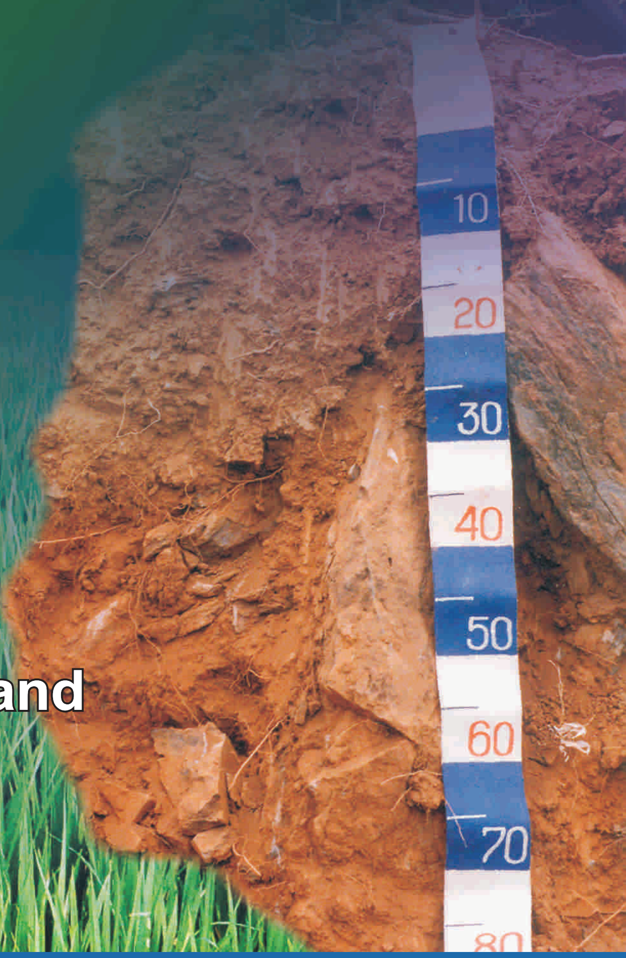
भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
2010-11
Annual Report

NBSS&LUP



राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो नागपुर

राष्ट्रीय मृदा सर्वेक्षण एवं
भूमि उपयोग नियोजन ब्यूरो (भा.कृ.अनु.प.)
नागपुर – 440 033

National Bureau of Soil Survey and Land Use Planning (I.C.A.R.)
Nagpur - 440 033

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Preface

The National Bureau of Soil Survey and Land Use Planning(ICAR), Nagpur, in continuation of its journey for inventorising natural resources for land use planning with special reference to soils, focussed on soil survey and mapping activities at the levels of village, block, watershed and district during 2010-11.

The present report briefly mentions the research achievements of this institute in the fields of Inventorising Natural Resource, Remote Sensing, GIS and Cartography, Basic Pedological Research, Soil Survey Data Interpretation and Application, Land Evaluation and Land Use Planning. The institute is also engaged itself in two research programmes of the National Agricultural Innovative Project (NAIP) one of these projects address the processes of developing a georeferenced soil information system in two most important food growing zones of the country, namely, the Indo-Gangetic Plains and Black Soils Region as lead centre under Component 4. The other project takes care of livelihood issues in selected clusters of villages in three disadvantaged districts of Maharashtra under Component 3.

The year has been especially significant for the institute in that it was involved in two important network projects, on district level land use planning and the methodology for farm level planning involving the HQrs. and all the regional centres. Besides, the institute is also actively participating in the ICAR network project on climate change (NPCC).

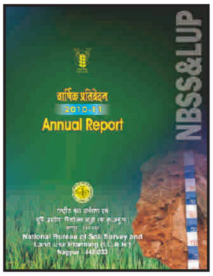
Nearly fifty research papers were published in national and international journals. Besides, two book chapters, fourteen research bulletins and soil survey reports were also published. In recognition of outstanding research contributions, a number of scientists were honoured by various professional bodies. The institute was actively involved in human resource development through imparting training in soil survey, winter/summer school, sponsored training programmes as well as deputing its staff for various training programmes. We also conduct teaching and research programmes for M.Sc. and Ph.D. students of different State Agricultural Universities.

I acknowledge the sincere efforts of my colleagues to complete this task in time. My compliment to the members of the Editorial Committee for editing the report to bring it in its present status.

I put on record my gratitude for the support received from the ICAR in accomplishing our target.

It gives me an immense satisfaction in placing the Annual Report (2010-11) for public scrutiny.

(DIPAK SARKAR)
DIRECTOR



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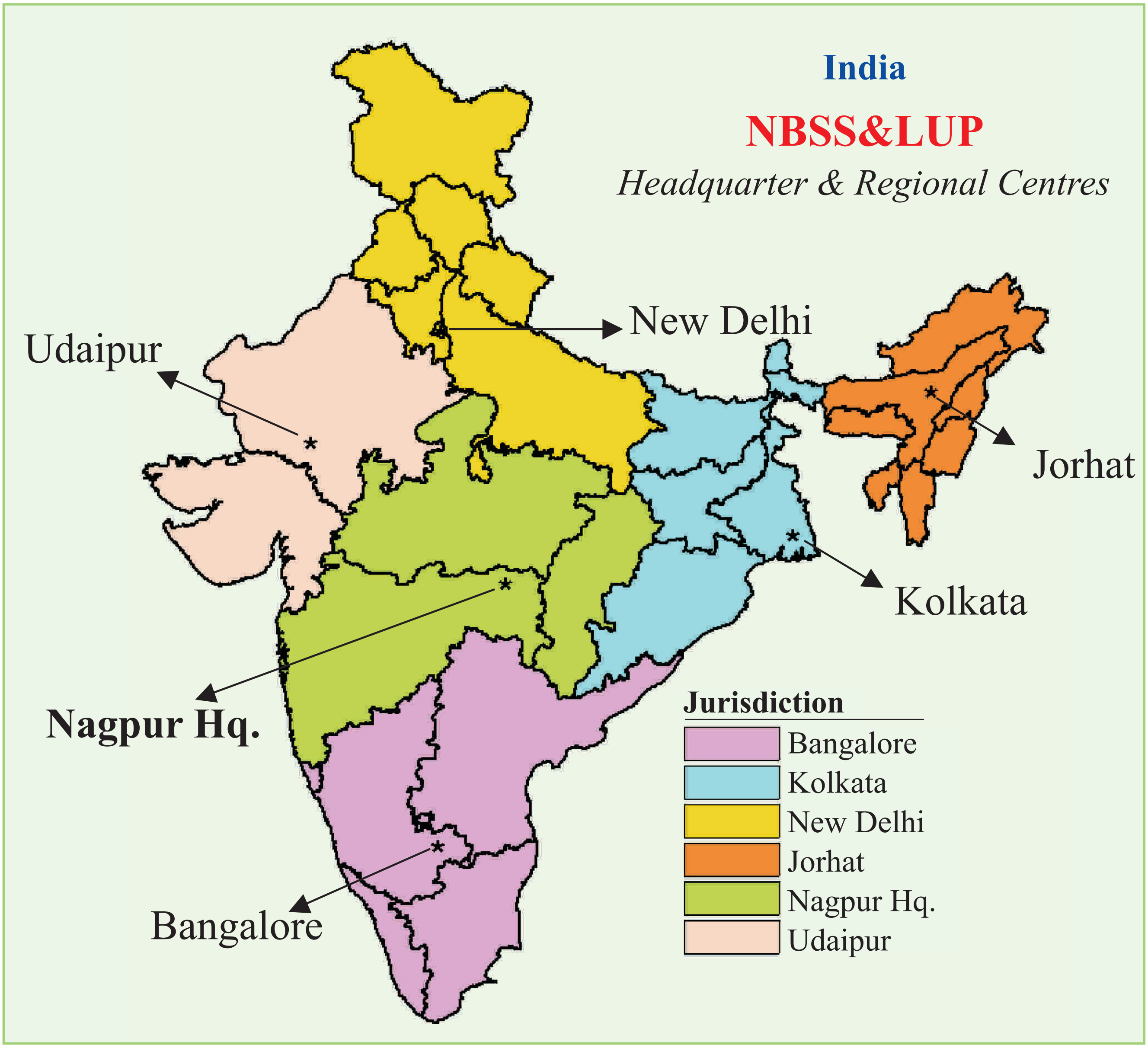

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कार्यकारी सारांश

राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो का मुख्यालय, पाँच क्षेत्रीय केन्द्र प्राकृतिक संसाधन प्रबंधन हेतु मृदा सर्वेक्षण, वर्गीकरण, सह-संबंधन और मानचित्रण के कार्य कर रहा है। मृदा सर्वेक्षण से प्राप्त आंकड़ो की जरूरत को भूमि के उचित आकलन और उपयोगिता के दृष्टिकोण से नेटवर्क प्रकल्प (प्रोजेक्ट) का आरंभ किया गया जिसमें ब्यूरो के मुख्यालय और क्षेत्रीय केन्द्रों के कई वैज्ञानिक कार्यरत हैं। यह प्रकल्प (प्रोजेक्ट) वातावरण में बदलाव और इसका मृदा में कार्बन और उसके पृथक्करण विभिन्न माडलों के द्वारा तथा फसल पैदावार पर असर का अध्ययन करने में सहयोग प्रदान करेगा।

राष्ट्रीय मृदा सर्वेक्षण एवं भूमि उपयोग नियोजन ब्यूरो द्वारा देखे जा रहे अन्य प्रमुख मुद्दों में कृषि-जलवायु मण्डलों की सीमाओं को पुनः निर्धारण, मृदा एवं इसकी गुणवत्ता में निम्नीकरण और आधुनिक सुदूर संवेदन एवं भौगोलिक सूचना प्रणाली का प्राकृतिक संसाधन प्रबंधन में उचित उपयोग है। किसानों के उचित जीवन-निर्वाह हेतु विभिन्न प्रकार की फसल-प्रणाली को अन्य सम्बंधित पेशे से जोड़ने का प्रयास किया गया है। ब्यूरो द्वारा डॉ. पंजाबराव देशमुख कृषि विश्वविद्यालय, अकोला के सहयोग से स्नातकोत्तर और पी.एच.डी. (भूमि संसाधन प्रबंधन) के छात्रों को उचित, सामयिक विषय ज्ञान और मार्गदर्शन दिया जा रहा है। संस्थान के अधीनस्थ कर्मचारियों को अपनी निपुणता और तकनीकी ज्ञान को और परिष्कृत करने हेतु विभिन्न प्रशिक्षण कार्यक्रमों/परिसंवाद इत्यादि में सहभागी होने हेतु भेजा जाता है।

अनुसंधान की विशिष्टिताएं

1. प्राकृतिक संसाधन का आकलन

- विशिष्ट जगहों का आँकड़ा प्राप्त करने हेतु मुख्यालय और इसके क्षेत्रीय केन्द्रों ने विभिन्न कृषि जलवायु मंडलों को विशेष अध्ययन किया गया जिसमें रोहतक, मांडया, जोरहाट, हुगली, नागपुर और चित्तौड़गढ़ के तहसील/मंडल/होबली की 75469 हेक्टेयर जमीन का समावेश है। सुल्तानपुर, मथुरा तथा चित्तौड़गढ़ के कुछ भाग का 1:50,000 पैमाने पर मृदा सर्वेक्षण कार्य किया गया। पश्चिम बंगाल में 120000 हेक्टेयर लवण-ग्रसित क्षेत्र का 1:50,000 के पैमाने पर सर्वेक्षण हुआ। औरंगाबाद और रोहतक जिले के करीबन 5,35,500 हेक्टेयर जमीन का 1:50,000 के पैमाने

पर सर्वेक्षण का कार्य पूर्ण किया गया। एक सूक्ष्म–जल–विभाजक (4032 हेक्टेयर) का विस्तृत सर्वेक्षण (1:12,500 पैमाने पर) भी किया गया।

- विस्तृत मृदा सह–संबंधन के द्वारा, बारह मृदा श्रेणियों को राष्ट्रीय मृदा श्रेणी का स्तर प्रदान किया गया और उनका राष्ट्रीय मृदा श्रेणी पंजिका में समावेश हुआ। इनमें हिमाचल प्रदेश का चार, राजस्थान, पंजाब, आसाम और गोवा की दो–दो श्रेणियों का समावेश है। इस तरह राष्ट्रीय पंजिका में मृदा श्रेणियों की संख्या 265 हो गयी है।

2. सुदूर संवेदन, भौगोलिक सूचना प्रणाली एवं मानचित्रण

- उप–ग्रह से प्राप्त छाया के आकलन से पता लगा कि रायपुर और रानीबंध ब्लॉक (खटरा उप–विभाग, बांकुरा जिला) में सात भू–आकृतिक हैं जैसे बंजरीला पहाड़ और उपरी तल, कटा–फटा पेडिमेंन्ट्स, उबड़–खाबड़ समतली मेडिमेन्ट्स, अकेले बिखरे पहाड़, भरी हुई घाटी, उपरी पुराने और नवीन जलोदीय समतल भाग। भूमि–उपयोग/आवरण के अध्ययन से पता लगा कि कृषि ही मुख्य उपयोग है और दूसरा भूमि–उपयोग जंगल है। सांख्यिकीय आकलन दर्शाता है कि बहुत अच्छी और अच्छी मृदा उर्वरकता 55 प्रतिशत क्षेत्र में है।
- बुल्ढ़ाना जिला (महाराष्ट्र) के मेहकर तहसील में स्थित सरस्वती सूक्ष्म जल–विभाजक (10,787 हे.) का क्षेणीकरण और मूल्यांकन उप–ग्रह से प्राप्त छाया (आई.आर.एस.पी. – 6 लिंस ।।।) के अध्ययन द्वारा किया गया। मृदाओं का मानचित्रण मृदा श्रेणी सम्बन्ध बनाकर तथा भू–आकृतिक को उपयोग में लाकर किया गया। आठ मृदाओं में लभ्य नत्रजन तथा छः मृदाओं में लभ्य फास्फोरस की कमी है। जिंक की कमी कुछ मृदाओं में देखी गयी। इन सभी मृदाओं का कपास की उपयुक्तता हेतु मुल्यांकन किया गया।
- उड़ीसा के उत्कल सपाट में स्थिति बढ़जोरे नाला सूक्ष्म–जल विभाजक (596 हे.) का विस्तृत मृदा सर्वेक्षण किया गया। अध्ययन से पता चला कि इसकी मृदायें बहुत अम्लीय से माध्यम क्षारीय है (पी.एच.मान 4.6 से 8.6 तक) मृदा अम्लीयता, कार्बनिक कार्बन, विनिमयी क्षार, मृत्तिका एवं जल–उपलब्धता उपरी समतल भाग से नीचे के समतल भाग में बढ़ गया है।
- सूखे की स्थिति में कृषि–जलवायु मंडलों की दर्शाने हेतु संगणीकृत मॉडल तैयार किया गया है। किसी क्षेत्रीय में मध्यम तथा अधिक सूखे की स्थिति होने की संभावना को वार्षिक वर्षा के आंकड़े से आकलन किया जा सकता है जैसा भारतीय मौसम विज्ञान ने बताया है।
- मानचित्र और फोटोग्राफ को रखने और उपयोग में लाने हेतु डिजिटल आंकलित किया गया है। स्कैन और छाया–चित्र की उचित गुणवत्ता को ध्यान में रखते हुए सौ दस्तावेजों को नम्बर दे दिया गया है।
- अट्ठाइस जिलों का डिजिटल ढलान मानचित्र बनाया गया है जिसमें पाँच जिलों के मानचित्र में बाह्य रूप के अंतर्गत विभिन्न पहलूओं जैसे दिशा समतल और पूरा झुकाव दिखाया गया है। इसके लिए सटल रडार टोपोग्राफी मिशन आंकड़े का प्रयोग किया गया है जिसका रेजलूशन 90 मीटर है।
- गंगा के मैदानी भाग (पंजाब व हरियाणा) से जमा किये गये 2092 नमूनों का स्पेक्ट्रल रिफ्लेक्टानस गुणधर्म जांचा गया है। इसका एक अच्छा सम–सम्बन्ध कार्बनिक कार्बन, विद्युत चालकता, कैल्शियम कार्बोनेट के साथ मिला है जो इस प्रणाली की प्रयोग की सार्थकता को साबित करता है।
- महाराष्ट्र राज्य के बुलढाना जिला के एक भाग में एक हाइपरिआन संवेदक की छाया प्रक्रमण को मृदा में बदलाव और उसके विभाजन के अध्ययन हेतु प्रयोग में लाया गया। इस अध्ययन से पता चला कि कार्बनिक और लभ्य पोटैशियम के दर्शन में हाइपरिआन की विभित्र तरंगों के वर्णक्रमों का नकारात्मक सम्बन्ध पाया गया।
- राष्ट्रीय सुदूर संवेदन केन्द्र, हैदराबाद द्वारा बनाए गए मृदा निम्नीकरण मानचित्र (1:50,000) को ब्यूरो के आंकड़े द्वारा और अच्छा किया गया। यह अध्ययन राष्ट्रीय सुदूर संवेदन केन्द्र (हैदराबाद) के सहयोग और अंतरिक्ष उपयोग केन्द्र (अहमदाबाद) द्वारा प्रदत्त वित्त के द्वारा किया गया। यह अध्ययन बारह प्रदेशों में हो चुका है।

3. आधारभूत मृदा शोध

- गाँव के स्तर पर मृदा सर्वेक्षण हेतु एक सरल मॉडल बनाया गया है जो भू–उत्पत्ति और इसके इसर पर आधारित है। यह मॉडल मानव–हस्थ के पृष्ठीय भाग तथा फैली हुई अंगुलियों के द्वारा प्रदर्शित किया जा सकता है। बीच का जमीन (धरातल) अंगूठे और अगली उंगलियों द्वारा दिखाया जा सकता है और संकरे महमेज (स्पर) के साथ लम्बे सिमटे हुए चरम बिन्दु हैं।

- माइक्रो-तरंग पाचन क्रिया जिसमें मृदा एवं पादप नमूने को बंद बरतन में पाचन क्रिया कराते हैं उसमें वाष्पन हास को जाँच करने के लिए प्रोटोकाल/तकनीकी विकसित की गयी है। दूसरे कई तरह के पदार्थ और उनकी मात्रा के अनुसार पाचन हेतु प्रोटोकाल/तकनीक विकसित की गयी है।

- काली मिट्टी में स्मेकटाईट की अधिक मात्रा होना यह दर्शाता है कि इसकी उत्पत्ति बेसाल्ट में उपस्थित प्लैजिओक्लेश खनिज से पूर्व के जलवायु में हुआ है। कैल्शियम आक्साइड और सोडियम आक्साइड का सान्द्रण छोटे होते कण में (आकार में) यह बताता है कि प्लैजिओक्लेश खनिज कम कठोर है। मृत्तिका का सूक्ष्म-आकृतिकी अध्ययन से पता चलता है कि काली मिट्टी का ऊपर-नीचे होना मृत्तिका संरचना को नुकसान पहुंचाने में सक्षम नहीं है।

- मृदा-जल उपलब्धता जानकारी के लिए कई पी.टी.एफ. का तुलनात्मक अध्ययन करने हेतु K-NN और ANN का उपयोग किया गया है। न्यूनरल पी.टी.एफ. का परिणाम सांख्यिकी पी.टी.एफ. से अच्छा रहा। थोक घनत्व मापन हेतु अच्छे पी.टी.एफ. के लिए रेत, सिल्ट, मृदा जल की क्षेत्रीय क्षमता और स्थायी उष्णता बिन्दु का आकड़ा चाहिए। इस तरह से बने अच्छे पी.टी.एफ. में आर.एम.एस.ई. (RMSE) तथा एम.ए.ई. (MAE) के अंक बहुत कम रहे लेकिन डी (d) तथा आर स्केवयर (R_2) का मान ज्यादा रहा।

- वर्मिकुलाट मृत्तिका-खनिज में एल्यूमिनियम के पृथक्करण की ज्यादा क्षमता है और इससे यह पौधों को एल्युमिनियम की विषाक्तता से बचाता है। अध्ययन से यह भी पता चला है कि ये लोह-जनित मृदाओं में कार्बनिक-कार्बन के पृथक्करण की भी ज्यादा क्षमता है। इसलिए कार्बन पदार्थ की पृथक्करण क्षमता तथा वर्मिकुलाईट की उपस्थिति मृदा गुणवत्ता हेतु मापदंड को दर्शाता है।

गंगा के मैदानी भाग से लिए गए सारभाग के मृदा नमूने (कालपीः 50 मीटर और रानीयाः 29 मीटर), मध्यम से प्रबल क्षारीय हैं और चूनायुक्त हैं। पी.एच. मान और चूने की मात्रा यह दर्शाती है कि जलोढ़ीय पदार्थ के एकत्र होने के बाद वहाँ की जलवायु शुष्क थी। इन मृदाओं में काफी मात्रा में मृत्तिका का पाया जाना यह दर्शाता है कि यह पदार्थ कई दूसरे पैतृक पत्थर से आये हैं जिनका एकत्र होना मुख्यतः यमुना नदी के कारण हुआ है।

4. मृदा सर्वेक्षण आंकड़ों का व्याख्यान एवं प्रयोग

- तमिलनाडु के कृषि-जलवायु मंडलीय मानचित्र दूसरी बार के प्रयास से इसको अब सत्रह कटिबंध में बदला गया। इस कटिबंधों के मृदाओं को उनके समान गुणवत्ता को ध्यान में रखते हुए प्रबंध इकाई में बदला गया। नीलगिरी कटिबंध (1.1) में केवल एक प्रबंध इकाई बन पायी जबकि भीतरी भाग के समतल कटिबंध (भाग) में दस प्रबंध इकाई बनी।

- भंडारा, चन्द्रपुर, गोन्दिया (महाराष्ट्र), मुरादाबाद और मुज्जफर नगर (उत्तर प्रदेश) के मृदा आधारित आंकड़ों को जिला मृदा निर्णायक सूचना प्रणाली (1:50,000 पैमाने) पर प्रदर्शित किया गया।

- धार जिला (मध्य प्रदेश) के सोयाबीन उगाने वाले क्षेत्रों में कार्बनिक पदार्थ, सल्फर, नत्रजन, फास्फोरस की कमी है।

- एक मृदा जल संतुलित मॉडल, मध्य भारत की फटने और फूलने वाली मृदाओं के जल को अच्छी तरह भविष्यवाणी किया। यह मृदा जल में बदलाव को अच्छी तरह भविष्यवाणी किया जब मृदा भींगना शुरू की लेकिन जब मृदा जल छोड़ना शुरू किया तो यह मॉडल असफल रहा।

- डिब्रूगढ़ और तिनसुकिया जिले (आसाम) में मृदा के सतही भाग में भारी तत्वों का अध्ययन किया जो दूषित हो गयी है। इसमें पी.एच.मान कारीबन सभी भारी तत्वों के साथ नकारात्मक सह-संबंध दिखाया जबकि कार्बनिक कार्बन धनात्मक सह-संबंध रहा।

- केरल राज्य में कृषि-जलवायु मण्डल उप-इकाई के बनाने का अध्ययन किया गया और इस तरह 20 उप-इकाईयाँ बनाई गयी। धरातल की दशा, मृदा और उनकी जल-धारण क्षमता को इस कार्य हेतु प्रयोग में लाया गया।

- लम्बे समय तक चलने वाले उर्वरक परिक्षण जिसमें ग्यारह जगह काली मिट्टी का और पाँच गंगा के मैदानी भाग का समावेश है, इन जगहों से प्राप्त आँकड़े यह बताते हैं कि कार्बनिक कार्बन की मात्रा मृदाओं में बढ़ी है जब यह कार्बनिक पदार्थों द्वारा डाला जाता है। सम्पूर्ण कार्बन में एका-एक बढ़ोत्तरी जब देखी गयी जब खाद को उर्वरकों के साथ मृदा में डाला गया। सेन्चुरी मॉडल शुष्क क्षेत्र में ज्यादा उपयुक्त रहा जबकि रोथ-सी मॉडल अर्द्ध-शुष्क और आर्द्र क्षेत्रों में उपयुक्त रहा।

- इनफों-क्रॉप मॉडल कपास, सोयाबीन, गेहूँ, करीब धान और मक्का के उत्पादन को सही भविष्यवाणी किया।

- आसाम के प्राथमिकता वाले तेरह जिलों के अध्ययन से पता चला कि कोकराझार और बोनाईगाँव के 91 प्रतिशत क्षेत्र में कार्बनिक कार्बन की मात्रा अधिक है। करीबन 61 प्रतिशत कोकराझार जिले का क्षेत्र लब्ध नत्रजन और पोटैशियम में मध्यम है जबकि बोनाईगाँव जिला का 86 प्रतिशत लब्ध नत्रजन और 53 प्रतिशत लब्ध पोटैशियम में मध्यम है। कोकराझार जिले का 34 प्रतिशत और बोनाईगाँव का 40 प्रतिशत क्षेत्र लब्ध पोटैशियम में कमी है। इसी तरह 30 प्रतिशत कोकराझार जिले का क्षेत्र और 50 प्रतिशत बोनाईगाँव जिले का क्षेत्र लब्ध फास्फोरस में मध्यम है। करीबन 34 प्रतिशत कोकराझार का क्षेत्र और 64 प्रतिशत बोनाईगाँव के क्षेत्र में लब्ध जिंक में कमी आँकी गयी।

- मध्यप्रदेश और महाराष्ट्र के सभी जिलों के कृषि और सम्बन्धित विभाग का आकस्मिकता योजना बनाने का कार्य शुरू किया गया। महाराष्ट्र के 29 जिले और मध्य प्रदेश के 11 जिलों का आकस्मिकता योजना बना दिया गया है। इस योजना में प्रत्येक जिले की मृदाओं के अनुसार फसलों की जाति तथा सस्य-क्रियाओं का भी समावेश किया है जो मानसून के आने और जाने की तारीखों के अनुसार है।

- पश्चिम बंगाल में कुछ स्थूल और सूक्ष्म तत्वों के निर्धारण हेतु मानचित्रण किया गया। करीबन 40 प्रतिशत बीरभूम के क्षेत्र में लब्ध फास्फोरस पोटैशियम और जिंक में कमी आँकी गयी। नादिया जिलों में तत्वों की उपलब्धता में कमी फसल तीव्रता के बढ़ने से हुई है। मृदा कण का आकार, पी.एच. मान में सम्बन्ध स्थापित करने से पता चला कि महीन लोम मिट्टी में पी.एच. मान बढ़ने से फास्फोरस और पोटैशियम की उपलब्धता में बढ़ोत्तरी हुई जबकि जिंक की उपलब्धता में कमी आई। सूक्ष्म तत्वों हेतु पी.एच.मान 5.5-6.5 सभी मृदाओं में फायदेमंद पाया गया।

- प्रतिच्छायापन के द्वारा प्रस्तावितों को सूक्ष्म तौर पर लागू करने जिससे कृषि-उत्पादन बढ़े इसके लिए मृदा परीक्षण की विभिन्न विधियों के साथ प्रतिच्छायापन स्पेक्टोस्कोपी का प्रयोग किया गया। यह अध्ययन बंगलौर और, बीजापुर और हैदराबाद के क्षेत्रों की मृदाओं पर आधारित था। बंगलौर की मृदाएं बीजापुर जिले की अपेक्षा ज्यादा प्रतिच्छायापन दिखायीं। बीजापुर की मृदाओं में 1900 नैनोमीटर पर तीव्र अवशोषण 2:1 तरह के खनिज को दर्शाता है जबकि बंगलौर की मृदाओं का 950 नैनोमीटर पर तीव्र अवशोषण मुक्त लौह आक्साइड को बताता है।

5. भूमि आकलन और भूमि उपयोग नियोजन

- नवाशहर जालंधर जिलों में धान-गेंहूँ के फसल चक्र ने मक्का, कपास, उर्द, मूँग, ग्वार, ज्वार, बाजरा, मूँगफली, अरहर, सनई तथा गन्ना (खरीफ) तथा गेहूँ+चना, गेहूँ, जौ, चना, मसूर सरसों, मटर, तौरिया (रबी) को पीछे छोड़ दिया है। नवाशहर में गेहूँ का फसली क्षेत्र (41%) घट गया है और धान का फसली क्षेत्र (28%) बढ़ गया है यदि इन आँकड़ों को 1983-84 और 2006-07 के मद्देनजर देखा जाए।

- कर्नाटक के रामनगर जिला के अंतर्गत तिरूले उप-जलागम में घटता जल-स्तर, फसलों की कम उत्पादकता और खेतीहर मजदूरों की कमी ही मुख्य कारण हैं। खेतों को समतल (सीढ़ी-नुमा) तथा मृदा की ऊपरी तथा नीचली सतह के मृदा कणों को अच्छा बनाकर इन कारणों से छूटकारा पा सकते हैं। इस जलागम का अच्छी जलवायु और इसका बंगलौर के पास होना, सब्जियों और फलों की खेती को बढ़ावा देता है।

- पुरातन खेती पद्धति के चलते डीरिंग-था-गलान्ग उप-जलागम, कार्वी-एन्गलांग और गोलाधर जिलों में धान, सरसों और उर्द की उत्पादकता बहुत कम है।

- बीरभूम जिला (पश्चिम बंगाल) के खुश्कारानी जलागम में कम और अनियमित वर्षा, मृदा निम्नीकरण तथा कम उर्वरता की प्रमुख कारण हैं।

- उत्तरी गोवा जिले में नारियल की खेती में उप-अनुकूलतम पुष्टिकारक तत्व, अच्छी पैदावार न देने वाले हाइब्रीड जातियों का प्रयोग और नारियल की अच्छी तरह न स्थापित करना ही प्रमुख कारण हैं। इसके लिए विशेष-जगह हेतु भूमि संसाधन तथा सस्य-क्रियाओं का पालन करना चाहिए।

- बूँदी जिले में पहले 49 भूमि प्रबंधन इकाई बनाई गयी थी जो बाद में उद्देश्यपूर्ण प्रबंधन हेतु 17 भूमि प्रबंधन इकाई में तब्दील कर दी गयी। भूमि-प्रबंधन इकाई संख्या 2, 5, 6, 7, 14, 49 में 3-8 प्रतिशत की ढ़ाल पर बनी उथली

पथरीली लोम मिट्टी में मक्का, सरसों, चना तथा गेहूँ की पैदावार बहुत कम थी। भूमि प्रचलन इकाई संख्या 35, 20, 31 और 42 की महीन लोम तथा महीन मिट्टियों में लाभांश ज्यादा रहा।

- नादिया जिला, पश्चिम बंगाल में पन्द्रह भूमि प्रबंधन इकाई बनायी गई जो चार उत्पादन पद्धति जैसे जूट और धानः जूट/धान और गेहूँ/दलहनी फसलें/तिलहनी फसलें: गन्ना और जूट/अनाज की फसलें/दलहनी, फसलें/तिलहनी फसलें और फल वाले वृक्ष और जूट/अनाज की फसलों के अंतर्गत हैं।

- मैसूर जिले में बारह भूमि-प्रबंधन इकाई की पहचान की गयी। चार और पाँच नम्बर की भूमि प्रबंधन इकाई (वर्षा-आधारित) में पाँच भूमि उपयोग नियोजन का चुनाव किया गया है जो प्राकृतिक संसाधनों तथा सामाजिक-आर्थिक सूचकों पर आधारित हैं। इन भूमि-प्रबंधन इकाईयों को मुख्य सिंचित भूमि (भूमि-प्रबंधन इकाई 1, 3), मुख्य वर्षा-आधारित भूमि (प्रबंधन इकाई 5 -12) और न्यूनतम भूमि (भूमि प्रबंधन इकाई 4, 8 और 10) में बांटा गया है। 1990-2009 के दौरान रागी और ज्वार का क्षेत्र पूरे फसली क्षेत्र और अनाज उगाने वाले क्षेत्र के संदर्भ में 46 से 41 प्रतिशत तक घट गया है जबकि दलहनी फसलों का क्षेत्रफल 15-20 प्रतिशत से बढ़ गया है।

- जोरहाट जिले में आठ भूमि प्रबंधन इकाईयों की पहचान की गयी। इनमें मृदा अम्लीयता और खेतीहर मजदूरों का न मिलना परेशानी का कारण हैं।

- फसल-पशुपालन जैसे हस्तक्षेव को गोन्दिया जिला(महाराष्ट्र) के दो पास-पास के गाँवों में चलाया गया। सबसे अच्छी सस्य-क्रियाओं के चलते 214 लोगों के खेतों में धान की पैदावार पचास प्रतिशत से ज्यादा बढ़ गयी। न्यूनतम भूमि के धारक और खेती-विहिन किसान को बकरी पालन हेतु उत्साहित किया गया। इस दौरान चौबीस लोगों के यहाँ नवजात बकरियों की संख्या 51 तक पहुँच गयी है। मछली-पालन 18 लोगों के लिए वरदान साबित हुआ जिसके चलते उनकी आय कृषि आय से काफी बढ़ गयी।

- सिरसा जिला (हरियाणा) की रेतीली मिट्टी में कपास की उत्पादकता कम है। इन मृदाओं में तिलहनी फसलें, दलहनी फसलें, मोटे अनाज और चारा फसलों को उगाना चाहिए। बी.टी. कपास हेतु सस्य-क्रियाओं पर कार्य करना चाहिए और इनको विभिन्न मृदा-इकाइयों पर किसानों को प्रदर्शित करके समझाना चाहिए।

स्नातकोत्तर शिक्षा

- डॉ. पंजाबराव देशमुख कृषि विद्यापीठ, अकोला के सहयोग से इस चालू शिक्षा सत्र के अंतर्गत एम.एस.सी. (भूमि संसाधन प्रबंधन) के चार तथा पी.एच.डी. (भूमि संसाधन प्रबंधन) के दो छात्र अपना शोध प्रबंध प्रस्तुत कर चुके हैं।

प्रशिक्षण कार्यक्रम का आयोजन

- इस वर्ष विभिन्न संगठनों के 137 कार्मिकों को सुदूर संवेदन, जी.आई.एस., मृदा सर्वेक्षण एवं मानचित्रण तथा भूमि संसाधन प्रबंधन विषयों से संबंधित अत्याधुनिक तकनीकी ज्ञान का प्रशिक्षण दिया गया।

प्रशिक्षण प्राप्त करना

- ब्यूरो के कुल 24 अधिकारियों ने विभिन्न विषय क्षेत्रों में प्रशिक्षण हासिल किया।

चल रहे अनुसंधान प्रकल्प (प्रोजेक्ट)

संस्थागत (चल रहे)	:	62
डी.एस.टी.	:	03
एन.ए.आई.पी. के चलाये जा रहे प्रकल्प	:	05
राज्य सरकार के चलाये जा रहे प्रकल्प	:	06
जलवायु परिवर्तन (भा.कृ.अनु.प.) पर चलाये जा रहे नेट-वर्क प्रकल्प	:	01
कुल	:	77

लिन्केज (अनुबंध)

- एन.बी.एस.एस.एंड एल.यू.पी. – डॉ. पी.डी.के.व्ही., अकोला
- एन.बी.एस.एस.एंड एल.यू.पी. – सी.आई.सी.आर., नागपुर
- एन.बी.एस.एस.एंड एल.यू.पी. – एन.आर.एस.सी., हैदराबाद
- एन.बी.एस.एस.एंड एल.यू.पी. – राजकीय कृषि विभाग
- एन.बी.एस.एस.एंड एल.यू.पी. – आई.आई.एस.एस., भोपाल
- एन.बी.एस.एस.एंड एल.यू.पी. – सी.एस.डब्ल्यू.सी.आर.टी.आई., देहरादून

- एन.बी.एस.एस.एंड एल.यू.पी. – एस.ए.सी., अहमदाबाद
- एन.बी.एस.एस.एंड एल.यू.पी. – एस.ए.यू.एस.
- एन.बी.एस.एस.एंड एल.यू.पी. – डी.एस.टी., नई दिल्ली
- एन.बी.एस.एस.एंड एल.यू.पी. – डी.डब्ल्यू.एम., भुवनेश्वर
- एन.बी.एस.एस.एंड एल.यू.पी. – सी.आई.एम.एम.वाय.टी.
- एन.बी.एस.एस.एंड एल.यू.पी. – आई.सी.आर.आई.एस.एस.ए.टी., हैदराबाद
- एन.बी.एस.एस.एंड एल.यू.पी. – बी.सी.के.व्ही.व्ही., पश्चिम बंगाल

प्रकाशन

- प्रकाशित अनुसंधान पत्र : 50
- तकनीकी/लोकप्रिय/रेडियो वार्ता : 20
- संगोष्ठी/परिसंवाद पत्र : 103
- मृदा सर्वेक्षण/रिपोर्ट/बुलेटिन : 14
- बुक चेप्टर्स/बुक : 02

पुरस्कार एवं सम्मान

- यह वर्ष ब्यूरो के लिए उपलब्धियों वाला रहा संस्थान के वैज्ञानिकों एवं स्टॉफ को कई पुरस्कार एवं सम्मान प्राप्त हुए।

Executive Summary

As a part of natural resource management soil survey, classification, correlation and mapping has been the major thrust areas of work at HQrs., Nagpur and its five regional centres. Utilization of soil survey data sets for land evaluation and land use planning received a focussed attention with the initiation of a network project of the Institute involving many scientists at HQrs. and regional centres. Besides, NBSS&LUP is also addressing the contemporary issues of climate change and its influence in soil carbon and its sequestration and crop yield through the help of various models. The other important issues addressed by NBSS&LUP are revision of agro-climatic zone boundaries, soil degradation, use of hyperion data and other remote sensing products, GIS in natural resource management, spectral properties of soils. The efforts are being made for livelihood security of farmers by combining the diversified cropping systems and other allied enterprises. Bureau is also involved in disseminating state-of-art information to post-graduate students of M.Sc. and Ph.D. (Land Resource Management) from Dr. PDKV, Akola. The staff of this institute were also deputed for various training programmes to improve their skills and technical knowledge in India and abroad.

RESEARCH HIGHLIGHTS

1. Inventorising Natural Resources

- To generate site-specific database for farm level planning case studies were carried out in different AESRs of country by Regional Centres of NBSS & LUP including the HQrs. The area includes part of Tehsil/Mandal/Hobli of Rohtak, Mandya, Jorhat, Hugli, Nagpur and Chittaurgarh districts covering an area of 75469 ha. Reconnaissance soil survey (1:50,000 scale) of Sultanpur, Mathura, part of Chittaurgarh covering an area of 859384 ha. was completed. Salt affected area (1,20,000 ha) of West Bengal (1:50,000 scale) was also mapped during this period. A total of 5,35,500 ha of land was surveyed in Aurangabad and Rohtas districts of Bihar on 1:50,000 scale. A watershed having an area of 4032 ha was surveyed and mapped (phase of soil series) at 1:12,500 scaleAfter intensive correlation, twelve soil series were finalized and given the status of Established Soil Series and entered into the

National Soil Series Register. These soil series belong to Himachal Pradesh (4 nos.), Rajasthan (2 nos.), Punjab (2 nos.), Assam (2 nos.), and Goa (2 nos.). The National Register now contains 265 soil series.

2. Remote Sensing, GIS and Cartography

- The interpretation of satellite imagery in Raipur and Ranibandh Blocks in Khatra sub-division of the Bankura district, West Bengal identified seven physiographic units viz. denuded hills and crests, dissected pediments, undulating pediment plain, isolated hillocks, valley fills, upper alluvial plain (older) and lower alluvial plain (younger). Land use/land cover analysis indicated that agriculture is the main land use in the area followed by forest. Multivariate analysis of productivity of soils indicated that very good and good land together constitute 55% of the total area.

- The soils of Saraswati watershed (10,787 ha) in Mehkar tehsil of Buldhana district of Maharashtra were characterized and evaluated using IRS P6 LISS-III data. The soils were mapped as association of soil series using physiography-soil relationship. Eight soils were found low in available N, six were low in available P and one was low in available K. Zn deficiency was also observed in a few soils. The soils were evaluated for suitability for cotton.

- A detailed soil survey was carried out in Badajorenala micro-watershed (596 ha) in Utkal plain of Orissa. The study indicated that soil pH was strongly acidic to moderately alkaline (pH: 4.6 to 8.6). The soil acidity (pH), organic carbon, exchangeable bases, clay, available water capacity of soils increased from upper to lower plains.

- A software module for drought analysis was developed for delineation of agro-ecological zones for crop planning. Probability of occurrence of moderate and severe drought in the area can be computed from annual rainfall data using the method described by IMD.

- A digital database system for storing and retrieval of maps and photographs and preparation of web-based library for data transmission is in process. Scanning, image quality check and indexing of 100 documents have been completed.

- Shuttle Radar Topography Mission (SRTM) elevation data with a resolution of 90 m was utilized for analysis and characterization of selected geomorphic parameters. Digital slope maps of 28 states and parameters like aspect, plane, profile and total curvature have been generated for 5 states.

- The spectral reflectance characteristics of soils (2092 samples) of IGP (Punjab and Haryana) were carried out. A good calibration was obtained for organic carbon, ECe and $CaCO_3$ indicating the use of this tool to predict soil properties.

- Hyperion hyperspectral data was utilized in soil variability mapping and zonation in part of Buldhana district of Maharashtra. The study indicated that soil organic carbon and available K showed significant negative correlation with soil reflectance at different wavelength bands of Hyperion. Relatively good calibration model (R^2=0.51*) for organic carbon was obtained.

- The land degradation maps on 1:50,000 scale generated by NRSC, Hyderabad were enriched with soil/soil loss parameters generated by NBSS&LUP. This study was taken up in collaboration with NRSC funded by SAC, Ahmedabad. Enrichment of land degradation datasets has been completed for 12 states.

3. Basic Pedological Research

- A simplified model has been developed for easy mapping of soils at village level based on the available geomorphic processes and their influences. This is represented by the dorsal view of a person's hand with the fingers spread over. The midlands are represented by the thumbs and forefinger which have narrow spurs, with elongated, restricted summits.

- The protocols and techniques were developed (i) to standardize microwave (MW) digestion technique using soil and plant samples for checking the evaporation loss as the samples are digested in closed teflon vessels (ii) to address the digestion protocols for different types of materials i.e. soil and plants and depending upon the number of samples to be analyzed at a time.

- Pedogenetic processes in Vertisols indicated the formation of huge amount of smectite upon weathering of plagioclase of Deccan basalt in an earlier humid climate. The concentration of CaO and Na_2O appears to decrease with decreasing particle-size might be due to less resistant nature of plagioclase feldspars. Presence of clay pedofeatures amidst papules indicates that the pedoturbation was not enough for the complete destruction of clay pedofeatures.,

- The comparative evaluation of PTFs to estimate available water capacity (AWC) was developed using k nearest neighbour (k-NN) and artificial neural networks (ANN). Neural PTFs performed better than statistical PTFs. The best PTF for bulk density required information on four variables namely sand, silt, field capacity (FC) and permanent wilting point (PWP). The best performing PTFs (input sand, silt, FC and PWP) had lowest RMSE (0.01), MAE (0.01) the highest d (0.95) and R^2 (0.83) when networks were fitted to the measured data.

- Vermiculite has a huge capacity to sequester Al in soils and it acts as a sink for Al^{+3} released during tropical weathering and protects the plants from Al toxicity. The study also indicates that the ferruginous soils also have a capacity to sequester huge quantity of organic carbon (about 2%). Therefore capacity of organic carbon sequestration and presence of vermiculite in these soils can be used as a land quality parameter.

Core samples (Kalpi:~50 m and Rania: ~29m) in the IGP are moderately to strongly alkaline in reaction and are calcareous. Both pH and $CaCO_3$ values indicate the influence of aridic climatic conditions during the post depositional period of the sediment. The high content of clay is not however expected in the core samples until there has been the influence of other rock formation amidst the deposition mainly controlled by Yamuna-river system.

4. Soil Survey Data Interpretation and Application

- The Agro-Ecological Zone (AEZ) map of Tamil Nadu after revision resulted in delineation of 17 zones. The soils in these zones were grouped into management units taking similar soil characteristics and behaviour to management practices into consideration. The Nilgiris (1.1) had only 1 management unit, while the Inland Plains (5.4) had the maximum 10 units.

