award of 2022-23 on 47th Foundation Day of by ICAR NBSS&LUP, Nagpur

Recognitions

- Dr. Jaya N Surya nominated as ICAR representative by ADG (NRM), ICAR, New Delhi to attend the meeting on "Engaging of Schools having science labs as soil testing labs to create awareness on soil health" Pilot programme of M/o A&FW & M/o S Education and act as executive committee member for pilot project of school soil health programme.
- Dr. Jaya N Surya identified by UPSC, New Delhi as a Adviser/subject expert for various Board meetings / interviews of UPSC.
- G.P. Obi Reddy was recognized as a faculty for PG Programme of IARI Mega University under Nagpur Hub from 3rd November 2023.

Awards and honours (Committee Members, etc)

- Dr. R. Srinivasan was elected Councillor in the Council of the Indian Society of Soil Science (ISSS) for the two years 2024 and 2025 at the 87th Annual General Body Meeting of the Society held on 4 October 2023
- Dr. S. Chattaraj was selected as one of the best project among Agri Grand Challenge Awardees 2022 during ISCTA 2023 International conference at Biswa Bangla Convention Centre, Kolkata on 19 to 20-12-2023 by C-DAC, Kolkata, MeitY, GOI under Agri Grand Challenge scheme by MeitY, GOI.
- Dr. S. Chattaraj recognized as one of the Best Reviewer and nominated as Track Chair of Remote Sensing and Aerial Imaging Session



during ISCTA 2023 International conference at Biswa Bangla Convention Centre, Kolkata on 19 to 20-12-2023 by C-DAC, Kolkata, MeitY, GOI.

- Dr. UK Maurya acted as Expert Member in Board of Wildlife & We Foundation, Mumbai.

- Dr. UK Maurya acted as Member Technical Expert for the Review of BIG proposals under Biotechnology Industry Research Assistance Council (BIRAC), A Government of India Enterprise, New Delhi.

Head Quarter, Nagpur

- Dr. Niteen V. Patil Vice-chancellor, MAFSU, Nagpur, Guest of Honor.
- Sh. Sandip Patil, DIG of Police, Gadchiroli, Guest of Honor.
- Dr. Brahma Swarup Dwivedi, Member, Agricultural Scientists Recruitment Board, New Delhi special invitee.
- Dr. S.K. Chaudhari, Deputy Director General (NRM), ICAR, New Delhi
- Dr. A. Velmurugan, ADG (SWM), NRM, ICAR, New Delhi on 24.04.2023
- Dr. C. D. Mayee, Former Chairman, ASRB, New Delhi
- Sh. Sambhaji Kadupatil, Director General, Vasantdada Sugar Institute, Pune on 16.01.2023
- Dr. Rajendra D. Sable, Joint Director of Agriculture, Govt. of Maharashtra, Nagpur on 27.9.2023
- Dr. A. Murkute, Director, MGIRI, Wardha on 27.9.2023
- Dr. K. Sami Reddy, Director ICAR-NISAM, Baramati
- Shri. Sudhir Rathod, Registrar, Dr. PDKV, Akola on 27.9.2023
- Dr. H.D. Charan, Former V-C, Bikaner Technical University, Bikaner on 27.9.2023
- Sh. Sakhambar Ajaonkar, Director, Krushakonnati Farmer Producer Co. Ltd, Pune on 27.9.2023
- Dr. N. Ahmed, Pr. Scientist, Deptt of Agril Chem. & Soil Science, ICAR-IARI, N. Delhi on 27.9.2023
- Dr. R.P. Mishra, Pr. Scientist, ICAR-IIFSR, Modipuram, U.P. on 27.9.2023

Regional Centre, Bangalore

- International visitors: 15 officers from 12 nations undergoing international training on Geo-spatial applications at NIRD, Hyderabad visited the centre to understand on LRI-under REWARD project on 24th March 2023.
- Sri Kamal Preeth Singh IAS, Agriculture production Commissioner Chhattisgarh visited LRI field at

Neergantinpalli watershed on 24th May 2023

- Sri Ranabir Sharma IFS: CEO, Watershed Dept, Govt of Chhattisgarh visited LRI field study sites on 24th May 2023
- Dr Anurag Srivatsava, and Dr Ashok Medha, Scientists from ART-PACK, IISc Bangalore on 02nd August 2023
- Dr Anjum, Scientist, NRSC(ISRO) Hyderabad on 12.10.2023.
- Dr Pyush Dogra, World Bank, North Eastern states on 12.10.2023.
- Smt. Nandini Choudhary: World Bank Environmental services specialist on 12.10.2023.
- Smt. Nitika Surie, World Bank Environmental services specialist on 12.10.2023.
- Sri Mohammad Anas: World Bank-IT- specialist on 12.10.2023.
- Dr Natrajan: world bank consultant: REWARD project on 12.10.2023

Regional Centre, Delhi

- Dr. Prashant Armorikar, Director (Watershed Development), National Rainfed Area Authority, New Delhi
- Sh. Milind Wadodkar, Chief soil Survey Officer, SLUSI, Delhi

Regional Centre, Jorhat

- A Team from Assam Agricultural Commission visited the Centre on the 3rd week of February 2023.
- Mr. Lipok I. Jamir, Joint Director (Agri), Govt. of Nagaland visited the Centre on 08.11.2023.

Regional Centre, Kolkata

- Dr. N.G. Patil, Director, ICAR-NBSS&LUP, Nagpur
- Swami Sadananda Maharaj, Secretary, Rama Krishna Ashram Mission, Nimpith
- Sh. Pravat Mishra, IAS, Principal Secretary, Accelerated Dept. for Minor Irrigations Project, Govt. of West Bengal
- Dr. Debabrata Basu, Vice Chancellor, UBKV,



Cooch Behar

- Dr. R.K. Samanta, Former Vice Chancellor, BCKV, Mohanpur
- Prof. S.K. Sanyal, Former Vice Chancellor, BCKV, Mohanpur
- Prof. Kunal Ghosh, Professor & Former Head, Dept. of Agricultural Science, University of Calcutta
- Dr. C. Chattopadhyay, Former Vice Chancellor, UBKV, Cooch Behar
- Prof. Biswapati Mandal, Former Pro Vice Chancellor, BCKV, Mohanpur
- Dr. A. Mukhopadhyay, Former National Director, NASF, ICAR, New Delhi
- Dr. Pradip De, Director, ICAR- ATARI, Kolkata
- Dr. Gauranga Kar, Director, ICAR- CRIJAF
- Dr. N. Trivedi, Former Director, Dept. of Agriculture, Govt. of West Bengal
- Dr. K.K. Satpathy, Former Director, ICAR- NINFET, Kolkata
- Dr. N.C. Sahu, Pr. Scientist & Head, SS KVK, RKMVERI, Sonarpur, South 24 Pgs.
- Dr. Pradip Sen, Former MD, WBSSC, Govt. of West Bengal
- Prof. S.S. Sahu, Former Head, Dept. of Ag. Chem. & Soil Science, BCKV
- Prof. S. K. Kothari, Director, School of Agriculture, The Neotia University
- Dr. Ashok Choudhury, Director of Research, UBKV, Cooch Behar
- Dr. B.K. Datta, Director, Vivekananda Institute of Biotechnology, Nimpith
- Sh. A.C. Ghosh, Former Director (GA&AE), ICAR, New Delhi
- Dr. H. Biswas, Principal Scientist, ICAR- NBSS&LUP, Nagpur
- Dr. Shyamal Chakraborty, Secretary, Forum of Scientists, Engineers and Technologists
- Dr. B.K. Bandyopadhyay, Former Head, ICAR- CSSRI, RRS Canning
- Dr. S. Satpathy, Head, Crop Protection, ICAR- CRIJAF, Barrackpore
- Dr. B. Maji, Former Head, ICAR- CSSRI, RRS Canning
- Dr. D. Kundu, Former Head, Crop Production, ICAR- CRIJAF, Barrackpore
- Dr. D. Burman, Head, ICAR- CSSRI, RRS Canning
- Dr. T. Ghosal, Head, ICAR- CIFE, RC Kolkata

- Dr. Partha Sengupta, Add. Director of Agriculture, Govt. of West Bengal
- Dr. Amit Saha, Former Head, Crop Production, ICAR- CRIJAF, Barrackpore
- Mrs. Shruti Mishra, Hindi Officer, Hindi Teaching Scheme, Central Hindi Training Institute, Kolkata
- Sh. Vivek Kumar, C.A.O., ICAR- CIFRI, Barrackpore
- Sh. Kundal Mitra, Chief Manager, Bank of Maharashtra
- Sh. Alok Kumar Madhukar, Chief Manager, State Bank of India

Fishers' Exposure Visit

- A team of 42 trainee fishers from Odisha visited ICAR- NBSS&LUP, Regional Centre, Kolkata on 07.06.23 for a half day exposure visit under their training programme at ICAR- CIFRI, Barrackpore.



42 trainee fishers from Odisha visited ICAR- NBSS&LUP, Regional Centre, Kolkata on 07.06.23

- An exposure visit for 16 final year students of College of Agriculture, Kyrdemkulai, Meghalaya (CAU- Imphal) as a part of their study tour on July 21.



- An Exposure visit has been organized for the students of 3rd Semester of M.Sc. courses in Agricultural Biotechnology (AgBT) and 1st Semester of Agriculture and Rural Development (ARD) of Integrated Rural Development



and Management (IRDM) Faculty center, Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI) on 11.01.2023 at ICAR-NBSS & LUP, RC, Kolkata. The total of 51 students were divided into three groups and visited the GIS, laboratory and Soil Museum rotationally and interacted with the concerned Scientists and Technical staffs.

Regional Centre, Udaipur

- Honorable Secretary (DARE) and DG (ICAR), New Delhi Dr. Himanshu Pathak visited the ICAR-NBSS&LUP, RC, Udaipur on 28.08.2023.
- Dr. S. K. Sharma, ADG (HRM) visited the ICAR-NBSS&LUP, RC, Udaipur on 14.08.2023.

SCIENTIFIC

Dr. B.P. Bhaskar, Acting Director (Upto 13th March 2023)

Dr. N.G. Patil, Director (from 14th March, 2023)

PRIORITY SETTING, MONITORING AND EVALUATION CELL

Dr. N.G. Patil, Principal Scientist (SWC E) & In-charge PME (up to 13th March 2023)

Dr. H. Biswas, Principal Scientist (Soil Science) & In-charge, PME

DIVISION OF SOIL RESOURCE STUDIES

1. Dr. Pramod Tiwary, Principal Scientist (SWCE) & Acting Head & Head (w.e.f. 02.12.2023)
2. Dr. K. Karthikeyan, Sr Scientist (Soil Science)
3. Dr. U.K. Maurya, Pr. Scientist (Soil Science)
4. Dr. Vasu, D., Sr. Scientist (Soil Science)
5. Sh. Gopal Tiwari, Scientist (Soil Science)
6. Dr. Ranjan Paul, Scientist (Soil Science)

DIVISION OF REMOTE SENSING APPLICATIONS

1. Dr. M.S.S. Nagaraju, Principal Scientist (Soil Science) & Acting Head (up to 11.01.2023)
2. Dr. G.P. Obi Reddy, Principal Scientist (Geography) & Head (w.e.f. 15.06.2023)
3. Sh. Nirmal Kumar, Sr. Scientist (Soil Physics)
4. Sh. Benukantha Dash, Scientist (SWCE)
5. Dr. Sunil B.H., Scientist (Soil Science)

DIVISION OF LAND USE PLANNING

1. Dr. N.G. Patil, Principal Scientist (SWCE) & Acting Head (Up to 29.01.23)
2. Dr. M.S. Raghuvanshi, Principal Scientist (Agronomy) & Acting Head (from 30.01.23 to 15.06.2023)
3. Dr. H. Biswas, Principal Scientist (Soil Science) & Head (w.e.f. 16.06.2023)
4. Dr. Ravindra Naitam, Sr. Scientist (Soil Science)
5. Sh. H.L. Kharbikar, Scientist (Agril. Economics)
6. Ms. Radhika C., Scientist (Agril. Economics)
7. Dr. P.C. Moharana, Scientist (Soil Science)
8. Dr. A.O. Shirale, Scientist (Soil Science)