- District Soil Information System (DSIS) on 1:50000 scale aims to store, process and manage the geospatial database at district level to enhance the utility of soil database and is available for six districts viz Bhandara, Chandrapur, Gondia, Nagpur (Maharashtra), Moradabad and Muzzaffarnagar (Uttar Pradesh).

- In the soybean growing areas of Dhar district in Madhya Pradesh, sulphur, organic carbon, nitrogen and phosphorus are deficient. A soil water balance model for shrink-swell soils of central India was able to predict soil moisture content satisfactorily. It predicted soil moisture variations while the soil was getting recharged but failed to predict changes when the soil moisture was released.

- Heavy metal pollution has been studied in surface soils of contaminated areas of Morigaon, Dibrugarh and Tinsukia districts of Assam. Soil acidity (pH) had a negative correlation with most heavy metals while organic carbon had a positive correlation.

- Delineation of Agro-Ecological subunits (AESUs) for 14 districts of Kerala has been carried out and 20 AESUs have been formed. Landform, soils and hydrological differences are the parameters used for differentiating subunits.

- Data from a total of 16 long term fertilizer experimental (LTFE) sites, [11 from black soil region (BSR) and five from the Indo Gangetic Plains (IGP)] indicated that total organic carbon (TOC) increased when organic carbon was externally added through organic sources as compared with the control. Rapid increase in TOC was observed when FYM was added with inorganic fertilizers. The Century model was more useful in soils of drier climate while the RothC model works both in humid and semi-arid bio-climatic systems.

- Changes in soil carbon reserves as influenced by different ecosystems and land use has been studied in the BSR and the RothC, Century and InfoCrop models were evaluated. InfoCrop model simulated yield correctly for crops like cotton, soybean, wheat, *kharif* rice and maize.

- Assessment and mapping of some important soil parameters including macro- and micronutrients for 13 priority districts of Assam showed that 91% of area of Kokrajhar and 80% of Bongaigaon district is high in soil organic carbon. About 61% of Kokrajhar and 86% and 53% of Bongaigaon district is medium in available N and K respectively. Nearly 34% and 40% of Kokrajhar and Bongaigaon districts respectively are low in available K. Approximately 30% area in Kokrajhar and 50% area in Bongaigaon districts are medium in available Phosphorus. About 34% area in Kokrajhar and 64% area in Bongaigaon districts are deficient in available Zinc.

- District-wise contingency plan for agriculture and allied sectors in Maharashtra and Madhya Pradesh has been initiated. Contingency plans for 29 districts in Maharashtra and 11 districts in Madhya Pradesh have been completed. Crop varieties have been suggested for each type of soil of the districts from available literatures for variation in onset and withdrawal of monsoon dates.

- Assessment and mapping of some important soil parameters including macro- and micronutrient for the state of West Bengal has been carried out. About 40% of the area in Birbhum district is affected with low availability of phosphorus, potassium and zinc. Increase in crop intensity led to increasing nutrient deficiency in Nadia district. Relationship between particle - size, pH and nutrient availability has been observed and in fine loamy soils increase in pH improved the availability of phosphorus and potassium while it decreased the availability of zinc. For micronutrients, the pH range of 5.5 to 6.5 was found to be beneficial in most of the particle size class of soils.

- Evaluation of soil analytical methods including reflectance spectroscopy to operationalise soil test based recommendations at micro level for enhancing agricultural productivity of rainfed system was carried out in areas from Bengaluru, Bijapur, and Hyderabad regions. Soils of Bengaluru showed high reflectance values as compared to Bijapur districts. Strong absorption at 1900 nm in Bijapur soils are indicative of 2:1 mineralogy while strong absorption at 950 nm in Bengaluru soils indicate presence of free iron oxides.

5. Land Evaluation and Land Use Planning

- In general, the rice-wheat cropping system replaced maize, cotton, black gram, green gram, clusterbean, sorghum, pearlmillet, groundnut, pigeonpea, sunhemp and sugarcane in *kharif* wheat+gram(mixed), wheat, barley, gram, lentil, mustard, peas and toria in *rabi* in Nawashahar and Jalandhar districts of Punjab. The area under wheat (41% of cropped area) decreased whereas that under rice (28%) increased during 1983-84 to 2006-07 in Nawashahar district.

- Declining ground water table, low crop productivity and labour scarcity are the major constraints in Tirulae sub-watershed in Ramnagar district, Karnataka. The constraints can be mitigated by terracing of cultivated fields, favourable textures of top soils and sub-surface soils. The suitable climate of watershed and its nearness to Bangalore invite for growing of fruit and vegetable crops.

- In Diring-Thanglong sub-watershed of Karbi-Anglong and Golaghar districts of Assam, the productivity of rice, mustard and black gram is lowdue to poor and primitive type of farming practices.

- Low and erratic rainfall, severely degraded soils and low soil fertility are the major constraints in Khuskarani watershed in Birbhum district of West Bengal.

- In North Goa district of Goa state, major constraints reported to coconut cultivation are sub-optimal nutrient management, use of non HYVs and improper plantations. Interventions suggested for improving its productivity include generation of site-specific land resources and agro-management.

- Forty nine Land Management Units (LMUs) tentatively identified earlier in Bundi district were re-grouped into manageable and purposeful 17 LMUs. The productivity of maize, mustard, gram and wheat was lowest in shallow loamy-skeletal soils on 3-8% slope (LMUs 2, 5, 6, 7, 14 and 49). The benefit: cost ratio and net profit per hectare were higher in LMUs 35, 20, 31 and 42 in medium to deep, fine-loamy to fine soils.

- Fifteen land management units were identified in Nadia district, West Bengal that were spread over four production systems, namely, jute and rice; jute/rice and wheat/pulse /oilseed; sugarcane and jute/cereals/pulses/oilseeds and fruit crops and jute/cereals.
- Twelve LMUs were identified in Mysore district. For LMUs (rainfed) 4 and 5, five land use planning options have been proposed based on natural resources and socio-economic indicators. The LMUs were also grouped under prime irrigated lands (LMU 1, 3), prime rainfed lands (LMU 5-12) and marginal lands (LMUs 4, 8 and 10). During 1990-2009 the area under ragi and sorghum (millets) to total gross cropped area and area under cereals have decreased (46 to 41%) whereas area under pulses has increased (15 to 20%).
- Eight LMUs have been identified in Jorhat district of Assam. The major constraints are low soil pH and labour scarcity. Crop-animal interventions were implemented in two clusters of Gondia district, Maharashtra. Best management practices for paddy cultivation resulted in more than 50% higher yields to 214 beneficiaries. Marginal and landless farmers were encouraged to take up goat rearing and within three months 24 beneficiaries increased the no. of animals by 51 (new born). Fish farming is a boon to 18 beneficiaries and their earned income surpassed agricultural income.
- The sandy soils occupying 32% in Sirsa district of Haryana are associated with low cotton productivity. These soils can be alternatively cultivated for oilseeds, pulses, millets and fodder crops. Agronomic and soil management needs for recently introduced Bt cotton may be worked out on soil series basis and demonstrated to farmers.

Post Graduate Education

- Four M.Sc. (LRM) and two Ph.D. (LRM) students submitted their thesis during the current academic session. This is in collaboration with Dr. PDKV, Akola.

Training Organised

- During the year 137 officials from different organizations were trained in the field of latest techniques of Remote Sensing, GIS, Soil Survey and Mapping and Land Resource Management.

Training Received

- Total 24 officials from the Bureau received training in various fields.

Projects undertaken

• Institutional (ongoing)	:	62
• DST	:	03
• Sponsored NAIP Projects	:	05
• Sponsored (State Govts.)	:	06
• Network project on Climate Change (ICAR)	:	01
Total	:	77

Linkages

- NBSS&LUP – Dr. PDKV, Akola
- NBSS&LUP – CICR, Nagpur
- NBSS&LUP – NRSC, Hyderabad
- NBSS&LUP – State Agricultural Departments,
- NBSS&LUP – IISS, Bhopal
- NBSS&LUP – CSWCRTI, Dehra Dun
- NBSS&LUP – SAC, Ahemdabad
- NBSS&LUP – SAUs
- NBSS&LUP – DST, New Delhi
- NBSS&LUP – DWM, Bhubaneswar
- NBSS&LUP – CIMMYT
- NBSS&LUP – ICRISAT, Hyderabad
- NBSS&LUP – BCKVV, West Bengal

Publication

● Research papers published	:	50
● Technical / popular/ Leaflets/Radio talk	:	20
● Seminar/Symposia papers	:	103
● Soil Survey Reports/Bulletins	:	14
● Book chapters/ Books	:	02

Awards and Recognition

- This year has particularly rewarding for the Bureau as its scientists and staff were awarded with a number of Awards and Recognitions.

1

Introduction

The National Bureau of Soil Survey and Land Use Planning has its Headquarters at Nagpur with three research divisions viz. Land Use Planning, Remote Sensing Applications, Soil Resource Studies. The divisions undertake fundamental and applied research, remote sensing applications in resource inventory and land use planning. These divisions also extend necessary support to various regional centres. These five regional centres located at Bangalore, Delhi, Jorhat, Kolkata and Udaipur, are involved in soil resource mapping, fundamental research on soils, soil correlation and classification and land use planning.

Mandate

- To conduct survey and mapping of the soils of the country at various scale to promote scientific and optimal land use programmes in collaboration with relevant institutions and agencies and proper documentation of Database.
- To conduct and promote research in the National Agricultural Research System (NARS) in the areas of Pedology, Remote Sensing Applications in Soil Resource Mapping, Land degradation, Land evaluation towards Land Use Planning.
- To create awareness on soil and land resources and their state of health.
- To conduct training and education programme in collaboration with SAUs in the country.

Major Research Achievements

The resource inventorization of soils remain the major focus of the institute during this year. Most of the areas were surveyed in 1:10,000 scale for various farms, villages, watershed, etc. Besides a few districts were surveyed in 1:50,000 scale.

The Bureau has initiated a network project on cadastral and block level survey to provide a common methodology. Besides the HQrs. all the five regional centres are involved in this effort. The output of this project will serve as a model for undertaking detail soil surveys in different agro-ecological region.

Bureau has initiated another network project on developing model district level land use plan in 6 regions of the country incorporating socio-economic status and the land use prevailing in each region. The district is divided into land management units taking into consideration the potential and constraints of soil, climate and socio-economic status. This plan will be disseminated to the district agricultural departments for implementation.

As a part of World Bank sponsored National Agricultural Innovation Project (NAIP) (Component 4) soil information system is being developed for black soil region and the Indo-Gangetic Plains in terms of morphological, physical, chemical and microbiological properties. Using this soil information the agro-ecological subregion map of the country is being modified. The Bureau is engaged in an other NAIP (Component 3) to develop the package of practice of livelihood security of farmers in a few selected village clusters of Maharashtra. Interventions were made in the village in terms of improved inputs, management practices, natural and common resource management and introduction of new enterprises. This has improved the livelihood status of the villagers.

The Bureau has enriched the National Register for soil series by the inclusion of 22 soil series representing to make the total number of soil series in the National Register as 265.

The Bureau has been consistently catering to the need of various State Agricultural Universities, State Government Officials and others, in terms of teaching and training, use soil survey data for planning and developing various types of soil and crop models.

In total 50 research papers were published in referred journals during this year besides other publication in the form of popular articles, book chapters, bulletins, soil survey reports and symposia papers.

Budget for the year 2010-11

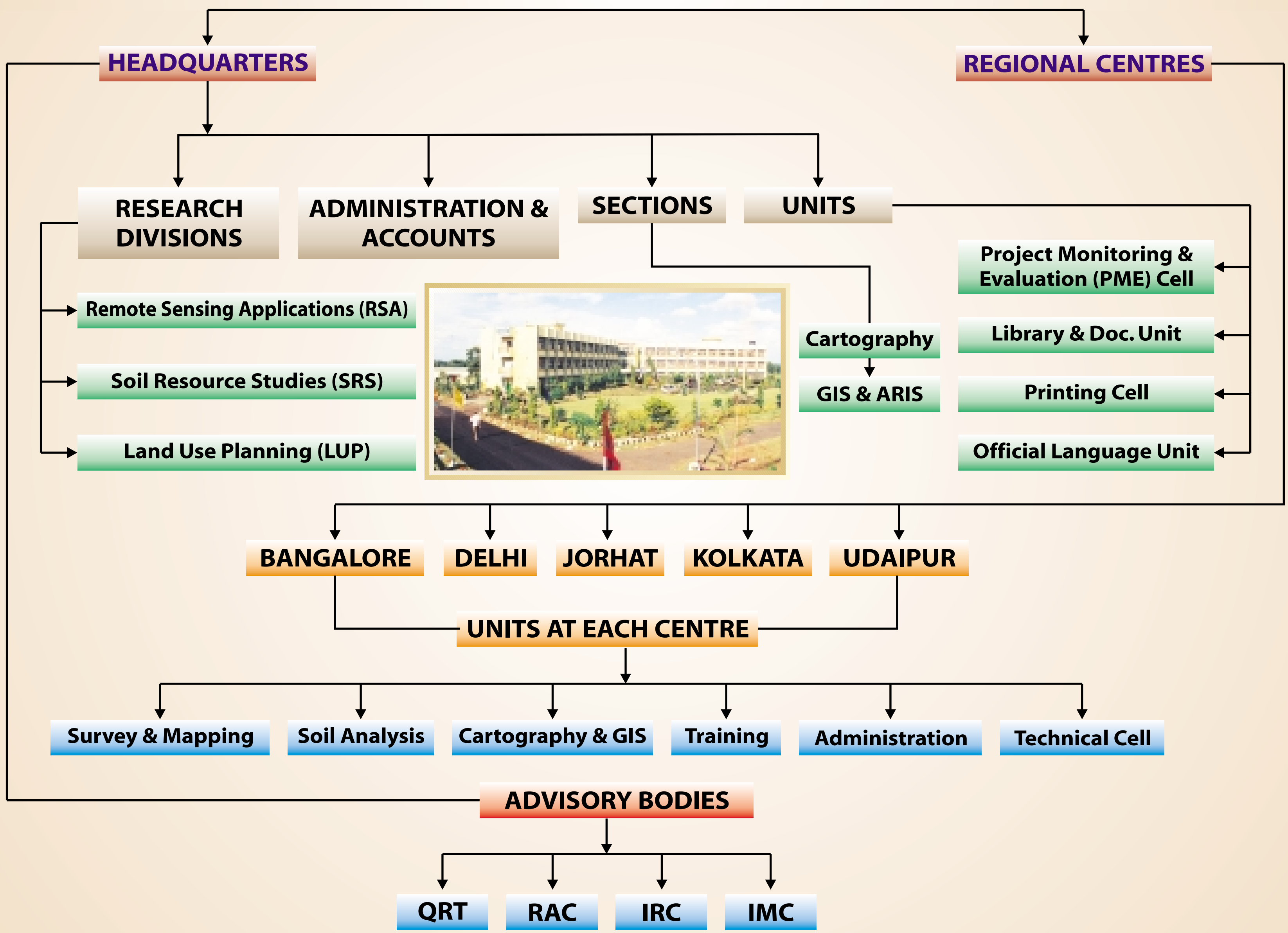
(Rs. in lakhs)

	Budget Sanctioned	Actual Expenditure
PLAN	450.00	449.99
NON-PLAN	3744.00	3650.00

Staff Strength as on 31.3.2011

Category	Sanctioned Strength	In Position
RMP	01	01
Scientific	99	64
Technical	189	178
Administrative	67	61
Supporting	84	82
Total	440	386

ORGANOGRAM



HEADQUARTERS
REGIONAL CENTRES
RESEARCH DIVISIONS
ADMINISTRATION & ACCOUNTS
SECTIONS
UNITS
Remote Sensing Applications (RSA)
Soil Resource Studies (SRS)
Land Use Planning (LUP)
Cartography
GIS & ARIS
Project Monitoring & Evaluation (PME) Cell
Library & Doc. Unit
Printing Cell
Official Language Unit
BANGALORE
DELHI
JORHAT
KOLKATA
UDAIPUR
UNITS AT EACH CENTRE
Survey & Mapping
Soil Analysis
Cartography & GIS
Training
Administration
Technical Cell
ADVISORY BODIES
QRT
RAC
IRC
IMC

2
RESEARCH ACHIEVEMENTS

2.1

Inventorising Natural Resources

♦

Soil and Land Resource Inventory

♦♦

Issue-based Survey: Soil Nutrients, Degradation and Desertification

♦♦♦

Soil Correlation and Classification

Assessment of land and soil resources of Malappuram district (part) of Kerala at 1:50,000 scale for land use planning

K.S. Anil Kumar, S. Thayalan, K.M. Nair, S. Srinivas, Rajendra Hegde, S.C. Ramesh Kumar and L.G.K. Naidu

Reconnaissance soil survey was carried out to delineate areas having identical climate, physiography and soils for agro-technology transfer and to help planners and user agencies to devise land use plans for the district. Pedons were studied in transects (Figs. 1.1 to 1.3) along the slope. Horizon-wise soils were sampled from typifying pedons of identified soil series during the study. Composite soil samples for soil fertility have been collected, analysed and interpreted for all the major soil delineations. Core samples were also collected and analyzed to know volume-weight relationship of the soils. Report compilation is under progress.

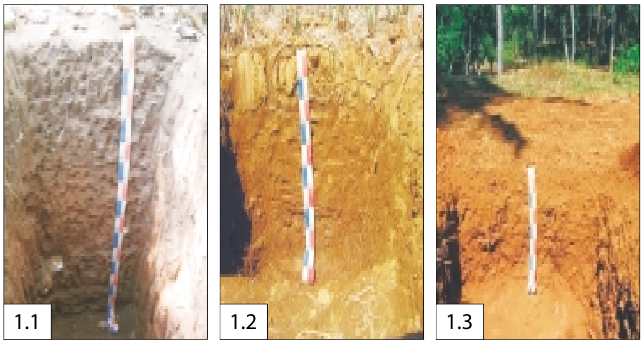


Fig. 1.1 Karuvarakundu series on Charnockite highlands
Fig. 1.2 Kolathur series on Charnockite midlands
Fig. 1.3 Kaipuzha series Laterite mounds under forest

Land resource inventory for farm planning in different agro-ecological regions of India

A. Natarajan, Jaya N. Surya, R.S. Meena S.K. Reza, S. Bandyopadhyay, S. Dharmarajan, Pushpanjali, K. Karthikeyan, and T.P. Verma and Dipak Sarkar

This pilot project was taken up in all five centres of the institute representing different agro-ecological regions of India, to show the relevance of site-specific database for farm-level planning in the country. The outcome of this network project is expected to provide a common platform for all the scientists of the Institute to evolve the necessary protocols required for undertaking cadastral level survey in the country. The details of area selected for the study by different centres have been given in table 1.1.

Tabe 1.1 Land Resource Inventory Project in operation in different Blocks/mandals

Location of the study area	Area (ha)	NBSS&LUP Regional Centre/ Division
Lakhan Majra Block, Rohtak Tehsil, Rohtak district	16653	Regional Centre, Delhi
Chikarsinakere Hobli, Mandya district	16873	Regional Centre, Bangalore
Katonigaon Panchayat, Titabar Block, Jorhat district	475	Regional Centre, Jorhat
East Lahing Gaon Panchayat (Chetiagaon, Sengsoa and Changmaigaon), Jorhat district	760	Regional Centre, Jorhat
Chinchura-Mogra and Polba-Dadpur Block, Hugli district	18983	Regional Centre, Kolkata
Parseoni Mandal, Parseoni tahsil, Nagpur district	16493	HQrs., Nagpur
Bhadesar Tehsil, Chittaurgarh district	5232	Regional Centre, Udaipur

Land resource inventory for farm planning in Chikarsinkere Hobli, Maddur Taluk. Mandya District, Karnataka – A Sub-project of the main project Land resource inventory for farm planning in different agro-ecological regions of India

R.S. Meena, A. Natrajan, S. Thayalan, S.C. Ramesh Kumar, V. Ramamurthy and S. Srinivas

The field work was carried out using the available cadastral maps. After intensive traversing, three landforms, namely, uplands, midlands and lowlands were identified in the block. Seven hundred observations including typical profiles were studied and based on the soil-site characteristics 13 soil series were identified. Out of this, 8 series occur in the uplands, one in the middle lands and 4 in the lowland lands. Village-wise soil maps were finalized with 118 mapping units in the area. Soil map of Alabhujanahalli village, Annur Panchayat, Chikkaarsinakere Hobli is presented in fig. 1.4.

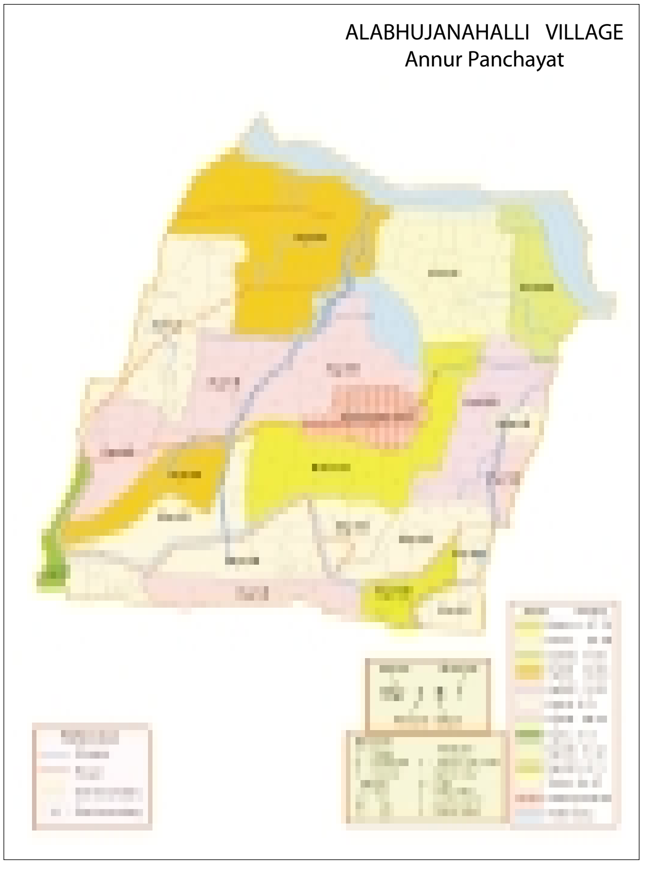


Fig. 1.4 Soil map of Alabhujanahalli village, Annur Panchayat, Chikkaarsinakere Hobli, Mandya district

Soil resource inventory and land evaluation of Aurangabad district, Bihar (1:50,000 scale) for land use planning

S.K. Gangopadhyay, K. Das, S. Mukhopadhyay, S.K. Singh and Dipak Sarkar

Aurangabad district lies between 24°17' 03" to 26°07' 46" N and 84°0' 26" to 84°53' 05" E in Bihar and covers an area of 3305 km^2 under two distinct physiographic units viz. (1) Chhotanagpur Plateau and (2) Alluvial plains. Chhotanagpur plateau includes moderately to strongly sloping plateau, undulating uplands, undulating plains and micro-depressions. Alluvial plains consist of alluvial terrace, active alluvial plains, recent and old alluvial plains. Extent of different physiographic divisions has been delineated using remote sensing data (Fig. 1.5). Soil-physiographic relationship has been established and dominant soils of different physiographic units are shown in table 1.2.

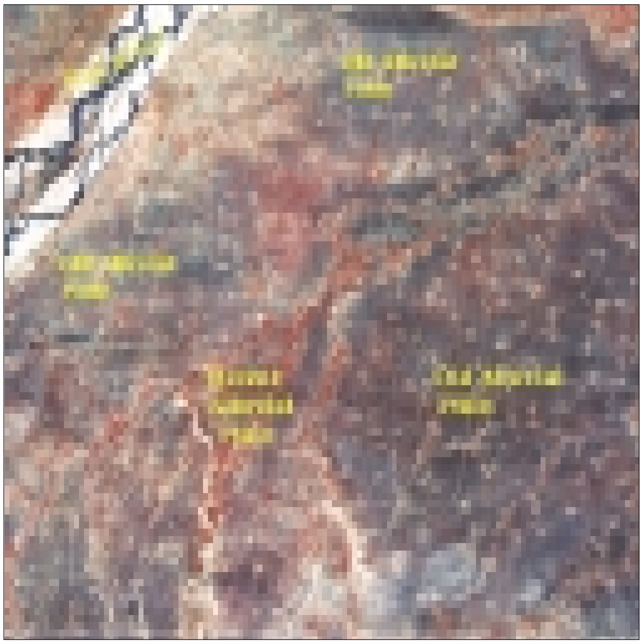


Fig. 1.5 Image characteristics of older and recent alluvial plains in Aurangabad district, Bihar

Black soils of Chhotanagpur plateau

The isolated pockets of black soils are extensively mapped in the region. The soils were deep to very deep, dark brown to dark yellowish brown; clay loam to silty clay on the surface; dark grayish brown to olive brown, silty clay loam to silty clayey in the sub-surface. Such soils resembled the Vertisols mapped elsewhere in other parts of the country with respect to texture, periodical opening and closing of cracks and sub-surface colour but have dissimilarity with respect to slickenside development, wedge shaped structure and colour on the surface. Genesis of these soils is debatable in this part of Bihar. Since the river Son and Punpun tributary of Ganga is draining to the area, both of which having their origin from the Vindhyan system, as such may not have ample ingredient in terms of chemical composition for the development of black soils. The residuum of basalts, were dotted with Archaean granite and gneiss and patches of Dharwar rocks (Phyllite, mica schists etc.) in Chhotanagpur plateau; may be the possible parent The isolated parcels of black soils in Aurangabad district were also in conformity with the dotted presence of basalt and basaltic materials in Chhotanagpur plateau. At places the presence of decomposed phylites below the residuum of basalt also provided strong support to the observations.

The spot height, ranging from 110 to 150 m above mean sea level indicated that black soils occupied relatively higher topographical position than the younger alluvial plains (90 to 110 meter). Sharp bend in Son river (Fig. 1.6) at the base of Chhotanagpur plateau in the district reconfirmed the presence of these soils on the elevated part of the landscape. The circumstantial events suggest that once upon a time the entire district was the part of Chhotanagpur plateau, with the abundance of micro-high and micro-low. Micro-low was occupied by the younger Gangetic alluvium, whereas elevated part of the landscape remained untouched during the formation of Indo-Gangetic alluvial plains. However, the debatable issue, the absence of slickensides and wedge-shaped structure in the sub-surface, is yet to be resolved. Probably mixing of alluvia at the surface having high proportion of non-expanding type of clay may be one of the reasons. The colour variation from the surface to sub-surface also supported the observations.

Fig. 1.6 Sharp bend of Son river in Aurangabad district, Bihar

Table 1.2 Dominant soils of Aurangabad district, Bihar

Physiography	Pedon sites	Depth (cm)	Colour (moist) Surface	Colour (moist) *CS	Texture Surface	Texture *CS	Horizon sequence
Alluvial Plain							
Alluvial terrace	Daudnagar	140±5	Dark yellowish brown to yellowish brown	Yellowish brown to brown	Sandy loam to loam	Loam to sandy clay loam	Ap-Bw
Active alluvial plain	Anchchya	140±5	Yellowish brown to dark yellowish brown	Yellowish brown to gray	Loamy sand to sand	Loamy sand to sand	Ap-C

cont...

Recent alluvial plain	Obra	130±5	Yellowish brown to dark yellowish brown	Yellowish brown to brown	Sandy loam to loam	Sandy clay loam to sandy clay	Ap- Bw
Old alluvial plain	Karma	135±5	Light olive brown to olive brown	Olive brown to dark grayish brown	Silty clay loam to clay	Silty clay to clay	Ap-Bw
	Sera	125±5	Olive brown to light grayish brown	Dark grayish brown to light brownish gray	Clay to sily clay loam	Silty clay to clay	Ap-Bw
Chhotanagpur Plateau							
Hills	Bhaluary	25±5	Dark yellowish brown to yellowish brown	Yellowish brown to brown	Clay loam to clay	Clay	A-Bw
Pediment	Sagarpur	45±10	Dark yellowish brown to yellowish brown	Yellowish brown to dark brown	Sandy loamto loam	Sandy loam to loam	A1- C
Undulating upland	Kashi-Tendua	140±5	Dark brown to brown	Brown to dark grayish brown	Silt loam to silty clay loam	Silty clay loam to silty clay	Ap-Bw(g)
Undulating plain	Bubhandi	155±5	Dark yellowish brown to yellowish brown	Yellowish brown to brownish gray	Sandy loam to sandy clay loam	Sandy clay loam to sandy clay	Ap- Bw
	Singhpur	125±5	Dark brown to dark grayish brown	Dark grayish brown to olive brown	Clay loam to sandy clay loam	Clay loam to loamy sand	Ap-Bw

*CS- control section; Depth, Mean± confidence interval at 95 % level of significance

Soil resource inventory and land evaluation of Rohtas district, Bihar (1:50,000 scale) for land use planning

D.C. Nayak, A.K. Sahoo, T. Banerjee, S. Mukhopadhyay and S. K. Singh

Rohtas district lying between 24°302 to 25°182 N and 83°432 to 84°282 E has an area of about 3838.2 km^2, which is 2.1% of total geographical area of Bihar. The district is administered with three sub-divisions; Dehri, Sasaram and Bikramganj and nineteen blocks. The climate is hot sub-humid and sub-tropical with hot dry summer and cool winter. Maximum and minimum average temperatures are 42°C and 11°C, respectively. The average annual rainfall varied from 1100-1200 mm.

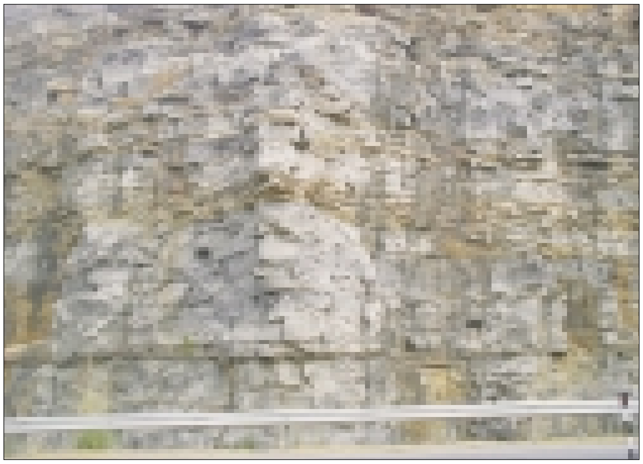


Fig. 1.7 Super-metamorphosed fine granite in Kaimur Plateau

The geology of the district comprises the hard rocks of Vindhyan systems, consisting of limestone, shale, sandstone in central high land (Kaimur Plateau Fig. 1.7) and alluvial sediments of Son river in the plain areas. The district has a variety of landscapes, consisting of flat plains of Son river running along the side of Kaimur Range and Rohtas Plateau. Alluvial plains are cultivated for paddy in summer and wheat/mustard in winter.

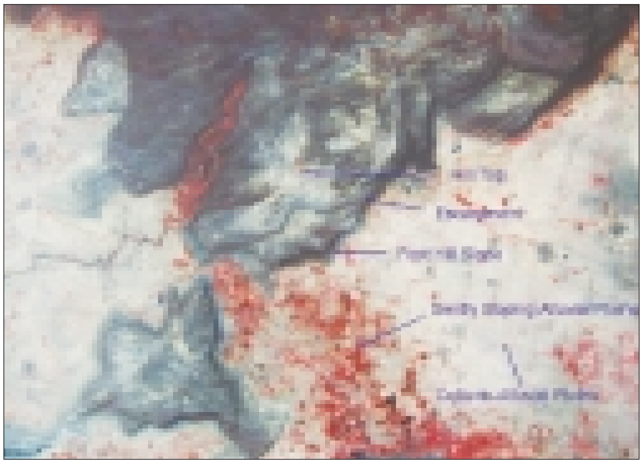


Fig. 1.8 Image characteristics of different physiographic units for a part of Rohtas district, Bihar

Soil survey of the district was carried out on 1:50,000 scale using IRS LISS III data as base map (Fig. 1.8). During the reporting year, about 2,05,000 (52% of the total geographical area of the district) was surveyed. Sixty five representative soil profiles in different transects were studied. Soil-physiography (Fig. 1.9) relationship was established and verified with random observations.

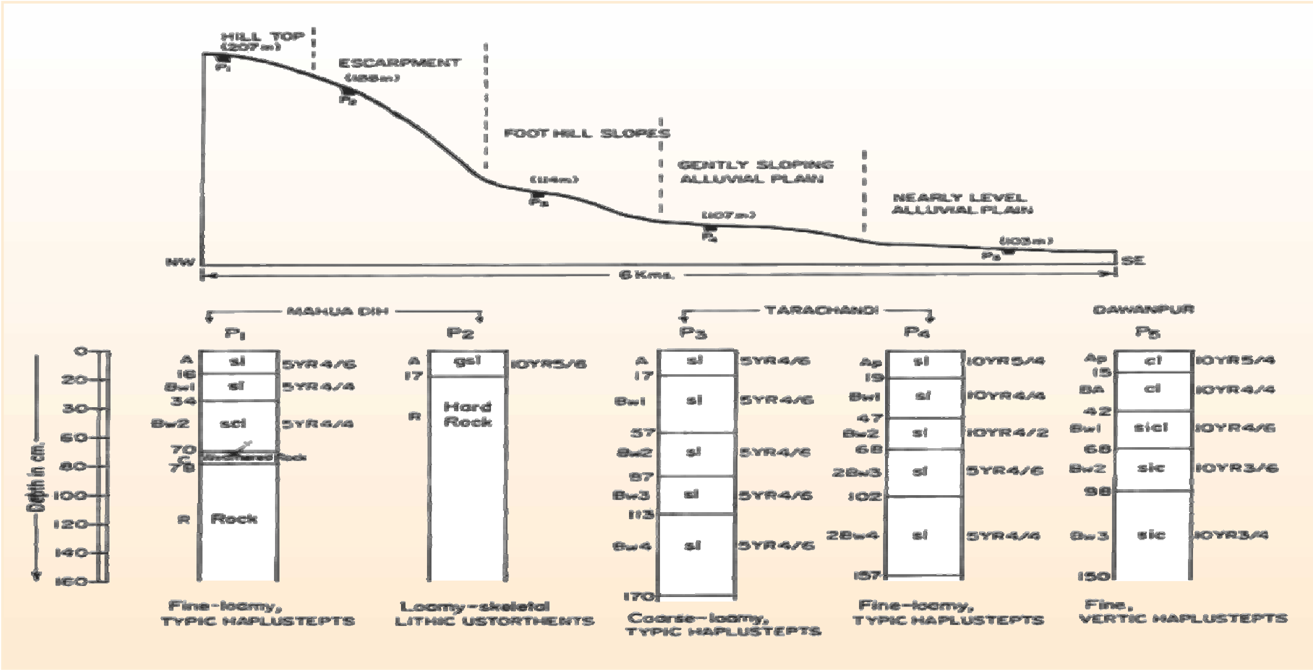


Fig. 1.9 Physiography-soil relationship in Rohtas district, Bihar

Soils on gently sloping alluvial plain were very deep, well drained, dark yellowish brown to reddish brown in colour and sandy loam to sandy clay loam in texture and were classified as a member of fine-loamy, mixed hyperthermic family of Typic Haplustepts. These were slightly eroded and mostly under vegetable cultivation. Other soils on nearly level alluvial plain were very deep, moderately well drained, dark yellowish brown in colour and silty clay to clay in texture and were classified as a member of fine, smectitic hyperthermic family of Vertic Haplustepts.

The soils on the hill top of Kaimur plateau were slightly deep to deep, well drained, dark reddish brown to reddish brown; sandy loam to sandy clay loam in texture, and were classified as member of fine-loamy, mixed, hyperthermic family of Typic Haplustepts. These were moderately to severely eroded and were covered with sparse forest vegetation. Other soils on the escarpment were very shallow, excessively drained, yellowish brown in colour and gravelly sandy loam in texture. Soils were classified as a member of loamy-skeletal, mixed, hyperthermic family of Lithic Ustorthents. These were severely eroded and rarely covered with vegetation. The soils on the foot hills were deep, well drained, yellowish red in colour, sandy loam in texture and were classified as a member of coarse-loamy, mixed hyperthermic family of Typic Haplustepts. These were moderately eroded and covered with sparse vegetation.

Dwarkeshwar micro-watershed in Puruliya district of West Bengal

T. Banerjee, K.Das and S.K. Singh

Based on geomorphometric study (elevation, slope, slope aspect, profile curvature, composite topographic index) and ground verification ten physiographic units (Fig. 1.10)

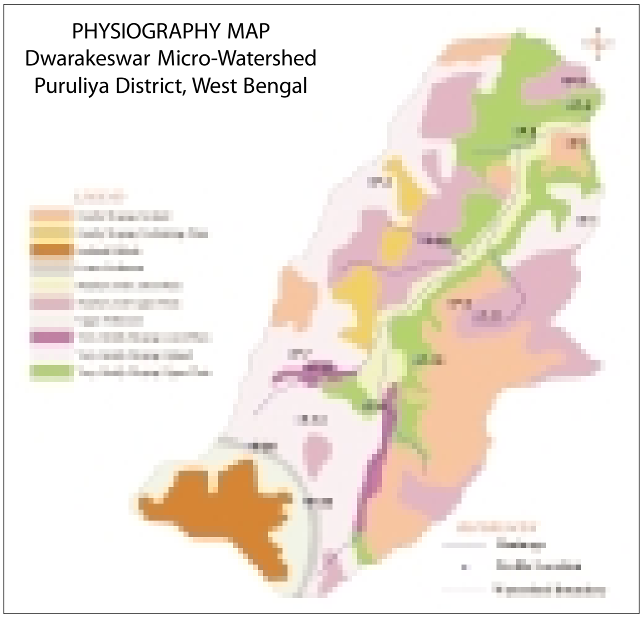


Fig. 1.10 Physiography map of Dwarakeswar micro-watershed, Puruliya district, West Bengal

were delineated in the micro-watershed. During detailed soil survey forty-five soil profiles and twelve auger bores were examined. Horizonwise samples were collected. One hundred twenty six samples at 200 m interval were also collected grid-wise for nutrient status mapping. Soil physiopraphy relationship in the micro-watershed is shown in table 1.3.

The study indicated that variations in soil depth, colour, texture, gravel content along the gradient or elevation do not follow the established trends with respect to soil depth, soil colour, gravel and texture relationship with slope and landforms. This may be attributed to the extensive soil conservation works, involving massive earth work and filling that might have obliterated the influence of natural process of soil formations.

Table 1.3 Soil-physiography relationship in Dwarkeshwar micro-watershed

Physiography		Pediment (Elevation 225-235m)		Undulating Upland (Elevation 220-230m)		Undulating Upper Plain (Elevation 210-220m)			Lower Plain (Elevation <210m)	
Soil Characteristics		Upper pediment	Lower Pediment	Gently sloping	Very gently sloping	Gently sloping	Very gently sloping	Nearly level	Very gently sloping	Nearly level
Mean depth (cm)		80	72	76	80	54	127	124	122	127
Colour	Surface	Dark yellowish brown to yellowish brown	Grayish brown to dark yellowish brown	Yellowish brown to dark yellowish brown	Yellowish brown to dark yellowish brown	Yellowish brown to dark yellowish brown	Yellowish brown to dark yellowish brown	Dark yellowish brown to light olive brown	Yellowish brown to dark yellowish brown	Yellowish brown to dark yellowish brown
	Control Section	Dark grayish brown to very dark brown	Dark yellowish brown to very dark brown	Yellowish brown to dark yellowish brown	Dark yellowish brown to very dark grayish brown	Yellowish brown to dark yellowish brown	Dark yellowish brown to very dark grayish brown	Yellowish brown to dark yellowish brown	Dark brown to dark yellowish/ olive brown	Dark yellowish brown to dark brown
Texture	Surface	Loamy sand to sandy loam	Loamy sand to sandy loam	Loamy sand to clay loam	Loam to sandy clay loam	Sandy loam to clay loam	Sandy loam to clay loam	Sandy loam to sandy clay loam	Sandy clay loam to clay loam	Sandy loam to clay loam
	Control Section	Sandy loam to clay loam	Sandy clay loam to clay loam	Sandy loam to sandy clay loam (gravelly)	Sandy loam to sandy clay loam (gravelly)	Sandy clay loamy to clay	Sandy clay loam to clay loam	Sandy loam to sandy clay	Sandy clay loam to clay loam	Sandy clay loam to clay loam
Coarse fragments	Surface	10-15%	10-55%	2-5%	5-10%	15-20%	2-30%	10-15%	-	5-10%
	Control Section	30-35%	5-65%	>80%	15-60%	15-25%	10-60%	10-15%	60-70%	30-35%
Horizon sequence		Ap-Bw	Ap-Bw	Ap-C	Ap-C	Ap-Bw	Ap-Bw	Ap-Bw	Ap-C	Ap-Bw-C
Slope (%)		8-15	3-8	3-5	1-3	3-5	1-3	0-1	1-3	0-1
Erosion		Severe	Moderate	Moderate to severe	Moderate	Slight to moderate	-	-	-	-
Classification		Coarse loamy Typic Haplustepts	Fine-loamy Typic Haplustepts	Loamy Lithic Ustorthents	Loamy Lithic Ustorthents	Coarse loamy Typic Haplustepts	Fine-loamy Typic Haplustepts	Fine-loamy Typic Haplustepts	Coarse loamy Typic Ustorthents	Coarse loamy Typic Haplustept

Land resource inventory for farm planning in Chinchura-Mogra and Polba-Dadpur block, Hugli district, West Bengal – A Sub-project of main project "Land resources inventory for farm planning in different agro-ecosystems of India"

S. Dharumarajan, S.K. Gangopadhyay, T. Banerjee and S.K. Singh

For standardizing the methodology of detailed soil survey in the lower part of the Indo-Gangetic alluvial plains, 18983 hectare area located between 22° 52' 06" to 23° 04' 07" N and 88° 09' 01" to 88° 24'54"E was selected in the Chinchura-Mogra and Polba-Dadpur . The climate is moist sub-humid with mean annual rainfall of 1599 mm and mean annual temperature of 26°C. Digital Elevation Model (Fig. 1.11) was prepared using ASTER DEM on 1: 50,000 scales.

Based on the Digital Elevation Model (DEM), levees, older alluvial plains, younger alluvial plains and paleo-channels were identified. Mango and Banana orchards were dominantly grown at the elevated part of the landscape, whereas rice-rice cropping system was practised at the lowest part of the landscape. The other cropping system consisting of rice-fallow and rice-vegetables.

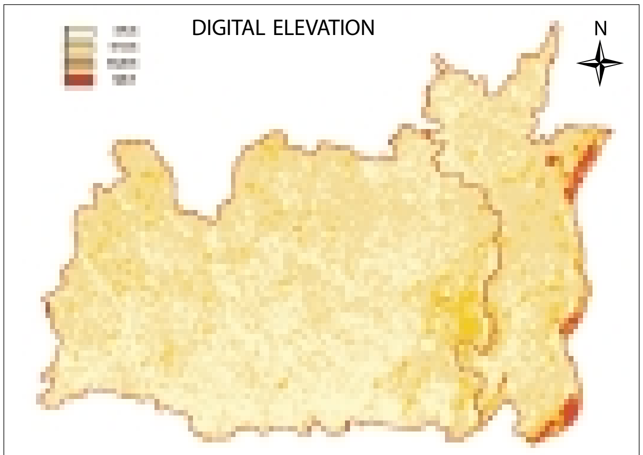


Fig. 1.11 Digital Elevation Model of study area

Intensive soil survey undertaken in the blocks indicated that soils on the levees (Table 1.4) were deep to very deep, poorly drained, dark grayish brown, silty clay loam to silty clay on the surface and silty clay to clay in the sub-surface. About 70 to 100 cm thick brown to dark yellowish brown, silt loam to loam in the upper and silty clay loam to clay in the lower part was situated on sandy loam to loamy sediments in the recent alluvial plains. In contrast, 15 to 25 cm thick light brownish gray to dark yellowish brown alluvia silty loam to loam in texture on older alluvial plains were found to occur on the similar sediment, constituting the substratum of the recent alluvial plains. Lithological discontinuity was prominently occurring at the depth of 75 to 100 cm and 15 to 25 cm in recent and older alluvial plains, respectively.