REGIONAL CENTRE, BANGALORE

1. Dr. Rajendra Hegde, Principal Scientist (Agronomy) & Acting Head (up to 12.01.2023)
2. Dr. V. Ramamurthy, Principal Scientist (Agronomy) & Acting Head (w.e.f. 13.01.23) and Head (w.e.f. 12.07.2023)
3. Dr. B.P. Bhaskar, Principal Scientist (Soil Science)
4. Dr. K.S. Anil Kumar, Principal Scientist (Soil Science)
5. Dr. S.C. Ramesh Kumar, Principal Scientist (Agril. Economics)
6. Dr. S. Srinivas, Principal Scientist (Computer Application)
7. Dr. S. Dharmurajan, Senior Scientist (Soil Science)
8. Sh. S.P. Maske, Sr. Scientist (SWCE)
9. Dr. R. Srinivasan, Sr. Scientist (Soil Science)
10. Mrs Vasundhara R., Sr. Scientist (Soil Science)
11. Dr. (Mrs) M. Lalitha, Sr. Scientist (Soil Science)
12. Dr. (Mrs) B. Kalaiselvi, Sr. Scientist (Soil Science)
13. Dr. (Ms) M. Chandrakala, Scientist (Soil Science)
14. Dr. (Mrs) Karthika, Scientist (Soil Science)

REGIONAL CENTRE, DELHI

1. Dr. (Mrs) Jaya N. Surya, Principal Scientist (Soil Science) & Head (w.e.f. 23.06.23)
2. Sh. Ashok Kumar, Sr. Scientist (Agronomy)
3. Dr. Rajesh Kumar Meena, Sr. Scientist (Soil Science)
4. Sh. Vikas, Scientist (Agricultural Statistics)
5. Ms. Ritu Nagdev, Scientist (Environmental Science)
6. Dr. Sunil Kumar, Scientist (Soil Science)

REGIONAL CENTRE, KOLKATA

1. Dr. S.K. Ray, Principal Scientist & Acting Head (up to 22.06.2023)
2. F.H. Rahman, Principal Scientist & Head (from 23.06.2023)
3. Dr. (Mrs.) Tapati Banerjee, Principal Scientist (Geography)
4. Dr. B.N. Ghosh, Principal Scientist (Soil Science)
5. Dr. K.M. Hati, Principal Scientist (Soil Science)

6. Dr. S. Mukhopadhyay, Principal Scientist (Soil Science)
7. Dr. Sah Kausar Reza, Senior Scientist (Soil Science)
8. Dr. S. Bandyopadhyay, Senior Scientist (Soil Science)
9. Dr. (Ms) S. Gupta Chaudhary, Sr. Scientist (Soil Science)
10. Dr. Sudipta Chattaraj, Sr. Scientist (Soil Physics)
11. Dr. Amrita Daripa, Sr. Scientist (Environmental Science)
12. Dr Ruma Das, Scientist (Soil Science)

REGIONAL CENTRE, JORHAT

1. Dr. U.S. Saikia, Principal Scientist (Met.) & Act. Head
2. Dr. R.S. Meena, Senior Scientist (Soil Science)
3. Dr. K.K. Mourya, Scientist (Soil Science)
4. Dr. Arijit Barman, Scientist (Soil Science)
5. Sh. Ravi Kumar, Scientist (Environmental Science)
6. Sh. Sandeep Kumar, Scientist (Agronomy)
7. Sh. Dibakar Roy, Scientist (Soil Science)

REGIONAL CENTRE, UDAIPUR

1. Dr. B.L. Mina, Principal Scientist (Soil Science) and Head 12.07.2023
2. Dr. R.P. Sharma, Senior Scientist, (Soil Science)
3. Sh. Roshan Lal Meena, Scientist (Agronomy)
4. Sh. Mahaveer Nogiya, Scientist (Soil Science)
5. Dr L.C. Malav, Scientist, (Env. Sci.)
6. Sh. Abhishek Jangir, Scientist (Soil Science)
7. Dr. Brijesh Yadav, Scientist, (Soil Science)

TECHNICAL

HEADQUARTERS, NAGPUR

1. Dr. S.S. Nimkhedkar, Chief Technical Officer (FFT)
2. Sh. V.P. Patil, Chief Technical Officer (FFT)
3. Dr. A.P. Nagar, Chief Technical Officer (FFT)
4. Mrs. Smita Patil, Chief Technical Officer (FFT)
5. Dr. (Mrs.) Ratna P. Roy, Asstt. Chief Technical Officer (FFT)
6. Sh. V.N. Parhad, Chief Technical Officer (FFT)
7. Dr. (Mrs.) Jiji Cyriac, Chief Technical Officer (LID)
8. Sh. S.S. Gaikawad, Chief Technical Officer (FFT)
9. Sh. P.V. Ambekar, Chief Technical Officer (Photo.)
10. Dr. M.T. Sahu, Asstt. Chief Technical Officer (P&E)
11. Sh. D.S. Mohekar, Asstt. Chief Technical Officer (FFT)

12. Sh. P.S. Butte, Asstt. Chief Technical Officer (FFT)
13. Sh. S.D. Meshram, Asstt. Chief Technical Officer (LT)
14. Sh. Ajit Kumar Meena, Senior Technical Officer (FFT)
15. Sh. Laxmanarayanan M., Senior Technical Officer (FFT)
16. Sh. R.K. Bhalsagar, Technical Officer (FFT)
17. Mrs. Ujwala Tijare, Technical Officer (WS)
18. Sh. B.M. Khorge, Technical Officer (WS)
19. Sh. R.N. Zambre, Technical Officer (WS)
20. Sh. S.S. Dohatre, Technical Officer (FFT)
21. Sh. V.T. Sahu, Technical Officer (FFT)
22. Sh. S.K. Mendhekar, Technical Assistant (FFT)
23. Sh. P.N. Jadhav, Senior Technician (FFT)
24. Sh. S.R. Singade, Senior Technician (FFT)
25. Sh. A.M.G. Sheikh, Senior Technician (FFT)
26. Sh. J.B. Padole, Technical Assistant (FFT)
27. Smt. Nisha A. Lade, Senior Technician (FFT)
28. Sh. Atul Dankhade, Senior Technician (WS)
29. Sh. L.G. Sontakke, Senior Technician (WS)
30. Sh. S.A. Bhoyar, Senior Technician (FFT)
31. Mrs. K.B.J. Prasanna Rani, Technician (LT)
32. Mr. Deepak Devdas Ganvir, Technician (FFT)