Water retention characteristics of soils

Water retention characteristics and available water capacity of the different soils of lower Gangetic plain were studied. The study indicated that water retention at field capacity (0.03 MPa) and at permanent wilting point (1.5 MPa) ranged from 0.16 to 0.44 m^3 m^{-3} and 0.08 to 0.25 m^3 m^{-3} respectively. Soils of upper levee retained more plant available water (205.6 mm m^{-1}) than the other soils. Pressure at 0.5 MPa removed 61 and 68 % of AWC in the soils of upper and lower levee (UL and LL) whereas the same pressure removed 75 and 80.5 % of water in soils of recent and older alluvial plain (RA and OA) (Fig. 1.12). The interpretation of results revealed that plants can sustain drought of longer duration in soils of upper and lower levee than recent and older alluvial plain. Silt and organic carbon were significantly (0.566* and 0.645**) positively correlated with available water content.

Table 1.4 Soil Series Characteristics

Physio-graphy	Series name	Elevation (m)	Land use	Texture		Colour		Drainage	Horizon sequence
				Surface	CS*	Surface	CS*		
UL	Chinchura*	49	Paddy- fallow	sic	sic to sicl	10YR 4/2	10YR 3/3	Imperfect	Ap- Bw
RA	Sangranpur	47	Potato-vegetables	scl	sl to ls	10YR 4/3	10YR 4/6	Mod.well	Ap- Bw
OA	Banseye	30	Potato-mustard	sil	sicl to ls	10YR 4/2	10YR 3/4	Mod.well	Ap- Bw
LL	Sugandha	25	Plantation	sl	sil to scl	10YR 5/4	10YR 4/4	Mod.well	Ap- Bw
OA	Amnan	47	Paddy-potato/ vegetables	sl	ls	10YR 6/2	10YR 6/2	Imperfect	Ap- Bw
LL	Benabharui*	40	Plantation	sicl	Sil to ls	10YR 5/4	10YR 3/3	well	Ap -C

* Calcareous soils; CS- control section

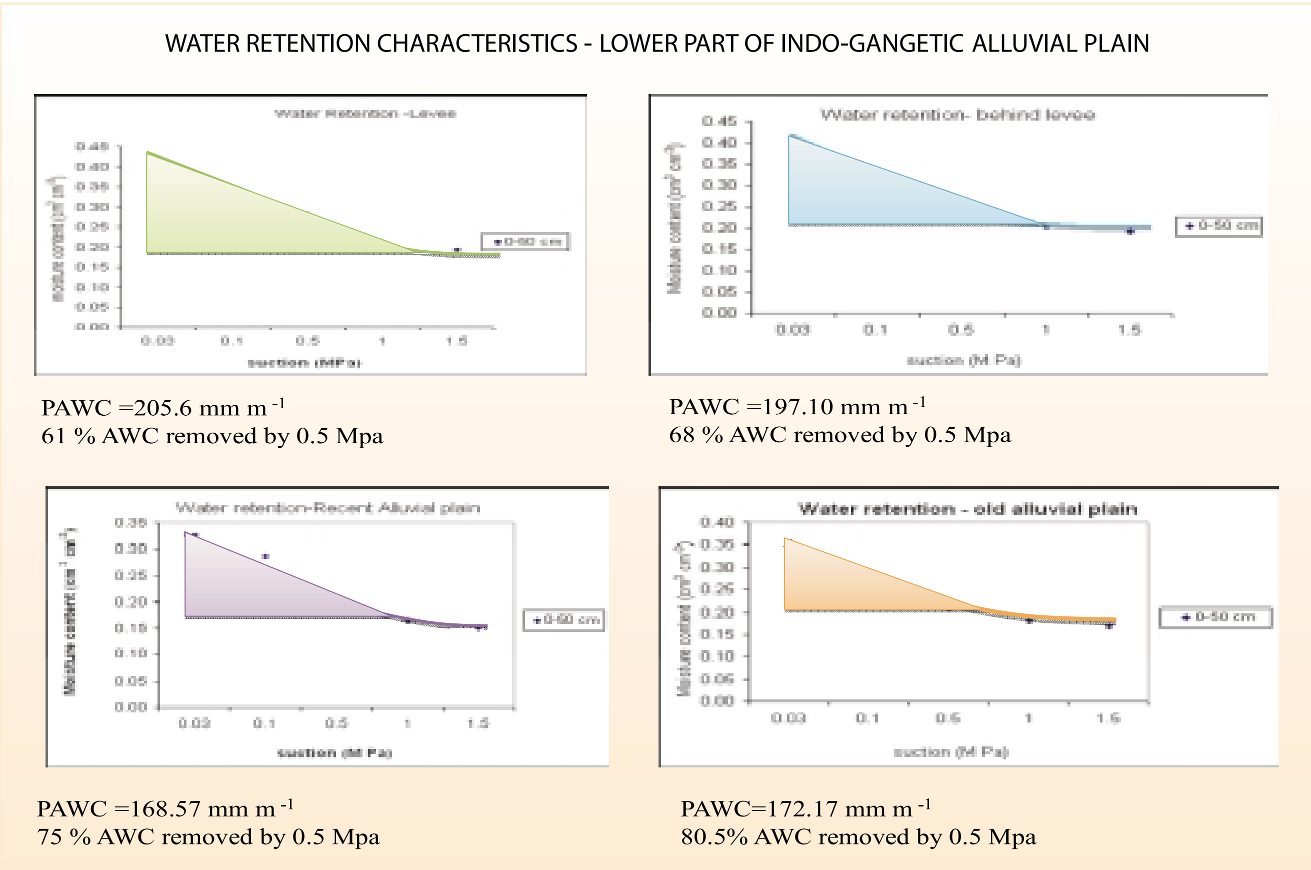


Fig. 1.12 Water retention characteristics of soils Lower part of Indo-Gangetic Alluvial Plain

Assessment and mapping of some important soil parameters including macro and micro-nutrients for the state of West Bengal (1:50,000 scale) towards optimum land use plan

Dipak Sarkar, D.C. Nayak, S.K. Singh, A.K. Sahoo, S. Mukhopadhyay, S.K. Gangopadhyay, K. Das, T. Chattopadhyay, D. Dutta, D.K. Sah and T. Banerjee

Soil sampling at one kilometer grid interval has been done for Budge-Budge–I and II, Maheshtala, Bishnupur-II, Bhanger-II blocks of 24 Parganas (S) district and Kalimpong-I & II, Gora Bathan, Rangli Rangliot, Phulbazar, Jore banglow, Mirik, Karsiong blocks of Darjiling district. The analysis of macro and micro-nutrient of Darjiling, Jalpaiguri, Murshidabad, Paschim Medinipur, and 24 Parganas (S) districts have been completed. Micronutrients for the districts of Puruliya, Bankura, Maldah, Uttar and Dakshin Dinajpur have also been analyzed. Extraction of boron and molybdenum for all the districts have been completed and analyzed for Puruliya, Uttar and Dakshin Dinajpur, Jalpaiguri, Maldah, 24 Parganas (N), Bankura, Barddhaman, Birbhum, Hugli, Haora and Nadia districts.

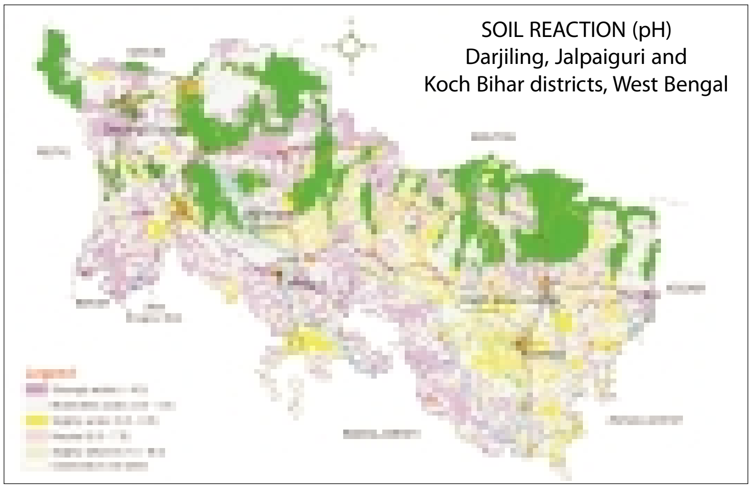


Fig. 1.13 Soil pH in Darjeeling, Jalpaiguri and Koch Bihar districts of West Bengal

Database comprising pH, EC, organic carbon, available nitrogen, phosphorus, potassium, sulphur, DTPA extractable copper, zinc, iron and manganese; hot $CaCl_2$ extractable boron, ammonium oxalate extractable molybdenum and soil texture have been developed for twelve districts and thematic maps of macro, micro nutrients, soil reaction (pH) and soil texture have been prepared by using inverse distance weighted method in GIS. A soil reaction map of Darjiling, Jalpaiguri and Kooch Bihar districts is shown in figure 1.13. Soil nutrient status maps for Darjiling, Jalpaiguri, Koch Bihar, Uttar and Dakshin Dinajpur, Maldah, Murshidabad, Bankura, Puruliya, Paschim (Part) and Purba Medinipur and 24 Parganas (S) have been processed. Some of the critical issues of soil fertility in the state of West Bengal are discussed. District-wise distribution of soils under different levels of acidity in the state in table l.5.

Table 1.5 District-wise distribution of soils of West Bengal under different levels of acidity*

Districts	Area (km ^{2}) under different classes of soil pH								
	Strongly acidic	Moderately acidic		Slightly acidic	Neutral	Slightly alkaline	Alkaline	Misc.	Total
	<4.5	4.5-5.0	5.0-5.5	5.5-6.5	6.5-7.5	7.5-8.5	>8.5		
Darjiling	838.5 (26.6)	1133.2 (36.0)	-	176.5 (5.6)	-	-	-	1000.8 (31.8)	3149.0 (100.0)
Jalpaiguri	1746.1 (28.0)	1729.9 (27.8)	-	485.1 (7.8)	319.5 (5.1)	-	-	1946.4 (31.3)	6227.0 (100.0)
Koch Bihar	889.0 (26.2)	1504.2 (44.3)	-	578.9 (17.1)	194.0 (5.7)	16.6 (0.5)	-	204.3 (6.2)	3387.0 (100.0)
Maldah	44.3 (1.2)	466.9 (12.5)	-	1068.2 (28.6)	908.6 (22.4)	904.1 (24.2)	-	340.9 (9.1)	3733.0 (100.0)
Murshidabad	87.8 (1.7)	597.8 (11.2)	-	1088.8 (20.5)	1746.5 (32.8)	1502.3 (28.2)	54.1 (1.0)	246.7 (4.6)	5324.0 (100.0)
Uttar Dinajpur	624.2 (19.9)	1824.2 (58.1)	-	576.3 (18.4)	98.8 (3.1)	-	-	16.5 (0.5)	3140.0(100.0)
Dakshin Dinajpur	361.8 (16.3)	1283.0 (57.8)	-	495.0 (22.3)	59.0 (2.7)	-	-	20.3 (0.9)	2219.0 (100.0)
Nadia	27.7 (0.7)	86.4 (2.2)	-	342.1 (8.7)	1856.8 (47.3)	1438.5 (36.6)	-	175.5 (4.5)	3927.0 (100.0)
Haora	27.1 (21.8)	158.1 (3.8)	-	581.6 (39.7)	409.1 (27.9)	95.2 (6.5)	16.5 (1.1)	179.4 (12.2)	1467.0 (100.0)
Hugli	77.8 (2.5)	903.4 (28.7)	-	1273.9 (40.5)	645.7 (20.5)	133.0 (4.2)	13.0 (0.4)	102.2 (3.2)	3149.0 (100.0)
Barddhaman	588.7 (8.4)	2661.0 (37.9)	-	2493.1 (35.5)	814.9 (11.6)	175.6 (2.5)	65.4 (0.9)	225.3 (3.2)	7024.0 (100.0)
Birbhum	98.7 (2.2)	2202.0 (48.4)	-	1648.7 (36.3)	437.1 (9.6)	40.6 (0.9)	-	117.9 (2.6)	4545.0 (100.0)
Puruliya	288.6 (4.6)	4144.4 (66.2)	-	1494.7 (23.9)	218.0 (3.5)	17.0 (0.3)	-	96.3 (1.5)	6259.0 (100.0)
Bankura	480.1 (7.0)	2405.7 (35.0)	2195.7 (31.9)	1316.9 (19.1)	163.5 (2.4)	48.8 (0.7)	-	271.3 (3.9)	6882.0 (100.0)
Purba Medinipur	113.8 (2.7)	975.7 (22.7)	-	1731.3 (40.3)	722.6 (16.8)	124.2 (2.9)	-	627.4 (14.6)	4295.0 (100.0)
Paschim Medinipur	1077.0 (15.9)	3285.7 (48.7)	-	1536.9 (22.8)	503.8 (7.5)	105.3 (1.5)	-	239.6 (3.6)	6748.4 (100.0)
24Parganas (N)	248.4 (6.1)	246.8 (6.0)	-	767.9 (18.8)	1591.2 (38.8)	543.0 (13.3)	196.6 (4.8)	500.1 (12.2)	4094.0 (100.0)
24Parganas (S)	537.3 (5.4)	1061.2 (10.7)	-	1415.1 (14.2)	916.0 (9.2)	225.6 (2.3)	198.8 (2.0)	5607.0 (56.2)	9961.0 (100.0)

Note: Figures within parentheses indicates (%) area of the districts *pH range as suggested by State Department

Variation in the extent and severity of acidity may be attributed to the nature of material, climate, vegetation and management. High acidic alluvia of eastern Himalaya under the influence of high rainfall and low temperature acidifying the soils of Darjiling, Jalpaiguri, Koch Bihar, Uttar and Dakshin Dinajpur districts. Acidity in the Chhotanagpur region was the major concern of Puruliya, Bankura, Birbhum, part of Paschim Medinipur and Barddhaman districts. Sulphur oxidation at places may be attributed to the acidity in the districts of Haora, Hugli, Purba Medinipur, 24 Parganas.

The impact of moving alluvia on acidity in Birbhum district was examined. The district was initially surveyed in the year 1982 into twenty five soil map units. During the year 2006 to 2007 the district was resurveyed on one km grid interval, using Global Positioning System (GPS) and Geographical Information System (GIS). Grid points were marked on the digitized map of 1982. Point data was arranged by mapping unit and mean pH for each of them was again determined in 2006-07. The difference in soil pH between 1982 and 2007 indicated that apart from four mapping units, pH decrease in other twenty one was found statistically significant (Fig. 1.14).

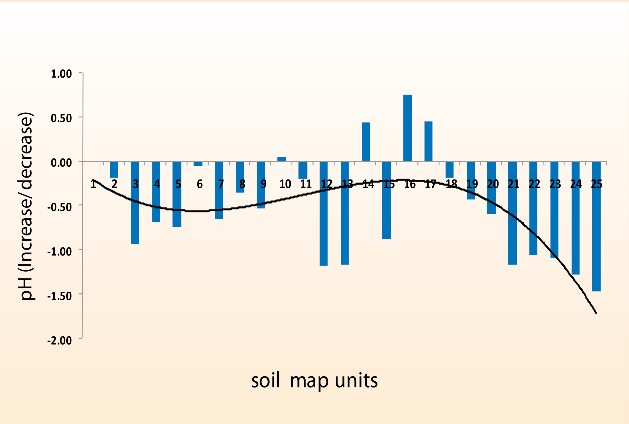


Fig. 1.14 Increase and/or decrease in soil pH in the year 2006-07 over the base year of 1982 in Birbhum district

Available phosphorus

Soils with low (< 45 kg ha^{-1} P_2O_5) and medium (45 to 90 kg ha^{-1} P_2O_5) available phosphorus are of serious concern, affecting the sustainability of agriculture in the state. Nearly 63 per cent area of the state was low to medium in available phosphorus (Table 1.6)

Table 1.6 Area-wise distribution of soils under different levels of available phosphorus (P_2O_5)

Districts	Area (km ^{2}) under different class of available phosphorus (kg ha^{-1})				
	Low <45 (kg ha^{-1})	Medium 45-90 (kg ha^{-1})	High >90 (kg ha^{-1})	Misc.	Total
Darjiling	358.9 (11.4)	1466.9 (46.6)	322.4 (10.2)	1000.8 (31.8)	3149.0 (100.0)
Jalpaiguri	991.6 (15.9)	1210.0 (19.4)	2079.0 (33.4)	1946.4 (31.3)	6227.0 (100.0)
Koch Bihar	509.1 (15.0)	599.6 (17.7)	2074.0 (61.1)	204.3 (6.2)	3387.0 (100.0)
Maldah	2384.0 (63.9)	564.2 (15.1)	443.9 (11.9)	340.9 (9.1)	3733.0 (100.0)
Murshidabad	1887.8 (35.5)	2075.5 (39.0)	1114.0 (20.9)	246.7 (4.6)	5324.0 (100.0)
Dinajpur North	468.2 (14.9)	564.0 (18.0)	2091.3 (66.6)	16.5 (0.5)	3140.0 (100.0)
Dinajpur South	556.0 (25.1)	610.9 (27.5)	1031.8 (46.5)	20.3 (0.9)	2219.0 (100.0)
Nadia	1014.8 (25.8)	1127.7 (28.7)	1609.0 (41.0)	175.5 (4.5)	3927.0 (100.0)
Haora	879.4 (60.0)	256.9 (17.5)	151.3 (10.3)	179.4 (12.2)	1467.0 (100.0)
Hugli	876.4 (27.8)	647.2 (20.6)	1523.2 (48.4)	102.2 (3.2)	3149.0 (100.0)
Barddhaman	3510.7 (50.0)	1802.5 (25.7)	1485.5 (21.1)	225.3 (3.2)	7024.0 (100.0)
Birbhum	3325.7 (73.2)	688.3 (15.1)	413.1 (9.1)	117.9 (2.6)	4545.0 (100.0)
Puruliya	5415.5 (86.6)	533.9 (8.5)	213.3 (3.4)	96.3 (1.5)	6259.0 (100.0)
Bankura	5120.1 (74.4)	809.8 (11.8)	680.8 (9.9)	271.3 (3.9)	6882.0 (100.0)
Medinipur Paschim	3420.0 (50.6)	1848.3 (27.4)	1240.5 (18.4)	239.6 (3.6)	6748.4 (100.0)
Medinipur Purba	979.0 1(46.1)	1043.5 (24.3)	645.1 (15.0)	627.4 (14.6)	4295.0 (100.)
24-Parganas(N)	2116.3 (51.7)	935.1 (22.8)	542.5 (13.3)	500.1 (12.2)	4094.0 (100.0)
24-Parganas(S)	3233.7 (32.5)	636.2 (6.4)	484.1 (4.9)	5607.0 (56.2)	9961.0 (100.0)

Note: Figures within parentheses indicates (%) area of the districts

Available potassium

District-wise distribution of available potassium in West Bengal presented in table 1.7 indicate that soils of low and medium available potassium accounted for 69% of the TGA of the state.

Table 1.7 Area-wise distribution of soils under different levels of available potassium

Districts	Area (km ^{2}) under different class of available potassium (kg ha^{-1})				
	Low <200 (kg ha^{-1})	Medium 200-350 (kg ha^{-1})	High >350 (kg ha^{-1})	Misc.	Total
Darjiling	633.9 (20.1)	715.5 (22.7)	798.8 (25.4)	1000.8 (31.8)	3149.0 (100.0)
Jalpaiguri	2469.1 (39.6)	1184.7 (19.0)	626.8 (10.1)	1946.4 (31.3)	6227.0 (100.0)
Koch Bihar	1888.0 (55.6)	846.2 (25.0)	448.5 (13.2)	204.3 (6.2)	3387.0 (100.0)
Maldah	2722.1 (74.3)	533.4 (14.3)	86.6 (2.3)	340.9 (9.1)	3733.0 (100.0)
Murshidabad	3658.0 (68.8)	986.6 (18.5)	432.7 (8.1)	246.7 (4.6)	5324.0 (100.0)
Dinajpur North	1866.7 (59.5)	925.8 (29.5)	331.0 (10.5)	16.5 (0.5)	3140.0 (100.0)
Dinajpur South	1229.2 (55.4)	578.5 (26.1)	391.0 (17.6)	20.3 (0.9)	2219.0 (100.0)
Nadia	893.8 (22.8)	2027.7 (51.6)	830.0 (21.1)	175.5 (4.5)	3927.0 (100.0)
Haora	127.9 (8.7)	854.2 (58.2)	305.5 (20.9)	179.4 (12.2)	1467.0 (100.0)
Hugli	1119.4 (35.6)	1410.2 (44.8)	517.2 (16.4)	102.2 (3.2)	3149.0 (100.0)
Barddhaman	4028.3 (57.4)	1946.9 (27.7)	823.5 (11.7)	225.3 (3.2)	7024.0 (100.0)
Birbhum	3122.5 (68.7)	1102.0 (24.2)	202.6 (4.5)	117.9 (2.6)	4545.0 (100.0)
Puruliya	4612.6 (73.7)	1298.9 (20.8)	251.2 (4.0)	96.3 (1.5)	6259.0 (100.0)
Bankura	4209.8 (61.2)	1758.5 (25.6)	642.4 (9.3)	271.4 (3.9)	6882.0 (100.0)
Medinipur Paschim	3635.4 (53.9)	1629.2 (24.1)	1244.1 (18.4)	1244.1 (3.6)	6748.4 (100.0)
Medinipur Purba	948.6 (22.1)	869.5 (20.2)	1368.9 (43.1	627.4 (14.6)	4295.0 (100.0)
24 Parganas (N)	1427.6 (34.9)	822.2 (20.1)	1344.1 (32.8)	500.1 (12.2)	4094.0 (100.0)
24 Parganas (S)	849.1 (8.5)	295.5 (3.0)	3209.4 (32.2)	5607.0 (56.3)	9961.0 (100.0)

Note: Figures within parentheses indicates (%) area of the districts

Available sulphur

Area under low, medium and high level of sulphur in different districts of West Bengal is shown in table 1.8. Sulphur availability was low and medium in 11.8% and 11.3% of the total geographical area of the state, respectively. About 50.0 % area of West Bengal exhibited high level of sulphur availability.

Table 1.8 Area-wise distribution of soils under different levels of available sulphur (mg kg^{-1})

Districts	Area (km ^{2}) under different class of available sulphur (mg kg^{-1})				
	Low <200	Medium 200-350	High >350	Misc.	Total
Darjiling	440.2 (14.0)	641.0 (20.3)	1067.0 (33.9)	1000.8 (31.8)	3149.0 (100.0)
Jalpaiguri	1817.7 (29.2)	585.1 (9.4)	1877.8 (30.1)	1946.4 (31.3)	6227.0 (100.0)
Koch Bihar	862.5 (25.4)	638.9 (18.8)	1681.3 (49.6)	204.3 (6.2)	3387.0 (100.0)
Maldah	245.1 (6.6)	743.5 (19.9)	2403.5 (64.4)	340.9 (9.1)	3733.0 (100.0)
Murshidabad	1442.4 (27.1)	731.9 (13.7)	2903.0 (54.6)	246.7 (4.6)	5324.0 (100.0)
Dinajpur North	768.2 (24.5)	450.7 (14.4)	1904.6 (60.6)	16.5 (0.5)	3140.0 (100.0)
Dinajpur South	170.1 (7.7)	160.5 (7.2)	1868.1 (84.2)	20.3 (0.9)	2219.0 (100.0)
Nadia	113.6 (2.9)	977.6 (24.9)	2660.3 (67.7)	175.5 (4.5)	3927.0 (100.0)
Haora	-	41.3 (2.8)	1246.3 (85.0)	179.4 (12.2)	1467.0 (100.0)
Hugli	-	-	3046.8 (96.8)	102.2 (3.2)	3149.0 (100.0)
Barddhaman	1223.3 (17.4)	1081.5 (15.4)	4493.9 (64.0)	225.3 (3.2)	7024.0 (100.0)
Birbhum	1685.7 (37.1)	937.8 (20.6)	1803.6 (39.7)	117.9 (2.6)	4545.0 (100.0)
Puruliya	1414.4 (22.6)	2070.3 (33.1)	2678.0 (42.8)	96.3 (1.5)	6259.0 (100.0)
Bankura	841.1 (12.2)	2572.2 (37.4)	3197.4 (46.5)	271.3 (3.9)	6882.0 (100.0)
Medinipur Paschim	2868.2 (42.5)	1645.6 (24.4)	1995.0 (29.5)	239.6 (3.6)	6748.4 (100.0)
Medinipur Purba	805.8 (18.7)	681.7 (15.9)	2180.1 (50.8)	627.4 (14.6)	4295.0 (100.0)
24-Parganas (N)	735.6 (18.0)	541.0 (13.2)	2317.3 (69.8)	500.1 (12.2)	4094.0 (100.0)
24-Parganas (S)	545.6 (5.5)	112.8 (1.1)	3695.6 (37.2)	5607.0 (56.2)	9961.0 (100.0)

Note: Figures within parentheses indicates (%) area of the districts

Available zinc

Distribution of deficient and sufficient area with respect to zinc nutrition is shown in different districts of West Bengal (Table 1.9). About 35 % area of the state is affected with zinc deficiency. The extent of deficiency was the highest, ranging from 55 to 70 % in Maldah, Murshidabad, Birbhum and 24 Parganas (N) followed by 40 to 50 % in Jalpaiguri, Koch Bihar, Purba and Paschim Medinipur and 30 to 40 % in Dakshin Dinajpur, Hugli and Barddhaman districts. Extent of zinc deficiency varied from 3.9 % in Bankura to 27.1% in 24 Parganas(S).

Table 1.9 Area-wise distribution of soils under different levels of available zinc (mg kg^{-1})

Districts	Area (km^2) under different classes of available zinc(mg kg^{-1})							
	Deficient	Sufficient					Misc.	Total
	<0.6	0.6-1.0	1.0-2.0	2.0-3.0	3.0-5.0	>5		
Darjiling	581.1 (18.5)	400.6 (12.7)	744.7 (23.6)	270.0 (8.6)	140.1 (4.4)	11.7 (0.4)	1000.8 (31.8)	3149.0 (100.0)
Jalpaiguri	2519.0 (40.4)	1023.6 (16.4)	501.3 (8.1)	70.9 (1.1)	42.2 (0.7)	123.6 (2.0)	-	6227.0 (100.0)
Koch Bihar	1395.4 (41.2)	1000.1 (29.4)	668.9 (19.7)	101.2 (3.0)	17.1 (0.5)	-	204.3 (6.2)	3387.0 (100.0)
Maldah	2076.0 (55.6)	881.8 (23.6)	375.4 (10.1)	37.7 (1.0)	10.4 (0.3)	10.8 (0.3)	340.9 (9.1)	3733.0 (100.0)
Murshidabad	3522.2 (66.2)	1383.2 (26.0)	171.9 (3.2)	-	-	-	246.7 (4.6)	5324.0 (100.0)
Dinajpur North	1644.4 (52.4)	777.8 (24.8)	596.0 (19.0)	89.2 (2.8)	16.1 (0.5)	-	16.5 (0.5)	3140.0 (100.0)
Dinajpur South	698.7 (31.5)	717.5 (32.4)	677.3 (30.5)	73.9 (3.3)	31.3 (1.4)	-	20.3 (0.9)	2219.0 (100.0)
Nadia	1010.5 (25.7)	1535.6 (39.1)	1036.7 (26.4)	142.9 (3.6)	25.8 (0.7)	-	175.5 (4.5)	3927.0 (100.0)
Haora	236.4 (16.1)	660.8 (45.1)	360.7 (24.6)	24.1 (1.6)	4.5 (0.3)	1.1 (0.1)	179.4 (12.2)	1467.0 (100.0)
Hugli	1148.4 (36.5)	876.3 (27.8)	774.1 (24.6)	166.7 (5.3)	67.1 (2.1)	14.2 (0.5)	102.2 (3.2)	3149.0 (100.0)
Barddhaman	2298.9 (32.7)	1896.2 (27.0)	1780.9 (25.4)	480.4 (6.8)	252.3 (3.6)	90.0 (1.3)	225.3 (3.2)	7024.0 (100.0)
Birbhum	3168.2 (69.7)	625.7 (13.8)	419.8 (9.2)	168.2 (3.7)	38.2 (0.8)	7.0 (0.2)	117.9 (2.6)	4545.0 (100.0)
Puruliya	1334.5 (21.3)	1938.9 (31.0)	2045.8 (32.7)	454.2 (7.3)	270.5 (4.3)	118.8 (1.9)	96.3 (1.5)	6259.0 (100.0)
Bankura	271.4 (3.9)	3348.7 (48.7)	2166.3 (31.5)	570.1 (8.3)	220.5 (3.2)	33.7 (0.5)	271.3 (3.9)	6882.0 (100.0)
Medinipur Paschim	2948.6 (43.7)	2231.3 (33.0)	1226.6 (18.2)	71.4 (1.0)	30.9 (0.5)	-	239.6 (3.6)	6748.4 (100.0)
Medinipur Purba	1918.6 (44.7)	1123.9 (26.1)	591.0 (13.8)	34.1 (0.8)	-	-	627.4 (13.6)	4295.0 (100.0)
24-Parganas(N)	273.9 (66.9)	551.8 (13.5)	197.3 (4.8)	105.3 (2.6)	-	-	500.1 (12.2)	4094.0 (100.0)
24-Parganas(S)	2696.2 (27.1)	1015.2 (10.2)	397.9 (4.0)	244.6 (2.5)	-	-	5607.0 (56.2)	9961.0 (100.0)

Note: Figures within parentheses indicates (%) area of the districts

Soil Resource Mapping of Sultanpur district of Uttar Pradesh for perspective land use planning

C.S. Walia, Tarsem Lal and G.S. Sidhu

Sultanpur district covers an area of 4396 sq km and represents semi-arid climate. The average rainfall of the district ranges from 950-1100 mm. The mean annual potential evaporation of the district is 1661mm. The length of growing period (LGP) estimated to be around 150 days.

Sixteen soil series were identified and mapped into 24 soil series associations. The soils of the district have been classified into 2 Orders, 4 Sub-orders, 5 Great groups and 7 Sub-groups. Inceptisols occupy nearly 88 % of TGA. Typic Haplustepts occupy the largest area in the district followed by Natric Haplustepts and Natric Endoaquepts. Among the soil families, fine- loamy soils are dominant followed by coarse- loamy soils.

Soil resource data has been interpreted to generate various thematic maps in GIS. Soils of the large part of district are fine-loamy, non-calcareous (46%), medium AWC(75%), neutral in reaction (43%) and low in organic carbon. Soils of about 18 % area suffer from imperfect to poor drainage while 10% area of district suffer from erosion. Salt affected soils occupy about 19 % area of TGA (Fig 1.15).

In the district nearly 28 % lands are grouped into class I, 34 % land into class II, 6 % land into class III, 26 % land into class IV (Fig. 1.16), 3 % land in class V land. The limiting factors are wetness or soil factor (soil texture, soil salinity and sodicity) and erosion. These factors limit 32 % lands and 5.7 % lands by wetness alone. About 8 % lands of the district are limited by the risk of both soil and erosion factors. The data indicated that about 62 % area in the district is suitable for cultivation with or without slight limitations However, in 6 % area (TGA) moderate to severe limitations of wetness, soil salinity and sodicity limit the choice of crop unless suitable agro-management or reclamation measures are taken. About 24 area is grouped in IV es (soil and erosion) and IV se (drainage/sodicity). The land that is not suitable for arable farming is 3 % due to severe problems of erosion / dissection and droughtiness owing to sandy texture.

The suitability for major crops of Sultanpur district was assessed by comparing the soil-site characteristics with standard suitability tables. The soil suitability analysis indicated that 69% area is suitable for wheat and 83 % area is suitable for rice (Fig 1.17). Sugarcane can be grown in 60 % of TGA. Nearly 64 % area can be put under soybean while only 46 % area is suitable for pigeon pea. Mustard, barley and sorghum can be cultivated in 61-63 % area of TGA. The major soil factor determining the soil suitability are soil texture, drainage, soil salinity/ sodicity and fertility.

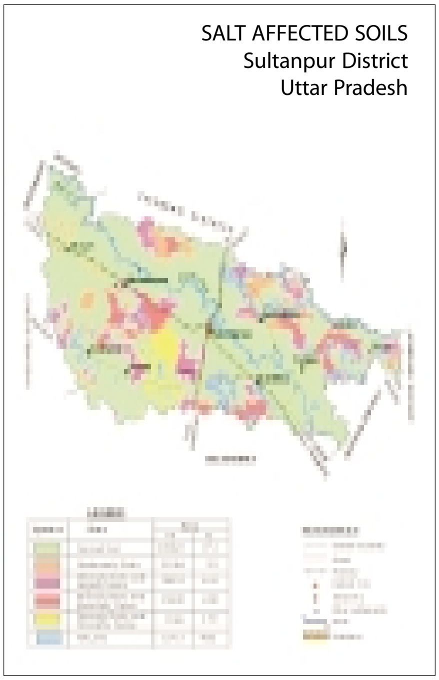


Fig. 1.15 Salt affected soils of Sultanpur district

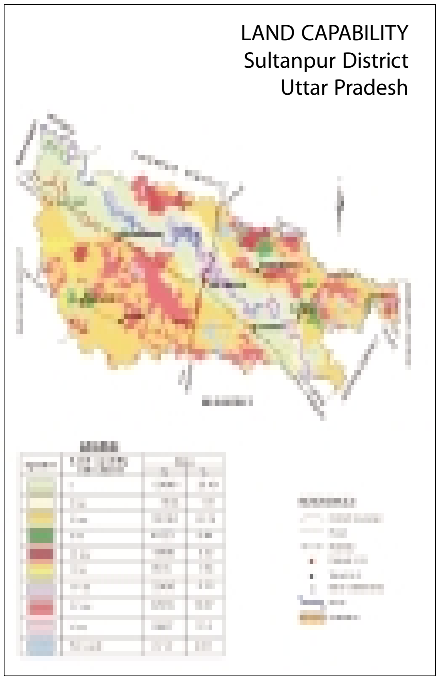


Fig. 1.16 Land Capability classification

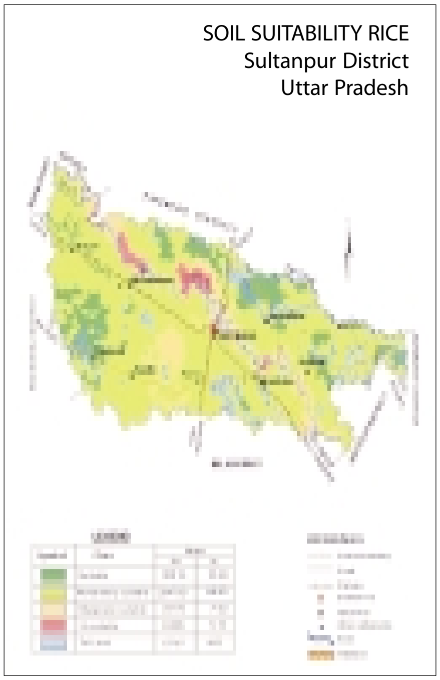


Fig. 1.17 Soil suitability for rice

Land Resource Inventory for Farm Planning in Lakhan Majra Block of Maham - Rohtak Tehsil, Rohtak District, Haryana

Jaya N. Surya, G.S. Sidhu, Tarsem Lal, S.K. Mahapatra, C.S. Walia and Dharam Singh

The present project is taken up as a pilot study in part of Lakhan Majra Block, in Rohtak district, Haryana to prepare land resource inventory of the study area (Fig. 1.18) and to provide the cost and time effective, site-specific database for farm level planning. Preliminary information has been collected for the preparation of resources database of the block.

Monthly ten years (1995-2004) and for the year 2008 climatic data of Lakhan Majra Block were collected. Area falls under semi-arid type climate with dry summer and cold winters. Maximum temperature in summer ranges between 40 to 44 ^{o}C and minimum in winter 3 to 6^{o} C. The relative humidity remains as low as 60% in summer months and high of 90% in rainy season. Average rainfall of last ten years is 564 mm.

Data on land use, cropping pattern, inputs and level of management, yields and other information collected for each village. The land utilization pattern shows that 90% area is under cultivation, 2% area is under cultivable wasteland and 8% are under miscellaneous use. Rice-wheat/mustard, rice/pulses-sugarcane, pearlmillet/pulses-wheat are the dominant cropping systems of the block. Wheat, mustard and sugarcane are main *rabi* crops while paddy, pearlmillet and sorghum are the main *kharif* crops.

In upland areas of Sunderpur and Titauli villages, sorghum, pearlmillet and cotton are the major crops (Figs. 1.19 and 1.20). Some other crops like clusterbean and pulses etc. are also grown in patches. Animal husbandry is another important production system existing in the area.

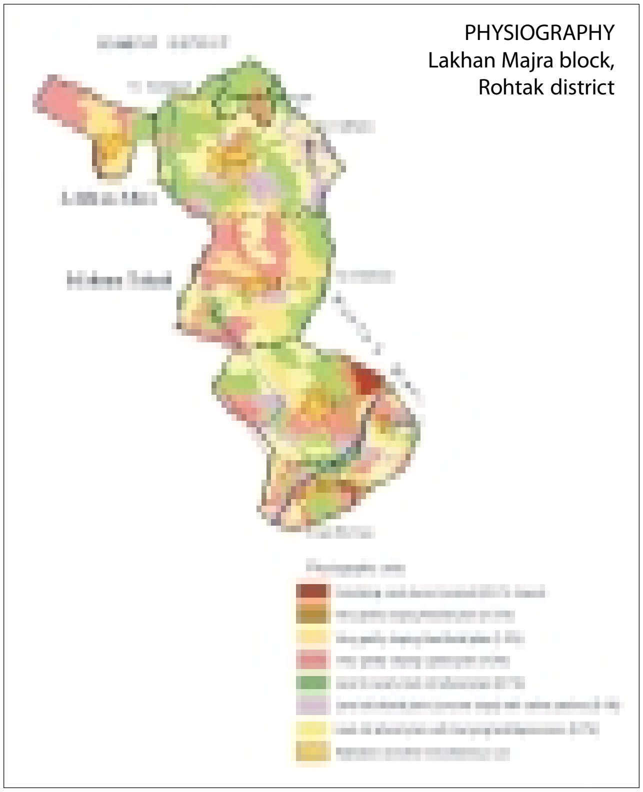


Fig. 1.18 Physiography of Lakhan Majra block of Rohtak district

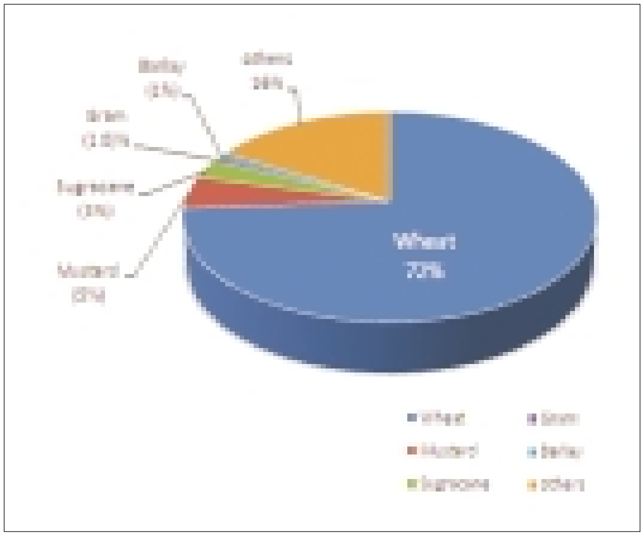


Fig. 1.19 Area under different *Kharif* crops

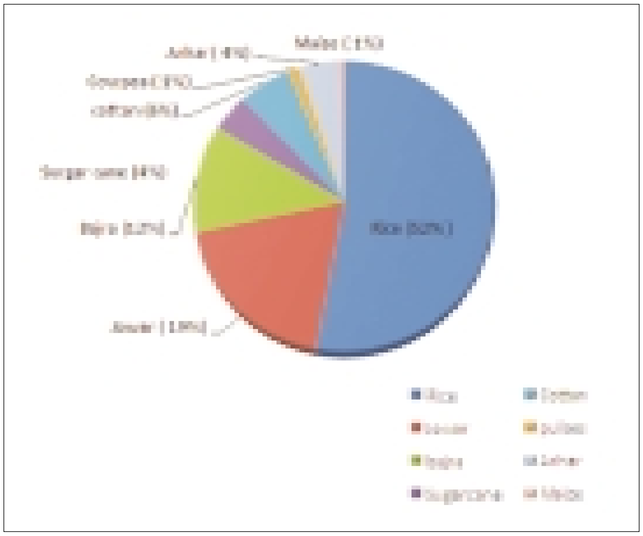


Fig. 1.20 Area under different *Rabi* crops

The area, in general, is plain and its altitude is between 219 meters (Chiri village) to 226 meters (Tatauli village) above mean sea level. Canal water is main source of irrigation. Bhiwani sub-branch and Kalanaur distributaries are the two main canals which make the passage through most of the villages and have created a network of sub-branches, minor and distributaries. Titauli and Chiri minors are the important canals and minors irrigating the area. Ground water table is very shallow (3 m depth) in northern and western part of block, shallow to moderate depth (3-10 m) in central, eastern and southern part.

Total population of the area is 30687 persons with 5222 households. Out of the total population, 16859 persons are males while13828 are females. The density of population in the area is 414 persons /km^2 . Village-wise analysis shows that the Chiri has highest population density with 471 persons/km^2 while Sasrauli has the lowest (209 persons/km^2). Analysis of the data show that 78% population is literate. Regarding land holding, 38% farmers in the area belong to marginal to small land holdings, 13% to semi-medium and only 5% farmers belong to medium to large category. Out of the total workers, 55.89 % are engaged in agriculture and allied activities, 7.68% in cottage and household industries and remaining persons engaged in other activities.

Soil Resource Mapping of Mathura District, Uttar Pradesh for Perspective Land Use Planning (1:50,000 scale)

S.K. Mahapatra, Jaya N. Surya, Tarsem Lal, G.S. Sidhu, J.P. Sharma and R.D. Sharma

Mathura district of Uttar Pradesh (27^{o}13’35’’ to 27^{o}57’24” N; 77^{o}16’35” to 77^{o}59’16”E) covering an area of 3303.84 sq km. The alluvium mainly of Yamuna river is continuous and conformable series of fluvial and alluvial deposits, mainly composed of unconsolidated beds of sand, silt and clay and their mixture in varying proportions, and also hillocks of Aravallis in patches. The district has been divided into 4 physiographic regions viz active flood plains, recent alluvial plains, old alluvial plains and Aravalli hills and further sub-divided into 10 physiographic units based on slopes and elevations. Soil resource inventory has been carried out on 1:50,000 scale and the map has been prepared. There were 20 series mapped into 35 soil series associations. The soils of the district belong to 2 Orders, 5 Suborders, 5 Great groups and 11 Soil Families. Inceptisols occupy nearly 79.6 % while Entisols cover 17.2% area. Ustepts occupy the major part of the district (68.0%) followed by Psamments (17.0%). Amongst the Great groups, Haplustepts occupy the largest area (68.0%) followed by Ustipsamments (17.0%) and Halaquepts (11.2%). Coarse-loamy soils occupy largest area followed by fine-loamy soils.

Nearly 70% lands are grouped into class II, 9% land into class III, 15 % into class IV and 0.2% into class VII. Soil salinity/sodicity, wetness and erosion are the major problems of the soil. Seventy eight per cent area is moderately suitable for irrigation while 18% is marginally suitable for irrigation owing to limitations of texture, sodicity, drainage and topography. Nearly 25% of the area is suitable for rice, 59% for wheat, 51% for maize, 54% for pigeon-pea, 81% for sugarcane, 72% for potato and 54% for mustard. Nearly 50% area is suitable for fruit crops like mango, guava, citrus, jujube (ber) and papaya. Most of the soils of the district are medium in organic carbon, available P and K content.

Nearly 26 % of the TGA are affected by salinity/sodicity and 12% from imperfect to poor drainage conditions. Nearly 10% area is susceptible to moderate to severe flooding in rainy season. Based on the soil and land qualities, land use plan has been suggested. About 39% area is suitable to all crops. Nearly 27% area is suitable to crops and also suitable to agro-forestry. About 3% area is suitable to salt tolerant crops while 11 % area is suitable for agri-horticulture/agri-floriculture. The vegetables may be grown in 10 % area. About 0.3% area may be encouraged for forestry/silvi-pasture.

Land resource inventory of East Lahing Gaon Panchayat of East Jorhat development block, Jorhat district, Assam (Sub project of land resource inventory for farm level planning in different agro-ecological regions of India)

S. Bandyopadhyay, S.K. Reza and Utpal Baruah

The study area (26^{o}49' to 26^{o}51' N, 94^{o}26' to 94^{o}30' E) cover an area of 760 ha in East Lahing Gaon Panchayat of East Jorhat Development Block, Jorhat district.

Farm level survey has been carried out using available village level cadastral maps (1: 4,000) in conjunction with Google Earth pictures. Four geomorphic units, viz., very gently sloping land (1-3% slope), nearly level plain (0-1% slope), upper terrace of Janzi river bank and flood plain have been identified associated with built-up, tea garden in very gently sloping land, tea garden in nearly level plain, rain-fed paddy in nearly level plain, rain-fed paddy in flood plain, bamboo plantation in upper terrace and currently fallow land with weeds and shrubs land use/cover features. There were five identified series (Seojipam, Changmai, Janzi, Panitola and Churamoni) and ten mapping units as phases of soil series (Table 1.10).

Poor management of farm resources limit the crop productivity. The availability of manpower is of major concern. The consumption of cereals and meat is relatively higher among marginal farmers than the small and medium farmers. In case of health and education, medium farmers pay out more than small and marginal farmers. Low productivity of paddy is also due to poor non-availability of improved rice varieties. The livestock comprise of small backyard non-descript type of animals. Small and marginal farmers do not venture for double cropping due to lack of irrigation facilities and high initial input costs. As a consequence, the net annual profit from farm for the marginal farmers is less than that of small and medium ones (Tables 1.11 and 1.12).

Table 1.10 Soil Series of the study area with different phases

Soil Series	Classification	Phases	Soil Mapping Units	Area in ha (% of TGA)
Seojipam	Fine loamy, mixed, hyperthermic Typic Hapludults	Loam	Sjp-l-d5-B-e2	45.7 (6.0)
Changmai	Fine loamy, mixed, hyperthermic Typic Dystrudepts	Sandy clay loam Sandy loam	Chm-scl-d5-A-e1 Chm-sl-d5-A-e1	89.2 (11.7) 117.7 (15.5)
Janzi	Fine loamy, mixed, hyperthermic Fluventic Dystrudepts	Loam Sandy loam	Jnz-l-d5-A-e1 Jnz-sl-d5-A-e1	18.3 (2.4) 104.8 (13.8)
Panitola	Fine loamy, mixed, hyperthermic Fluventic Eutrudepts	Sandy loam Loam Silt loam	Pnt-sl-d5-A-e1 Pnt-l-d5-A-e1 Pnt-sil-d5-A-e1	87.3 (11.5) 24.0 (3.1) 69.8 (9.2)
Churamoni	Fine silty, mixed,	Silt clay loam	Chr-sicl-d5-A-e1	27.7 (3.6)
	hyperthermic Fluvaquentic Eutrudepts	Silt loam	Chr-sil-d5-A-e1	107.3 (14.1)
		Built-up		46.9 (6.2)
		River & Streams		21.3 (2.8)
		Total		760 (100)

Table 1.11 Farming system appraisal

Major crops	Productivity (t/ha)	Net profit/ ha (Rs.)	Livestock assets (No. per households)	Category of Farmers	Households	Net Annual Farm Profit (Rs./ year)
Paddy (rain-fed)	2.32	13239	Cattle (cow + bullock): 3+1 or 2+2	Marginal	45	8833
Tea	0.86	40000	Goat: 5-6 Poultry: 15-20	Small	30	21376
			Duck: 15-12 Piggery: 1-2	Medium	15	43748

Table 1.12 Socio-economic appraisal

Category of farmers	Food consumption (kg/month)	Health (Rs./year)	Education (Rs./year)
Marginal (< 1 ha)	23.8	5000	2500
Small (1-2 ha)	19.1	9750	15750
Medium (2-10 ha)	17.1	12600	20,000

Land Resource Inventory of Katonigaon Panchayat of Titabar Block, Jorhat District (Part of Land Resource Inventory for Farm Planning in different Agro-ecological Regions of India)

S.K. Reza, S. Bandyopadhyay, A. Natarajan and Utpal Baruah

The Katonigaon Panchayat is located on the southwestern part of Jorhat district. The upper part of the area covers the foot hills of Naga hills. Major part of the area is covered by alluvium deposited by the river Brahmaputra and its tributaries. IRS P6 LISS-IV MX (83J/6SE, 83J/6NE and 83J/6NW) satellite imagery at 1:25,000 scale in conjunction with Survey of India Toposheet at 1:50,000 scale and Cadastral map at 1:4,000 scale were interpreted to identify the various land forms and land-use/land-cover pattern before traversing the area. Soil series, their extent and taxanomy has been shown in table 1.13.

Table 1.13 Soil series identified in the study area

Soil Series	Area (ha)	% of the total area	Soil Taxonomy
Nagajanka-1	14.00	2.95	Coarse-loamy, mixed, hyperthermic Fluventic Dystrudepts
Nagajanka-2	51.58	10.87	Coarse-loamy, mixed, hyperthermic Fluventic Eutrudepts
Nagajanka-3	89.90	18.93	Coarse-loamy, mixed, hyperthermicTypic Hapludults
Nagajanka-4	80.62	17.00	Coarse-loamy, mixed, hyperthermic Typic Dystrudepts
Bachabihari	171.00	36.00	Sandy, mixed, hyperthermic Udipsamments
Settlements	67.90	14.25	—

Study of crop moisture availability of soils during post - *kharif* period in Sibsagar district of Assam

Dipak Dutta, S.K. Reza and U. Baruah

Soil samples from 0-20, 20-40, 40-60, 60-80 and 80-100 cm depths were collected (1st phase) in the month of February from fifteen locations of the district under paddy-fallow system. Moisture content by gravimetric method (oven dry weight) has been measured. Estimation of moisture at different moisture tensions, namely 1/3, 1, 5 and 15 bar for two profiles using pressure plate apparatus has been accomplished. The soil moisture has been converted to volumetric soil moisture (m^3m^{-3}) using the respective bulk density (Mg/m^3) values.

The actual water content (w) is calculated as a depth of water by calculating the sum of the èv at each depth, multiplied by the depth of soil layer represented by that water content m^3 m^{-3}) and by subtracting the wilting level from the total. Thus, the available water (w) upto 80 cm depth are 966 and 11.0 cm for loamy and clayey soils respectively.

Soil Resource Inventory and Land Evaluation of Chittaurgarh district for Land Use Planning

T.P. Verma, J.D. Giri, R.S. Meena, R.K. Naitam and R.L. Shyampura

The project was undertaken to prepare soil resource inventory of Chittaurgarh district for land use planning on 1: 50,000 scale using geocoded merged data IRS 1D (PAN) and IRS P6 (LISS III). Imageries were visually interpreted in conjunction with SOI toposheet to delineate photomorphic units. Based on spectral signature (tone, texture, pattern), geology, slope and land use, four major physiograhic units were identified in the district which are Aravailli landscape, Eastern Rajasthan upland, Pathar and Bundelkhand (Vindhyan landscape) and Malwa plateau. These were further sub-divided into different landforms units. An area of about 90,000 ha in toposheet 45P/5 and 45P/9 of Rawatbhata tehsil have been surveyed and mapped at soil series association level. The soils are developed on gneiss, schist, phyllites and alluvium of Chambal river and its tributaries. After correlation, tentatively 40 soil series have been identified and described. Out of total series identified, 7 series belong to Aravalli landscape, 14 series in Eastern Rajasthan upland, 10 series to Pathar and Bundelkhand (Vindhyan landscape) and 9 series to Malwa plateau. The major series of the area on different physiographic units/ landforms are given in table 1.14.

Table 1.14 Dominant Soil Series in Chittaurgarh district (Rajasthan)

Soil series	Depth (cm)	Colour	Text. (Surface)	Slope (%)	Erosion	Calcareousnes - Soil	Taxonomy
			Soils of Aravali Land scape				
(a) Hilly terrain							
Umedpura	<25	5YR3/3, 3/4	sl	15-30/30-50	V. Severe	-	Lithic Ustorthents
(b) Pediment							
Dhokpani	25-50	5YR3/2, 3/3	sl	8-15/15-30	Severe	-	Lithic Ustorthents
(c) Intervening valley							
Kakra	25-50	7.5YR3/4, 3/3	scl	8-15/15-30	Severe	-	Lithic Ustorthents
Mawai	50-75	10YR3/2, 3/3	Scl	3-8	Moderate	-	Typic Haplustepts
(d) Plain							
Motiber	75-100	10YR3/2, 3/3	sl	3-8	Slight	-	Typic Haplustepts
Jambuvela	100-150	10YR3/4	sl	3-8	Moderate	-	Typic Haplustepts
			Soils of Eastern Rajasthan Upland				
(a) Dissected hill and ridges							
Borda	<25	7.5YR 3/4, 4/4	sl	15-30	V. Severe	-	Lithic Ustorthents
(b) Pediments							
Narsigarh	<50	10YR 5/3, 3-4	Sl	3-8	Moderate	Calcareous	Lithic Ustorthents
(c) Upland							
Bhadsora-b	50-75	10YR3/3, 4/4	scl/sl	3-8	Slight	Calcareous	Typic Haplustepts
(d) Dissected river valley							
Madanpura	<50	7.5YR3/4, 4/4	sl	3-8	Severe	Calcareous	Lithic Ustorthents
(e) Plain							
Daulatpura-d	75-100	10YR3/3, 3/2	cl	1-3	Slight	Calcareous	Vertic Haplustepts
Parliawas	100-150	10YR3/2, 2/1	c	<1	Slight	Calcareous	Sodic Haplusterts*
			Soils of Pathar and Bundelkhand Plateau				
(a) Hill with escarpments							
Sajanpura	<25	7.5YR3/4-4/4	sl	15-30	3/4	-	Lithic Ustorthents
(b) Plateau							
Ranchhorpura	<50	10YR3/4, 4/4	sl	3-8	Severe	-	Lithic Ustorthents
Pratappura	50-75	10YR3/2	cl	1-3	Moderate	Calcareous	Typic Haplustepts
Mainagar	50-75	10YR3/3, 3/4	sl	3-8	Moderate	-	Typic Haplustepts
(c) Intervening valley							
Chauhankhera	<50	10YR3/4	scl	3-8	Moderate	Calcareous	Lithic Haplustepts
Arniajosh	75-100	103/3, 3/4	sl- scl	1-3	1	Calcareous	Typic Haplustepts
(d) Plain							
Chaprol	100-150	10YR3/2, 2/2	c	1-3	1	Calcareous	Typic Haplusterts
Bacheri	100-150	10YR3/3, 3/2	cl	1-3	Slight	Calcareous	Typic Haplustepts
			Soils of Malwa Plateau				
(a) Hilly terrain with escarpments							
Achalpur	<50	5YR3/2-3/3	sl	8-15/15-30	3/4	Non calcareous	Lithic Ustorthents
(b) Plateau							
Dahvaliya	50-75	10YR3/2-3/3	c	3-8	Moderate to severe	Non calcareous	Typic Haplustepts
Mahurikhera	50-75	10YR3/2-2/2	c	3-8	Moderate to severe	Calcareous	Vertic Haplustepts
(c) Plateau Plain							
Gopalpura	75-100	10YR3/3-3/2	scl	1-3	Slight to moderate	Calcareous	Typic Haplustepts
Devgarh	100-150	10YR2/1-3/1	c	<1/1-3	Moderate	Calcareous	Typic Haplusterts

* moderate salinity

Land resource inventory for farm planning Jhalarapatan block of Jhalawar district in Rajasthan

R.S. Meena

Jhalarapatan block (24° 32' 10" N; 76° 10' 30" E) covers an area of 12,8167 ha. Forest cover is about 31.4% with a net sown area of 39.55%. Saline and non-cultivable land occupies 4.8 % area. The area lies in the south-east corner of Rajasthan at the edge of Malwa plateau with area of small hills and shallow plains. The climate of the block is dry with average annual rainfall of 883 mm and mean annual temperature of 25°C. The geology of area is of basalt, sandstone and shales with a band of limestone. The Kalisindh and Ahu are the main rivers of Jhalawar district. Though the block is hilly in parts, there are plains with fertile soils. The black soils developed from basalt floors are suitable for growing cotton, sorghum, maize, groundnut and sesame in *kharif* season and wheat, gram, opium, coriander, linseed and sugarcane in *rabi* season. The Jhalarapatan block has become a horticulture bowl for the production of good quality orange and mango. The major crops in *kharif* are soybean (38890 ha) and maize (6678 ha) and in *rabi* coriander (14369 ha) and wheat (10732 ha) followed by gram and fenugreek. The productivity of gram, fenugreek and coriander in the block is higher as compared to the district.

Land use planning of Chanavada II watershed for integrated development

R. Naitam and T.P. Verma

The project was undertaken to inventorize natural resources of the Chanavada micro watershed to identify the potential and constraint for optimization of land resources. The Chanavada micro-watershed (24°15' to 24°16' N; 73°35' to 73°40' E) of Upper Soam (5E3A8) is located in Girwa tehsil of Udaipur district of Rajasthan state and lies between The elevation of the area ranges from 439 to 642 m above MSL. The climate of the area is tropical semi-arid characterized by hot summer and intense winter. The average rainfall is 650 mm and it ranges from 600 to 800 mm. The mean annual temperature is 24°C while the minimum and maximum temperature varies between 10° to 40°C. Geologically the Aravalli system is derived from argillaceous deposits, composed of slates, phyllites and mica-schist along with granite and quartzite. The natural vegetation of the area is tropical dry deciduous type forest. The present land utilization is agriculture in 4.32% (63.72 ha) whereas rest of the area is non-arable. The major crops grown in the *kharif* season are sorghum, maize, sesame, clusterbean and other beans whereas rice is grown in patches in valleys portion. The crops grown in the *rabi* season on the residual soil moisture are gram, clusterbean and wheat in patches.

The boundary of the watershed is delineated following the drainage divide. The drainage map of the watershed is derived from the Survey of India Toposheet No. 45 H/11 by digitizing the drainage using Arc GIS software Ver. 9.3.1 and latter updated using satellite data of IRS P6 LISS IV of two seasons i.e. Oct. 2007 and March 2008. Chanavada watershed is elongated in shape with a perimeter of 21.84 km covering total geographical area of 1475 ha. It has maximum width of 2.12 km in the North West direction and a maximum length of 7.97 km in the east to west direction. The area is mainly drained by three streams originating from the upper reaches of the hills and finally joining the main stream.

Land evaluation and land use planning: farm/ watershed/district/region/state/country : Cluster of 10 villages in Bhadesar tehsil, Chittaurgarh district

T.P. Verma and R.S. Singh

The detailed survey was carried out in cluster of 10 villages of Bhadesar tehsil for preparation of land resource inventory on 1:12,500 scale for farm planning. Field study was conducted using information from IRS ID PAN and IRS P6 LISS III merged geo-coded data along with Survey of India Toposheet on 1:50,000 scale and using base map (cadastral map) on 1:4000 scale. Out of the 10 villages, mapping of seven villages (Bhadsora, Bagund, Gudha, Madanpura, Narbadia, Nardari and Parliyawas) covering an area of 4032 ha has been completed. Three major landform units viz. gently to undulating land with hillocks (subdued hills and pediment), upland and plain have been delineated which has been further sub-divided into different landforms based on slope, tone, texture. In the villages, 14 soil series has been mapped into 29 units. The salient characteristics of soil series and physical-chemical properties of major soil series are presented in tables 1.15 and 1.16, respectively.

Table 1.15 Description of soil series in cluster of 10 villages in Bhadesar tehsil

Soil series	Depth (cm)	Colour(Moist)	PSC	Surface texture	Surface stoniness (%)/ salinity-sodicty	Present land use	Taxonomy
Gently to undulating land with hillocks : (a) moderately sloping subdued hill							
Madanpura	<25cm	7.5YR4/4,4/3	Lsk	scl	60-70	Barren/pasture	Lithic Ustorthents
Gently to undulating land-pediments							
Daulatpura-a	25-50	10YR4/4, 7.5YR3/4,4/4	Lsk	l	35-40	Pasture/barren	Lithic Ustorthents
Daulatpura-b	50-75	10YR4/4, 7.5YR3/4	Lsk	sl	40-50	Sorghum	Typic Ustorthents
Gently sloping upland							
Bhadsora-a	25-50	10YR3/3 to 4/3	Lsk	cl	35-40	Maize	Lithic Haplustepts
Bagund-a	25-50	10YR3/3 to 3/4	L	l	20-25	Maize, wheat, mustard	Lithic Haplustepts
Narbadia-a	25-50	10YR3/3 to 3/2	C	cl	15-20	Pasture/maize	Lithic Haplustepts
Bhadsora-b	50-75	10YR4/4 to 3/4	Fl	sl	-	Maize, soyabean	Typic Haplustepts
Nearly level to gently sloping plain							
Daulatpura-c	50-75	10YR3/3, 3/2	F	cl	-	Maize, soyabean	Typic Haplustepts
Nardari-a	50-75	10YR4/4	F	cl	-	Maize, sorghum, groundnut, soyabean	Vertic Haplustepts
Nardari-b	75-100	10YR3/3, 3/2	F	sil	-	maize	Typic Haplustepts
Daulatura-d	75-100	10YR3/3, 3/2	F	cl	-	Maize, wheat, mustard	Vertic Haplustepts
Gudha	100-110	10YR4/3, 3/2	Fl over Fs	scl	S1N2	Maize, wheat, mustard	Typic Haplustepts
Narbadia-b	100-150	10YR3/3, 3/2	Fl	l	S1N2	Maize, wheat, mustard	Calcic Haplustepts
Paraliyawas	100-150	10YR3/2, 2/2	F	l	S2N2	Maize, wheat/pasture	Sodic Haplusterts

Lsk- Loamy-skeletal, L- Loamy, C- Clayey, Fl- Fine-loamy, F- Fine, Fs- Fine-silty

Table 1.16 Physical and chemical properties of major soil series of Bhadesar Tehsil

Horizon	Depth (cm)	Particle-size distribution(%)			pH (1:2.5)	EC (1:2.5)	$CaCO_3$ (%)	O.C. (%)	Available Nutrients (Kg ha^{-1})		
		Sand	Silt	Clay					N	P_2O5	K_2O
					Madanpura						
A	0-12	49.0	23.6	27.4	8.8	0.13	7	0.46	95	8	113
					Daulatpura-a						
A	0-10	46.0	32.0	22.0	8.1	0.19	4	0.65	138	6	93
Ck	10-20	51.9	29.0	19.1	8.2	0.18	15	0.42	124	4	72
					Bagund-a						
Ap	0-15	31.5	41.4	27.1	7.6	0.80	6	0.90	152	20	221
Bw	15-45	26.6	39.9	33.5	8.2	0.31	10	0.78	145	10	130
					Bhadsora-b						
Ap	0-16	56.2	25.1	18.7	6.8	0.11	1	0.43	138	6	161
Bw1	16-37	50.3	24.9	24.8	7.5	0.06	2	0.40	124	2	175
BC	37-65	60.5	20.0	19.5	7.4	0.10	1	0.35	110	2	100
					Daulatpura-c						
Ap	0-12	31.4	35.5	33.1	7.7	0.18	2	0.75	152	14	250
Bw1	12-35	27.6	34.1	38.3	7.8	0.25	2	0.69	125	6	250
Bw2	35-46	25.8	34.1	40.1	7.5	0.17	4	0.66	124	4	231
BCk	46-70	32.4	32.4	35.2	8.5	0.06	24	0.54	110	4	183
					Daulatpura-d						
Ap	0-12	30.9	39.1	30.0	8.1	0.26	4	0.98	138	22	208
Bw1	12-30	31.1	37.6	31.3	8.2	0.20	4	0.96	131	16	189
Bw2	30-55	25.3	33.2	41.5	8.4	0.17	4	0.68	110	2	175
BC	55-80	28.4	28.4	43.2	8.4	0.16	6	0.47	100	2	193

Land resource Atlas of Vidarbha region of Maharashtra

C. Mandal, Dipak Sarkar, D.K. Mandal, S.N. Goswami and Pushpanjali

The project was initiated by NBSS&LUP to prepare a scientific document of natural resource availability of Vidarbha region and their scientific utilization on sustainable basis. The available information on soils of Maharashtra on (1:250,000 scales) was used as a base for the Atlas. The Vidarbha region has 11 districts with an area of 97 lakhs hectares covering 31.6% of TGA of Maharashtra. Despite of the fact that the Vidarbha region falls under assured rainfall zone and abundant natural resources, the region has been termed as backward region of Maharashtra in terms of poverty, illiteracy, per capital income, industrial growth, health care and human resource index. The Atlas contain the following broad chapters like administrative set-up and people; the land, water and climate features; socio-economic status; soils and interpretative maps; agriculture and livestock status; crop suitability and other important issues.

Fifty three maps were prepared on different themes and interpretation for each map for practical applicability. The Atlas was formally released by Vice chancellor PDKV in ISALUP conference on 8th October 2010. The final printing of Atlas is under progress. The sample map theme (Fig. 1.21) shows that vast area of Vidarbha region is suitable for orange.

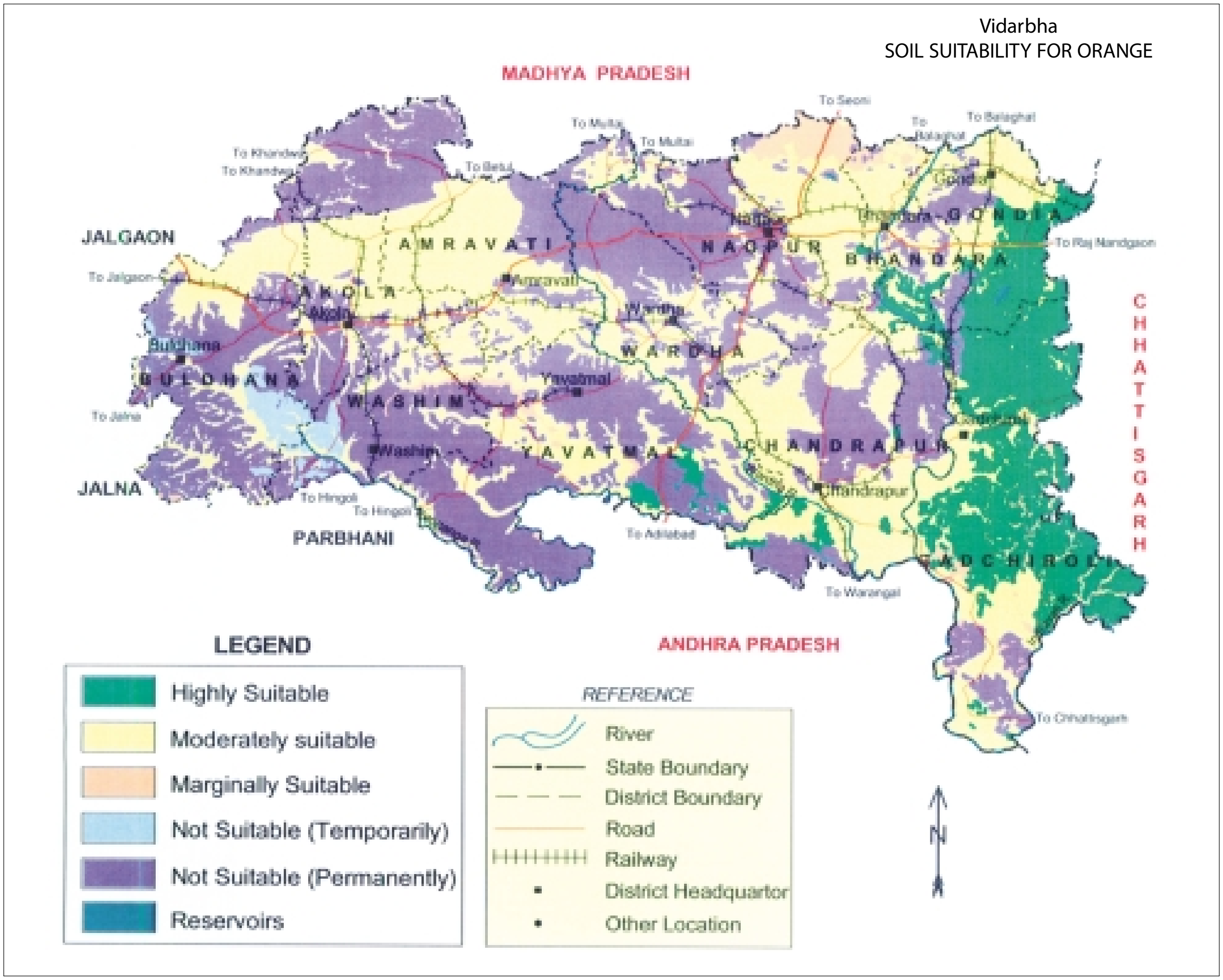


Fig. 1.21 Theme map showing the soil suitability for orange

Land resource inventory for farm planning in Parseoni mandal of Parseoni taluka, Nagpur District, Maharashtra

Pushpanjali, K. Karthikeyan, C. Mandal, Jagdish Prasad, J.D. Giri and Malathi Bommidi

To provide the required site-specific database suitable for farm level planning, this project is taken up as a pilot study in Parseoni mandal of Parseoni taluka, Nagpur district, Maharashtra. Total area of Parseoni mandal is 16,493 ha. The area falls under AESR 10.2 and the mean annual rainfall ranges between 1000-1300mm. Base Map has been prepared with the help of Google Earth, Survey of India toposheet (1:50,000) and cadastral maps to identify the broad landforms and physiographic units occurring in the area and for verifying village boundaries. Parseoni mandal comprises of 31 villages out of which two villages were surveyed (1,345 ha.) with an idea to standardize the field methodology for soil mapping at cadastral level for whole mandal. Sixty seven profiles were studied and four tentative soil series has been identified. Based on the soil data different theme maps have been generated. The pH map generated by Iwd method.

Reconnaissance soil survey in Yavatmal district

B.P. Bhaskar, M.S. Gaikwad, S.V. Bobade, A.M. Nimkar, S.S. Gaikwad, V.N. Parhad and K.M. Gaikwad

The project is aimed to generate land and soil resource inventory for suitable agricultural and other planning. The delineation of landform involves study of soil profiles, soil classification and correlation, soil–physiography relationship for soil map generation, laboratory characterization, soil survey interpretations and generation of thematic maps.

The district has dominant rocks of Deccan Traps (basalt) and rocks belonging to the Gondwana system (shales, slates, limestone, and sandstones) in south eastern half of Wani taluka. Fourteen land units were delineated such as hills and ridges, Isolated hills/elongated hill, mesa and butte, upper plateaus, escarpments, upper pediplains, middle plateaus, lower plateaus, lower pediplains, gently to moderately sloping alluvial plains, very gently sloping to gently sloping plains, flood plains and stony gravelly waste. The plateaus occupy 38.7% followed by hills and ridges (24.52%), pediplains (20.54%), alluvial plains (4.62%) and stony gullied lands (1.45%).

Twenty two land use units identified with IRSP6 satellite imageries of April and May, 2007. Broadly these are further grouped into forestlands (19%), cultivated lands and barren rocky and coal mining lands (11%).

The distinct variations in sand, silt and clay has been observed. The sand content less than 5% is recorded in Apti, Chanoda, Dhanki, Hirdi, Kalambi, Penganga, Selodi and Wanodi series whereas silt content more than 40 % in seven series namely Arni, Dhanora, Kalamb, Loni, Ralegaon, Saykheda and Sindola and more than 60% of clay in Apti, Chanoda, Dhanki, Hirdi, Lakhi and Penganga. The clay soils have high available water holding capacity of 12 to 20% in deep black soils but reduced to 7% in shallow red and black soils. These soils are slightly to moderately alkaline with low organic carbon and high calcium carbonate content. These soils have high cation exchange capacity (38 to 72 cmol kg^{-1}) with an exchangeable magnesium per cent (EMP) of 11 to 21 % and exchangeable sodium per cent (ESP) of 0.87 to 11%.

The soil map is prepared showing 48 soil mapping units. The mapping units were evaluated and grouped into four land capability classes for annual crops and five capability classes for perennial crops. The district has 2.2 per cent of excellent land for perennials and 4.2 per cent for annual crops. More than 52 per cent of area is evaluated as very suitable for cotton.

Thirty seven per cent of area is suitable for cotton based cropping systems as against the current area of more than 50% where as 29% is suitable for cereal based cropping systems as against the 34% (Table 1.17).

Table 1.17 Soil-site suitability for different crop combinations

S. No.	Suitable crop combinations								Area (ha)	%
1.	Cotton	Sorghum	Wheat	Soybean	Redgram	Gram	Ground nut		48868	3.6
2.	Cotton	Sorghum	Wheat	Soybean	Gram	Groundnut			211562	15.56
3.	Cotton	Sorghum	Wheat	Soybean	Redgram	Gram			8382	0.61
4.	Cotton	Sorghum	Wheat	Soybean	Groundnut				31206	2.29
								Total	300018	22.06
5.	Cotton	Maize	Sorghum	Wheat	Soybean	Redgram	Gram	Ground nut	49263.7	3.62
6.	Cotton	Sorghum	Wheat	Redgram	Gram	Groundnut			19811	1.46
7.	Cotton	Sorghum	Wheat	Redgram	Gram				167055	12.3
8.	Cotton	Sorghum	Wheat	Groundnut					47051	3.46
								Total	233917	17.22
9.	Cotton	Maize	Sorghum	Wheat	Redgram	Gram	Ground nut		53684	3.94
10.	Cotton	Maize	Sorghum	Wheat	Groundnut				4093.6	0.3
								Total	57777.8	4.24
11.	Sorghum	Wheat						Total	348605	25.64
12.	Sorghum	Wheat	Soybean	Groundnut					33663	2.48
13.	Sorghum	Wheat	Soybean	Redgram					8600.6	0.62
								Total	42263.5	3.1

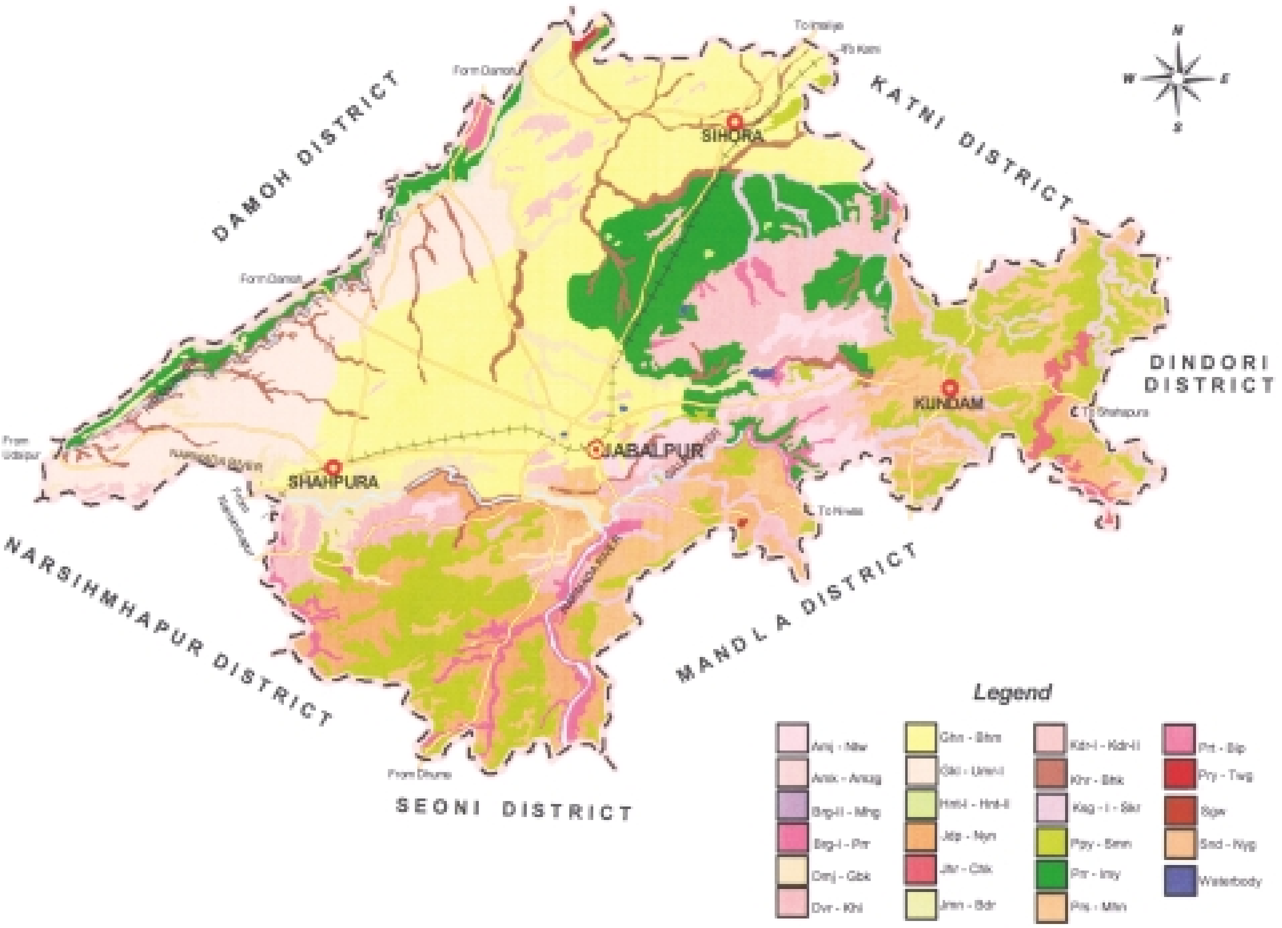
Reconnaissance soil survey, mapping and classification of soils of Jabalpur district, Madhya Pradesh

Jagdish Prasad, A.M. Nimkar, S.S. Gaikwad and C. Mandal

The objective of project to inventorise the land/soil resources of the Jabalpur district for sustainable planning. Jabalpur district (Mahakaushal region) falling in AESR 10.1 with TGA of 519700 ha is situated between 22°49' to 24°81' N and 78°21' to 80°50' E. Physiographically the district admits of division into 5 natural regions. The 'haveli' (seasonally impounded) consist of the south-western portion including Patan and Panagar and part of Sihora tehsils of comprising black soil (Granary of district) with its embanked fields. The southern portion of Jabalpur tehsil is covered by Deccan trap. The soils are frequently inferior but good black soils also occur below the Narmada and Khamaria circle. To the north of the trap, area is characterised by low ridges of metamorphic rocks. The eastern part is watered by Mahanadi and its affluent Katni is an open trap with good soils. The principal mountain systems of the district are the Bhander and Kymore both offshoots of Vindhyas, the Bhitrigarh and spurs of Satpuras. The Narmada and its tributaries, Hiran and Gaur drain the southern part of portion of the district. Despite blessed with varied geology, majority of soils show shrink-swell properties.

In general district receives 1351.7 mm rainfall of which 1201mm through south-west monsoon. The cultivated area comprises of 274800ha, forest 78000 ha, land under non- agricultural use 32100ha, permanent pastures 39900ha, cultivable wasteland 24600ha, land under miscellaneous trees, crops and groves 100ha, barren and uncultivable land 36800ha, current fallows 16900ha and other fallows 16800ha with a cropping intensity of 137.1. The 22 physiographic units have been mapped through 42 soils series (21 soil series association) belonging to Inceptisols (305781.8ha; 58.3%), Vertisols (122291.3ha; 23.53%), Entisols (63577.44ha; 12.23%) and Alfisols (26314.08ha; 5.06%) including miscellaneous area of 1735.4 ha that is 0.35% (Fig. 1.22). The thematic maps of physiography, soil, erosion, organic carbon (%), pH, available N, P, K, DTPA-Zn have been prepared in GIS environment. The forest mainly of Bamboo and part of cultivated land sequester higher organic carbon (0-20 cm) and (0-100 cm) and available Zn was also higher.

SOIL
Jabalpur district



Soil series association	Subgroup Association	Soil series association	Subgroup Association
Amj – Ntw	Typic Haplustepts- Typic Haplusterts	Jmn-Bdr	Lithic Ustorthents-Lithic Ustorthents
Amk-Amzg	Typic Ustorthents-Vertic Haplustepts	Kdr-I-Kdr-II	Lithic Ustorthents- Haplustepts
Brg-II – Mhg	Lithic Usorthents-Typic Ustorthents	Khr-Bhk	Vertic Haplustepts-Vertic Haplustepts
Brg-I –Prr	Vertic Haplustepts-Vertic Haplustepts	Ksg-Skr	Vertic Ustifluvents-Vertic Haplustepts
Dmjj-Gbk	Vertic Haplustepts –Vertic Haplustepts	Pry-Smn	Lithic Ustorthents- Lithic Ustorthents
Dvr-Khi	Vertic Haplustepts- Typic Haplusterts	Prr-Imy	Typic Haplusterts-Vertic Haplustepts
Ghn-Bhm	Typic Haplusterts-Vertic Haplustepts	Prs-Mhn	Lithic Ustorthents-Lithic Haplustepts
Gkl-Umr-I	Vertic Haplustepts-Typic Haplusterts	Prt-Bip	Typic Haplustepts-Vertic Endoaquepts
Hnt-I-Hnt-II	Lithic Ustorthents-Typic Haplustepts	Pry-Twg	Fluventic Haplustepts- Typic Haplustepts
Jdp-Nyn	Typic Haplusterts- Vertic Haplustepts	Snd-Nyg	Vertic Haplustepts-Vertic Haplustepts
Jhr-Chk	Vertic Haplustepts-Vertic Haplustepts	Sgw	Skeletal and gravelly wasteland

Fig. 1.22 Soil Map of Jabalpur district

Detailed resource soil survey of Hayatnagar research farm of CRIDA, Hyderabad

P. Chandran, S.K. Ray, P. Raja, A.M. Nimkar, D.K. Pal, T. Bhattacharyya, C. Mandal, M.S.S. Nagaraju and Dipak Sarkar

The detailed soil survey of farm was carried out on 1:5000 scale with the IKONOS imagery received from CRIDA. The field work and laboratory analysis of the soil samples of 20 representative series has been completed (Fig. 1.23). The soil map has been finalized with 89 soil units and farm was mapped. The majority of the soils are slightly acidic to neutral in reaction with an exception of few series which are alkaline. The maps for different themes such as slope, erosion, depth, soil pH, bulk density, organic carbon, micronutrients etc has been prepared and write up of the report is in progress. The study indicates that the organic carbon of these soils is low (0.1 to 0.8%). The total carbon in the surface soils (0-30 cm) varies from 0.33 to 1.87% indicating the presence of inorganic carbon in the soils. Many soils do not show effervescence in the field. However, laboratory analysis indicated presence of $CaCO_3$. Among the micronutrient Zn in the surface samples (0-15 cm) is < 1 ppm indicating its deficiency. But Fe (> 5.8 ppm), Cu (> 0.5 ppm) and Mn (> 4 ppm) are all found to be in adequate amount in these soils. Available K content of the soils varies from 166 to 470 kg ha^{-1} suggesting medium to high content of available K (Fig. 1.24).

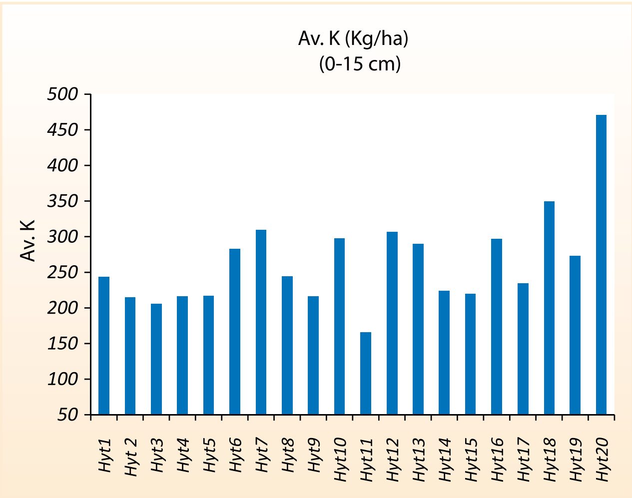


Fig. 1.24 Available K status in different soil series of the Hayatnagar Research Farm, CRIDA, Hyderabad (0-15 cm soil depth)

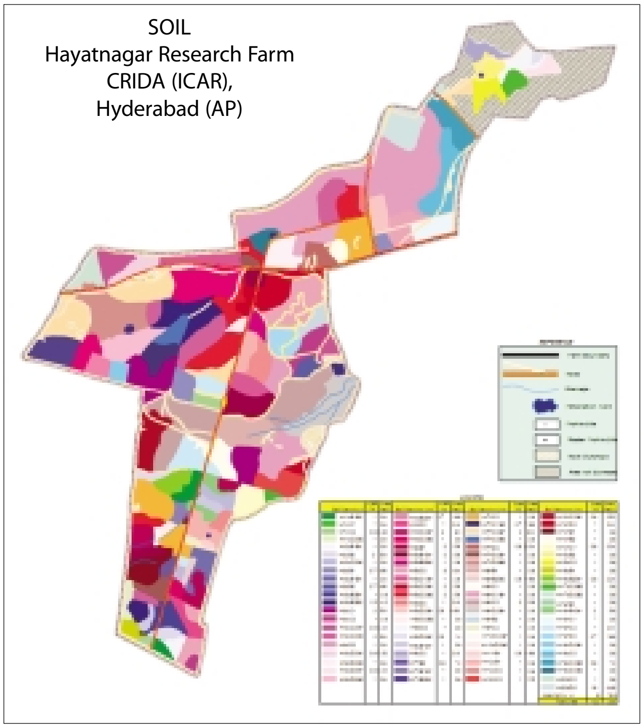


Fig. 1.23 Soil map of Hayatnagar Farm, CRIDA (ICAR), Hyderabad (AP)

Correlation of soil series of India

T. Bhattacharyya, P. Chandran, Jagdish Prasad, B.P. Bhaskar, S.K. Ray, R. Srivastava, J.D. Giri, L.G.K. Naidu, A. Natarajan, K.M. Nair, G.S. Sidhu, S.K. Mahapatra, C.S. Walia, U. Baruah, S.K. Reza, S.K. Singh, D.C. Nayak, K. Das, A.K. Sahoo, D. Dutta, R.S. Singh, T.P. Verma, R.S. Meena

Soil correlation is one of the mandated activity of the Bureau. This activity is being carried out with the active participation of all the regional centres of Bureau and the Headquarter. The major objective of this project is to establish new soil series in each state and union territory of the country after correlating with the existing series and update the information in the national register. During the period under report, a series of soil correlation meetings were held both at headquarter and regional centres. In these meetings, discussions were held to finalize soil series of the states wherein district survey on 1:50000 scales were completed and reports were finalized. Discussions were also held with The Chief Soil Survey Officer of Soil and Land Use Survey of India (SLUSI) to finalize some of the identified soil series documented by the SLUSI. They were requested to send these soil series to NBSS & LUP, Nagpur for final correlation at the national level.

During the year under report, 12 soil series were finalized and given the status of established soil series and these series were entered into National Soil Series Register from the states of Himachal Pradesh, Rajasthan, Punjab, Assam and Goa table 1.18. Thus the total number of soil series in the National register is has become 265.