REGIONAL CENTRE, BANGALORE

1. Mrs. Arti Koyal, Chief Technical Officer (FFT)
2. Dr. M. Ramesh, Asstt. Chief Technical Officer (LT)
3. Sh. D.H. Venkatesh, Chief Technical Officer (LT)
4. Mrs. K. Sujatha, Senior Technical Officer (WS)
5. Sh. Ranabir Chakraborty, Senior Technical Officer (FFT)
6. Mrs. K.V. Archana, Technical Officer (FFT)
7. Sh. N. Maddileti, Senior Technician (FFT)
8. Ms. S. Parvathy, Senior Technician (LT)

REGIONAL CENTRE, KOLKATA

1. Dr. (Mrs.) J. J. Mukhopadhyay, Chief Technical Officer (FFT)
2. Dr. Abhijit Haldar, Asstt. Chief Technical Officer (FFT)
3. Sh. V. Mohan, Asstt. Chief Technical Officer (LT)
4. Sh. A.K. Maitra, Senior Technical Officer (FFT)
5. Mrs. R. Basu, Technical Officer (LT)
6. Mrs. S. Saha, Technical Officer (WS)
7. Sh. P. Mondal, Technical Officer (WS)
8. Sh. S. Sarkar, Technical Officer (FFT)
9. Sh. Sukonto Pal, Technical Officer (FFT)
10. Sh. Siddharth Karamkar, Technical Assistant (LT)



11. Smt. Kalpana Biswas, Sr. Technician (LT)
12. Sh. Mahesh Roy, Sr. Technician (FFT)
13. Sh. Abhijit Sampat Meshram, Technician (FFT)

REGIONAL CENTRE, NEW DELHI

1. Dr. D.K. Katiyar, Chief Technical Officer (FFT)
2. Sh. Harjit Singh, Asstt. Chief Technical Officer (FFT)
3. Sh. Manish Olaniya, Senior Technical Officer (FFT)
4. Sh. S. Saboo, Technical Officer (WS)
5. Sh. Vijay Singh, Technical Officer (WS)
6. Sh. P.R. Kharwar, Senior Technical Assistant (FFT)
7. Sh. Kuldeep Singh, Senior Technical Assistant (FFT)
8. Sh. Rajesh Rajpal, Senior Technical Assistant (FFT)
9. Sh. Shiv Kumar, Technical Assistant (FFT)
10. Sh. Rajneesh Kumar, Technical Assistant (FFT)
11. Sh. Roshan Lal, Technical Assistant (FFT)
12. Sh. Harendra Singh Rawat, Technician (FFT)

REGIONAL CENTRE, JORHAT

1. Sh. Durnan Gogai, Technical Officer (WS)
2. Mrs. Shamoli Chetia, Technical Officer (WS)
3. Sh. Gopi Saikia, Technical Officer (WS)
4. Sh. Dilip K. Dutta, Senior Technical Assistant (WS)
5. Sh. N. Saikia, Technical Assistant (FFT)
6. Sh. Pradip Kotoky, Technical Assistant (FFT)
7. Sh. Chandeshwar Das, Technical Assistant (FFT)
8. Sh. Amitabh Baruah, Senior Technical Assistant (FFT)

REGIONAL CENTRE, UDAIPUR

1. Sh. Bhagwati Lal Tailor, Senior Technical Officer (WS)
2. Sh. K.M. Soni, Technical Officer (FFT)
3. Sh. N.D. Khan, Technical Officer (WS)
4. Sh. Bansilal Jat, Technical Officer (FFT)
5. Sh. Nola Ram Ola, Technical Officer (FFT)
6. Sh. B.S. Kumawat, Senior Technical Assistant (FFT)
7. Sh. B.R. Meena, Technical Assistant (WS)
8. Sh. Ambalal Bhoi, Technical Assistant (WS)
9. Sh. C.K. Kumawat, Senior Technician (FFT)
10. Sh. Sohan Lal Sharma, Senior Technician (FFT)
11. Sh. J.S. Rao, Senior Technician (FFT)
12. Sh. Shiv Pal Singh, Senior Technician (FFT)

13. Sh. Manish Choudhary, Technician (WS)
14. Smt. Vandana Patil, Technician (FFT)
15. Shri Devilal Prajapat, Technician (FFT)
16. Sh. Shambhu Lal Meena, Technician

ADMINISTRATIVE, FINANCE & ACCOUNT

HEADQUARTERS, NAGPUR

1. Sh. Ramdeen, Chief Administrative Officer
2. Sh. Aswani Garg, Chief Finance and Accounts Officer
3. Sh. Devendra Kumar Dharam, Dy. Director (OL)
4. Sh. Toran Prasad, Assistant Administrative Officer
5. Sh. Kamlesh Sharma, Assistant Administrative Officer
6. Sh. Ajay Meshram, Assistant Administrative Officer
7. Sh. Nitin Mohurle, Assistant
8. Sh. U.S. Kapse, Assistant
9. Mrs. Shalu Nandanwar, Assistant
10. Sh. S.M. Pathak, Private Secretary
11. Mrs. Wasudha D. Khandwe, Private Secretary
12. Sh. N.B. Mankar, Assistant
13. Sh. S.S. Kamble, Assistant
14. Sh. S.J. Patil, Assistant
15. Sh. Swapil B. Suryawanshi, Lower Division Clerk
16. Ms. Sonal M. Rekhate, Lower Division Clerk
17. Ms. Priya N. Kodape, Lower Division Clerk

REGIONAL CENTRE, BANGALORE

1. Mrs. P. Chandrakala, Assistant
2. Sh. Pankaj Gopal Wani, Lower Division Clerk

REGIONAL CENTRE, DELHI

1. Sh. Sumit Sindhu, Asstt. Administrative Officer
2. Mrs. Sunita Mittal, AAO w.e.f.12.01.2023
3. Mr. Rahul Yadav, Stenographer - III

REGIONAL CENTRE, JORHAT

1. Sh. P.K. Das, Assistant Administrative Officer
2. Sh. N.C. Baruah, Personal Assistant

REGIONAL CENTRE, KOLKATA

1. Sh. Biswajit Baruh, Administrative Officer
2. Ms Bedantika Dutta, Assistant Administrative Officer
3. Mrs. Nirmala Kumar, Assistant Administrative Officer
4. Mrs. Aparna Das, Personal Assistant