Preparation of soil resource inventory of coastal salt affected areas of West Bengal and Orissa using satellite imagery and characteristics and classification of the soils to determine their potentials, problems and management

K.D. Sah, Dipak Sarkar, A.K. Sahoo and S.K. Singh

Reconnaissance soil survey (1:50,000 scale) of 1, 20,000 ha area in coastal plain of East Medinipur district, West Bengal was carried out using IRS-LISS-P6 data. The nearly level plains under rice-fallow system showed dark reddish tone with dull white patches whereas similar landform under rice-rice system was identified with light pink tone and whitish patches. Very gently sloping plains under rice-fallow system was marked with dark reddish tone and black patches. Similar landscape under multiple cropping systems was delineated with light pink tone and bluish patches. Wet lands under paddy- fisheries system were noted with bluish tone and dark patches (Fig. 1.25). Soil-physiography relationship of the area is presented in table 1.19.

Sub-physiographic zone	Image characteristics
BCP 1	Dark reddish tone with dull white patches
BCP 2	Light pink tone with whitish patches
BCP 3	Dark reddish tone with black patches
BCP 4	Light pink tone with bluish patches
BCP 5	Bluish tone with dark patches

B – Bengal, C- Coastal, P- Plains;
1–Rice-fallow; 2-Rice-rice; 3–Plantation; 4–Multiple cropping; 5- Rice +fisheries

Fig. 1.25 Image characteristics of different physiographic units

Table 1.18 Soil series entered into the National register during the year

Sl No.	State	Series No	Name of Series	Classification
1	Himachal Pradesh (4)	254	Bhager	Dystric Eutrudepts
		255	Hatwar	Dystric Eutrudepts
		256	Kelol	Dystric Eutrudepts
		257	Rajpura	Typic Eutrudepts
2	Rajasthan (2)	258	Atoli	Sodic Haplusterts
		259	Nayagoan	Typic Haplusterts
3	Punjab (2)	260	Jassi Pauwali	Aridic Haplustept
		261	Jodhpur Ramana	Aridic Haplustalfs.
4	Assam (2)	262	Netravali	Rhodic Kanhaplustalfs
		263	Torse	Lithic Haplustepts
5	Goa (2)	264	Mathurapur	Oxyaquic Dystrudepts.
		265	Bhuyabasti	Rupti-Alfic Eutrudepts.

Table 1.19 Soil-physiography relationship in coastal plains of West Bengal

Image characteristics	Nearly level plains		Very gently sloping plains		
	Rice-fallow	Rice-rice	Rice-fallow	Rice-rice	Rice+ fisheries
	Dark reddish tone with dull white patches	Light pink tone with whitish patches	Dark reddish tone with black patches	Light pink tone with bluish patches	Bluish tone with dark patches
Morphological properties					
Soil colour					
Surface	Light reddish brown to reddish brown	Pale olive to dark grayish brown	Dark grayish brown to very dark grayish brown	olive	Dark grayish brown
Control section	Reddish brown	Olive to dark gray	Dark gray to olive gray	Grayish brown to dark grayish brown	Dark gray to dark grayish brown
Mottles	Yellow to dark yellowish brown	Yellow to yellowish brown	Yellow to brownish yellow	Light olive brown to olive yellow	Light olive brown to olive yellow
Texture					
Surface	Clay loam to silty clay loam	Silty clay loam to clay	Silty clay loam to silty clay	Loam to sandy clay loam	Silty clay to silty clay loam
Control section	Silty clay loam to silty clay	Silty clay loam to silty clay	Silty clay to silt loam	Sandy loam to sandy clay loam	Silty clay
Horizon sequence	Ap-Bw-Bw(g)	Ap-Bw(g)	Ap-Bw-Bw(g)	Ap-A(g)	Ap-Bw-Bw(g)
Identified soil series	Gazipur	Khrigaria	Akubpur	Sijabpur	Gurgram

Generation of soil information data base of IARI Farm (Collaborative Research Project with IARI, New Delhi)

S.K. Mahapatra and G.S. Sidhu

Detailed Soil Survey of the IARI Farm has been initiated in March 2011 using 1:4,000 scale base maps. On the basis of morphological characteristics of the soils, the following five soil series have been identified.

Pusa-1: Very deep, well drained, brown to dark yellowish brown, sandy loam soils on nearly level (0 to 1 % slope) old alluvial plain with sandy loam surface and very slight erosion (Coarse loamy, mixed, hyperthermic Typic Haplustepts.

Pusa-2: Very deep, well drained, brown to dark yellowish brown, calcareous, sandy loam soils on nearly level (0 to 1 % slope) old alluvial plain with sandy loam surface and very slight erosion (Coarse-loamy, mixed (calc.), hyperthermic Typic Haplustepts.

Pusa-3: Very deep, well drained, brown to dark yellowish brown, calcareous, sandy loam soils on nearly level (0 to 1 % slope) old alluvial plain with sandy loam surface and very slight erosion. Many calcretes were observed after 100 cm. (Coarse-loamy, mixed (calc.), hyperthermic Typic Haplustepts).

Pusa-4: Very deep, well drained, brown to dark yellowish brown, calcareous, sandy loam to loam / clay loam soils on nearly level (0 to 1 % slope) old alluvial plain with sandy loam to loam surface and very slight erosion (Fine loamy over coarse loamy, mixed (calc.), hyperthermic, Typic Haplustepts).

Pusa-5: Very deep, well drained, brown to dark yellowish brown, loamy sand to sandy loam soils on nearly level (0 to 1 % slope) old alluvial plain with sandy loam surface and very slight erosion (Coarse-loamy over sandy, mixed, hyperthermic Fluventic Haplustepts).

Soils of Thirupuram, Kanjramkulam and Kadinanamkklam Panchayats of Thiruvananthapuram district, Kerala

K.M. Nair, S. Thayalan, K.S. Anil Kumar, L.G.K. Naidu and Dipak Sarkar

The project was taken to carry out a detailed study of soils of three panchayats of Thiruvananthapuram district viz., Thirupuram, Kanjiramkulam and Kadinamkulam covering nearly 3415 ha. These panchayats form a window for characterizing typical area of coconut production, source for experimental material (coconut fiber) of the NAIP sub-project Component II.

The soils of the area, developed under humid tropical climate, exhibited typical features of laterite soils (red color, acidic soil pH, very low cation exchange capacity). Unlike the laterite soils of the rest of the state, the soils of the area are conspicuous by the absence of iron-rich gravel. Based on physiography-soil relationship four soil series were identified and mapped in the area (Fig. 1.26). The salient characteristics of soils are briefly described below.

Neyyattinkara series: Very deep, well drained, red clay soils on very gently and gently sloping uplands of Thirupuram and Kanjiramkulam panchayats.

Kanjiramkulam series: Moderately deep, well drained, dark yellowish brown, clay soils on gentle to moderate side slopes of the uplands including eroded surfaces of Thirupuram and Kanjiramkulam panchayats.

Poovar series: Very deep, imperfectly drained, dark yellowish brown, clay soils on nearly level valleys of Thirupuram and Kanjiramkulam panchayats.

Kadinamkulam series: Very deep, well drained, light yellowish brown, sandy soils of uplands of Kadinamkulam panchayat.

The spatial distribution of the soils has been delineated in the panchayats as phases of the soil series (Figs. 1.27, 1.28 and 1.29).

Soil fertility in the area was assessed by collection of surface soils randomly from all over the panchayats and analyzing them for soil reaction and available content of macro- and micro-nutrients. Soil pH varied from very strongly acid to near neutral and most samples from Kadinamkulam sands were strongly acid. More than seventy per cent samples were deficient in plant available nitrogen. Nearly seventy five per cent samples were adequate in plant available phosphorus. About seventy five per cent samples were deficient in potassium; many samples with extremely low levels. Secondary nutrients calcium and magnesium are likely to be deficient in the strongly acid soils. Deficiency of micro-nutrients, copper, zinc is widespread. Boron was deficient in few samples. Manganese was found to be deficient in many samples from coastal sandy soils of Kadinamkulam.

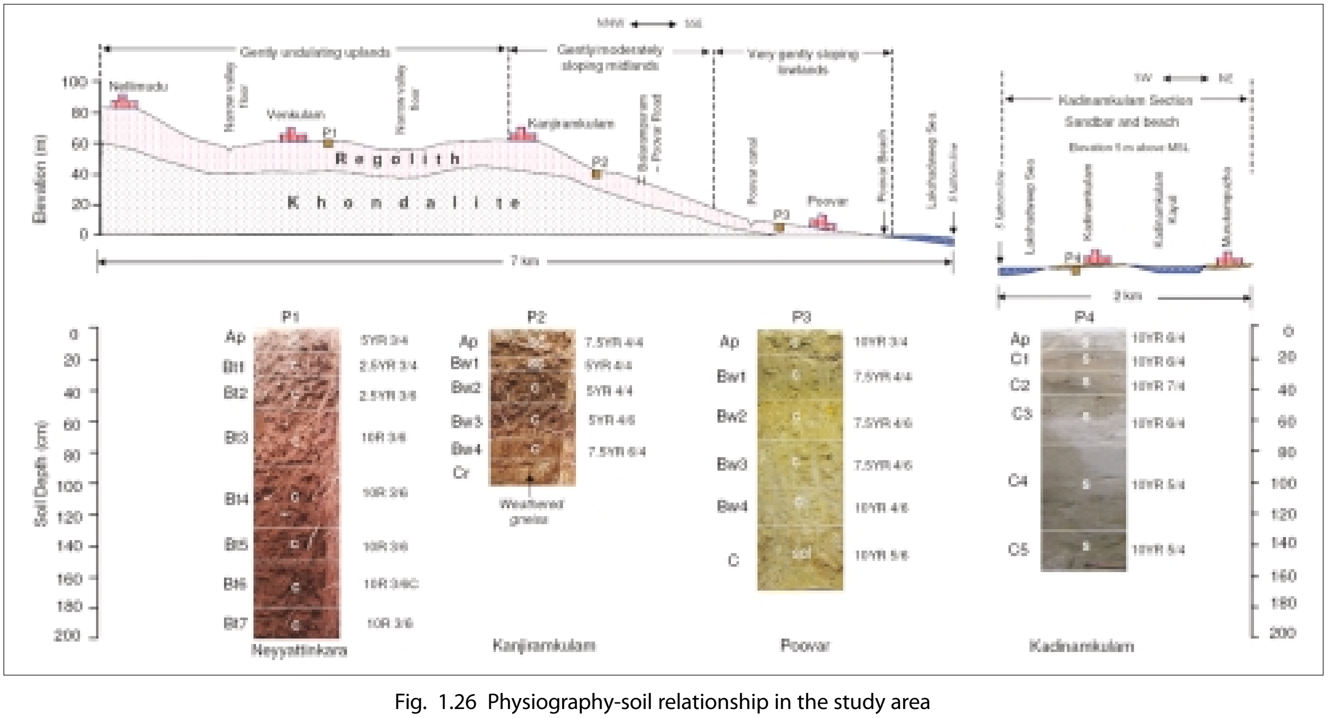


Fig. 1.26 Physiography-soil relationship in the study area

Fig. 1.27 Spatial distribution of soils in Kanjiramkulam panchayat

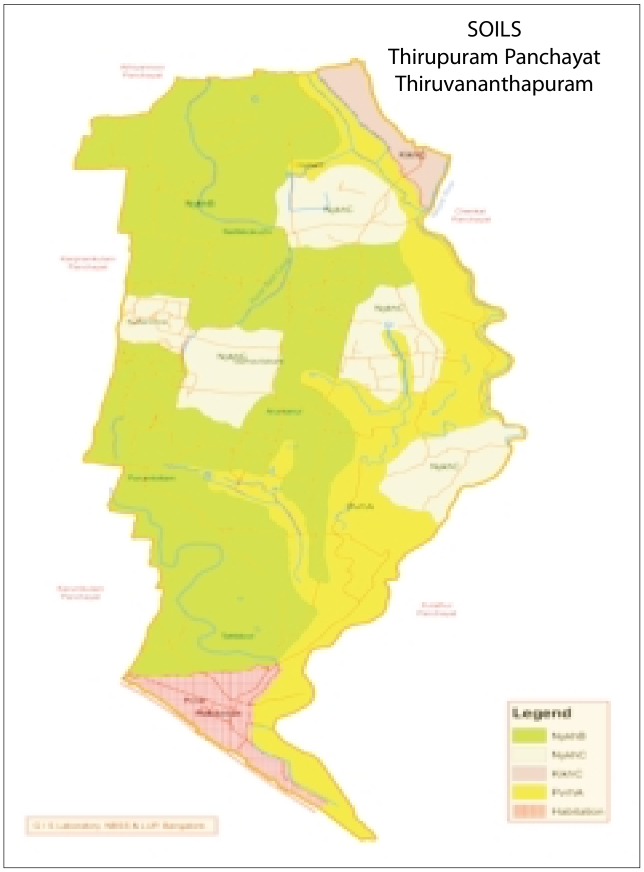


Fig. 1.28 Spatial distribution of soils in Thirupuram Panchayat

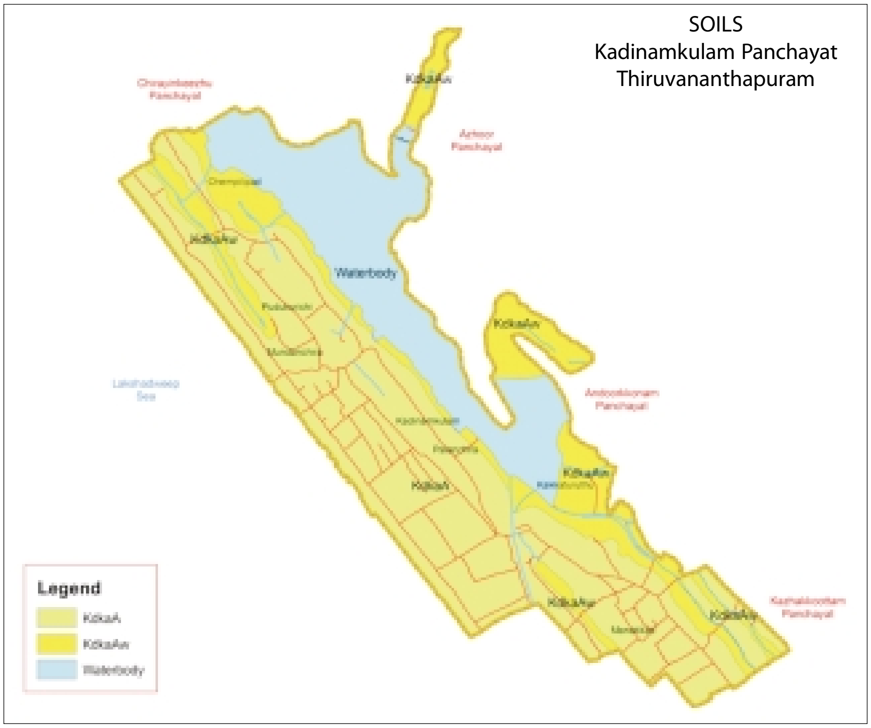


Fig. 1.29 Spatial distribution of soils in Kadinamkulam panchayat

2.2

Remote Sensing, GIS and Cartography

Remote Sensing and its application

Digital database and thematic mapping

Soil based approach towards rational land use planning using Remote Sensing and GIS

S. Mukhopadhyay and T. Banerjee

The study area encompasses Raipur and Ranibandh blocks in Khatra sub-division of the Bankura district with an area of 827 km^2. The interpretation of satellite imageries indicated seven physiographic units viz. denuded hills and crests, dissected pediment, undulating pediment plain, isolated hillocks, valley fill, upper alluvial plain (older) and lower alluvial plain (younger). Land use and land cover map indicated that agriculture is the main land use followed by forest, culturable waste and plantations (Table 2.1). The overall productivity of the soils (Fig. 2.1) of the area was generated through multi-variate analysis of all the productivity indices consisting of Land productivity index (Storie Index), Soil productivity index (Riquier model) and Land capability classification (LCC). Multi-variate analysis indicated that very good and good land together constituted 35% of the total area, whereas moderately good and average land occupied an area of 34%. Remaining 31% area, comprising hills, pediment and laterite caps were rated as area not fit for agriculture and may be considered as area having potential for developing forestry and plantations (Table 2.2).

Table 2.1 Area under different land use in Raipur and Ranibandh blocks

Landuse	Area (Sq. km)	% of TGA	Cumulative %
Kharif	438.5	52.97	52.97
Kharif & Boro	22	2.66	55.62
Kharif & Rabi	8.1	0.98	56.60
Culturable waste and fallow	102	12.32	68.92
Plantation	7.85	0.95	69.87
Forest	162	19.57	89.44
Stony Waste	11.7	1.41	90.78
Gullied & bad land	11.6	1.40	92.18
Miscellaneous (habitat, water bodies etc)	64.15	7.75	100.00
Total	827.9	100.00	

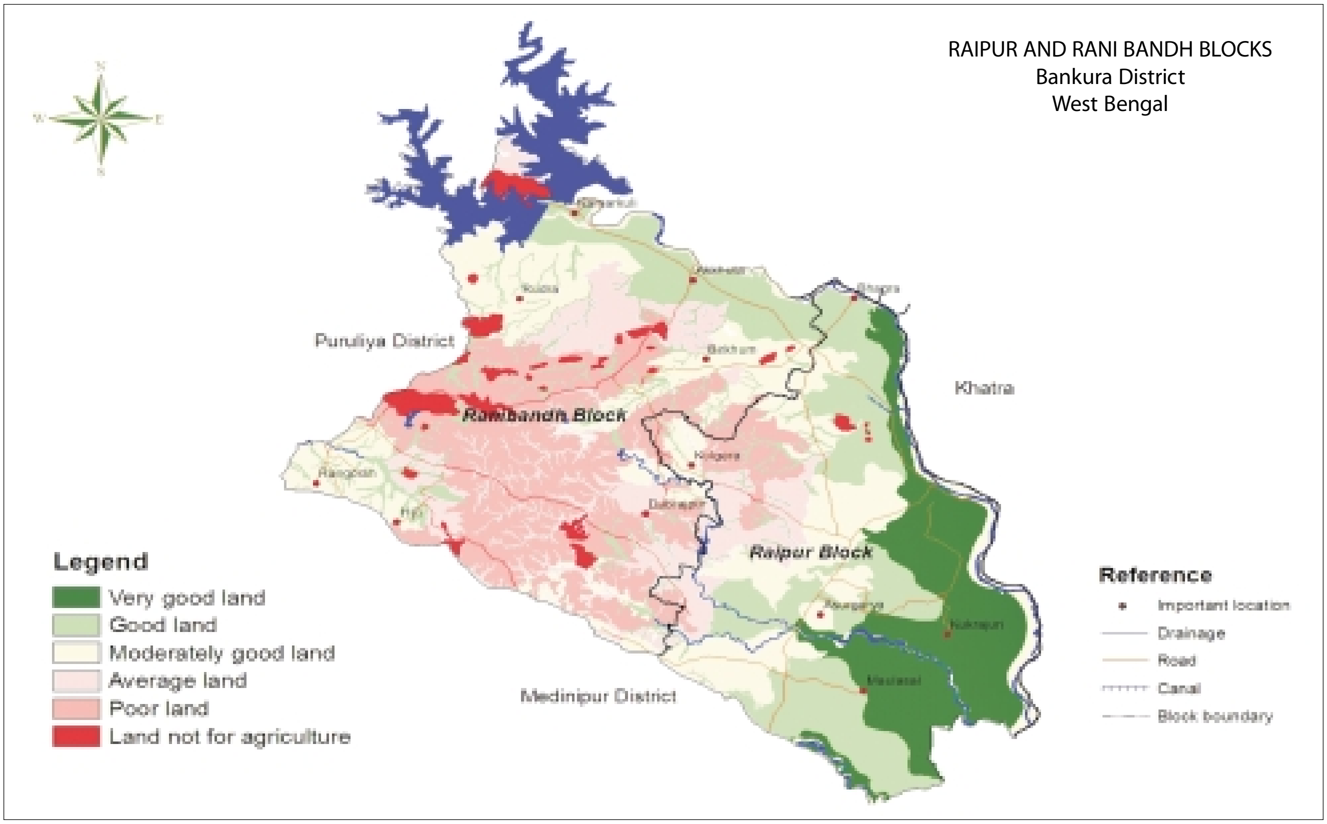


Fig. 2.1 Overall productivity index of the soils

Table 2.2 Area under different productivity classes

Class	Area (sq km)	% TGA
Very good land	114.10	13.78
Good land	183.64	22.18
Moderately good land	175.34	21.18
Average land	105.60	12.76
Poor land	162.94	19.68
Land not fit for agriculture	21.53	2.60
Miscellaneous land	64.75	7.82
Total	827.90	100.00

Integrated approach of remote sensing and GIS in land resources characterization and evaluation of land resources in Saraswati watershed of Buldhana district of Maharashtra

M.S.S. Nagaraju, Rajeev Srivastava, A.K. Maji and A.K. Barthwal

A study was carried out in Saraswati watershed (19^{o} 09' to 20^{o} 01' N; 76^{o} 26' to 76^{o} 35' E) covering an area of 10787 ha in Mehkar tehsil of Buldhana district, Maharashtra to characterize and evaluate the land resources using remote sensing (IRS-P6 LISS-III) data. Ten soil series were tentatively identified representing different physiographic units. Physiography-soils relation-ship was established and mapped as association of soil series representing eleven mapping units (Fig. 2.2).

The available nitrogen in surface soils indicates that the soils are low in available nitrogen (122.2 to 244.4 kg ha^{-1}) except the soils of Lonar and Wadgaon (280.5 to 426.8 kg ha^{-1}). The available phosphorus in surface soils indicates that soils are low to medium in available phosphorus except soils of Kinhi, Lonar and Wadgaon. The available potassium in surface soils indicate that soils of Titwi are low in available potassium (105 kg ha^{-1}); soils of Dhad-1, Khurampur-1, Khurampur-2 and Dhad-2 are medium (125 to 218.9 kg ha^{-1}) and soils of Kinhi, Saraswati, Lonar, Wadgaon and Dhad-3 are high in available potassium (297.5 to 684.8 kg ha^{-1}). The DTPA extractable Fe and Mn in these soils are found to be much higher than the critical level of 4.5 and 3.0 mg kg^{-1}, respectively. DTPA-Cu of the soils varies from 2.2 to 8.8 mg kg^{-1} and decreased with depth but was higher than the critical (0.2 mg kg^{-1}) in all the soils. DTPA-Zn of the soils varies from 0.3 to 2.0 mg kg^{-1}. The soils of Saraswati, Wadgaon and Dhad-3 showed zinc deficiency.

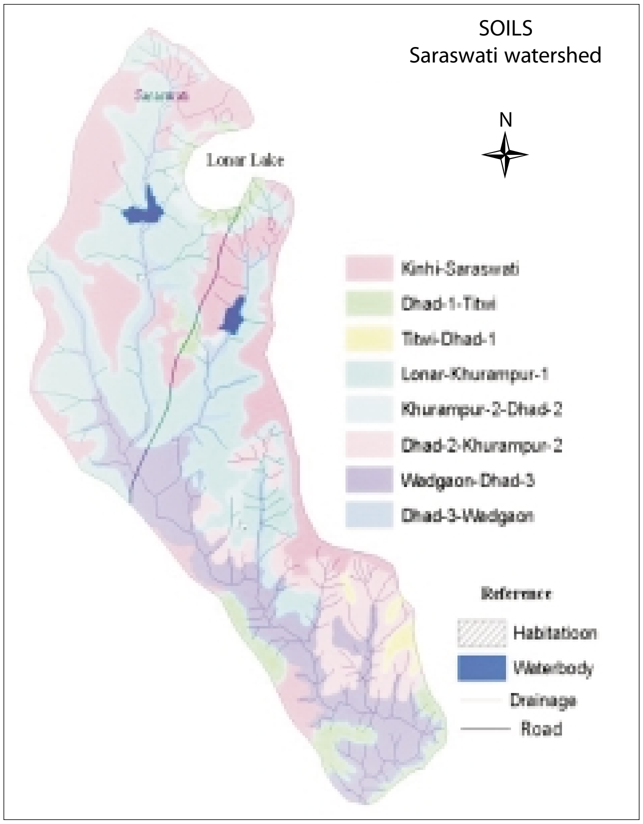


Fig. 2.2 Soils of Saraswati watershed

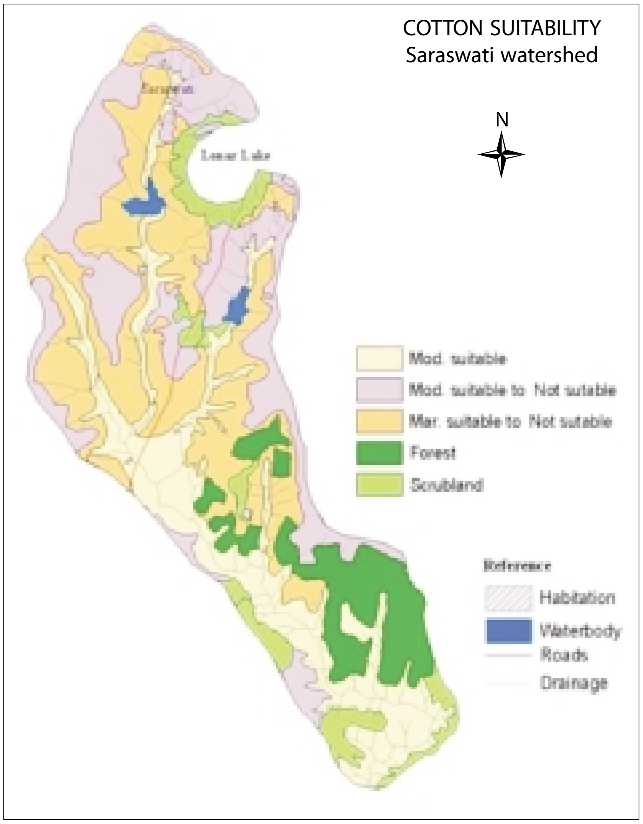


Fig. 2.3 Cotton suitability of soils of Saraswati watershed

Land irrigability: The soils have been evaluated for their land irrigability. About 24% of the area has been grouped under land irrigability sub-classes 2s as these soils have moderate limitations of soil depth and soil texture whereas about 55% area has very severe limitations of soil depth, coarse fragments, slope and erosion

Soil-site suitability for Cotton: The soils of Kinhi, Wadgaon and Dhad-3 series are moderately suitable (S2) for growing cotton as these soils have moderate limitations of erosion, soil texture and depth (Kinhi); erosion and soil texture (Wadgaon) and erosion and $CaCO_3$ (Dhad-3). The soils of Lonar are marginally suitable (S3) with severe limitations of soil depth whereas soils of Saraswati and Khurampur-1 series are not suitable (N) due to very severe limitations of soil depth. The suitability map is presented in figure 2.3.

Natural resource assessment using RS and GIS – a case study in Badajorenala micro watershed in Utkal plain of Orissa

K. Das, S.K. Singh, T. Banerjee and S. Dharumarajan

The Badajorenala micro-watershed (596.12 hectare) represents a vast stretch of plain land with occasional exposed laterites, developed over the base of charnockites and khondalites in Khurda district of Orissa.

During the detailed soil survey forty profiles and twenty augur bores were studied on different physiographic units in transects and horizon-wise samples were collected. One hundred and sixty surface soil samples (0-25 cm) at 200 m interval were also collected for nutrient status mapping. Soil-physiography relationship in the watershed has been shown in table 2.3. Few soils on the middle plain showed redoximorphic features with Fe-Mn concretions, clay illuviation and occasional gleying.

Soil pH was strongly acidic to mildly alkaline (pH_{aq} 4.6 to 8.6 and pH_{kcl} 3.6 to 6.3) and increased from upper to lower plains. Silt (14.8 to 67.8%), clay (9.6 to 56.8%) and organic carbon (0.01 to 0.73%) also increased along the transect, whereas gravel content showed reverse trend. Exchangeable bases increased from upper to lower plains. Available water capacity (AWC) in soils of upper plains varied from 64 to 72 mm m^{-1}, increased in the middle plain and nearly level lower plains (108 to 161 mm m^{-1}).

Table 2.3 Soil-physiography relationship in Badajorenala microwatershed,Khurda district,Orissa

Physiography		Upper plain			Middle plain		Lower Plain	
Site/Soil Characteristics		Nearly level	Very gently sloping	Gently sloping	Nearly level	Very gente to gently sloping	Nearly level	Very gently sloping
Slope (%)		0-1	1-3	3-5	0-1	1-5	0-1	1-3
Mean depth (cm)		45	44	82	121	118	130	123
Colour	Surface	Strong brown to brown	Yellowish red to dark brown	Dark reddish brown to reddish yellow	Light olive brown	Light olive brown to yellowish brown	Light olive brown	Light olive brown to light yellowish brown
	CS*	Dark brown	Yellowish red to very dark brown	Reddish yellow to dark reddish brown	Olive brown to very dark grayish brown	Olive brown to yellowish brown	Olive brown to dark grayish brown	Olive brown to dark grayish brown
Texture	Surface	Sandy loam	Gravelly sandy loam	Sandy loam to gravelly sandy loam	Loam to sandy loam	Sandy clay loam to clay loam	Clay loam	Sandy clay loam to clay loam
	CS*	Sandy clay loam	Gravelly sandy clay loam to clay loam	Clay loam to gravelly clay	Clay to silty clay	Clay loam/ silty clay loam to silty clay	Clay to silty clay	Clay to silty clay
Coarse	Surface	30-35%	30-55%	15-20%	-	5-10%	-	-
fragments	CS*	50-80%	50-75%	55-60%	30-40%	20-25%	-	-
Horizon sequence		A-C	A-C	A-Bw	Ap-Bw	Ap-Bw-Bt	Ap-Bw-Bt	Ap-Bw-Bw(g)
Drainage		Well	Well	Somewhat excessively drained	Moderately well	Moderately well	Moderately well to poorly drained	Moderately well to poorly drained
Erosion		Moderate	Moderate to severe	Moderate to severe	Slight to moderate	Slight to moderate	Slight	Slight
Classification		Lithic Ustorthents	Lithic/ Ustorthents	Typic Haplustepts	Aeric Endoaquepts	Typic Haplustalfs	Typic Endoaqualfs	Typic Endoaquepts

* CS-control section

Application of Cartosat-1 data for cadastral level soil mapping in basaltic terrain for land resource management

M.S.S. Nagaraju, J.D. Giri, Nirmal Kumar, D.S. Singh, S.N. Das, Rajeev Srivastava

The main aim of this project is to study the applicability of IRS-P5 (Cartosat-1) data with a spatial resolution 2.5 m in detailed soil mapping at cadastral level for faster and precise mapping in basaltic terrain. The study was undertaken (in collaboration with RRSC, Nagpur) in Savli village, Wardha district of Maharashtra. The DEM of the study area was prepared (Fig. 2.4) under GIS environment using Geomatica software (V.9.1.8). The contour information was extracted from SOI toposheet (55K/12 and 55K/8). The elevation ranged from 420 to 510 m above MSL. This DEM will be refined further using Cartosat-1 stereo-pair for landform analysis to be used as base map for detailed soil mapping.

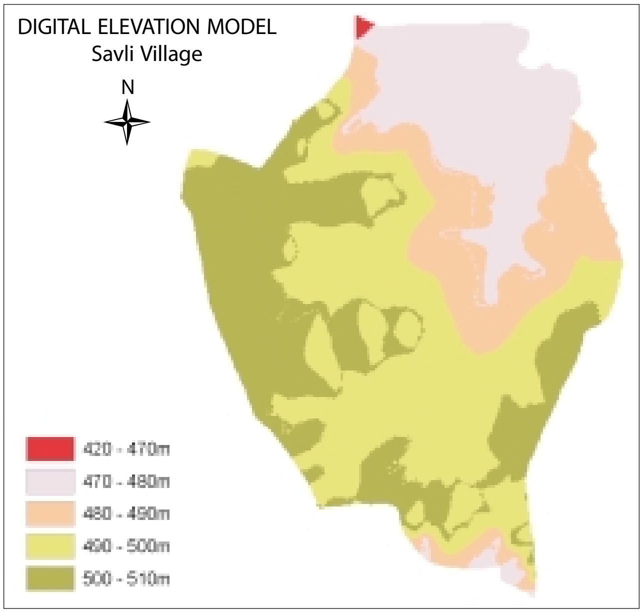


Fig. 2.4 Digital Elevation Model of Savli village

Comparative assessment of large scale soil mapping by conventional method and remote sensing techniques: a case study in Parsori micro-watershed, Katol tehsil, Nagpur District, Maharashtra

J.D. Giri, M.S.S. Nagaraju, D.S. Singh and Rajeev Srivastava

Large-scale mapping at cadastral level through conventional survey is very tedious, time consuming and costly. The multispectral data with a spatial resolution of 5.8 m from Indian Remote Sensing satellite (IRS-P6, Resourcesat-1) helps significantly in soil mapping at 1:25000, 1: 12500, or larger. For application of high resolution data in detailed soil mapping at cadastral level, it is important to develop a standard methodology for achieving reasonable accuracy and its cost-effectiveness in comparison to conventional survey. Keeping this in view, the present study was undertaken in Parsori micro-watershed (21°12' to 21°14' N, 78°31'to 78°34' E), covering an area of 1330 ha in Parsori village of Katol tehsil, Nagpur district of Maharashtra.

Geocoded false colour composites of IRS 1D LISS-IV data of February 2006 was interpreted following standard visual interpretation techniques to generate the physiography map of the area. Six broad physiographic units viz. plateau, escarpment, isolated hillocks, pediment, narrow valley and alluvial plain have been identified. These units were further sub-divided based on slope and land use/land cover. The ground truth verification was carried out to check the physiography boundaries delineated based on LISS-IV FCC and toposheet of the area and corrected accordingly. The physiography map is presented in figure 2.5.

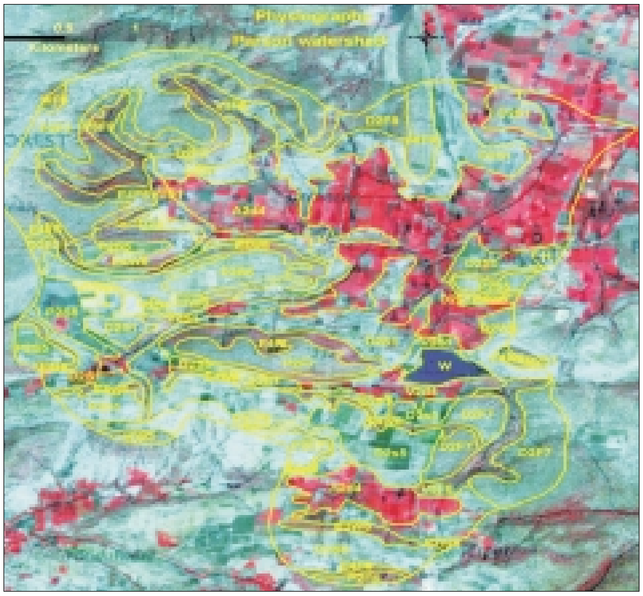


Fig. 2.5 Physiography units in Parsori watershed

Development of software modules for land evaluation and agro-climatic analysis

S. Srinivas, K.M. Nair, L.G.K. Naidu, Rajendra Hegde and V. Ramamurthy

Software module for drought analysis was developed as it is one of the important aspects of agro-climatic analysis for delineation of agro-ecological zones for crop planning. Probability of occurrence of moderate and severe drought in an area was computed from annual rainfall data using the method described by IMD. A year was considered normal when the rainfall deviated from normal by 25 per cent or less and above normal when the rainfall was higher than normal by more than 25 per cent. A year was considered to have moderate drought if the rainfall was 50-75 per cent of the normal and severe drought when the rainfall was less than 50 per cent of the normal rainfall. Initial and conditional probability of dry or wet weeks were also calculated using 20 mm as rainfall limit by Markov Chain of Probability model. A week was considered dry if it received less than 20 mm rainfall. The moderate drought probability (Fig. 2.6) and the Coefficient of Variation (Fig. 2.7) in rainfall in different agro-ecological units of Kerala have been generated by software.

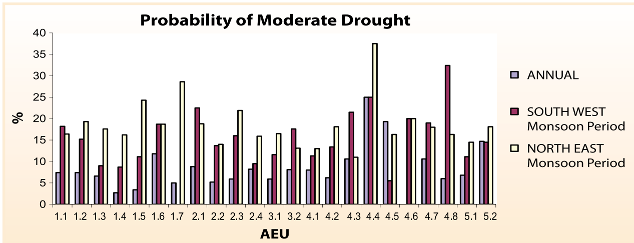


Fig. 2.6 Probability of moderate drought in different agro-ecological units of Kerala

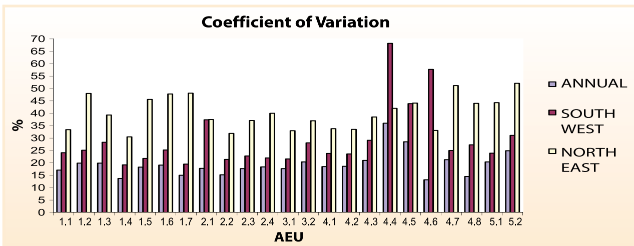


Fig. 2.7 Coefficient of Variation (Rainfall) in different agro-ecological units of Kerala

Digital maps of derived soil quality of different states of India

A.K. Maji, G.P. Obi Reddy and Sunil Meshram

In this project, state-wise soil pH database viz. strongly acidic (pH < 4.5), moderately acidic (pH 4.5 to 5.5), slightly acidic (pH 5.5-6.5), neutral (pH 6.5-7.5), slightly alkaline (pH 7.5-8.5), moderately alkaline (pH 8.5 to 9.5) and strongly alkaline (pH> 9.5) along with an acid soil map at national level (1:250,000 scale) have been generated. Acid soil map of Uttarakhand and Jharkhand state have been shown in figures 2.8 and 2.9. In Jharkhand, pH 4.5-5.5, pH 5.5-6.5, > 6.5 and others cover 44.0, 32.5, 22.3 and 1.2 per cent respectively. The technical report on “Acid Soils of India” along with maps of 15 states showing the degree and areal extent of acid soils has been submitted for printing.

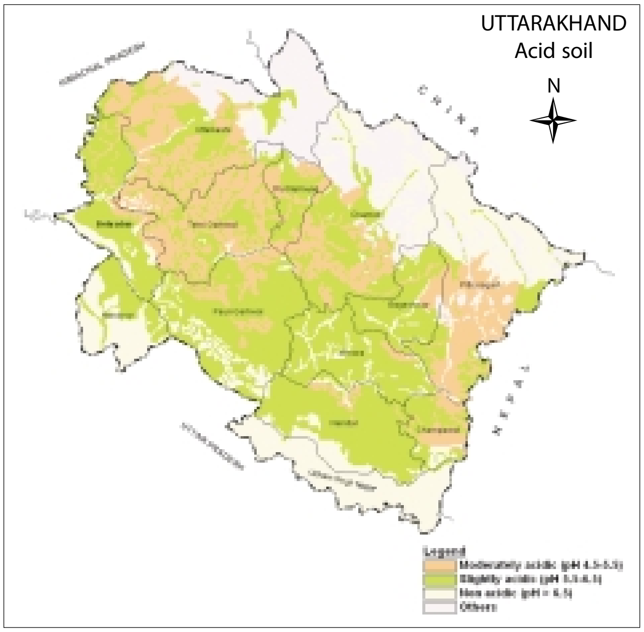


Fig. 2.8 Acid soil map of Uttarakhand

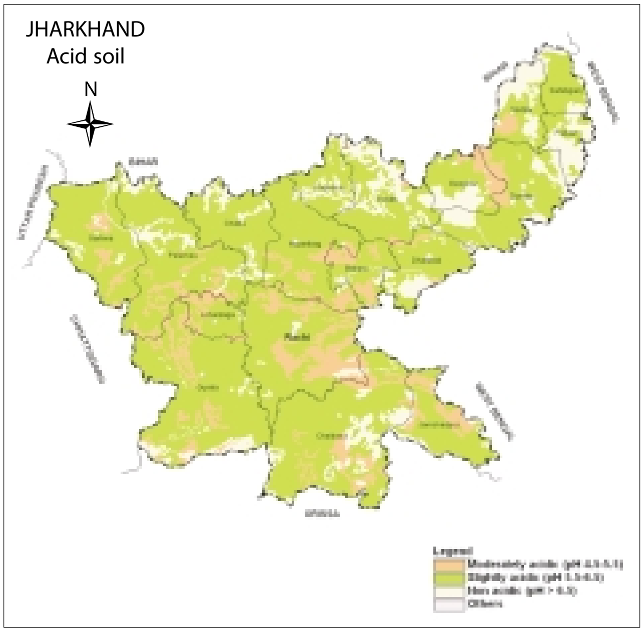


Fig. 2.9 Acid soil map of Jharkhand

Documentation and Storing of Maps and Photographs: Concept of Digital Map Library

C. Mandal, Pushpanjali, D.K. Mandal, Jagdish Prasad, T. Bhattacharyya, R. Srivastava and D. Sarkar

The project was initiated to develop a digital database system for storing and retrieval of maps and photographs and preparation of Web-based library for data transmission.

Many Documents/Maps (which includes fifty BSR reports) have already been segregated and scanned. The image quality check and enhancement was also completed. The indexing of the scanned documents/maps has been completed. All documents are now being uploaded simultaneously for further use.

Development of GIS based seamless mosaic of SRTM elevation data of India to analyze and characterize the selected geomorphometric parameters (Inter institutional project between NBSS&LUP and RRSC, Nagpur)

G.P. Obi Reddy, A.K. Maji, S.N. Das and Rajeev Srivastava

This inter-institutional project was taken up to develop a seamless mosaic of SRTM digital elevation data (90m) for India to analyze and characterize the selected geomorphological parameters namely elevation, slope, aspect, hill shade, plane curvature, profile curvature, total curvature, flow direction, flow accumulation and topographic wetness index. Digital slope maps have been generated for all the 28 states. The database on the other parameters like aspect and plane, profile and total curvatures have been generated for five states. The generated database on digital terrain model, SRTM elevation and slope of Uttarakhand state is shown in figure 2.10.

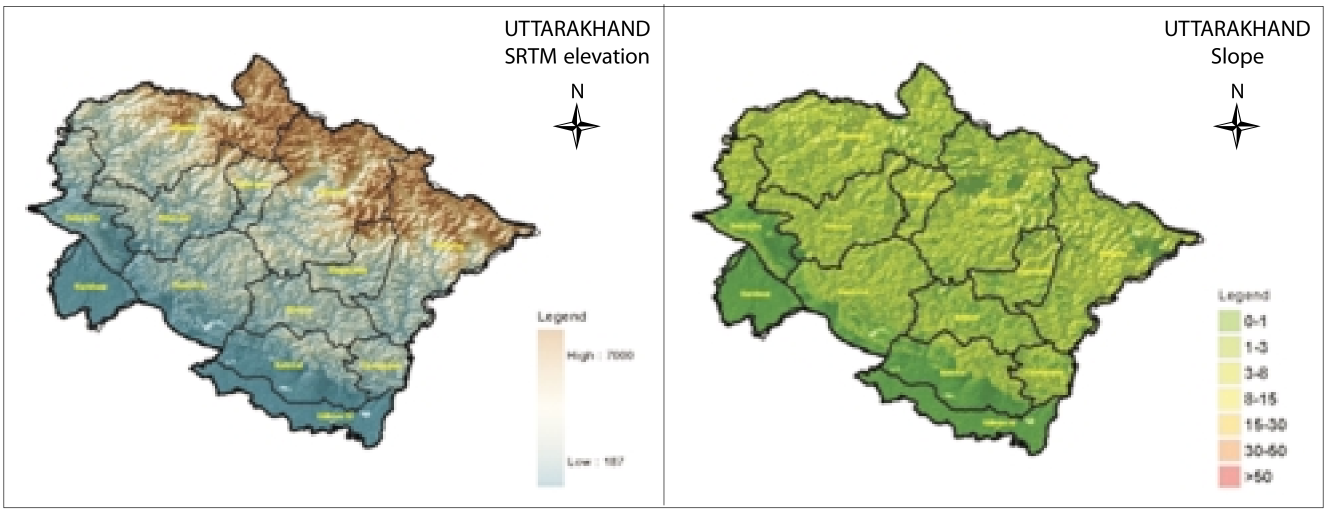


Fig. 2.10 SRTM elevation and slope of Uttarakhand state

Design and development of spatial soil database and analysis in GIS

A.K. Maji, G.P. Obi Reddy and Sunil Meshram

To generate spatial database of soils at 1:250,000 scale in GIS, printed soil maps on 1: 500,000 scale were re-digitized on toposheet basis (1:250,000 scale). Each soil sheet has been scanned, geo-referenced, digitized and mosaic was prepared to generate state soil layers in GIS. The database on site, physical and chemical parameters were created in MS-Access and the same was assigned to the soil polygons of the respective state. The suitable annotations like legend, palettes, north arrow and scale were used to compose the thematic maps. The region-wise number of soil sheets digitized in GIS are shown in table 2.4. The methodology adopted in design and development of spatial soil database and analysis in GIS is shown in figure 2.11.

The thematic maps on slope, surface form (landform), soil taxonomy, depth, texture, drainage, organic carbon, cation exchange capacity, water-holding capacity and flooding were generated at state level with area under respective parameters. The soil-based thematic maps have been generated for Bilaspur, Bastar, Satna, Ganjam, Ranchi, Balaghat, Jalgaon and Raichur districts with area analysis cutting across the states.

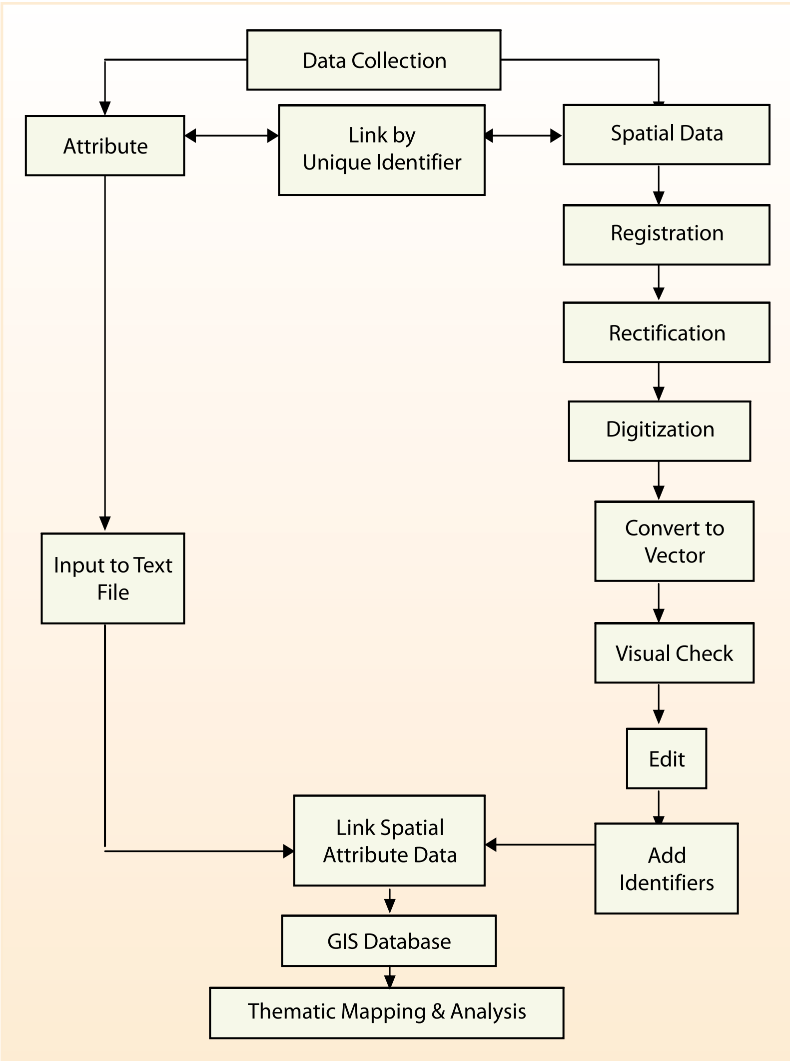


Fig. 2.11 Flow chart of methodology

Table 2.4 Region-wise number of soil sheets used in generation of GIS based soil database

State	No. of soil sheets digitized
States of Northern region	
Uttar Pradesh	42
Uttarnchal	10
Himachal Pradesh	11
Jammu & Kashmir	23
Punjab	11
Haryana	11
States of Eastern region	
Bihar	18
Jharkhand	14
Orissa	26
West Bengal	17
States of Western region	
Gujarat	29
States of Central region	
Madhya Pradesh	58
Chhattisgarh	23
Maharashtra	42
States of North-Eastern region	
Arunachal Pradesh	18
Assam	17
Mizoram	4
Meghalaya	5
Manipur	6
Nagaland	4
Tripura	4
States of Southern region	
Andhra Pradesh	40
Karnataka	29
Tamil Nadu	20
Kerala	11
Total	493

Development of spectral reflectance methods and low cost sensors for real-time application of variable rate inputs in precision farming (NAIP – Component 4)

Rajeev Srivastava and Dipak Sarkar

The project was undertaken in collaboration with PAU, Ludhiana (Lead Centre), CSSRI, Karnal and Punjab Remote Sensing (PRS), Ludhiana to study the spectral reflectance characteristics of soils of the Indo-Gangetic Plain (IGP) and to identify the suitable bands for characterization of soil properties. The soils (1660 collected by Lead Centre from Punjab) and 432 samples from salt affected soils of Haryana state (collected by CSSRI, Karnal) were analysed for different properties using standard techniques. The statistical parameters of salient soil characteristics of soils are given in table 2.5.

The spectral reflectance characteristics of all the 2092 soil samples were measured under laboratory conditions between 350-2500 nm using ASD spectroradiometer. The spectral reflectance curves of soil samples collected from Bhatinda, Gurdaspur, Ludhiana and Moga in Punjab is depicted in figure 2.12. The soils are dominated by mica. The variation in spectral properties of soils appears to be due to difference in soil texture, organic carbon and calcium carbonate contents.

Table 2.5 Descriptive statistical parameters of soils properties

State	Soil property	No. of samples analysed	Min.	Max.	S.D.	Percentile					
						5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}
Punjab	pH	400	7.19	9.02	0.32	7.68	7.76	7.92	8.09	8.37	8.60
	EC (dSm^{-1})	400	0.1	1.1	0.16	0.18	0.22	0.27	0.37	0.49	0.62
	Org. C (%)	400	0.40	1.67	0.23	0.48	0.53	0.62	0.74	0.90	1.05
Haryana	pH	416	7.00	9.20	0.35	7.60	7.70	8.00	8.20	8.42	8.60
	ECe (dSm^{-1})	416	0.00	167.0	29.27	0.62	0.77	1.50	4.11	14.25	51.72
	Org. C (%)	416	0.10	2.80	0.17	0.25	0.30	0.40	0.46	0.51	0.60
	$CaCO_3$ (%)	416	0.30	12.0	1.34	0.60	0.70	0.90	1.50	2.50	3.10
	Na^+ (me/l)	416	1.90	1765.0	285.56	3.80	4.70	11.63	35.0	129.0	503.50
	K^+ (me/l)	416	0.03	255.0	24.39	0.06	0.08	0.17	0.30	1.07	2.90
	$Ca^{++}+Mg^{++}$ (me/l)	416	2.40	762.0	86.54	4.00	4.27	7.00	13.50	48.00	137.90
	CO_3^{2-} (me/l)	416	0.00	8.0	0.95	0.00	0.00	0.00	0.00	0.00	1.30
	HCO_3^- (me/l)	416	0.00	22.5	2.31	1.21	1.75	2.75	4.00	5.00	6.00
	Cl^- (me/l)	416	2.00	2018.0	341.27	3.00	4.00	7.50	23.75	116.00	647.10
	SO_4^{2-} (me/l)	416	0.00	210.0	28.88	0.00	1.10	5.38	17.50	40.23	72.00

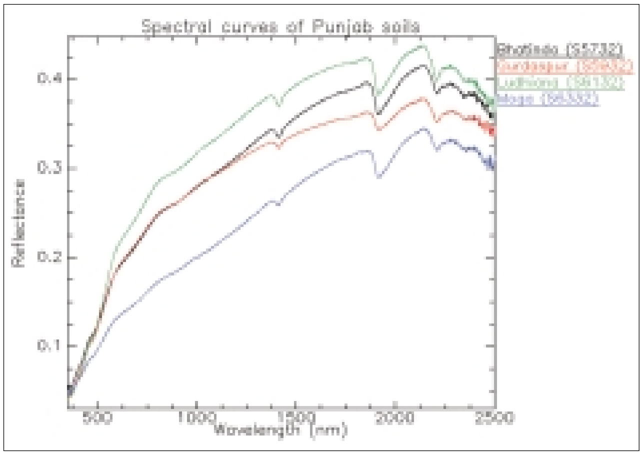


Fig. 2.12 Spectral reflectance curves of soils of different clusters in Punjab

Soil variables viz., organic carbon of Punjab state and ECe and $CaCO_3$ of salt affected soils of Haryana state have been calibrated against the 198- derivative reflectance wavebands through step-wise multiple linear regression (SMLR). Before regression analysis, the datasets were randomly divided into two sets wherein one set was used for calibration and other set for validation. Good calibration have been obtained for org. C (r^2 = 0.862**), ECe (r^2 = 0.915**) and $CaCO_3$ (r^2 = 0.749**). The application of calibration model for given soil attribute also resulted in good correlation (r^2= 0.829**, 0.869** and 0.70**) for org. C, ECe and $CaCO_3$, respectively (Fig. 2.13), indicating that soil reflectance properties may be used as a potential tool for predicting wide range of soil properties.

A - Calibration B - Validation

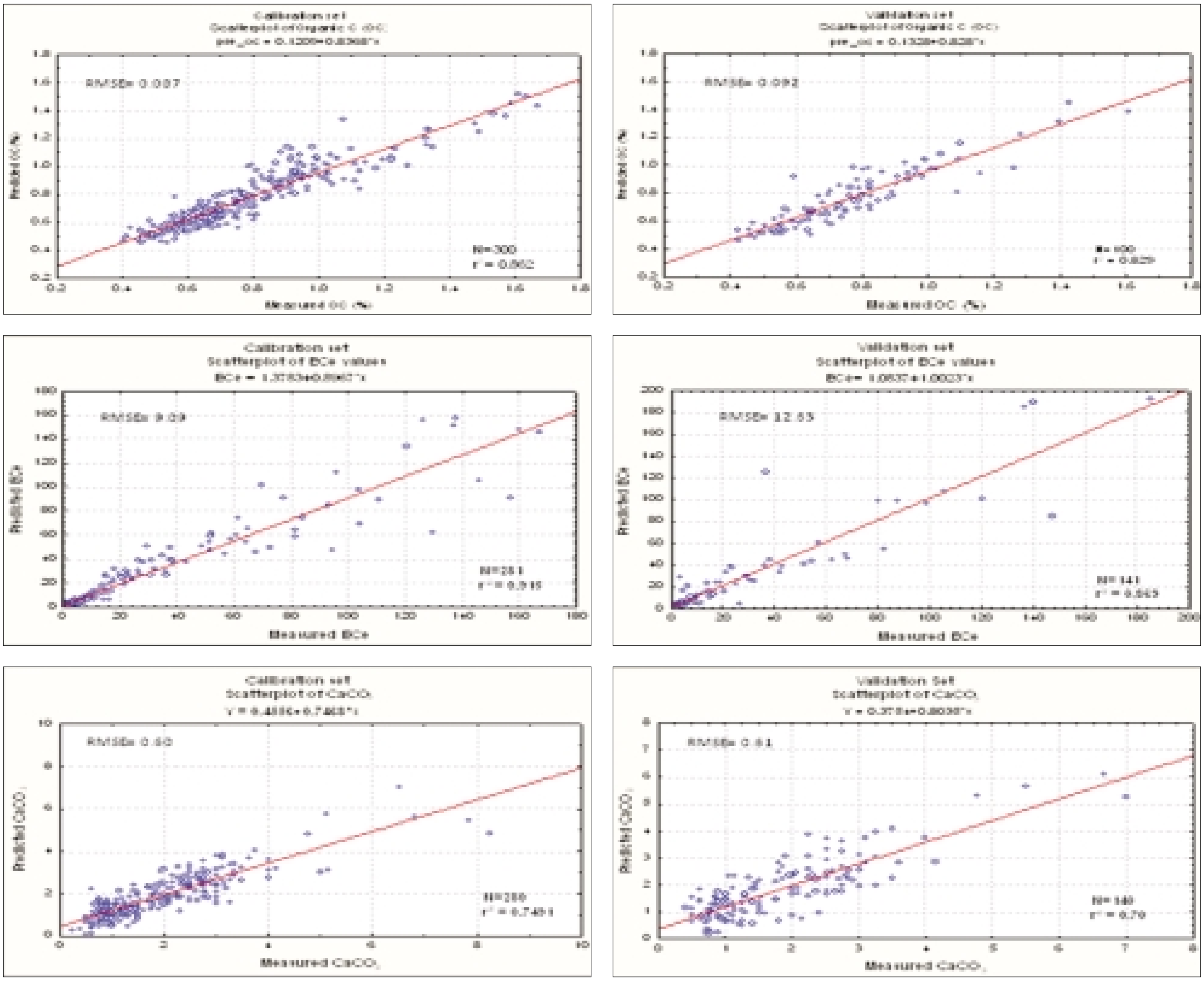


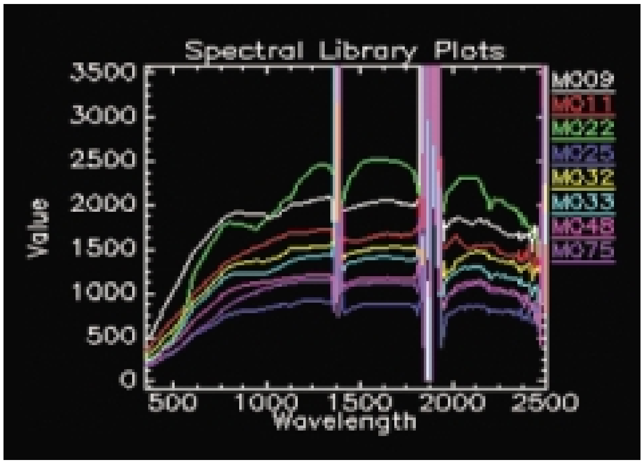
Fig. 2.13 Scatter-plot comparison of measured and predicted values of org. C, ECe and $CaCO_3$ for calibration (A) and validation (B) datasets

Soils variability mapping and fertility zonation using Hyperspectral data (A collaborative project between NBSS&LUP and SAC, Ahmedabad)

A.K. Maji, Rajeev Srivastava, Dipak Sarkar, M.S.S. Nagaraju, D.S. Singh, A.K. Barthwal and R.L. Mehta (SAC, Ahmedabad)

A study was carried out in part of Buldhana district Maharashtra (19^0 45’ to 20^0 15’ N;76^0 26’ to 76^0 37’E) in collaboration with SAC Ahmedabad to study the applicability of hyperspectral data (Hyperion sensor data) in mapping soil variability and delineating soil fertility zones. For delineation of fertility zones, green vegetation, waterbodies and clouds were masked with NDVI map (pixels) whereas for shadow areas (pixels), a mask was generated through digitization. Ground observation points (sampling prints) were overlaid on the atmospherically corrected georeferenced Hyperion data. The reflectance spectra of these points were collected from the Hyperion image. Statistical correlations between reflectance data in different bands of Hyperion and soil properties were studied. Regression models were developed between spectral reflectance in different bands and soil properties measured in the laboratory. After developing suitable regression model, the model was applied on the Hyperion image for mapping of soil properties.

The in-situ measured ASD spectroradiometer spectral curves of all the soils showed water band noise around 1400 nm and 1900 nm. Broad absorption feature around 950 nm observed in soils having hue of 5YR or redder due to iron oxides (Fig. 2.14). In general, soil reflectance values on the Hyperion image were relatively higher than the ASD spectroradiometer measured values but the Hyperion spectra were not as smooth as ASD measured spectra. This could be due to atmospheric noise which has not been completely removed after applying atmospheric correction model. Statistical parameters of salient soil characteristics vis-à-vis reflectance values in the dataset are presented in table 2.6.



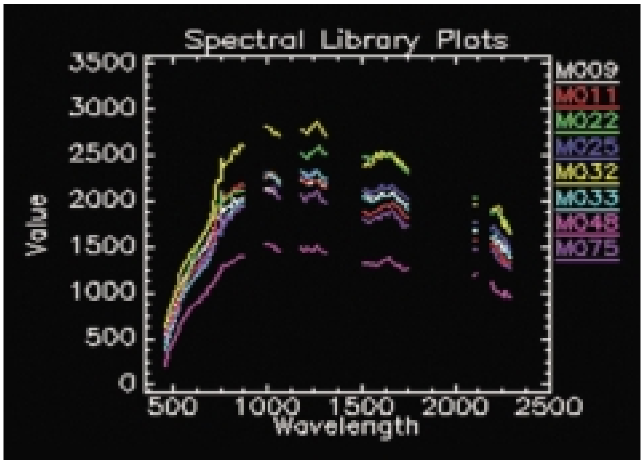


Fig. 2.14 Reflectance spectra of selected soils measured from ASD spectro-radiometer (left) and reflectance spectra of same soils collected from Hyperion image (right)

Table 2.6 Descriptive statistical parameters of soils properties

Soil property	Min	Max	SD	Percentile				
				10^{th}	25^{th}	50^{th}	75^{th}	90^{th}
pH	6.5	8.7	0.49	7.2	7.7	8.2	8.3	8.5
EC (dSm^{-1})	0.03	0.34	0.06	0.06	0.09	0.12	0.17	0.23
OC (%)	0.21	1.27	0.21	0.39	0.54	0.68	0.81	0.89
Avail. N ($kgha^{-1}$)	109.2	475.9	66.7	158.3	190.2	219.8	250.7	284.5
Avail. P ($kgha^{-1}$)	1.1	62.2	11.2	2.2	6.5	9.8	16.7	24.5
Avail. K ($kgha^{-1}$)	110.7	1066.7	238.3	155.1	219.2	387.4	642.4	772.4

Soil organic carbon and available K showed significant negative correlation with soil reflectance at different wavelength bands of Hyperion. However, the effect of soil pH, EC, available nitrogen and available phosphorous was found non-significant.

The step-wise multiple linear regression (SMLR) technique was used to relate the 139 bands reflectance spectra of Hyperion with measured soil properties. Before applying SMLR, reflectance data of Hyperion image were transformed using logarithmic function. Sixty-nine soil samples were used for developing spectral model. Relatively good calibration model (R^2 =0.51*) for organic carbon and scatter plot of observed and predicted values of organic carbon (Fig. 2.15) shows good correlation (r =0.71*). Spectral model for soil pH, available N, available P and available K had R^2 less than 0.50. Further research with large datasets is needed for development of robust spectral models for these soil properties.

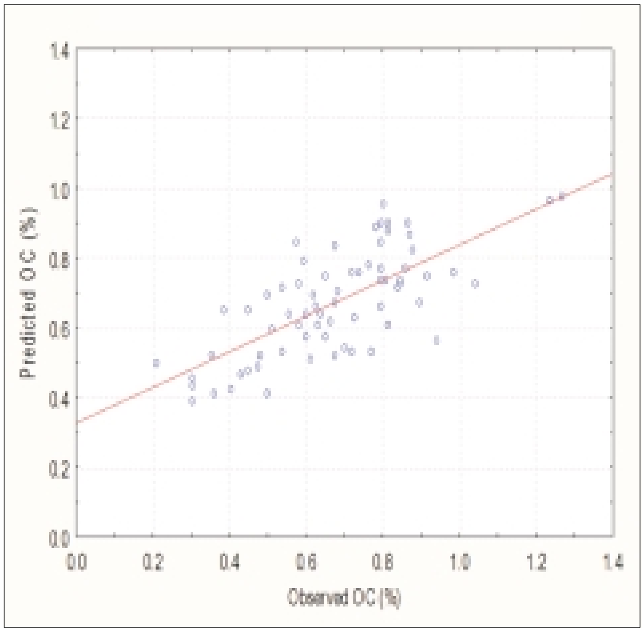


Fig. 2.15. Scatter plot of observed and predicted values of organic carbon

The model obtained for organic carbon prediction is given below.

$$\text{Organic carbon (\%)} = 5.617-0.819*\log_{10}(B457.3) + 0.6399*\log_{10}(B1114.2) + 2.874*\log_{10}(B1578.3) - 4.52*\log_{10}(B2304.7)$$

Where, B457.3, B1114.2, B1578.3 and B2304.7 refers to Hyperion band with central wavelength 457.3, 1114.2, 1578.3 and 2304.7, respectively.

The organic carbon spectral model was applied on the Hyperion data for spatial mapping of the soil organic carbon. The spatial distribution of organic carbon content in surface soils in the study area is shown in figure 2.16.

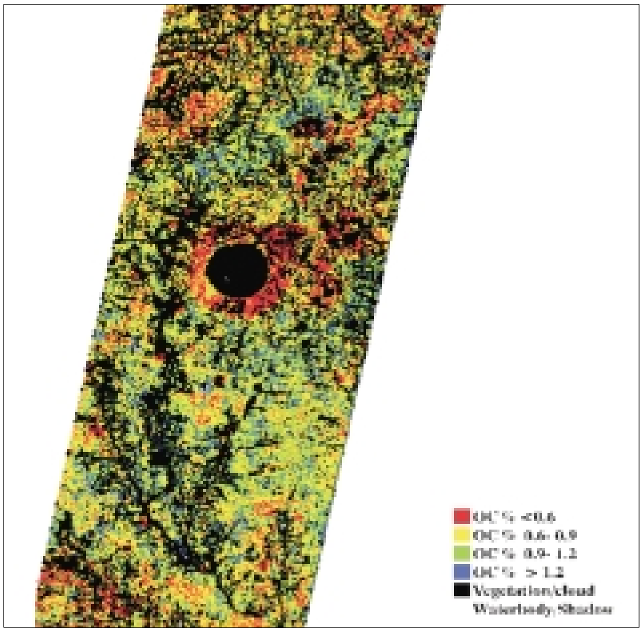


Fig. 2.16 Distribution of organic carbon in study area

Enrichment of land degradation datasets with soils datasets of different states of India

NBSS&LUP : G.P. Obi Reddy, Rajeev Srivastava, G.S. Sidhu, A.K. Sahoo, K.S. Anil Kumar, Siladitya Bandyopadhyay, R.S. Singh, Nirmal Kumar, Ravindra Naitam

NRSC: T. Ravisankar, K. Srinivas, G. Sujatha and M.A. Fiazy

Coordinators: Dipak Sarkar, NBSS&LUP and P. S. Roy, NRSC

This inter-institutional project was undertaken to enrich the land degradation maps on 1:50,000 scale generated by NRSC with soil/soil loss parameters of NBSS&LUP. Further, it was also aimed to finalize the state-wise land degradation maps of India.

During the reported year, the participating scientists from NRSC and NBSS&LUP had several discussions, meetings, workshops and finalized the GIS based methodology for enrichment of state-wise land

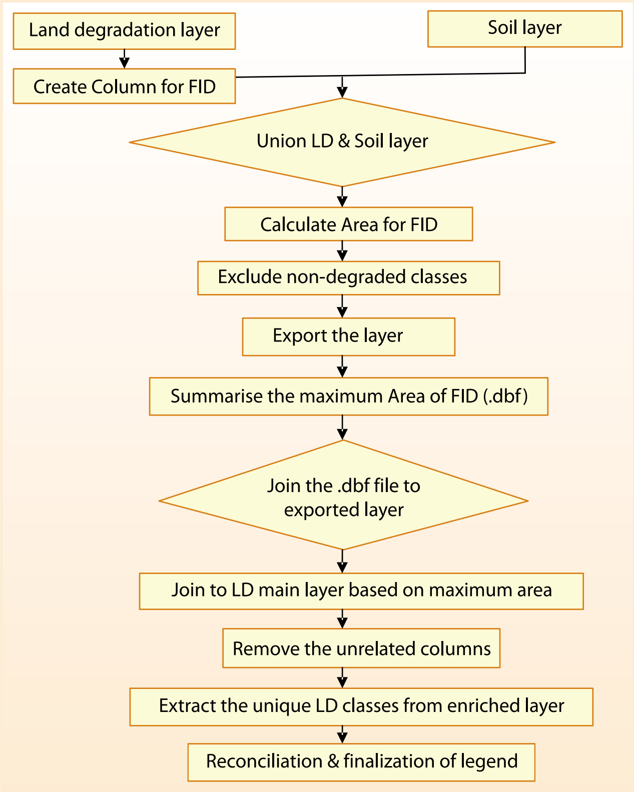


Fig. 2.17 GIS based Methodology for enrichment of land degradation datasets

degradation datasets (Fig. 2.17). The enrichment of land degradation datasets has been completed for 12 states by appending the selected soil attributes and generated enriched land degradation maps with appropriate legend for each state. The enriched land degradation map of Orissa is shown in figure 2.18.

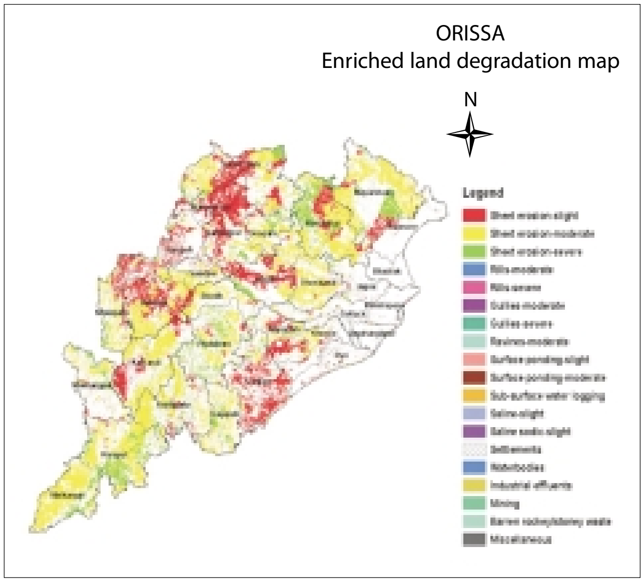


Fig. 2.18 Enriched land degradation map of Orissa state

2.3

Basic Pedological Research

♦

Land-form soil relationship

♦♦

Methods of soil analysis

♦♦♦

Soil genesis and mineral transformation

Geomorphological analysis and study on landform-soils-landscape relationship in Southern India

S. Thayalan, A. Natarajan, K.M. Nair, K.S. Anil Kumar, S.C. Ramesh Kumar, V. Ramamurthy and L.G.K. Naidu

Generalized landform assemblages were delineated from the available information such as the geology and physiographic maps along with the amalgamation of the latest Google Earth images (Fig. 3.1). In total, 10 divisions were made, which are distinct from one another in their relief, geology and form and composition of slopes.

The lateritic terrain consists of two distinct types that formed from the outliers of flood basalts represented around Bidar and Belgaum and the other one is formed from the granite-gneissic complex around Bangalore. The basalt plateaus are mostly confined to the northern parts of the state, which is in fact an extension of the Central Basaltic Province of Maharashtra and Madhya Pradesh. The sedimentary terrain, mainly consisting of shale, sandstone/conglomerate and limestone is confined mostly to the northern parts of the state. The Dharwars occur south of the towns of Hubli, Dharwar and Chitradurga consisting of dissected uplands near Dharwar and Chitradurga. The basement complex consisting of granite and geneiss with later intrusions occur extensively in the Mysore, Bangalore and Chitradurga plateaus. The residual hills are mostly available as inliers around Nandi hill complex with dykes and lineaments spread around.

The Eastern Ghats are in fact a denudation hill complex running south of Mysore especially in parts of Chamrajnagar, Anekal and Kollegal. The dissected eastern footslopes occur as a narrow, restricted band running north – south, parallel to the Western Ghats, starting from Dharwar up to Madikere of Coorg district.

The Western Ghats as a distinct landform unit runs parallel to the coast from Belgaum to the south of Mysore. The Coastal plains are a narrow strip of landform near Karwar, but while moving southwards, it widens out through Udipi to Mangalore.

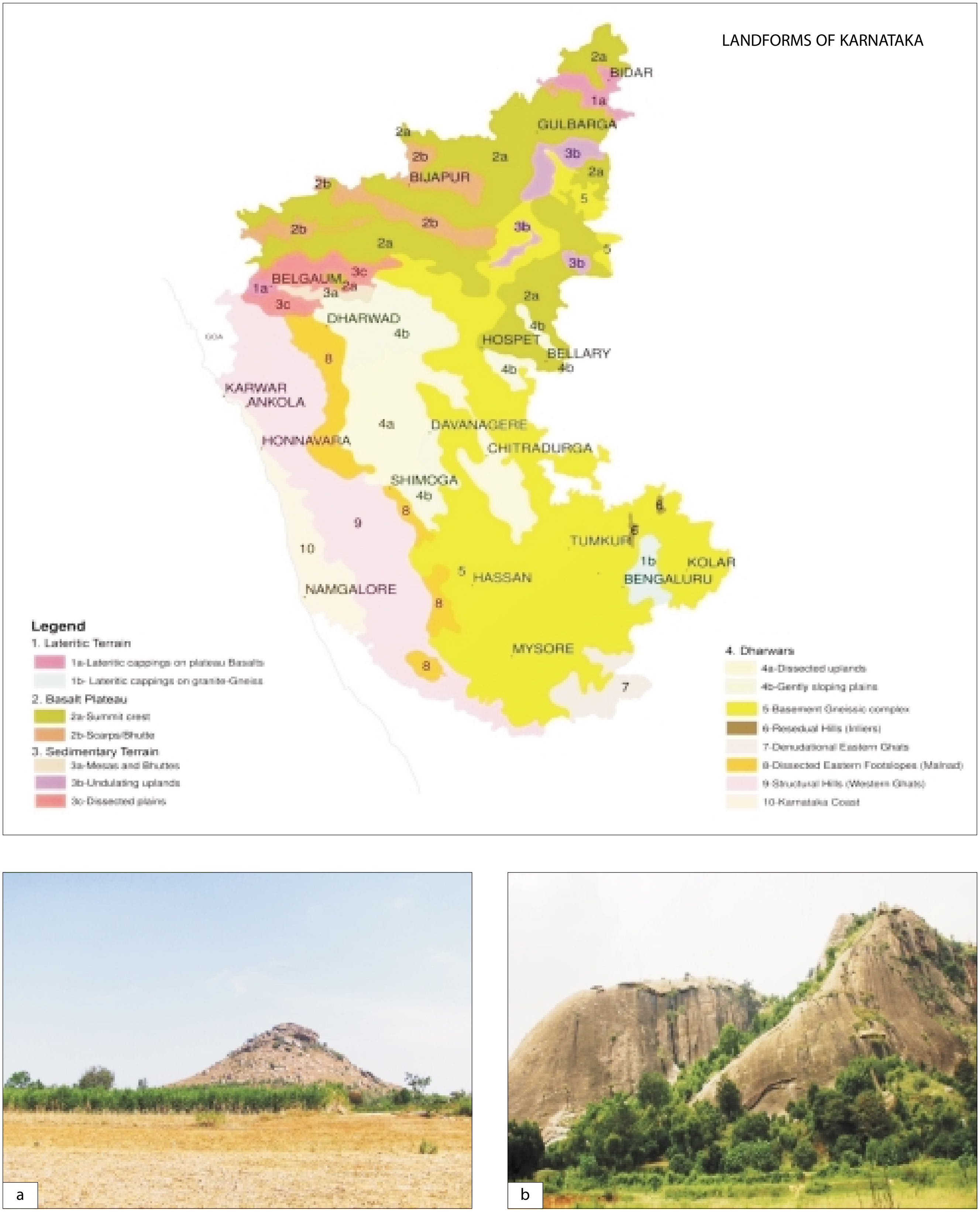


Fig. 3.1 Landforms of Karnataka showing (a) Granite conical hill with tor boulders and (b) exhumation of domical rises

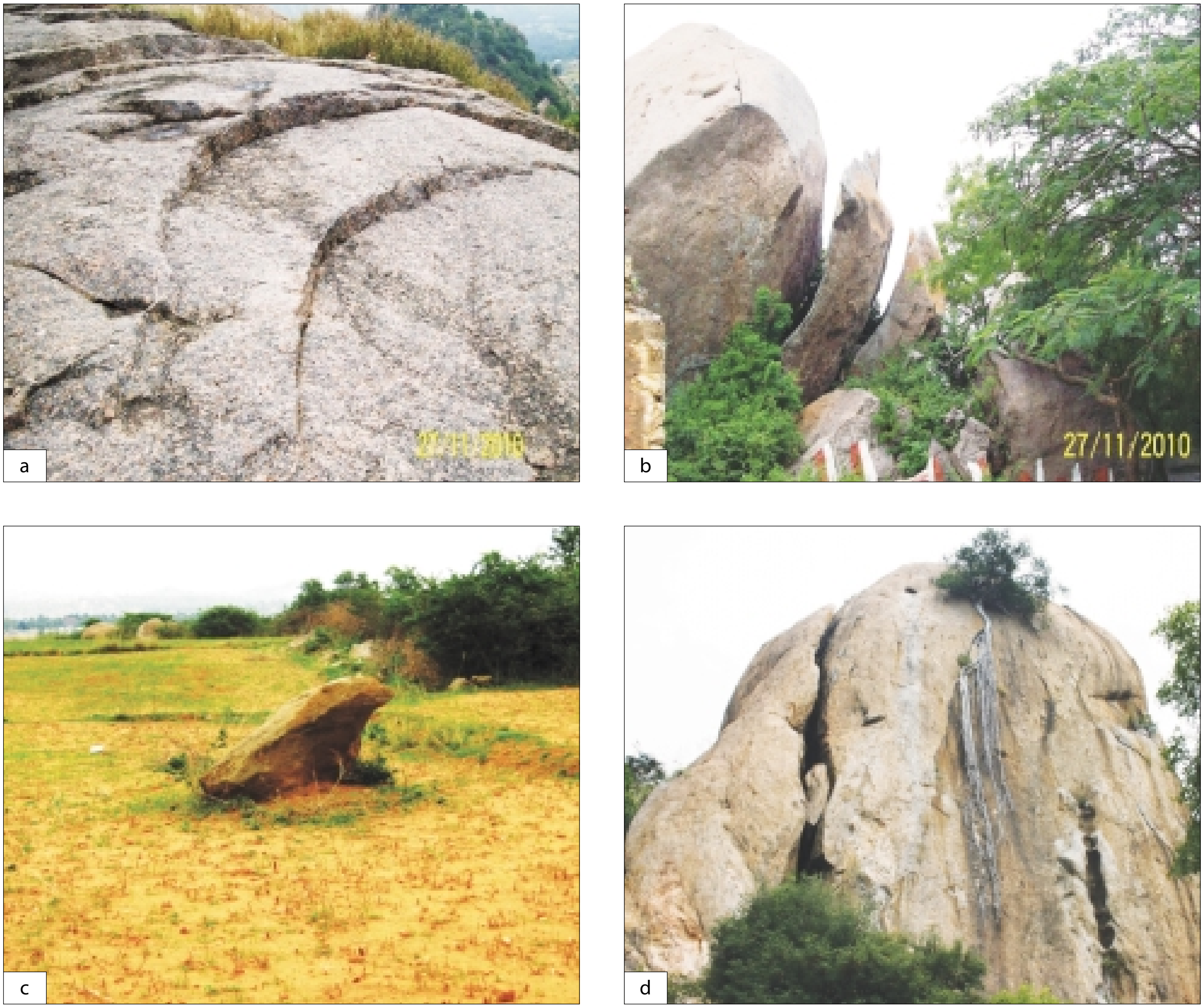


Fig. 3.2 Geomorphic processes in the granite-gnessic terrain

(a) Sheeting results from release of confined pressure due to exhumation;

(b) Formation of large scale weathering rinds as a result of spheroidal weathering of granite;

(c) Alveolar weathering that leads to the formation of "leaping frog";

(d) The influence of vegetation and biological activity along with block disintegratio.

Granite – gneissic terrain landform – Soils relationship

The major geomorphic processes identified in the granite-gnessic terrain are depicted in figure 3.2.

Transect passing through Doddaarisinakere to Chickkarisiankere have been studied to understand the landform-soils relationship (Fig. 3.3). The upland soils on the summits are moderately deep, dark red, very gravelly and clayey in texture, whereas, the soils on shoulder slopes are moderately deep, dark red, non-gravelly and fine-loamy (particle size class).

The lowland soils are very deep, dark brown to gray/ black, clayey or sandy over clayey showing aquic, fluventic and vertic characteristics. The major land use in the uplands is fingermillet (ragi) and pulses interspersed with coconuts. In the lowlands however, the major land use is paddy, sugarcane and coconut on field bunds.

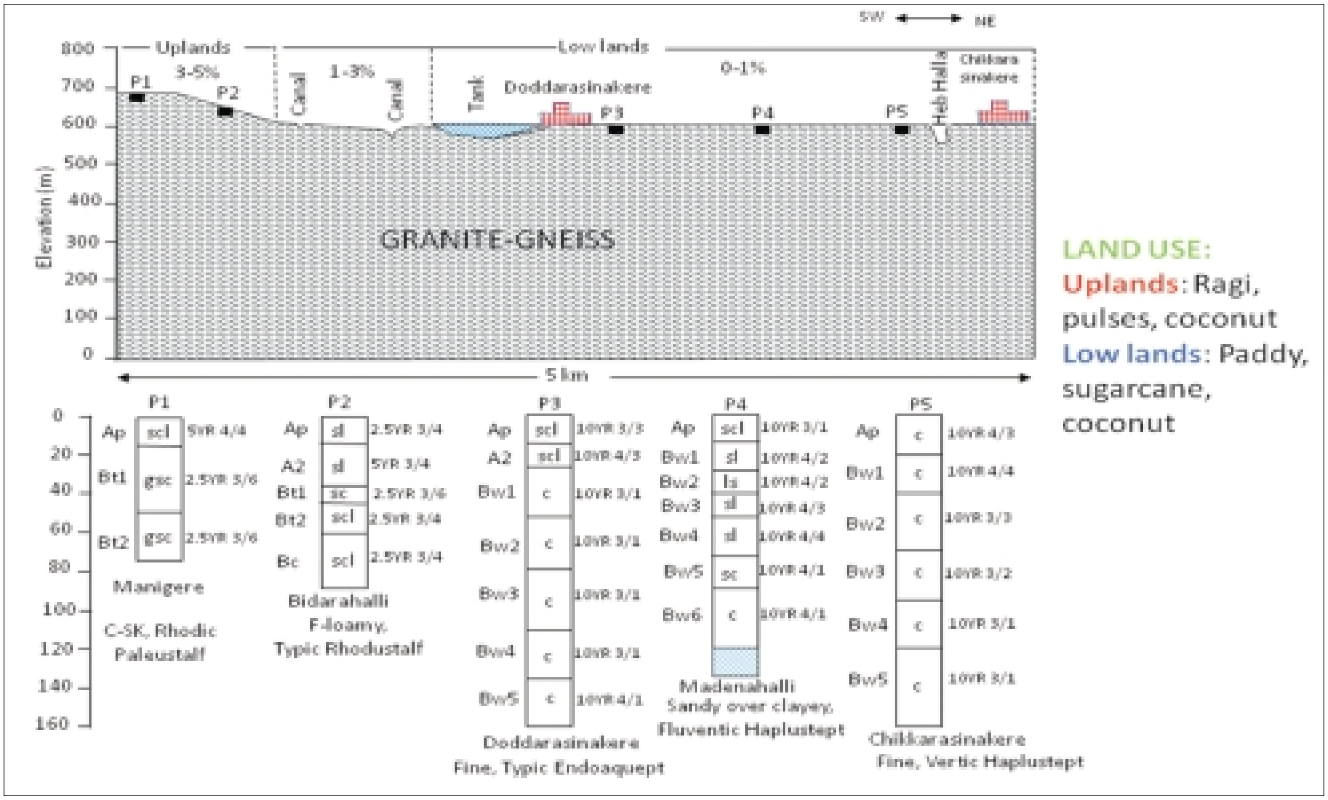


Fig. 3.3 Landform-soils relationship in Chikkarasinakere, Maddur, Mandya district

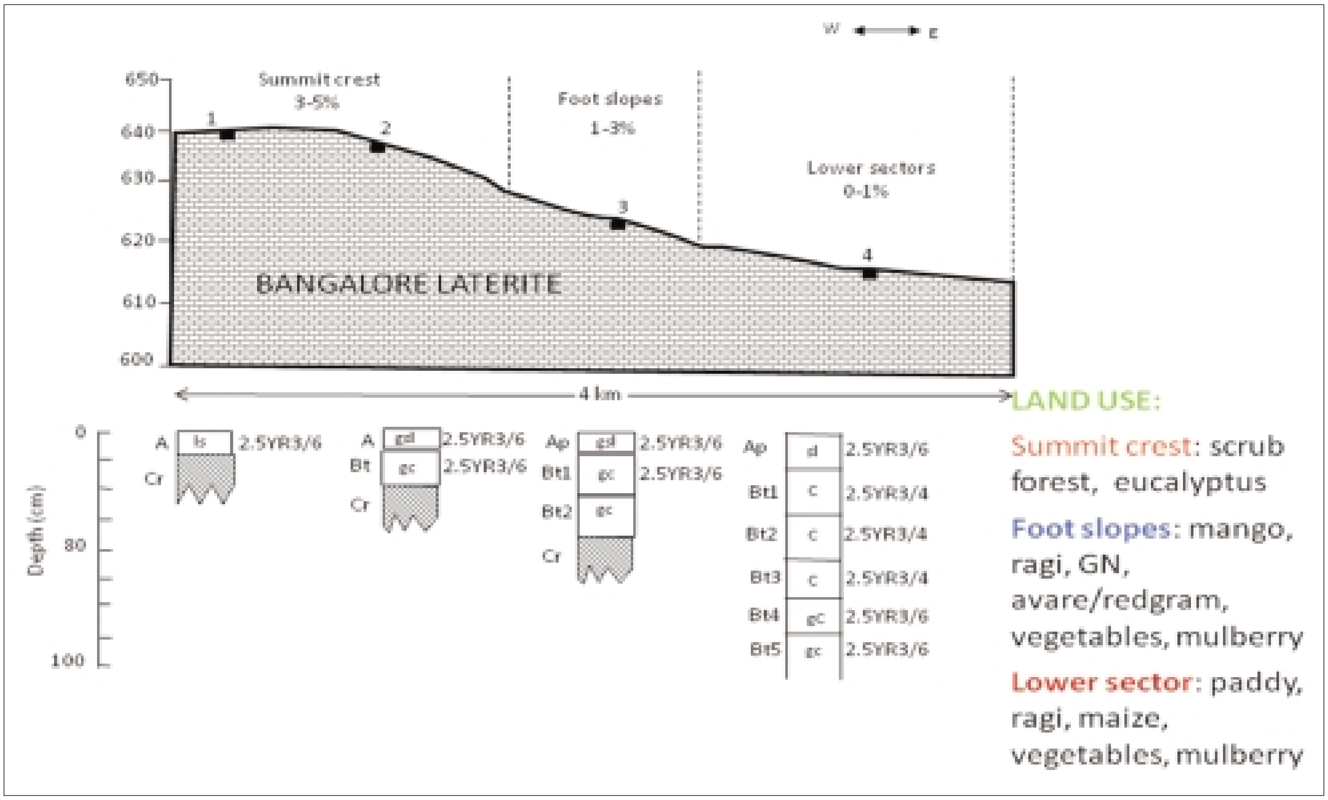


Fig. 3.4 Landform-soils relationship near Attur village, Chintamani Taluk, Chikkaballapur district

Lateritic terrain

The lateritic landform of Bangalore plateau around Chintamani area have been shown in figure 3.4. The soils of the summit crest are very shallow, dark red, sandy (texture) in the upper portions, and shallow, dark red and gravelly and clayey in the lower portions. The soils of the foot slopes are slightly deep to moderately deep, dark red, gravelly clay in texture. The soils of the lower sectors are very deep, dark red, non-gravelly and clayey in texture. The land use in the summit crest is dominated by scrub forest with Eucalyptus plantations, whereas in the foot slopes the land use is mango, ragi, groundnut, redgram, vegetables and mulberry. In the lower sectors, in addition to this, paddy is the dominant land use replacing mango.