REGIONAL CENTRE, UDAIPUR

1. Sh. Sumit Sindhu, Assistant Administrative Officer
2. Sh. Harish Rajput, Personal Assistant
3. Sh. Unnikrishnan Nair, K.K., Assistant
4. Sh. V.S. Sankhla, Assistant
5. Sh. Bhanwar Singh Devra, Upper Division Clerk

SKILLED SUPPORTING STAFF

HEADQUARTERS, NAGPUR

1. Sh G.B. Topre
2. Sh. N.T. Thawkar
3. Sh. Ramesh Khawle
4. Ms. Merlin Anthony
5. Sh. Aniket Gedam
6. Mrs. Rina Yadav
7. Mrs. Gayatri Chigore
8. Sh. Rahul Taksande

Regional Centre, Bangalore

1. Sh. R. Balakrishna

Regional Centre, Delhi

1. Rakesh Kumar

Regional Centre, Jorhat

1. Sh. Dilip Borah
2. Sh. R.C. Rajak
3. Raju Balmiki
4. J.C. Baruah
5. Sh. J.P. Gogai
6. Pabitra Gogai

Regional Centre, Kolkata

1. Sh. V.N. Mishra
2. Mrs. Radha Turi
3. Mrs. Alpana Roy
4. Krishna Guchait

Regional Centre, Udaipur

1. Sh. Mohan Lal Meghwal

New Entrants

1. Sh. Ramdeen joined on 17.01.2023(F/N) to the post of Chief Administrative Officer at ICAR-NBSS&LUP, Nagpur after relieving from ICAR-CAZRI, Jodhpur.
2. Sh. Biswajit Baruh, Administrative Officer join on 20.03.2023(F/N) at Regional Centre, Kolkata after relieving from CIFRI, Barrackpore

STAFF RETIREMENT/SUPERANNUATION

S.No.	Name of Employee	Date of Superannuation
1	Sh. D.R. Borkar, Technical Assistant (Driver), Nagpur	31.01.2023
2	Dr. T. Chatopadhyay, Sr. Scientist, Regional Centre, Kolkata	30.04.2023
3	Dr. K.S. Anil Kumar, Pr. Scientist, Regional Centre, Bangalore	30.04.2023
4	Sh. H.J. Bhondve, Technical Officer, Nagpur	30.04.2023
5	Smt. S.N. Gajbhiye, Technician, Nagpur	31.05.2023
6	Sh. S.V. Bobade, Chief Tech. Officer, Nagpur	31.05.2023
7	Sh. S.K. Kalbande, Technical Officer (Driver), Nagpur	30.06.2023
8	Dr. M.S.S. Nagaraju, Principal Scientist, RSA Division, Nagpur	31.07.2023
9	Dr. K.V. Niranjana, Chief Tech. Officer, Regional Centre, Bangalore	31.07.2023
10	Sh. M.D. Kadhav, Technical Officer (Driver), Nagpur	31.07.2023
11	Sh. K.K. Bharadwaj, Technical Officer, Regional Centre, Delhi	31.07.2023
12	Dr. S. Mukhopadhyay, Pri. Scientist, Regional Centre, Kolkata	31.08.2023
13	Dr. A.M. Nimkar, CTO, SRS Division, Nagpur	31.08.2023
14	Sh. Madan Das, PS, Regional Centre, Jorhat	31.08.2023
15	Dr. M. Ramesh, CTO, Regional Centre, Bangalore	30.09.2023
16	Smt. Rohini Watekar, PS, Nagpur	31.10.2023
17	Sh. J.C. Baruah, S.S.Gr.II, Regional Centre, Jorhat	30.11.2023
18	Sh. C. Das, Sr. Tech. Asstt., Regional Centre, Jorhat	31.12.2023
19	Sh. K.M. Soni, Technical Officer, Regional Centre, Udaipur	31.12.2023
20	Sh. P.K. Das, AAO, Regional Centre, Jorhat	31.12.2023



3. Dr. K.M. Hati, Pri. Scientist joined on 27.03.2023(F/N) at Regional Centre, Kolkata after relieving from IISS, Bhopal.
 4. Sh. Ravi Kumar joined on 11.04.2023(F/N) to the post of Scientist at Regional Centre, Jorhat.
 5. Dr. Feroze Hasan Rahman, Pri. Scientist joined on 23.06.2023 (F/N) to the post of Head, Regional Centre, ICAR-NBSS&LUP, Kolkata after relieving from ICAR-ATARI, Kolkata.
 6. Sh. Sandeep Kumar joined on 15.06.2023(F/N) to the post of Scientist at ICAR-NBSS&LUP, Regional Centre, Jorhat.
 7. Sh. Dibakar Roy joined on 03.07.2023(F/N) to the post of Scientist at ICAR-NBSS&LUP, Regional Centre, Jorhat after relieving from ICAR-DWR, Jabalpur.
 8. Dr. Smt. Sirisha Adamala, Scientist (Land & Water Management Engineering) joined on 18.12.2023(F/N) at ICAR-NBSS&LUP, Nagpur after relieving from ICAR- CIARI, Port Blair.
 9. Dr. (Smt.) Ch. Jyotiprava Dash, Sr. Scientist (Land & Water Management Engineering) joined on 26.12.2023(F/N) at ICAR-NBSS&LUP, Nagpur after relieving from ICAR-IISWC, RC, Koraput.
- Dr. G.P. Obi Reddy, Principal Scientist joined to the post of Head, Division of RSA on 15th June 2023.
 - Dr. Hrittick Biswas, Principal Scientist joined to the post of Head, Division of LUP on 16th June 2023.
 - Dr. (Mrs.) Jaya N. Surya, Principal Scientist joined to the post of Head, Regional Centre, Delhi on 23rd June 2023.
 - Dr. V. Ramamurthy, Principal Scientist joined to the post of Head, Regional Centre, Bangalore on 12th July 2023.
 - Dr. B. L. Mina, Principal Scientist joined to the post of Head, Regional Centre, Udaipur on 12th July 2023.
 - Dr. Pramod Tiwary, Principal Scientist joined to the post of Head, Division of SRS on 2nd December 2023.
 - Mrs. Sunita Mittal, Assistant promoted to the post of Asstt. Administrative Officer w.e.f. 12.01.2023.
 - Sh. Ashwani Garg, Sr. Finance & Accounts Officer promoted to the post of Chief Finance & Accounts Officer w.e.f.28.03.2023.

STAFF MOVEMENT

1. Sh. Kamlesh Sharma, Asstt. Administrative Officer transferred from Regional Centre, Udaipur to NBSS&LUP, HQrs., Nagpur.
 2. Dr. Ms. Surabhi Hota, Scientist transferred from NBSS&LUP, Regional Centre, Jorhat to ICAR-DWR, Jabalpur
 3. Ms. Shilpi Verma, Scientist transferred from NBSS&LUP, Regional Centre, New Delhi to ICAR-IARI, New Delhi.
 4. Smt. Radhika C., Scientist transferred from NBSS&LUP, HQrs., Nagpur to Regional Centre, Bangalore.
 5. Shri Harish Rajput, PA transferred from NBSS&LUP, Regional Centre, Udaipur to NRCSS, Ajmer.
 6. Sh. Sumit Sindhu, Asstt. Administrative Officer is on deputation at Delhi State Industrial & Infrastructure Development Corporation Limited, New Delhi.
 7. Sh. Pradeep Kumar, LDC transferred from ICAR-NBSS&LUP, Nagpur to ICAR-NRCSS Ajmer.
- Smt. P. Chandrakala, Assistant promoted to the post of Asstt. Administrative Officer w.e.f. 24.05.2023.
 - Sh. S.J. Patil, UDC promoted to the post of Assistant w.e.f.28.11.2023.
 - Sh. Sanjay Kamble, UDC promoted to the post of Assistant w.e.f.28.11.2023.
 - Sh. S.S. Gaikwad, Asstt. Chief Tech. Officer (T-7-8) Nagpur promoted to the post of Chief Technical Officer
 - Dr. Smt. J. Mukhopadhyay, Asstt. Chief Tech. Officer (T-7-8) Kolkata promoted to the post of Chief Technical Officer
 - Dr. D.H. Venkatesh, Asstt. Chief Tech. Officer (T-7-8) Bangalore promoted to the post of Chief Technical Officer
 - Dr. Smt. Jiji Cyriac, Asstt. Chief Tech. Officer (T-7-8) Nagpur promoted to the post of Chief Technical Officer.
 - Smt. Smita Patil, Chief Technical Officer (T-9) Nagpur received advance increment.
 - Dr. M. Ramesh, Chief Technical Officer (T-9) Bangalore received advance increment.
 - Smt. P. Chandramati, Ex- Chief Technical Officer (T-9) Bangalore received advance increment.
 - Sh. H.L. Kharbikar, Scientist (Agricultural Economics), Division of LUP, Nagpur promoted to

PROMOTIONS

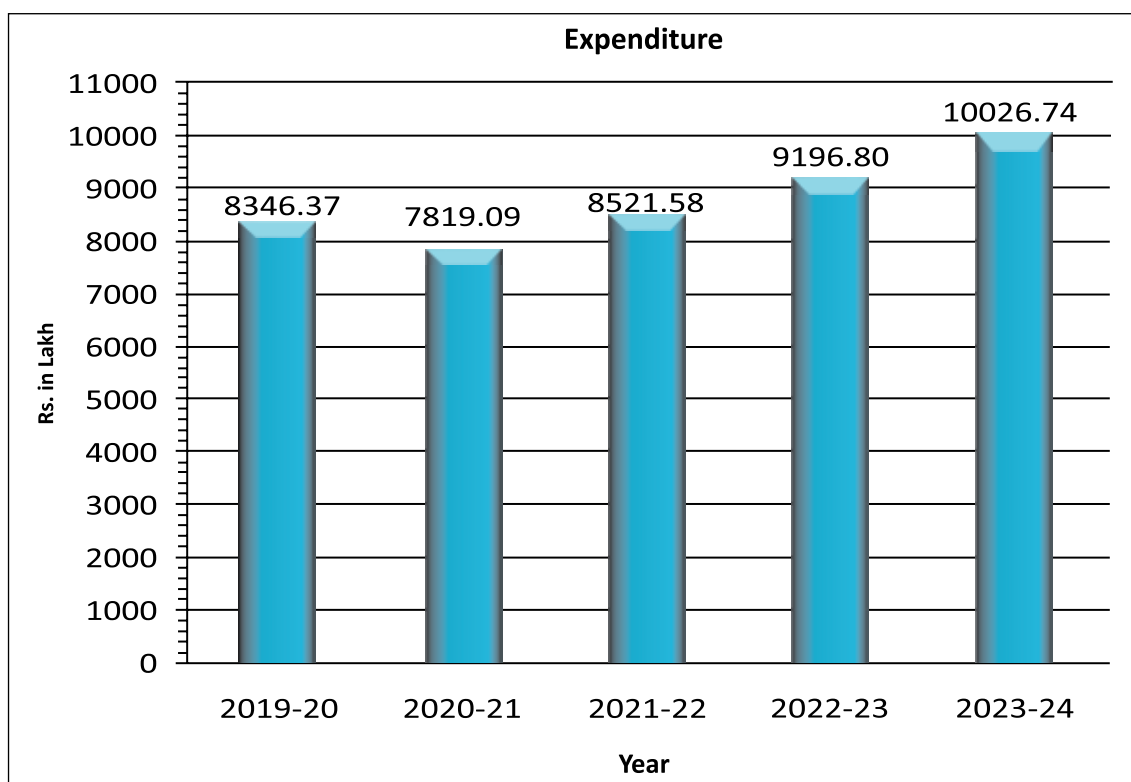
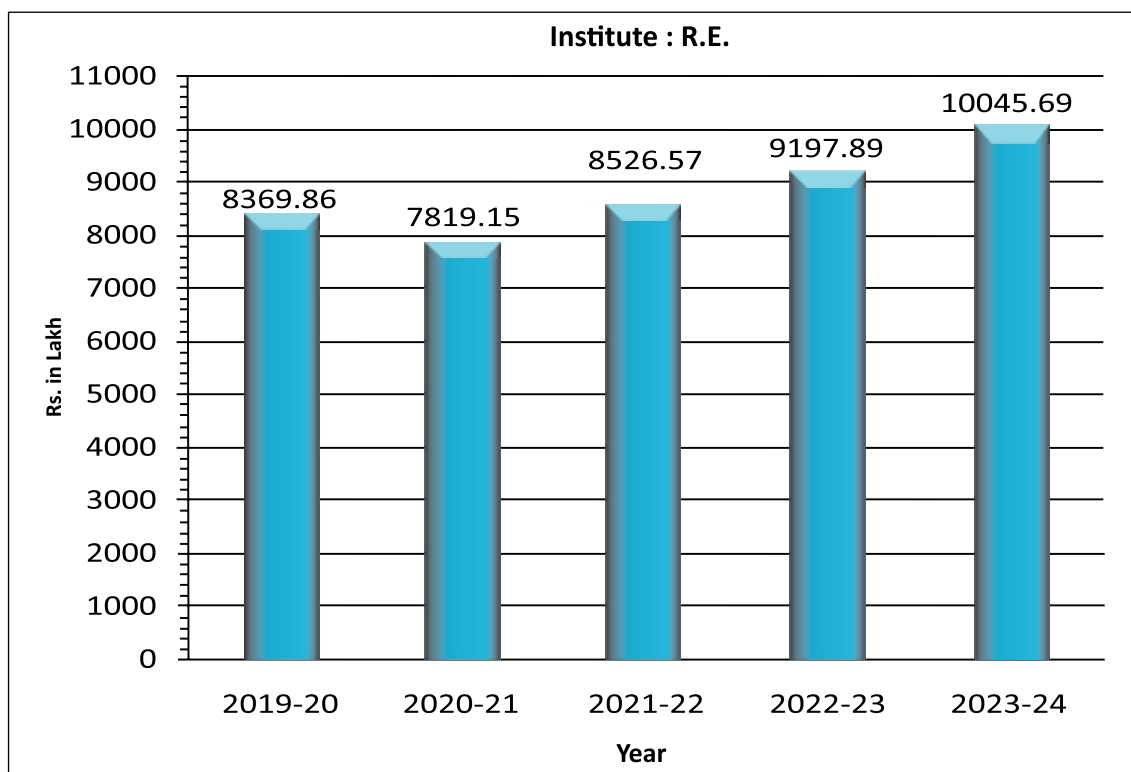
- Dr. N.G. Patil, Principal Scientist & Head, Division of LUP appointed to the post of Director, ICAR-NBSS&LUP, Nagpur and joined on 14th March 2023.