A Simplified Model for Soil Mapping at Village Level

A simplified model has been developed for easy mapping of soils at village level based on the available geomorphic processes and their influences (Fig. 3.5). In the uplands, the summit crest is the highest elevated part, in which the dominant geomorphic processes are sheet wash and rill wash with incipient gulley formation, occasional rock outcrops and isolated hillocks. This is represented by the dorsal view of a person's hand with the fingers spread over.

The midlands are represented by the thumbs and forefinger which have narrow spurs, with elongated, restricted summits. The dominant geomorphic processes are slope wash, with cut and leveled bench terraces and terracettes.

The lowlands constitutes broad valley between the thumb and forefingers, and medium to narrow valleys between other fingers with manmade storage tanks spread out. Colluvial and entrainment geomorphic processes are dominant here. Away from the finger tips, the area is surrounded by the thalweg, always represented by a stream channel, which is the lowest elevated area of the village/watershed. In between the midland and the lowlands, the area is dominated by nose slopes, where flow lines radiate outwards; head slope where flow lines converge and starting of the drainage channels occurs and the side slopes, where the flow lines are parallel to each other.

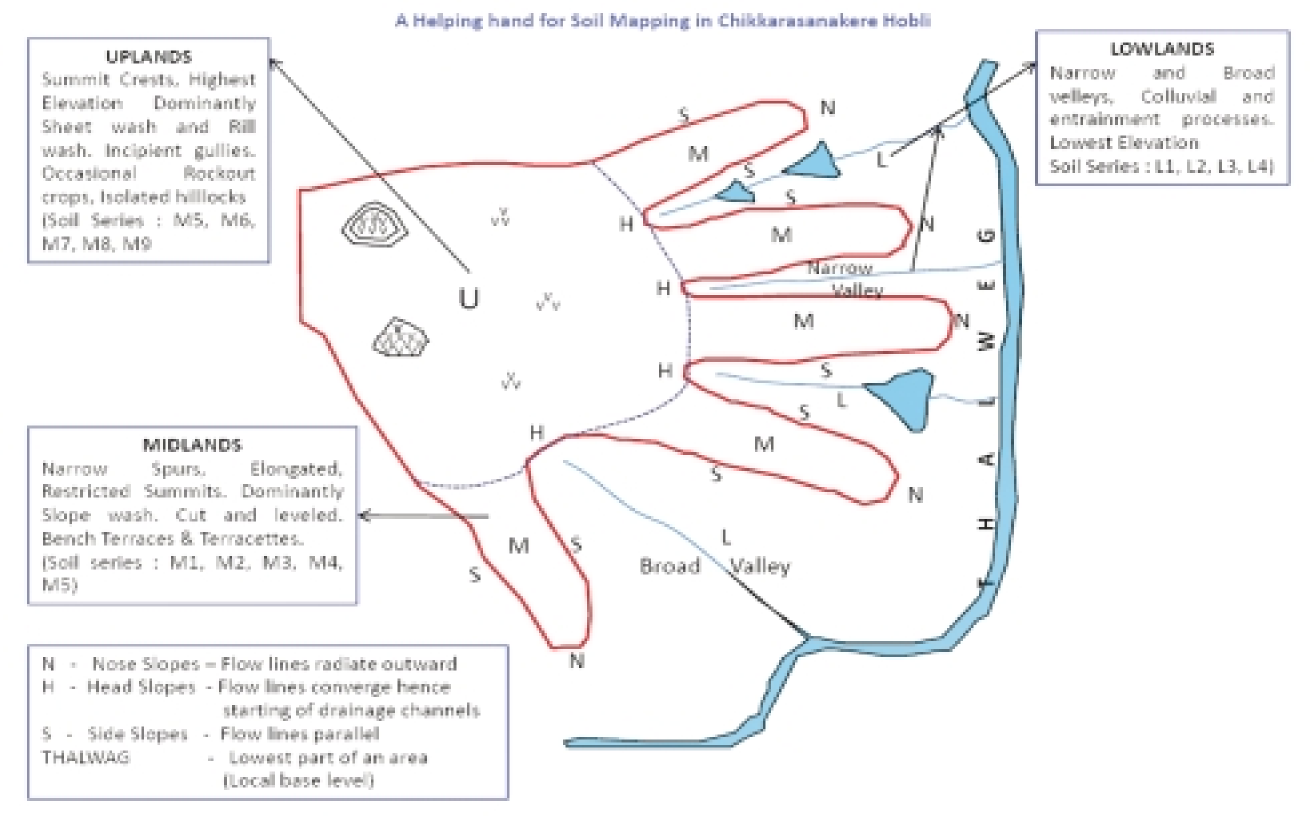


Fig. 3.5 A simplified model for easy mapping of soils at village level

Development of protocols for digestion, standards and methods to determine elements in soil and sediments using Inductively Coupled Plasma Spectrometry (ICP-AES)

S.K. Ray, P. Chandran, T. Bhattacharyya, P.L.A. Satyavathi, D.K. Pal, S.G. Anantawar and P. Raja

Elemental analysis continues to play an important role in the characterization of soils. Analysis of major, trace, minor and rare earth elements provides necessary data to users of soil survey in a variety of areas such as elemental source, forms, mobility and bio-availability. Soil geochemistry is functional in characterization of soil types, determining soil processes or issues related to soil quality and health such as evaluating suitability of soils for urban or agricultural land use as well as define ranges of soil properties for soil series or mapping unit. Much of the current emphasis on geochemistry in soil science is related to the chemistry of trace elements controlling the movement, distribution and fate in plants and soils of native pools and anthropogenic addition of elements. In the light of this, the following protocols and techniques were used to carry out the project work: (i) To standardize microwave (MW) digestion technique using soil and plant samples. This technique helps to check the evaporation loss as the samples are digested in closed teflon vessels as well as bring about more efficient dissolution as a result of increased vapor pressure in a relatively small time; (ii) Different methods were developed to address the digestion protocols for different types of material i.e. soil and plants and depending upon the number of samples to be analyzed at a time. Details of each method are given in programmes 1 to 6.

In order to restrict the total number of steps to the barest minimum, we preferred neutralization of the HF, residue from the silicate digestion step by addition of 4% boric acid solution to enable Si to be simultaneously analyzed along with other major (Ti, Al, Fe, Mn, Mg, Ca, Na, K) and trace elements (Ba, Sr, Ni, Cr, Cu, Zn, Pb, Cd, P, S, Mo, As, Se, Hg) from the same solution. The unneutralized HF in the sample solution would harm the glasswares used in the sample nebulization, spray chamber and plasma torch assembly of the ICP instrumentation. Moreover, neutralization of HF is essential to ensure minimum error from loss of SiF_4. Exactly 100mg of 300 mesh soil/plant samples were weighed in teflon vessels. To it 5ml of double distilled water, 2ml of concentrated aqua regia and 3 ml concentrated HF were added and then digested in Microwave (Milestone) for 44 minutes at different power using programme 1. After cooling the teflon vessels for 24 h in a fridge, 10 ml of 4% boric acid was added and repeated using programme 2. In all the programmes, Rotor control and twist should be on and vent for 5 minuts. After cooling overnight, the digested sample was transferred into wide - mouthed polypropylene bottles of 120ml capacity repeatedly washing with 40ml 4% boric acid. The mixture was shaken for 25 minutes, allowed to stand overnight and the volume made upto 100ml with 1N HNO_3.

Programme 1 (10 vessels)

Step	Time (min)	Power (watt)
1	5	250
2	1	0
3	10	250
4	8	600
5	15	250
6	-	-

Programme 2 (10 vessels)

Step	Time (min)	Power (watt)
1	5	250
2	1	0
3	10	250
4	8	600
5	15	250
6	3	0
7	15	250
8	-	-

Programme 3 (2 or 4 vessels)

Step	Time (min)	Power (watt)
1	5	100
2	1	0
3	10	100
4	8	200
5	15	100
6	-	-

Programme 4 (2 or 4 vessels)

Step	Time (min)	Power (watt)
1	5	100
2	1	0
3	10	100
4	8	200
5	15	100
6	3	0
7	15	100
8	-	-

Programme 5 (6 or 8 vessels)			Programme 6 (6 or 8 vessels)		
Step	Time (min)	Power (watt)	Step	Time (min)	Power (watt)
1	5	200	1	5	200
2	1	0	2	1	0
3	10	200	3	10	200
4	8	400	4	8	400
5	15	200	5	15	200
6	-	-	6	3	0
			7	15	200
			8	-	-

Ascertaining the pedogenetic processes for the clay enriched Bss horizons of Vertisols

P.L.A. Satyavathi, S.K. Ray, P. Chandran, P. Raja, S.L. Durge and D.K. Pal

Nearly uniform clay free sand/silt distribution in the soils indicates the lithological continuity. Morphological examination of the pedons did also not indicate any stratification. Thus, the clay enrichment in the Bss horizons of Vertisols under study may not be due to sedimentation. Depth distribution of total and fine clays suggests the clay illuviation process for the enrichment of clays in the Bss horizons of the soils. Smectite dominates the clay fraction of Bss horizons and the depth distribution of smectite indicates illuviation of fine clay smectite. Feldspars (upto 83%) and quartz (4 to 65%) were the dominant minerals in silt size fractions (coarse silt, medium silt and fine silt), whereas the main component of clay size fractions (coarse clay, medium clay and fine clay) is smectite (23 to 99%). The other minerals identified in silt and clay size fractions are vermiculite (nil to 20%), chlorite (nil to 35%), mica (nil to 28%), kaolin (nil to 21%) and zeolites (nil to 15%). The study indicated that huge amount of smectite must have been formed upon weathering of plagioclase of Deccan basalt in an earlier humid climate and deposited in lower elements of topography where Vertisols generally occur. The smectite has been preserved till date in the relatively less leaching environment of the drier climate. The concentration of CaO and Na_2O appears to decrease with decreasing particle-size from coarse silt to fine clay. This might be due to less resistant nature of plagioclase feldspars. Presence of clay pedofeatures amidst papules indicates that the pedoturbation was not enough for the complete destruction of clay pedofeatures. Thus, the presence of clay pedofeatures in the soils of different climatic regions suggests that the Vertisols under study have experienced the process of clay illuviation amidst pedoturbation.

Estimating saturated hydraulic conductivity, bulk density, and other physical properties of the Vertisols and Vertic intergrades from published research and soil survey data

N.G. Patil, D. K. Pal, C. Mandal and D. K. Mandal

Ten different functions to describe soil water retention characteristics (SWRC) were evaluated for the available data while developing a model on the formation and resilience of naturally degraded black soils of the peninsular India as a decision support system for better land use planning

Campbell model fitted better than any other model as evidenced by relatively lower RMSE (0.0199), highest degree of agreement (0.9867), low mean absolute error (0.0134) and better coefficient of determination (0.9512). Barring maximum error which was lower in BC model, all other indices established the superiority of Campbell function in describing SWRC data of the black soils followed by modified Cass-Hutson function, VG and BC.

The comparative evaluation of PTFs to estimate available water capacity (AWC) developed using k nearest neighbour (k-NN) and artificial neural networks (ANN) showed that at lowest input level (texture-SSC), the performance of k-NN PTF was relatively better as indicated by lower RMSE (0.0339) than RMSE of 0.0437 at the same input level in neural PTF. Both the techniques underlined importance of choosing a correct input variable for Vertisols rather than the number of variables. As a tool, k-NN performed better than neural networks with additional advantage of simplicity in use and possible appending of development dataset and hence could be a tool of choice.

Neural PTFs performed better than statistical PTFs. The best PTF (Fig. 3.6) required information on four variables namely sand, silt, field capacity (FC) and permanent

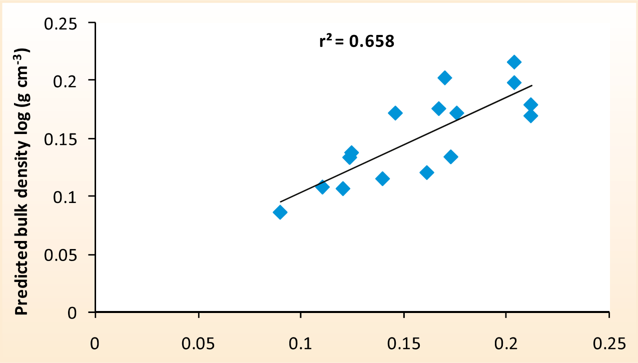


Fig. 3.6 Correspondence between measured and predicted bulk density values with sand, silt fractions and moisture constants (FC and PWP) data as an input in derived PTF

wilting point (PWP). There was an improvement in PTFs performance when FC and PWP were included in place of clay fraction as an input. It could be argued that the measures of structure as well as information on pore structure were essential to predict bulk density accurately. Exclusion of clay as an input variable led to improvement in PTFs performance probably due to the fact that the clay content was always above 40 % with low coefficient of variation that caused difficulty in training networks. The best performing PTFs (input sand, silt, FC and PWP) had lowest RMSE (0.01), MAE (0.01) the highest d (0.95) and R^2 (0.83) when networks were fitted to the measured data. It also had the lowest RMSE (0.01), MAE (0.01) and the highest d (0.7) and R^2 (0.65) when tested for predictive ability.

Thus it was evident that the PTFs to predict bulk density of the impounded shrink swell soils could be used for obtaining reasonable estimates with relatively higher number of input variables compared to PTFs reported in the literature.

Water retention characteristics and saturated hydraulic conductivity of dominant soil series of Yavatmal district, Maharashtra

P.L.A. Satyavathi, Pramod Tiwary, S.K. Ray, P. Chandran, B.P. Bhaskar, Jagdish Prasad and Tapas Bhattacharyya

The soils of the district are neutral to alkaline in reaction as they are mostly derived from calcareous or baserich parent materials. About 68 per cent samples were observed to be moderately alkaline, 16 per cent are strongly alkaline, 8 per cent are slightly alkaline, 6 per cent are neutral and the remaining 2 per cent are very strongly alkaline in soil reaction. The pH between 7.8 to 8.2 in these soils indicates the presence of calcium carbonate. All the studied soils are non-saline (EC <1dS m^{-1}). The soils contain free $CaCO_3$ ranging from 0.44 to 37 per cent which increases with depth. The per cent moisture retained in these soils ranged from 4 to 34 at 1 bar and from 2 to 25 at 12 bar.

Genesis and Classification of Benchmark ferruginous soils of India

P. Chandran, S.K. Ray, T. Bhattacharyya, D. K. Pal and Dipak Sarkar.

Most of the ferruginous soils of India are acidic in nature, low to medium in CEC and base saturation, except the ferruginous soils of arid and semi arid climates (South India).

Formation of pedogenic $CaCO_3$ as lubinite mineral and subsequent development of sub-soil sodicity is indicative of natural degradation process and climate change in these ferruginous soils.

Presence of gibbsite along with 2:1 minerals in these soils does not support anti-gibbsite hypothesis proposed by many researchers earlier. Therefore presence of gibbsite could not be considered as an index of advanced stage of weathering. Classical chemistry of the precipitation of Al^{+3} ion (in the alkaline condition) as gibbsite proves this fact. Gibbsite is product of alkaline environment and has no relevance in the contemporary pedogenesis of acid Utisols. Thus the “Gibbsittic” and “Allitic” mineralogy class for the so called highly weathered soils should be discontinued.

Detailed studies on X-ray diffraction pattern of large number of samples of BM soils of India indicate that 0.7nm peak of kaolin are not true kaolinite as perceived earlier but interstratified with 1:4nm mineral. Therefore true kaolinite in tropical ferruginous soils is improbable suggesting that mono-minerallitic composition like kaolinite is rare in contrast to National and International claims. The Kaolin minerals are still in the intermediate stage of weathering (KI-HIV, KI-HIS) in ferruginous soils and the Clay CEC > 24 cmol (p^+) Kg^{-1}. Therefore it would be prudent to assign mixed mineralogy class for ferruginous soils to justify their good productivity unlike those group of soils dominated by kaolinite.

High SiO_2 / Al_2O_3 and SiO_2/R_2O_3 ratio in all ferruginous soils under study indicate that desilication is not active in the highly weathered ferruginous soils and these soils still have good amount of weatherable minerals though our study was restricted to Alfisols and Utisols. Silica solubility in an acid environment is not possible because it is soluble in alkaline pH .Thus the theory of formation of kaolinite generally found in acid soils from K-HIV is questionable. Therefore laterization process (alkali hydrolysis) cannot be active in acid soils. Desilication can occur only under alkaline environment. The genetic model on the formation of soils in tropical environment in vogue and also transformation of Utisols to Oxisols appears to be in error. This raises a doubt on the very existence of Oxisols in nature thus needs a revision of Soil Taxonomy.

Vermiculite has a huge capacity to sequester Al in soils and it acts as a sink for Al^{+3} released during tropical weathering and protects the plants from Al toxicity. The study also indicates that these soils also have a capacity to sequester huge quantity of organic carbon (about 2%). Therefore capacity of organic carbon sequestration and presence of vermiculite in these soils can be used as a land quality parameter. Besides laterized material is soft as long as they are well beneath the soils and irreversible hardening takes place when the materials are exposed. The method of puncturing the laterite cap and plantation of mango, rubber is followed in these soils. Keeping the soils under vegetation can restrict the process of hardening.

Interfluve Stratigraphy, Sedimentology and Geochemistry of Central and Southern Ganga Plains (Funded by DST, New Delhi)

T. Bhattacharrya, P. Chandran, S. K. Ray, P. Raja, P.L.A. Satyavathi, Chetna Likhar and Shubhangini Thakre

Samples of two cores of Kalpi(~50 m) and Rania(~29m) were completed and the location of cores are shown in Fig. 3.7. Core samples up to the depth of about 16.56 m are moderately to strongly alkaline in reaction. Below this depth core is very strongly to extremely alkaline in reaction up to 28.37 m depth with very low concentration of soluble salts. The entire core is calcareous and maximum concentration of $CaCO_3$ (~23 %) is noted in sediments at about 26.30 m depth, but content of organic carbon is considerably low (<0.5 %). Bulk density of core ranges between 1.1 to 1.5 Mgm^{-3}. The texture of the core is silt loam through out depth with high content of silt fraction than clay fraction. There is an appreciable increase in silt fraction between 2.06 to 6.21 m, 7.85 to 12.57 m, 12.97 to 16.14 m and 16.56 to 28.37 m. Clay fraction increase from 2.06 to 8.30 m depth and decrease with 9.07 to 28.37 m depth (Fig. 3.8).

The Kalpi core samples are moderately (at 8.0 to 15.21 m depth) to strongly alkaline (at 7m depth) in reaction, calcareous and contain some amount of soluble salts (8.95 m to 10.64m and 11 to 12.50m depth), organic carbon is > 0.1% at 7 to 8.7m depth and below this depth the organic carbon is less indicates that there was little time lag between episodes of sediment deposition. Both pH and $CaCO_3$ values indicate the influence of aridic climatic conditions during the post depositional period of the sediment. The texture varies from silt loam to clay loam. This indicates that the fluvial deposits were of various textural classes. The high content of clay is not however expected in the core samples until there has been the influence of other rock formation amidst the deposition mainly controlled by Yamuna-river system. The silt fraction is dominant throughout the depth upto 15.21 m. The increase in clay content from 8.28 to 15.21 depth may indicate the movement of clay but shows the highly irregular distribution of fine clay content indicates the increase in clay appears to be associated with sedimentation. Kalpi core resembles the characteristics of Bhognipur core (Fig. 3.8).

Fig. 3.7 Location map of study area

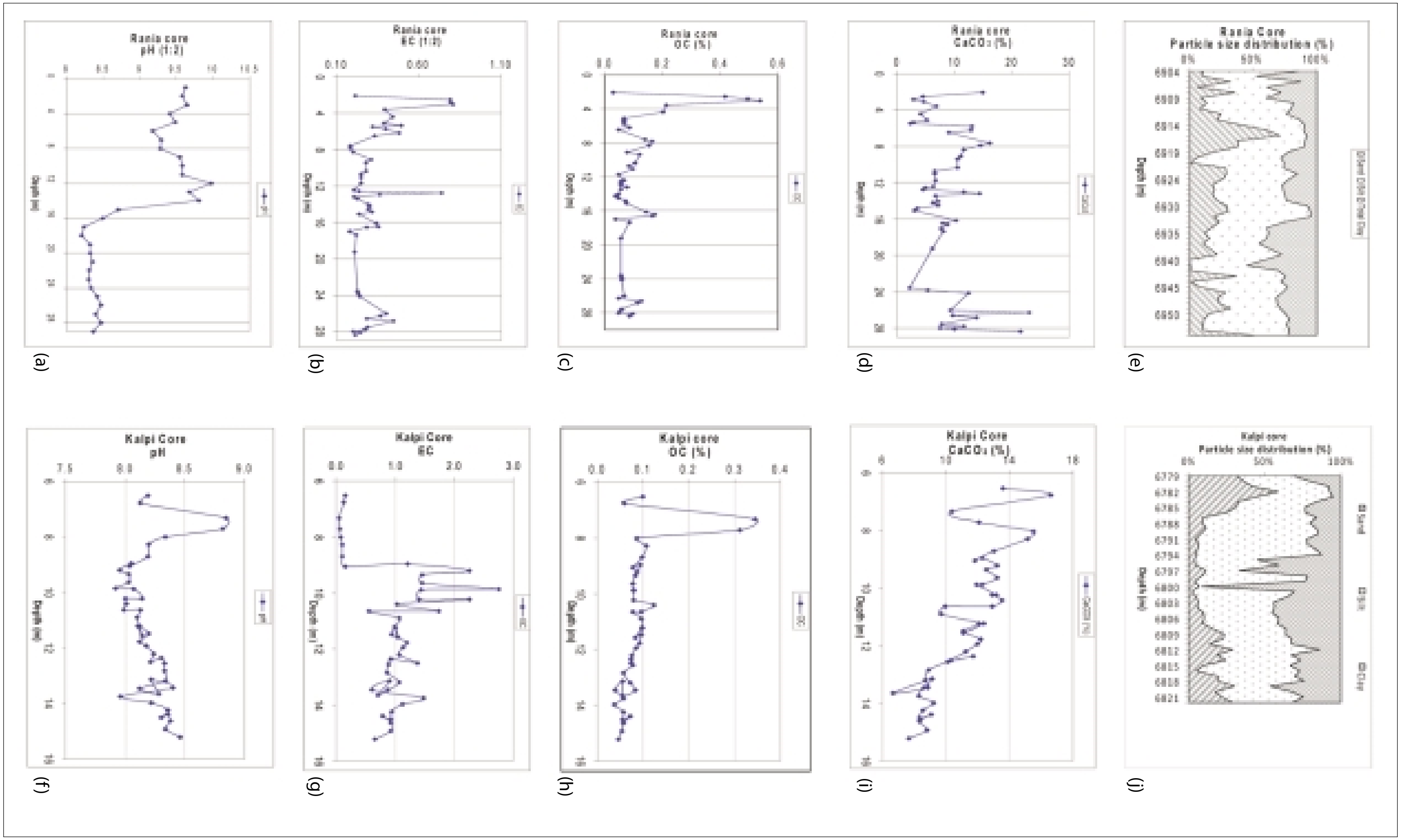


Fig. 3.8 Distribution of various soil parameter in Rania core (2.86 – 28.37 m depth) (a-e) and Kalpi core (6.52 – 15.21 m depth (f-j).

2.4

Soil Survey Data Interpretation and Application

Agro-Ecological Zoning

Land Resource Management

Soil Health/Quality and Monitoring

Soil and Crop Modelling

Soil resource data and their interpretation for implementation of river link projects- Ken – Betwa river link project

A.K. Maji, G.P. Obi Reddy, S. Thayalan, M.S.S. Nagaraju and A.K. Barthwal

The project was aimed to generate soil resource information and interpret the data for implementation of Ken-Betwa river link project. IRS-IC LISS-III satellite data in conjunction with contours (20 m) and drainage was interpreted for delineation of various physiographic units in the river basin. Slope map of the area was prepared based on contour information available on SOI toposheet. Similarly, two seasons IRS-IC LISS-III data have been analysed to delineate different land use/land cover classes based on image interpretation techniques. The major physiographic region is divided into Malwa Plateau, Pathar and Bundelkhand Upland and Vindhyan Ranges with Escaprment. The physiography legend is presented in table 4.1 and the physiography map is in figure 4.1a.

Other soil based thematic maps, namely, soil depth, soil texture, drainage, soil erosion and soil salinity/sodicity maps have been generated in ArcGIS software using soil databases of Madhya Pradesh and Uttar Pradesh states on 1:250,000 scale. In order to delineate potential submergence zones in the river basin, the parameters like topography, slope, drainage and land use systems were considered. The area under high, moderate and low potential submergence zones constitutes 1515.4, 2505.9 and 2153.9 km^2 respectively (Fig. 4.1b).

Table 4.1 Physiography legend of Ken-Betwa river basin

Map Symbol	Landforms	Physiographic description	Area (Sq. km.)
	C	**Central Highland**	
	Cm	**Malwa Plateau**	
	Cma	*Basaltic Landscape*	
1	Cma1	Moderately sloping hills with escarpment	124.9
2	Cma2	Gently sloping Plateau	3451.7
3	Cma3	Very gently sloping alluvial plain	5050.2
4	Cma4	Very gently sloping valley plain	3669.7
	Cp	**Pathar and Bundelkhand upland**	
	Cpa	*Sand stone Landscape*	
5	Cpa1	Moderately sloping hills with escarpment	1109.9
6	Cpa2	Undulating plateau	265.5
7	Cpa3	Gently sloping intervening basin	214.8
8	Cpa4	Gently sloping pediment	461.0
	Cpb	*Granite-gneissic Landscape*	
9	Cpb1	Hilly terrain	2945.0
10	Cpb2	Undulating to rolling land with residual hills	1231.1
11	Cpb3	Undulating plateau	3561.1
12	Cpb4	Gently sloping plateau	3665.6
13	Cpb5	Very gently sloping river valley	1397.7
	Cpc	*Alluvial Plain*	
14	Cpc1	Residual hillocks with pediment	91.4
15	Cpc2	Undulating Upland	375.8
16	Cpc3	Moderately sloping upland with hummocks	870.6
17	Cpc4	Gently sloping upland with hummocks	181.6
18	Cpc5	Very gently sloping plain with hummocks	3445.7
19	Cpc6	Flood Plain	361.3
20	Cpc7	River valley (highly dissected)	3865.7
	Cv	**Vindhyan Ranges and Escarpment**	
	Cva	*Sandstone Landscape*	
21	Cva1	Moderatly sloping hills with escarpment	2274.2
22	Cva2	Hills with narrow valley	194.8
23	Cva3	Residual hillocks with pediment	588.6
24	Cva4	Gently sloping pediment	488.3
25	Cva5	Intervening valley	558.6
	Cvf	*Basaltic Landscape*	
26	Cvf1	Moderately sloping hills with pediment	737.5
27	Cvf2	Gently sloping plateau	301.2
28	Cvf3	Very gently sloping alluvial plain	826.5
29	Cvf4	Very gently sloping river valley	230.2
		Waterbodies	675.0
		Rivers	225.0
		Settlements	153.0
		Total	43593

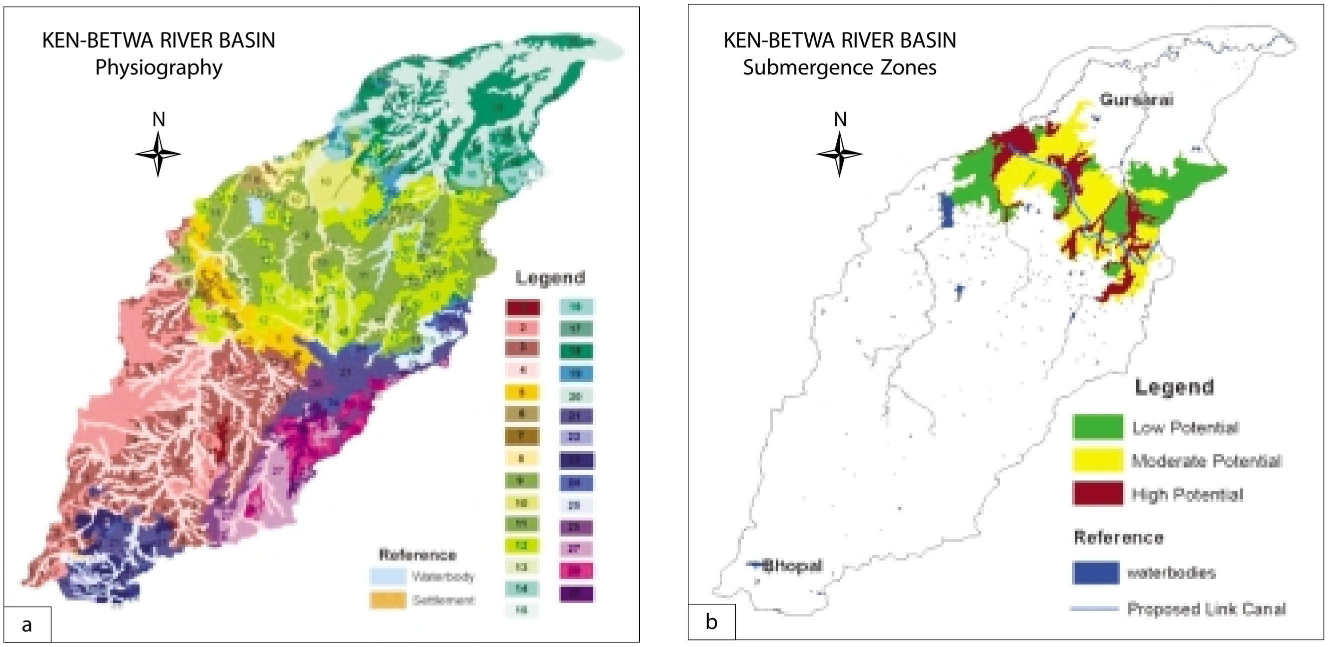


Fig. 4.1 Physiography (a) and submergence Zones (b) of Ken-Betwa river basin

Agro-ecological zoning of Tamil Nadu

L.G.K. Naidu, S. Srinivas, A. Natarajan, S. Thayalan and V. Ramamurthy

Agro-ecological zone (AEZ) map of Tamil Nadu was revised and 17 zones were delineated. The revised AEZ map was sent to 29 Research station of TNAU for validation of Length of Growing Period (LGP) and these station agree with our zones. However, there was a lot of heterogenity in soil within the zone. Thus soils occurring in each zone were grouped into management units (Fig. 4.2) considering similar soil characterstics, behavior and response to management. Lowest number (1) of management unit is in Nilgiris (1.1) and highest of number (10) of management units were in Inland plains (5.4). Blanket recommendations being followed at present need to be revalidated and refined considering management unit as a basis.

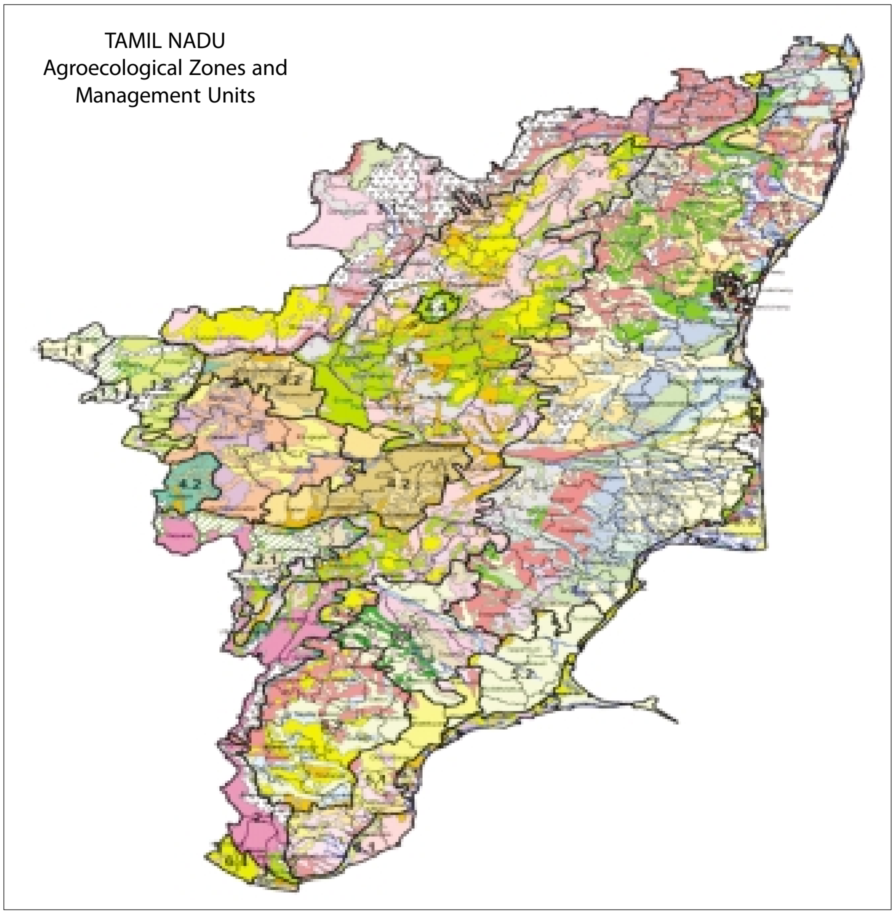


Fig. 4.2 Agro-ecological zones and management units

Legend

1.1 LGP 210-240 days
- Deep to very deep clayey soils

1.2 LGP 240-270 days
- Deep to very deep clayey soils
- Deep calcareous clay soils (low lands)
- Medium deep red loamy soils
- Shallow red gravelly loam soils

2.1 LGP >270 days
- Deep to very deep red clayey soils
- Medium deep red loamy soils
- Deep calcareous clay soils (low lands)
- Medium deep red clayey soils
- Shallow red gravelly loam
- Deep to very deep black soils

3.1 LGP 150-180 days
- Medium deep red clayey soils
- Deep clayey soils (low lands)
- Very shallow red loamy soils
- Medium deep red gravelly clay
- Medium deep red gravelly clay
- Deep to very deep red clay soils

4.1 LGP <90 days
- Shallow red gravelly loam
- Medium deep red gravelly loam
- Deep calcareous clay soils (low lands)

4.2 LGP 90-120 days
- Shallow red gravelly loam
- Medium deep red loamy soils (gravelly in patches)
- Very shallow red loamy soils
- Deep calcareous clay soils (low lands)

4.3 LGP 150-180 days
- Medium deep red gravelly clay soils
- Shallow red gravelly loam
- Medium deep loam soils (low lands)
- Deep to very deep red clayey soils
- Medium deep red gravelly loam
- Deep clay soils (low lands)

4.4 LGP 240-270 days
- Shallow to medium deep red gravelly loam

5.1 LGP <90 days
- Very deep calcareous black soils (low lands)
- Medium deep red gravelly loam
- Deep to very deep black soils (up lands)
- Medium deep loamy soils (low lands)

5.2 LGP 90-120 days
- Very deep calcareous black soils (low lands)
- Deep to very deep black soils (up lands)
- Medium deep red gravelly clay soils
- Deep to very deep red loamy soils
- Deep calcareous loamy soils (low lands)

5.3 LGP 120-150 days
- Very deep calcareous black soils (low lands)
- Deep to very deep black soils (up lands)
- Medium deep red gravelly clay soils
- Deep red gravelly clay

5.4 LGP 150-180 days
- Very deep calcareous black soils (low lands)
- Deep calcareous clay soils (low lands)
- Deep to very deep black soils (up lands)
- Deep to very deep red loamy soils
- Very deep lateritic clayey soils
- Medium deep red gravelly clay soils
- Deep calcareous loamy soils (low lands)
- Medium deep red gravelly loam
- Deep red gravelly clay
- Very deep sandy soils

6.1 LGP <90 days
- Very deep sandy soils
- Deep to very deep black soils
- Medium deep red gravelly loam
- Very deep calcareous black soils (low lands)
- Deep red gravelly clay

6.2 LGP 90-120 days
- Very deep sandy soils
- Very deep black soils (low lands)
- Deep to very deep loam soils

6.3 LGP 150-180 days
- Very deep sandy soils
- Very deep calcareous black soils (low lands)
- Deep to very deep black soils (up lands)

6.4 LGP 180-210 days
- Very deep sandy soils
- Deep to very deep black soils (uplands)
- Very deep calcareous black soils (low lands)
- Medium deep to deep red clayey / lateritic clay

6.5 LGP 240-270 days
- Deep red gravelly clay
- Deep clayey soils (low lands)

- Forest
- Rocky lands
- Water body
- Mining
- Marshy land
- Settlements
- Pondicherry

Development of Indian soil information system (ISIS) - A GeoPortal

G.P. Obi Reddy, C. Mandal, Rajeev Srivastava, T. Bhattacharya, L.G.K. Naidu, G.S. Siddhu, U. Barua, S.K. Singh, R.S. Singh, Nirmal Kumar and Dipak Sarkar

The project has been undertaken to address some of the research gaps like non-availability of seamless soils data of India (1:250,000 scale) on a common GIS platform (without any generalization), lack of metadata as per the OGC/FGDC norms, lack of interactive spatial data mechanism for updation, retrieval and lack of globally compatible projection systems and datum. The aim of the project is to design and develop seamless Indian Soil Information System (ISIS) on 1:250,000 scale in GIS with metadata to store, update, manage and query the geospatial soil database, to design and develop a GeoPortal (Stand alone) through assimilating ISIS with soil loss, acid soils, degraded/wastelands, along with digital terrain and satellite database at regional scale and to provide the single point geospatially enabled GeoPortal to access the harmonized geospatial soil information.

In order to provide seamless soil database (1:250,000 scale) at national scale, the compilation of state-wise soil information is in progress. To provide the other soil related databases, the generation of river basins and sub-basins at national scale has been completed. Assimilation of AER and AESR database with soil resource database at national scale is in progress.

Development of district soil information system (DSIS) on 1:50,000 scale (50 districts)

G.P. Obi Reddy, C. Mandal, Rajeev Srivastava, T. Bhattacharya, L.G.K. Naidu, G.S. Siddhu, U. Barua, S.K. Singh, R.S. Singh, Nirmal Kumar and Dipak Sarkar

Though NBSS&LUP has completed the soil survey in more than 70 districts on 1:50,000 scale, the availability of digitized soil database (1:50,000 scale) for the same on a common GIS platform in uniform standard is not available and hence the project has been undertaken. The aim of project is to design and develop District Soil Information System (DSIS) on 1:50,000 scale (50 districts) with uniform standards to store, process, manage the geospatial soil database at district level, to enhance the utility of soil database at district level and to provide the standardized and enriched district soil information to query and retrieve at district, tehsil and block level for the users. During the reporting period, the district soil database of Bhandara, Chandrapur, Gondia, Nagpur (Maharashtra), Moradabad and Muzzffarnagar (Uttar Pradesh) districts were converted into uniform projection system and brought under India district database (Fig. 4.3).

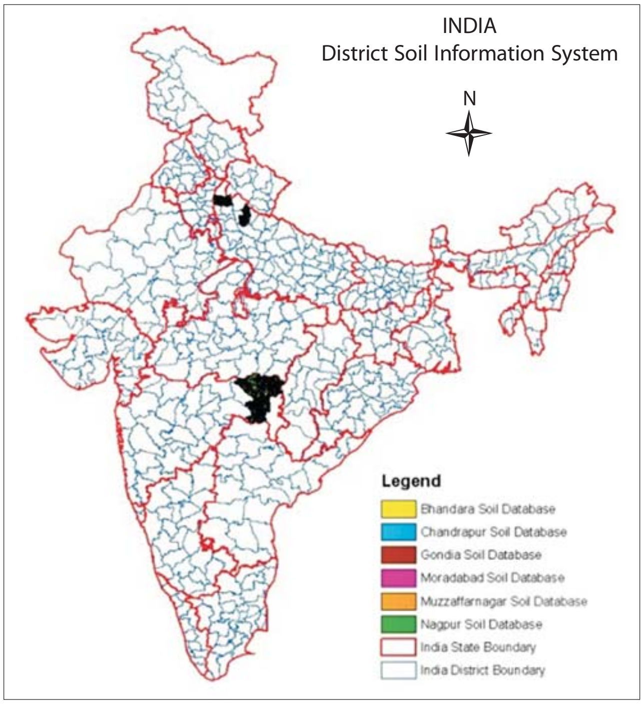


Fig. 4.3 District Soil Information System

Characterization and evaluation of carbon (SOC) and sulphur status in soybean growing areas of Dhar district, Madhya Pradesh to suggest an alternative cropping pattern

K.Karthikeyan, Jagdish Prasad, Pushpanjali and Dipak Sarkar

Three window areas were demarcated in Malwa Plateau viz., Sardarpur, Badnawar and Dhar which come under the administrative boundary of Dhar district. These areas are the prominent soybean growing areas of Madhya Pradesh. Window areas were demarcated and seven soils were studied. Surface samples were also collected to know the depletion status of the nutrient under study. Characterization of these soybean-growing soils in terms of morphological, physical and chemical characteristic was done. These soils were silty clay to clay in texture, with pH 7.6 to 9.0. Soils were deficient in sulphur and organic carbon. The clay CEC is more than 60, indicating the presence of smectitic clay. Potassium is sufficient, whereas phosphorus and nitrogen are deficient. The COLE values are found to be moderate (0.03 to 0.06) to very high (>0.09) at room temperature. Micro-nutrient analysis indicated that no other nutrients (Mn, Cu and Fe) except Zn shows a definite trend in the profile.

Soil microbial biomass carbon and nitrogen in selected soil series of North-Eastern Region as affected by different land uses and varied agro-ecological conditions

T. Chattopadhyay, D. J.Nath, D. Dutta, S.K. Reza and U. Baruah

Horizon-wise soil samples from two different land uses viz. tea and paddy were collected from different depths using steel ring (10cm diameter and 5 cm height) from Sonari Tea Estate of Sonari village and Goghaingaon village of Sibsagar district and transferred immediately to ice boxes at a temperature not exceeding 4^0C. The samples were kept in lyophillizer for analysis of Soil Microbial Biomass Carbon (SMBC) and nitrogen. From Jorhat district, samples were collected from two forest sites viz. Disai valley and Gibbon R.F using the same technique. A separate set of samples were collected for routine analyses of different physical and chemical properties. Samples for bulk density analysis were collected using core sampler. Data for the 19 samples are presented in table 4.2.

Soil microbial biomass carbon was determined in the microbiological laboratory of Assam Agricultural University, Jorhat using the formula MBC (Microbial Biomass Carbon; µg/g) = EC/K_{EC}; where EC = (OC from fumigated samples – OC from non fumigated samples) and K_{EC} = 0.38.

Table 4.2 Salient properties of soils of different land use in north-eastern region

Profile No	Depth (cm)	Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	% of OC	pH (1:2.5 H2O)	SMBC (µg/g)
		… (% of <2mm) …					
P1/SON	Land Use : Tea						
	0-20	18	47	35	1.04	5.7	136
	20-42	12	28	60	0.86	5.5	123
	42-64	9	31	60	0.48	5.3	111
	64-95	9	31	60	0.46	5.2	37
	95-150	9	31	60	0.40	5.9	12
P2/DISAI VALLEY	Land Use: Forest						
	0-20	53	27	20	0.48	5.1	148
	20-42	66	18	16	0.19	5.2	24
	42-86	65	19	16	0.17	5.0	25
	86-120	66	18	16	0.21	5.0	25
	120-150	63	16	20	0.19	5.3	12
P3/GIBBON RF	Land Use: Forest						
	0-20	45	45	10	0.69	5.0	74
	20-60	41	39	20	0.42	4.8	49
	60-92	41	38	20	0.38	4.9	37
	92-122	40	35	25	0.31	2.2	12
P4/DILIHI VILL.	Land Use: Paddy						
	0-20	4	36	60	2.19	5.3	74
	20-52	3	27	70	0.73	5.4	25
	52-83	3	22	75	0.59	5.5	25
	83-103	3	22	75	0.36	5.2	12
	103-142	13	32	55	0.27	5.1	12

The results indicated that the vertical distribution of soil C and soil MBC was very similar in the profiles and showed a decreasing trend with depth.