the next higher grade in PB-3 Rs. 15600-39100 + RGP Rs. 7000/- (Pay Level – 11) w.e.f.15.12.2015.

- Dr. Nirmal Kumar Scientist (Soil Science) Promoted to the next higher grade of PB-4 Rs. 37400-67000+ RGP Rs. 9000/- (Revised Research Pay Level – 13A) w.e.f.10.02.2022 and may be re-designated as Senior Scientist w.e.f.10.02.2019.
- Dr. Smt. Shreyasi Gupta Choudhury Sr. Scientist (Soil Science) Promoted to the next higher grade of PB-4 Rs. 37400-67000+ RGP Rs. 9000/- (Revised Research Pay Level – 13A) w.e.f. 27.04.2023.
- Dr. S. Ramachandran Scientist (Soil Science) Promoted to the next higher grade of PB-3 Rs. 15600-39100+ RGP Rs. 8000/- (Revised Research Pay Level – 12) and re-designation as Senior Scientist w.e.f.24.01.2021.
- Dr. D. Vasu, Scientist (Soil Science) Promoted to the next higher grade of PB-3 Rs. 15600-39100+ RGP Rs. 8000/- (Revised Research Pay Level – 12) and re-designation as Senior Scientist w.e.f. 01.01.2022.
- Dr. Rajesh Kumar Meena Scientist (Soil Science) Promoted to the next higher grade of PB-3 Rs. 15600-39100+ RGP Rs. 8000/- (Revised Research Pay Level – 12) and re-designation as Senior Scientist w.e.f. 01.01.2022.
- Dr. Smt. Kalaiselvi B., Scientist(Soil Science) Promoted to the next higher grade of PB-3 Rs. 15600-39100+ RGP Rs. 8000/- (Revised Research Pay Level – 12) and re-designation as Senior Scientist w.e.f. 01.01.2023.
- Dr. Ms. Surabhi Hota, Scientist Promoted to the next higher grade of PB-3 Rs.15600-39100+ RGP Rs.7000/- (Revised Research Pay Level –11) w.e.f. 02.07.2022.
- Dr. Smt. Amrita Daripa, Scientist (Environmental Science) Promoted to the next higher grade of PB-3 Rs. 15600-39100+ RGP Rs. 8000/- (Revised Research Pay Level – 12) and re-designation as Senior Scientist w.e.f. 01.01.2023.
- Dr. Lal Chand Malav, Scientist (Environmental Science) Promoted to the next higher grade of PB-3 Rs.15600-39100+ RGP Rs.7000/- (Revised Research Pay Level–11) w.e.f. 04.01.2022.
- Sh. B.R. Meena, STA RC Udaipur promoted to Tech. Officer Driver (T-5) w.e.f. 29.06.2022.
- Sh. Manish Choudhari, Sr. Technician, RC Udaipur promoted to Tech. Asstt. (T-3) Driver (T-5) w.e.f. 05.09.2022.
- Sh. U.B. Gaikwad, STA, Nagpur promoted to Tech. Officer Driver (T-5) w.e.f. 29.06.2016.
- Sh. Roshan Lal, Sr. Technician, RC Delhi promoted to Tech. Asstt. (T-3) w.e.f. 03.10.2022.

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BUDGET



NBSS & LUP to celebrate Foundation Day on Sept 1

■ Staff Reporter

THE ICAR National Bureau of Soil Survey and Land Use Planning (ICAR-NBSS & LUP), Nagpur is celebrating its 47th Foundation Day on September 1.

At a press conference ahead of the Foundation Day, Dr N G Putil, Director of the Bureau, informed that Dr S K Chaudhari, Deputy Director General (NRM), ICAR, New Delhi will be the chief guest. Dr Niren V Putil, Vice-Chancellor-MAFSU, Nagpur and Sandip Putil,



Dr N G Patil, Director, ICAR-National Bureau of Soil Survey and Land Use
Planning, as the bureau celebrates its 47th Foundation

TheHitavada

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ICAR-NBSS&LUP and VSI Pune sign MoU



Dr B P Bhaskar and Sambhaji Kadam Patil exchanging the MoUs

■ Staff Reporter

THE ICAR-National Bureau of Soil Survey and Land Use Planning, Nagpur (ICAR-NBSS&LUP) signed a Memorandum of Understanding (MoU) with Vasandada Sugar Institute (VSI), Pune to strengthen the research collaboration for sustainable sugarcane cultivation in India.

Dr B P Bhaskar, Acting Director, ICAR-NRISS&LUP and Sambhuji Kadam Puri, Director General, VSI signed MoU on behalf of their respective organisations. The joint collaboration would be of immense benefit to both parties by harnessing

each other's capabilities for the interest of the farming community. ICAR-NBSS&LUP is known for its excellence in remote sensing and GIS applications in land resource inventory, land degradation assessment and land use planning, while VSI is known for its cutting-edge research, academia, and extension programmes in overall sustainable sugarcane cultivation and the self-reliance of the Indian sugar industry.

Both organisations can jointly work in the application of remote sensing and GIS in mapping and characterisation of soil and identification of suitable areas for sugarcane-cultivated areas.

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The Bureau has five Regional Centres located at Bangalore, Dehra Dun, Kolkata and Udaipur for the five regions of the country to build the land resource inventories for the states under their jurisdiction. The Bureau is collecting and documenting the information on land resources of India for the last 4 years for the benefit of the development of the country.

गुमथी येथे 'स्वच्छता ही सेवा' कार्यक्रम

कोराडी • राष्ट्रीय मूद्रा सर्वोत्थान व मूली उपचोखम नियोजन बसुरी, नानाभूत पांथ्या सहकार्याने तुमची केले संघटता ही संघ कड्या मुक्त भारत मा कार्यक्रमाचे आयोजन करण्यात आले.



साया तरेण (बांबी) मनःशून्य सांगितला. हास्यविभूषण वीरबाबा वाघवीर (केशवरावजी) सारंगी, तबल	कार्यक्रमाच्या संपूर्ण सीमा भेदे थेअल बंद, बहिष्ता पोपर, (स- मानवटकर, होला रोपाडे, बंदू भेदे सकायन आरोपकर, जी ही सारंगी
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लोकमत समाचार

भारतीय समाज की पहचान है हिंदी

'Space technology, digital soil mapping can mitigate impact of climate change'



Dr N G Patil delivering
Dr Ashok Juwarkar memk.
lecture at CSIR-NEERI on
Friday.

over declining grazing land in western Maharashtra, Dr Patil said that weather based crop advisory started by Indian Council of Agricultural Research (ICAR) is enabling farmers to take appropriate measures for crop management. He further briefed about soil maps prepared by ICAR-NBSS&LUP for various states of the country and exhorted to evolve a more rigorous and robust scientific method for land

नागपुर : माधव रेलेवे के मंडल रेल प्रबंधक तुलारकांत पांडेय ने कहा कि हिंदी राष्ट्र को जोड़ने वाली नामा है हिंदी के माध्यम से राष्ट्रीय एकता का कार्यक्रम है। यह हमारी राष्ट्रीय एकता का सूत्रधार है। वे राष्ट्रपति तुलसीदास महाशय नागपुर विश्वविद्यालय के हिंदी विभाग में आयोजित कार्यक्रम दौरान बोल रहे थे। उन्होंने कहा कि हिंदी सिर्फ एक भाषा नहीं है बल्कि एक प्रेम-प्रतिभा प्रमित को एकत्रित करने का माध्यम है।

राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो

गणेश की मूर्त साँझों एवं भूमि प्रयोगी निवेशन व्यूते में हिंदी टिकल बनाया गया. इस समारोह निदेशक डॉ. ए. ओ. पारिल को अध्यक्षता में हिंदी टिकल एवं तख्तभाषा हिंदी परवर्द्धन का उपकरण किया गया. कार्यक्रम दोहन मुख्य अतिथि के रूप में पब्लिशिंग लीजनेर सोसायटी ऑफ इंडिया के अध्यक्ष प्रमोदराज (पब्लिशिंग) सत्यदेव प्रसाद सिंह प्रसिधित थे. सिंह ने अपने वक्तव्य में हिंदी की क्षामिकताएं एवं शैक्षिक स्वीकारिता पर प्रकाश डाला. कार्यक्रम का संवाचन देवेन्द्र कुमार धरण ने किया.



दादासाहब धनवटे नगर विद्यालय

नागपुर शिक्षण मंडल द्वारा संशोधन -
अनुरोध २००० ई.

to evolve a more rigorous and robust scientific method for land.

Sat, 29 April 2023
<https://epaper.bhaskarhindi.com/c/72294078>

एकीकृत मृदा सूचना

भारत सरकार
भारतीय मूल सर्वेक्षण एवं भूमि उपयोग
नियोजन ब्यूरो, नागपुर में कृषि और किसान कल्याण
विभाग द्वारा गठित संवर्धन समिति की एकत्रित मृदा
मुलेख प्रणाली पर उप-समिति-1 की बैठक शुक्रवार को
सुबह सायंक ४.३० बजे (एसडीएम) (एसडीएम)

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पनाएं : चौधरी

स्वागत किया और उनसे नीति निर्वाचन और लिखावटों के लिए उसीसे तथा विश्वसनीय उपाय करने का आग्रह किया। डॉ. वेदमुखाण ने विभिन्न संगठनों में मृदा संरक्षण से संबंधित डेटा के अधिस्रण और अंतर-संकायन के लिए एक तंत्र तैयार करने पर जोर दिया। मृदा संरक्षण अध्ययन में शामिल विभिन्न संगठनों द्वारा किए गए कार्य में समर्थिपताएं और विपरी की जानकारी के लिए डॉ. विजितल मीणा की उत्कृष्ट प्रणाली के क्रिसम पर दिया। बैठक में आईसीए संस्थानों, एनआरएएससी, एएससी, एएसएलएसआई, एसएल, आईआईआई और राज्य प्रमोटर्स से संबंधित जैसे विभिन्न के द्वारा प्रमोट मोड पर लगभग 75 वक्ताओं और

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