Development of a soil water balance model for shrink-swell soils of Central India

P. Tiwary, D.K. Mandal and T.N. Hajare

A soil water balance model (**SowBass**) was developed for the shrink-swell soils of Central India using Visual Basic 6.0 (Fig. 4.4). The input parameters required to run the model are weather, soil and crop information. The weather data comprises latitude, longitude and altitude of the location, rainfall, maximum and minimum temperatures, net solar radiation or sunshine hours, vapour pressure or relative humidity, and wind speed. The soil input parameters are depth wise moisture contents at 33 kPa, 100 kPa and 1500 kPa, bulk density and saturated hydraulic conductivity, initial moisture content and amount of water to be infiltrated through the cracks. The crop information required as input parameters are date of sowing, crop coefficient values and crop duration at initial, development, mid and late stages. For missing weather data, indirect method is used to estimate the potential evapotranspiration.

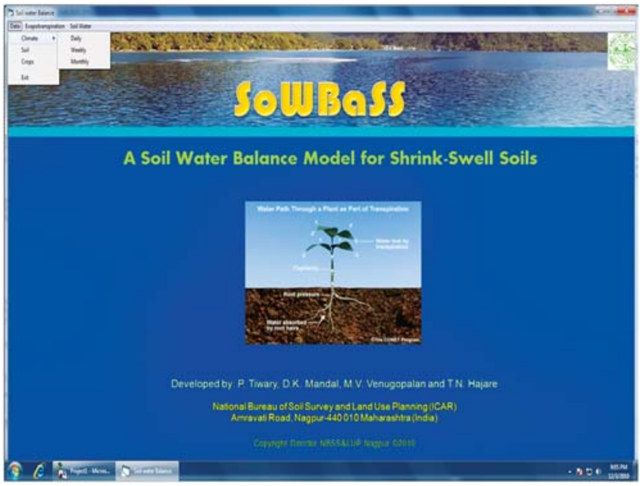


Fig. 4.4 Graphical User Interface of the developed soil water balance model (SowBass)

The developed soil water balance model was validated using soil moisture data recorded fortnightly in the experimental farm of CICR, Nagpur from 2001 to 2003. The mean of errors (ME), the root mean square error (RMSE) and model efficiency (EF) were calculated for all the three years (Table 4.3). The observed and predicted values were plotted and based on 1:1 line, the goodness of fit was determined (Fig. 4.5) and a graph was also plotted for the observed and simulated soil moisture of the year 2003 (Fig. 4.6).

Table 4.3 Estimated values of ME, RMSE and EF

Year	ME	RMSE	EF
	(%)		
2001	-0.1	5.9 (20.5)	-0.44
2002	1.7	6.0 (19.1)	0.16
2003	-3.75	8.0 (30.2)	-2.89

Note: figures in parentheses indicate the percentage RMSE value with respect to mean observed value

From the table 4.3, it is observed that the developed model could enable predict the soil moisture contents satisfactorily for the years 2001 and 2002 with ME values of - 0.1% and 1.7% and RMSE values of 5.9% and 6%, respectively. However, the model efficiency (EF) is negative for the year 2001, which is not in acceptable range. It also could capture the trend of soil moisture variations well in the moisture recharging period, but failed in the moisture depletion/release period (Figs. 4.5 and 4.6) resulting in its under-prediction during this period. The reason could be the complexity involved in the water release behavior of the shrink-swell soils. Hence, the model needs to be validated with more number of soil moisture datasets and refinement of the algorithm dealing the moisture retention-release behavior of the shrink-swell soils.

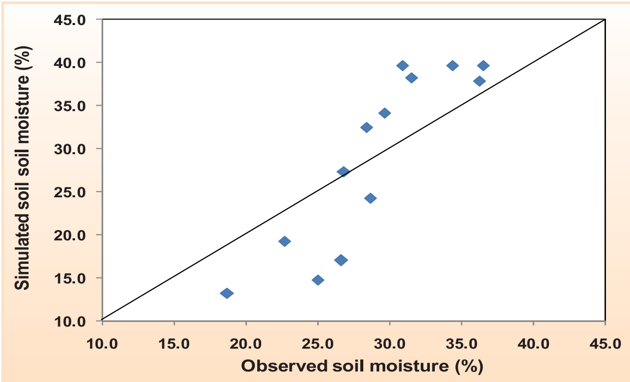


Fig. 4.5 Goodness of fit based on 1:1 line between observed and simulated moisture contents

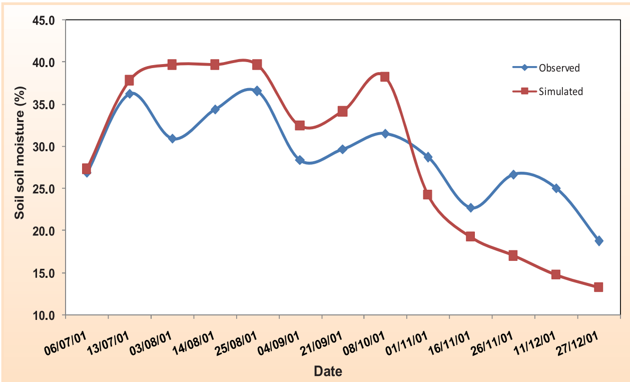


Fig. 4.6 Plot between observed and simulated moisture contents for the year 2001

GIS modeling to predict land productivity potential (LPP) for major crops in sub-humid (Dry) region of Wardha district in eastern Maharashtra

Nirmal Kumar, G. P. Obi Reddy and S. Chaterjee

The project was undertaken to delineate and characterize Pedo-Ecological Units (PEU) of Wardha district, Maharashtra using terrain, climate, soil, crop and cropping system for evaluating the land productivity potential (LPP) for major crops in GIS environment.

During the reporting period, Landsat ETM^+ data of different seasons of year 2000-2001 were downloaded and district mosaic was prepared for Wardha district. In order to develop the terrain database, ASTER GDEM (30 m) scenes were put in mosaic format and different terrain parameters like slope, hill shade, aspect etc. were generated. Landsat ETM + data and ASTER Elevation map of Wardha district are shown in figure 4.7.

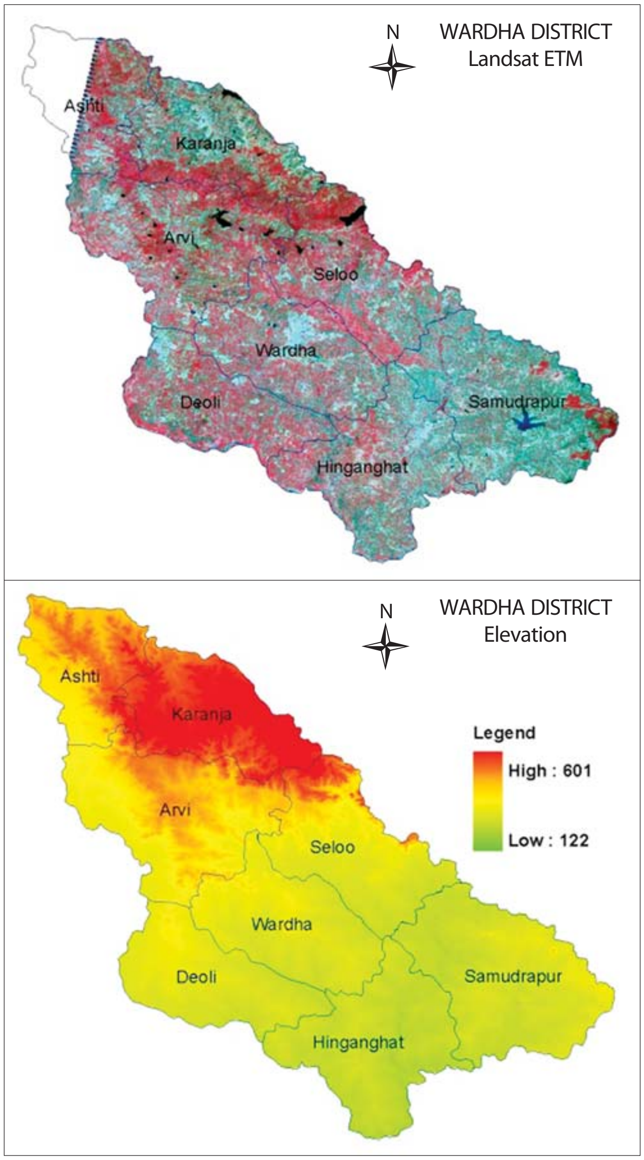


Fig. 4.7 Landsat ETM+data and ASTER Elevation map of Wardha district

Assessment of heavy metal pollution and its mapping in soils of contaminated areas of Morigoan, Dibrugarh and Tinsukia districts of Assam

S.K. Reza, S.K. Ray and Utpal Baruah

Grid maps at 500 m interval were prepared and surface soil samples (0-25 cm) were collected from each contaminated area. Eighty three grid samples from Ledo (1968 ha,) 224 grid samples from Digboi (5328 ha), 252 grid samples from Namrup (6110 ha), 188 grid samples from Jagiroad (1968 ha) were collected.

Descriptive statistics (mean, median, standard deviation, coefficient of variation, minimum, maximum, skewness and kurtosis) for concentrations of Fe, Mn, Cd, Cr, Pb and Ni, as well as pH and organic carbon are reported (Table 4.4). Among the metals, Fe had the highest mean concentration (7629.3 mg kg^{-1}), while the lowest value was for Cd (0.13 mg kg^{-1}). The mean concentrations of other metals were 952 mg kg^{-1} for Mn, 52 mg kg^{-1} for Cr, 32 mg kg^{-1} for Ni, and 13.12 mg kg^{-1} for Pb. Total concentrations varied from 64107 to 13339 mg kg^{-1} for Fe, 61 to 4041 mg kg^{-1} for Mn, 0.01 to 0.70 mg kg^{-1} for Cd, 12 to 136 mg kg^{-1} for Cr, 0.64 to 49 mg kg^{-1} for Pb, and 0.22 to 58 mg kg^{-1} for Ni. The coefficient of variation (CV) of the metals was calculated as indicator of heterogeneity, which varied from 22% for Fe to 84% for Cd. For most metal concentrations, the CVs exceeded 80% indicating high variability. Soil pH was also variable ranging from extremely acid (< 4.5) to alkaline (7.8), with the mean value of 5.3. Soil organic carbon varied from 0.15 to 5.40%, with an average content of 1.63%.

Pearson correlation coefficients calculated for each pair of variables showed high interdependence of total metal concentrations and selected soil parameters (Table 4.5). There were: (1) significant positive correlations for almost all heavy metals, whereas Mn was correlated somewhat less strongly to the other elements; (2) significant negative correlations between heavy metal concentrations and pH; (3) significant positive correlations between Mn, Cr, Pb, Ni and organic carbon; (5) no obvious correlations between Fe and Cd and organic carbon.

Table 4.4 Summary statistics of heavy metal concentrations and selected soil properties of Jagiroad paper mill area (n = 177)

	pH	Organic carbon (%)	Fe(mg kg^{-1})	Mn(mg kg^{-1})	Cd(mg kg^{-1})	Cr(mg kg^{-1})	Pb(mg kg^{-1})	Ni(mg kg^{-1})
Mean	5.3	1.6	7629	952	0.13	52	13	32
Median	5.1	1.4	8024	597	0.12	53	10	34
SD	0.81	0.9	1749	788	0.11	15	10	13
CV (%)	15.28	55.2	22	82	84.61	30	81	42
Minimum	3.6	0.1	4107	61	0.01	12	0.60	0.2
Maximum	7.8	5.4	13339	4041	0.70	136	49	58
Skewness	0.68	1.1	0.55	0.88	1.40	0.42	1.61	-0.35
Kurtosis	-0.18	1.5	0.62	0.39	3.75	3.64	2.04	-0.81

SD=standard deviation; CV=co-efficient of variation

Table 4.5 Pearson correlation coefficients matrix of heavy metal concentrations and selected soil properties of Jagiroad paper mill area (n = 177)

	pH	OC	Fe	Mn	Cd	Cr	Pb	Ni
pH	1.00							
OC	0.04	1.00						
Fe	-0.15	0.01	1.00					
Mn	-0.07	0.27**	0.18*	1.00				
Cd	-0.08	0.15	0.16*	0.03	1.00			
Cr	0.06	0.26**	0.06	-0.06	-0.06	1.00		
Pb	-0.19*	0.23**	-0.04	0.09	0.22**	-0.02	1.00	
Ni	-0.29**	0.16*	0.08	-0.03	-0.12	0.40**	0.40**	1.00

*Correlation is significant at the 0.05 level;
**correlation significant at the 0.01 level

Assessment of quality and resilience of soils in diverse agro-ecosystems – (NAIP–Component 4)

T. Bhattacharyya, Dipak Sarkar, P. Chandran, S.K. Ray, C. Mandal and B. Telpande

To assess the quality and resilience of soil in diverse agro-ecosystems, four AESRs were selected. These AESRs represent Bankura and Hooghly from West Bengal (15.1), Warangal and Nalgonda from Andhra Pradesh (7.2), Vidisha and Sehore from Madhya Pradesh (10.1) and Roopnagar and Ludhiana from Punjab (4.1) respectively. Two benchmark soil series such as Kantaban and Bhulanpur represent Bankura districts and Baligori and Harit soils represent Hooghly district. The characterization of these AESRs in terms of climate, soils and crops are shown in table 4.6. The digitization of soil and village maps of Bankura, Hooghly, Warangal, Nalgonda, Sehore and Vidisha districts have been completed. The thematic maps of various soil properties have been generated using krigging point data for converting polygon information by interpolation (Fig. 4.8). These maps showing the ranges of different properties will ultimately culminate into an useful soil quality parameters to assess for resilience of soils.

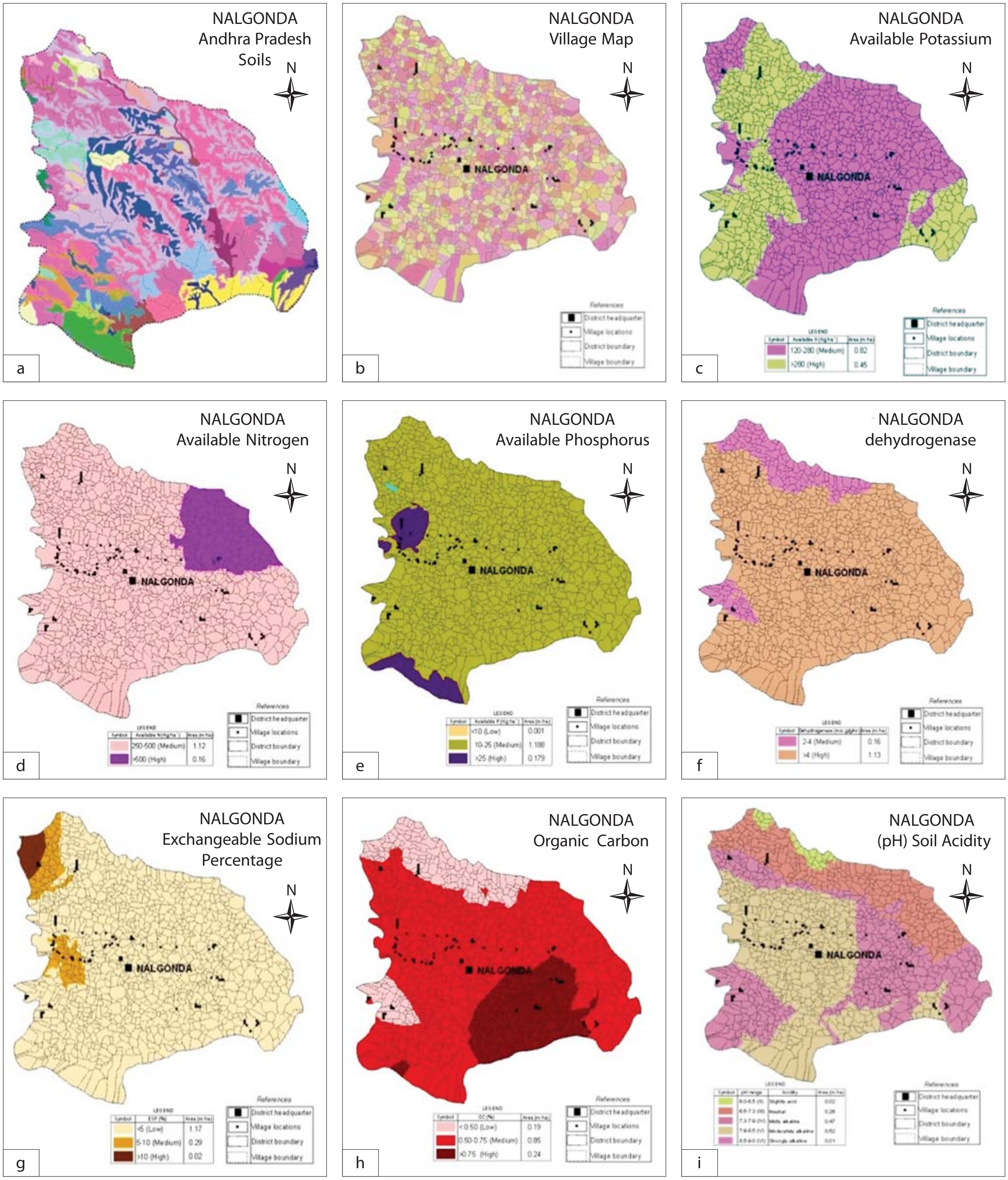


Figure 4.8. Thematic maps of Nalgonda district, Andhra Pradesh (a) soils (b) village boundary. The maps (c) to (i) have been generated following the kriging technique from the 219 no. of point data of soil sample collection. The properties shown in figures (c) to (i) viz. available potassium (Av. K), available nitrogen (Av. N), available phosphorus (Av. P), dehydrogenase (DHA), exchangeable sodium percentage (ESP), organic carbon (OC) and soil acidity (pH) are the major characteristics of soils to assess soil quality for its resilience.

Table 4.6 Study area for Assessment of Quality and Resilience of Soils in Diverse Agro-ecosystems (National Agriculture Innovation Project)

State (districts)	Climate		Soils	Crops
	MAT (°C)	MAR (mm)		
AESR 15.1: Bengal basin and North Bihar Plain, hot moist subhumid ESR[1] with deep loamy to clayey, alluvium derived soils, medium to high AWC[2] and LGP[3] 210-240 days				
West Bengal (Bankura and Hooghly)	25-26	1300-1600	Typic Haplaquepts (Kantaban series) Ultic Haplustalfs (Bhulamnpur series) Aeric Fluvaquents (Baligori series) Endoaquepts (Harit series)	Paddy-Wheat
AESR 7.2: North Telangana Plateau, hot moist semi-arid ESR with deep loamy and clayey mixed Red and Black Soils, medium to very high AWC and LGP 120-150 days				
Andhra Pradesh (Warangal and Nalgonda)	25-29	700-1000	Vertisols	Rice-Sorghum
AESR 10.1: Malwa Plateau, Vindhyan Scarpland and Narmada Valley, hot dry, sub humid ESR with medium and deep clayey Black Soils (shallow loamy Black soils as inclusions), high AWC and LGP 150-180 days				
Madhya Pradesh (Sehore and Vidisha)	24-25	1000-1500	Vertisols and associated shallow shrink-swell soils	Wheat-Wheat
AESR 4.1: North Punjab Plain, Ganga-Yamuna Doab and Rajasthan Upland, hot semi-arid ESR with deep loamy alluvium-derived soils (occasional Saline and Sodic phases), medium AWC and LGP 90-120 days				
Punjab (Ludhiana and Roopnagar)	25	600-800	Inceptisols and Entisols	Maize-Wheat

[1]ESR: Eco sub region; [2]AWC: Available water capacity; [3]LGP: Length of growing period

Georeferenced Soil Information System for Land Use Planning and Monitoring Soil and Land Quality for Agriculture (NAIP–Component 4)

Bhattacharyya, T., Dipak Sarkar, Mandal, D.K., Jagdish Prasad, Sidhu, G.S., Sahoo, A.K., Nair, K.M., Singh, R.S., Das, T.H., Venugopalan, M.V[1]., Srivastava, A.K.[2], Raychaudhari, Mausumi[3]., Velmourougane, K.[1], Meena, K.K., Mandal, D.K., Mandal, C., Srivastava, R., Sen, T.K., Chatterji, S., Chandran, P., Ray, S.K., Obireddy, G.P., Patil, N.G., Mahapatra, S.K., Das, K., Singh, A.K. S. Srinivas, Reza, S. K., Tiwary, P., Mrunmayee Lokhande, Wadhai, K. Vishakha Dongare, Mohanty, B., Majumdar, S., Ganjanna, K.V., Garhwar, R.S., Hazarika, D., Sahu, A[1]., Mahapatra[3], S. and Ashutosh Kumar[2].

[1]Central Institute of Cotton Research, Nagpur, [2.]National Bureau of Agriculturally Important Micro-organisms, Mau, [3.] Directorate of Water Management, Bhubaneshwar

For the development of Georeferenced Soil Information System (GeoSIS) information on morphological, physical and chemical properties of about 800 soil profiles (point data) representing 30 agro-ecological sub-regions (AESRs) of Black Soil Region (BSR) with total geographical area of 76.40 m ha, and 14 AESRs of Indo-Gangetic Plains (IGP) with TGA of 52.01 m ha was used. Temporal datasets on physical, chemical and microbiological properties of the soils, climate and crop yields from 32 Benchmark (BM) spots (soil series) were collected to link in SOTER-GIS environment for monitoring soil and land quality. SOTER datasets were finalized for part of BSR with 23 soil profiles. Yield gap analysis was carried for cotton, soybean and wheat crops for 4 BM sites in the Black Soil Region (BSR) using InfoCrop model. The InfoCrop model is being improvised to include some important soil properties as input parameters. For monitoring soil quality and developing land quality indices, soil and site parameters were analysed for 20 BM hotspots (Table 4.7). Agro-Ecological Subregion (AESR) 3.0 was modified and divided into two AESRs based on the soil type and LGP as AESR 3.1 dominated by the red soils with LGP (< 90 days) and AESR 3.2 dominated by the black soils with LGP (90-120 days) (Fig. 4.9). To monitor the changes in soil properties (physical, chemical and biological) induced by dynamic land use changes, 32 benchmark soil series or hot spots (15 for IGP and 17 for BSR) were selected and based on the information collected during soil sampling the land utilization types (LUTs) were characterized in terms of cropping system rainfed/irrigated, management regime inputs used and yield for 12 benchmark sites.

Table 4.7. Salient features of the Indo-Gangetic Plains (IGP) and Black Soil Regions (BSR)

S. No.	Parameters	IGP	BSR
1	Total Area (m ha)	52.01	75.38
2	No. of Great group association	51	54
3	States covered	Punjab, Haryana, Uttar Pradesh, Delhi Bihar, West Bengal, Tripura.	Andhra Pradesh, Assam, Bihar, Chhattisgarh, Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Tamil Nadu, Jammu & Kashmir, Rajasthan, Orissa, Punjab, West Bengal, Kerala, Uttar Pradesh.
4	Total no. of Georeferenced points	396	407
5	Remaining number of points to be georeferenced	30	73
6	Completion of soil data series in excel format for IGP	426	90 % of the work is over
7	Total Number of AESRs	17	36 (AESRs 14, 15.2,15.4,19.3, 2.1, 4.3 were added later)

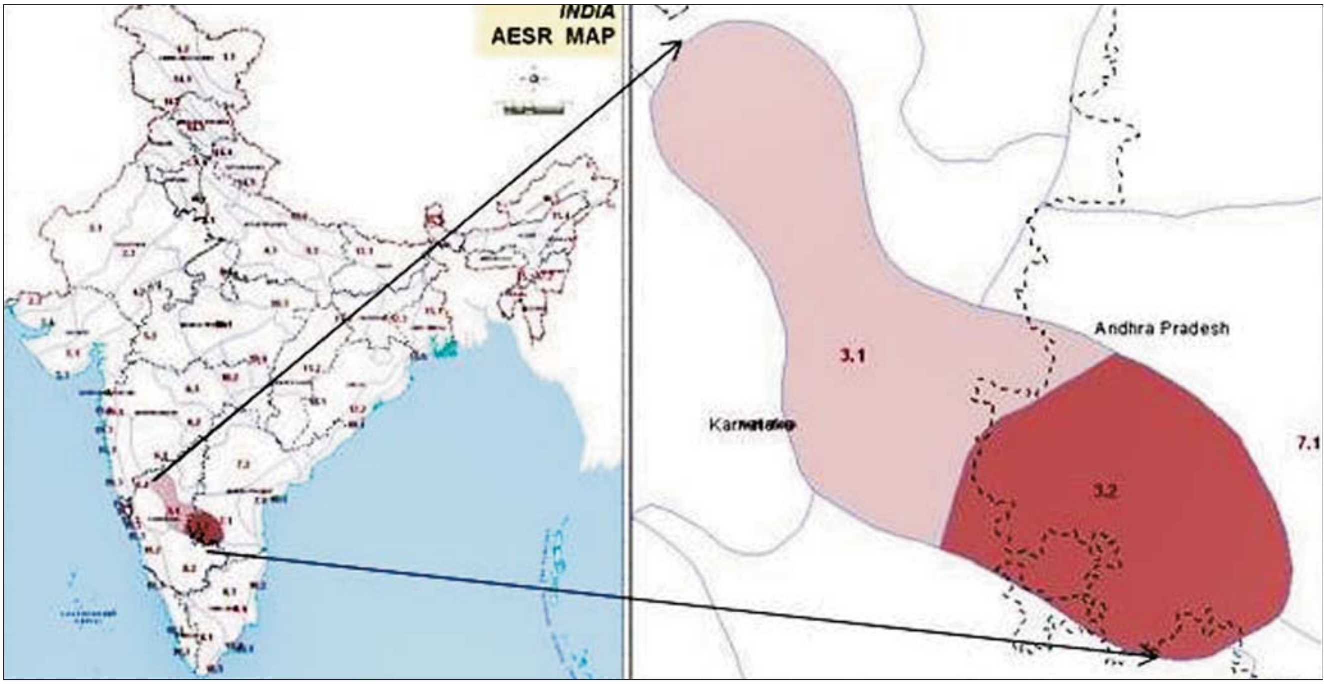


Fig. 4.9 AESR 3.0 was modified and divided into two AESRs viz. 3.1 and 3.2. AESR 3.1 with LGP < 90 days and AESR 3.2 with LGP = 90-120 days

Nutrient indexing and soil fertility assessment of Kole lands

K.M. Nair, K.S. Anil Kumar, S. Srinivas, L.G.K. Naidu and Dipak Sarkar

The project was undertaken in collaboration with Kerala Agricultural University (KAU) to assess soil reaction, soil salinity and plant available macro- and micro-nutrients in Kole lands of Thrissur and Malappuram district in Kerala State. Digital processing of cadastral information pertaining to 20 panchayats (out of 32) with Kole lands have been completed. These lands in coastal areas remain submerged under water for most part of the year, allowing only a small window of one month (when dewatering operation is carried out to facilitate rice cultivation) for soil sampling.

Soil based plant nutrient management plan for agro-ecosystems of Kerala

K.M. Nair, S. Thayalan, S.C. Ramesh Kumar, V. Ramamurthy, K.S. Anil Kumar, S. Srinivas, P. Chandran, Dr. L.G.K. Naidu and Dipak Sarkar

Realizing the importance of soil health in crop productivity, State Planning Board, Kerala developed a major project to assess plant available primary, secondary and micro-nutrients in soils of Kerala for "Soil Based Plant Nutrient Management Plan for Agro-ecosystems of Kerala". The project was approved by Govt. of Kerala with financial sanction of Rs. 6.12 crores and launched in August 2010. National Bureau of Soil Survey and Land Use Planning has been identified as the Lead Institute. The overall objective of the project is to develop a soil-based plant nutrient management plan for all the panchayats (1000), agro-ecological units (23), districts (14) and the state.

Procedures and protocols for multistage soil sampling was evolved and documented. Nehru Yuvak Kendra (NYK) (Ministry of Youth Affairs, GOI) with its presence in all districts of the State was entrusted the task of field soil sampling. The Coordinators and volunteers of NYK were trained for the purpose by experts from the participating institutions. About 2,30,000 samples are estimated to be collected from all over the state. So far 1,50,000 samples have been collected and delivered to institutional laboratories.

Composite surface sample collected from farmer's field is to be analysed for 13 parameters and the task had been distributed among the various participating laboratories. Methods of soil analysis had been standardized and a manual of procedures was distributed to the laboratories. Nearly 5000 soil sample have been anlaysed so far.

Software for management of data collected during sampling process, data generated in laboratories and generation of soil fertility advisory have been developed, tested and made operational for on line processing. The system is already open for access and input of data from participating laboratories.

Agro-ecological units of 14 districts of Kerala

K.M. Nair, Champa Mandal, Arun Chaturvedi, S.Thayalan, S.C. Ramesh Kumar, V. Ramamurthy, K.S. Anil Kumar, S. Srinivas, L.G.K. Naidu and Dipak Sarkar

Agro-ecological sub-units are sub-divisions of agro-ecological units primarily based on landform, soils, hydrology and land use. The spatial boundary limits of the agro-ecological units have been made to correspond to the administrative boundaries of panchayats. That is to say that any agro-ecological unit is a collection of panchayats, with only few exceptions. This has been done to facilitate planning of developmental activities on an administrative basis. However, the process has resulted in inclusion of lands with land form, soils and hydrology at considerable variance from the dominant/major land features described for the agro-ecological unit. In order to account for and bring out the variability of land, soil and hydrology within an agro-ecological unit, agro-ecological subunits were delineated for each agro-ecological unit. The agro-ecological sub-units have the same overhead climate described for the unit, but differ in land form, soils and hydrology and consequently vegetation and use potential. Within a given agro-ecological unit the spatial limits of agro-ecological sub-units did not follow administrative divisions. The agro-ecological sub-units were delineated (Fig. 4.10) and the description of land units constituting the sub-units is presented (Table 4.8). For brevity only unique terrain units used to define the sub-unit is presented in the map.

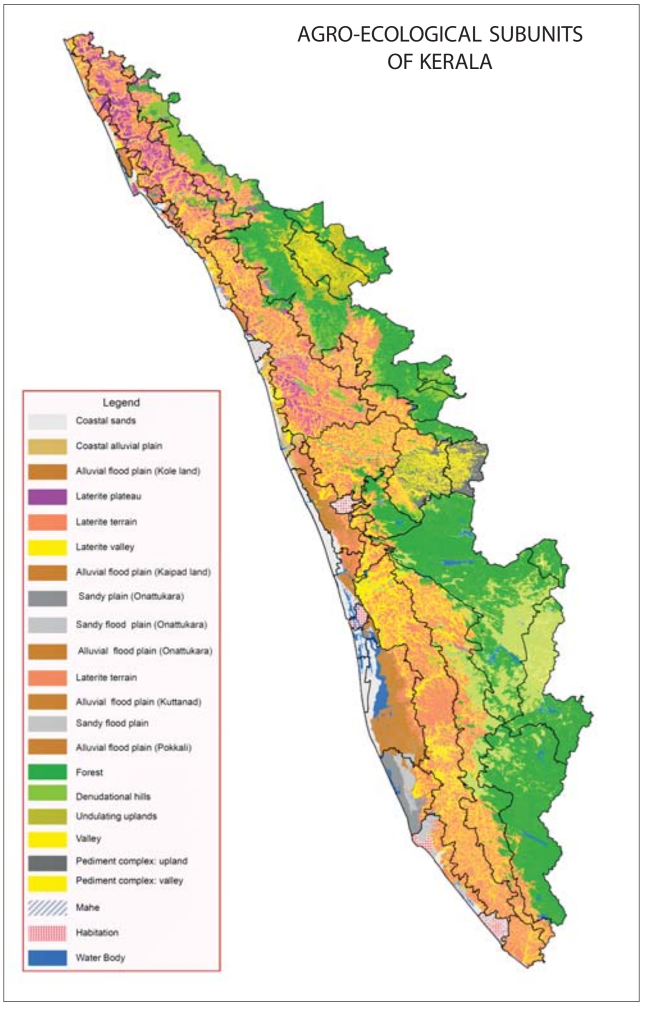


Fig. 4.10 Agro-ecological subunits of Kerala

Table 4.8 Description of terrain units used for delineation of agro-ecological sub-units

Land unit	Description	Area (ha)
1	**Coastal Sandy plain:** The nearly level sandy plain adjacent to the coastline comprising beach sands, sandy ridges and sandy depressions.	1,09,211.59
2	**Coastal Sandy Flood Plain:** Very gently sloping coastal lands with sandy soils and shallow water table. They are subject to periodic inundation with water.	13,517.52
3	**Coastal Alluvial Plain:** These are nearly level lands formed by alluvial deposits. The soils herein are mostly fine textured, and occasionally sandy. The water table is shallow and low lying areas are often inundated with water for long periods.	12,335.06
4	**Onattukara Sandy Plain:** The sub-unit delineated as Onattukara sandy plain represents the extensive upland areas with sandy soil. They are not generally inundated with water though shallow water table is common.	27,725.37
5	**Onattukara Sandy Flood Plain:** The sub-unit represents areas with sandy soil, often subject to inundation. The depressions in the delineation are under water for most part of a year.	13,806.99
6	**Onattukara Alluvial Flood Plain:** The sub-unit is an extension of alluvial flood plain of Kuttanadu intruding into the Onattukara sandy flood plain. The low lying lands are permanently inundated with water. The soils have developed from alluvial and marine deposits.	4,751.30
7	**Kuttanadu Alluvial Flood Plain:**The subunit comprise the lands which are below sea level or very near. They are submerged under water for most part of the year. The entry of sea water is controlled through bunds and barrages and rice cultivation is made possible by pumping out water from fields. The soils are potential acid sulphate soils.	74,288.66
8	**Kole Alluvial Flood Plain:** The land of this sub-unit, like Kuttanadu, is below sea level and submerged with water year round, unless pumped out to facilitate rice production. Here also sea water inundation is controlled through barrages. The soils are potential acid sulphate soils.	29,746.77
9	**Pokkali Alluvial Flood Plain:** The sub-unit comprises lands below sea level and inundated with water year round. Unlike Kuttanadu and Kole, the entry of sea water into these lands is not controlled. The soils are potential acid sulphate soils.	16,051.72
10	**Kaipad Alluvial Flood Plain:** These lands are also below sea level or very near to it and submerged under water for most part of the year. Like in Pokkali lands sea water intrusion is not prevented here too. The soils are potential acid sulphate soils.	13,431.34
11	**Laterite Plateau:** The laterite duricrust widely developed in northern parts of Kerala constitute the sub-unit for many agro-ecological units. Characteristically the laterite plateau is hard crust with very little soil cover and vegetation.	72,218.87
12	**Laterite uplands:** Laterite uplands refer to lands with laterite soils (with or without phinthite /laterite in sub-soil) and excludes laterite plateau, valleys intervening laterite uplands and lateritised soils of Wayanad plateau. It is the most extensive in the state. Laterite upland encompass different slope classes, nearly level to steeply sloping land. Characteristic feature is well drained, red coloured, gravelly clay soils.	12,17,436.15
13	**Laterite Valley:** The valleys intervening laterite uplands constitute this sub-unit. The lands forming the unit are nearly level and occupy lowest position in the landscape. They are inundated with water for most part of the year.	4,28,810.08
14	**Denudational Hills:** Denudational hills are moderately sloping to very steeply sloping hills stripped off much of the forest cover. The land cover may be either degraded forests or plantation agriculture. They form sub-units in most of the agro-ecological units except in the coastal plain. Denudational hills are extensive in foot hill land high hill agro-ecological zone.	4,16,451.35
15	**Forested Hills:** Agro-ecological sub-unit are delineated based primarily on land cover of forest. The land form associated with the sub-unit is mostly moderately sloping to very steeply sloping hills.	10,43,794.07
16	**High-Land Valleys:** The valleys in high hills form this sub-unit. Highland valleys are nearly level narrow valleys at higher elevations. They occupy lower landscape positions and are often inundated with water. The soils are very deep, imperfectly drained, acidic, rich in organic matter and generally very fertile.	10,139.96
17	**Wayanad Undulating Uplands:** The sub-unit comprises gently to moderately sloping uplands occuring on Wayanad plateau at elevations more than 700 meters above MSL.	84,304.45
18	**Wayanad Valleys:** The nearly level valley lands of Wayanad plateau constitute the sub-unit. The valley lands occupying lower landscape positions are inundated with water during monsoon.	32,215.85
19	**Pediment Complex:** UplandThe sub-unit covers the undulated uplands of Palakkad Gap. These lands occupy relatively higher landscape position and gradually merge to valleys.	71,599.07
20	**Pediment Complex:** ValleysThe valleys in Palakkad Gap constitute this sub-unit. These lands occupy lower landscape positions and are subject to inundation with water during monsoon season.	47,099.87

Assessment of land resources for growing horticultural crops in selected districts for Tamil Nadu under the National Horticultural Mission project (National Horticultural Mission Project)

A. Natarajan, V. Ramamurthy, S. Thayalan, S. Srinivas, K.V. Niranjana, M. Ramesh, D.H. Venkatesh and L.G.K. Naidu

The suitability of soil and other land resources of 14 districts, identified for the promotion of horticultural crops in the state under the National Horticultural Mission project, was assessed for the cultivation of horticultural crops based on the information available from the soil resource Mapping project. All the components of the project have been completed in the previous years and during 2010 and 2011 period, the reports for all the 14 districts were finalised and given to the department for printing.

Predicting soil carbon changes under different cropping system in soils of selected benchmark spots in different bioclimatic systems in India

T. Bhattacharyya, S K. Ray, P.Chandran, C. Mandal, Ashwini Deshmukh,Rupali Deshmukh, Bhagyashree Telpande

Total sixteen long term fertilizer experimental (LTFE) sites were selected for the present study; eleven were from Black soil region (BSR) and five from the Indo-Gangetic plains (IGP) (Table 4.9). Seven LTFE spots were utilized to carry out RothC and Century C model evaluation and five spots were used for Century C model. The data obtained from all the LTFE's indicated that TOC was marginally increased when organic carbon was externally added through organic sources as compared with the control. Rapid increase in TOC was observed in treatments where FYM was added in combination with inorganic fertilizers (Table 4.9). The Century and RothC model evaluation showed that these models can work in selected BM spots of IGP and BSR. The Century model was more successful when applied to drier climate represented by soils with high amount of cracking clay while RothC works in both humid and semi-arid bioclimatic systems. The prediction of soil carbon status in sub-humid (Sarol) and humid (Mohanpur) bioclimatic system was similar when the RothC and Century carbon models were used. The management of cropping pattern and agronomic practices are shown for selected BM spots keeping in view the modelled soil carbon output (Fig. 4.11).

Table 4.9 Predicted TOC trend for selected LTFE sites using RothC and Century C model

6			BM spots and cropping	Century (t Cha^{-1})		
Years			systems	Years		
1990	*2000*	*2050*	*Sarol (Soybean-Safflower)*	*1990*	*2000*	*2050*
6.25	6.24	6.15	Control	6.99	6.30	5.93
6.27	6.27	6.31	NPK	6.60	5.95	5.76
12.97	18.20	31.88	NPK+FYM	18.12	24.21	34.11
			Teligi(Paddy-paddy)			
6.13	6.08	6.05	Control	15.66	14.67	11.33
6.13	6.14	6.20	NPK	15.57	14.61	14.82
8.84	13.83	27.86	NPK+FYM	17.46	17.98	19.58
			Akola (Soybean-Wheat)			
7.90	6.97	5.55	Control	9.81	4.00	2.64
8.26	7.79	7.46	NPK	10.08	6.51	7.47
13.74	21.76	40.50	NPK+FYM	12.08	14.00	20.60
			Mohanpur (Rice-Wheat)			
26.66	23.79	21.14	Control	24.8	23.76	21.98
26.66	23.80	23.40	NPK	24.55	25.24	28.34
33.81	36.69	50.37	NPK+FYM	25.7	26.38	28.03

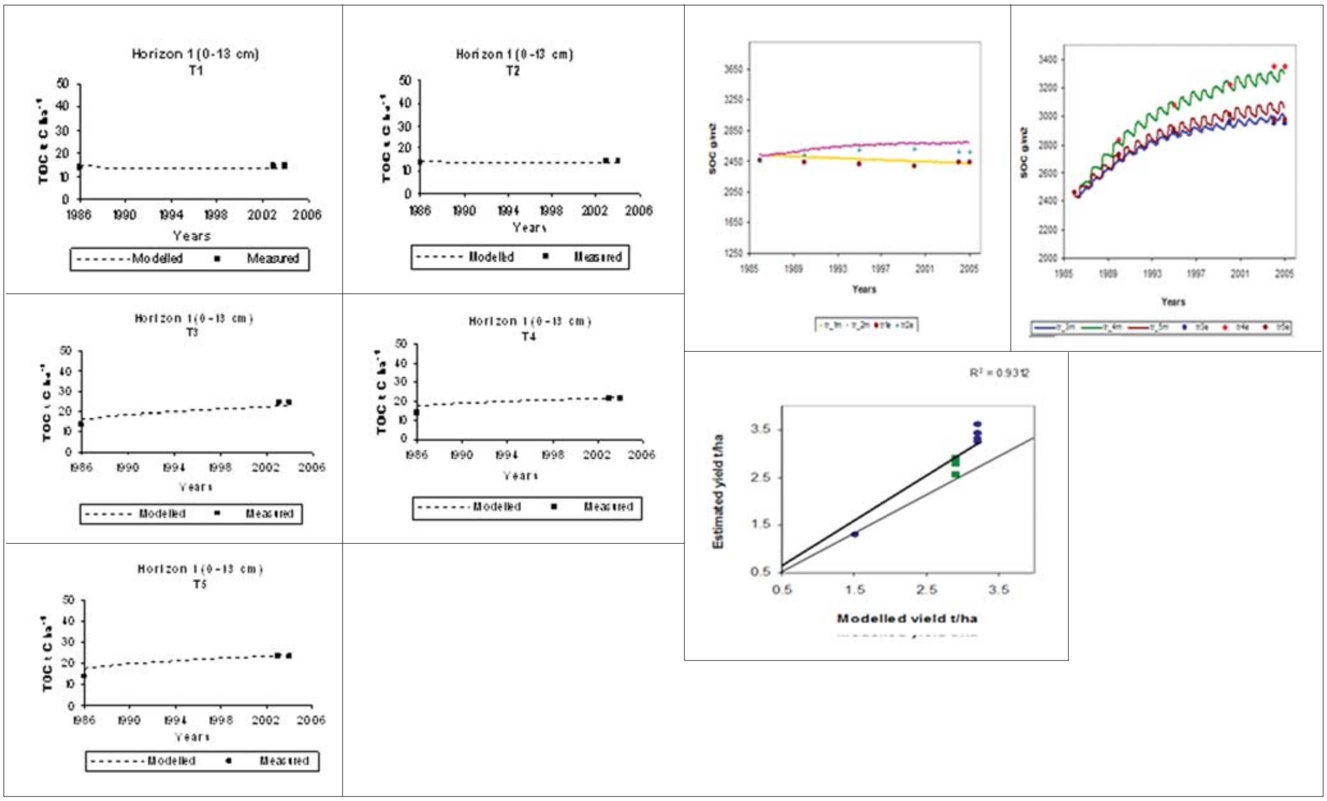


Fig. 4.11 Evaluation of RothC and Century model in different LTFE sites in the Indo-Gangetic Plains

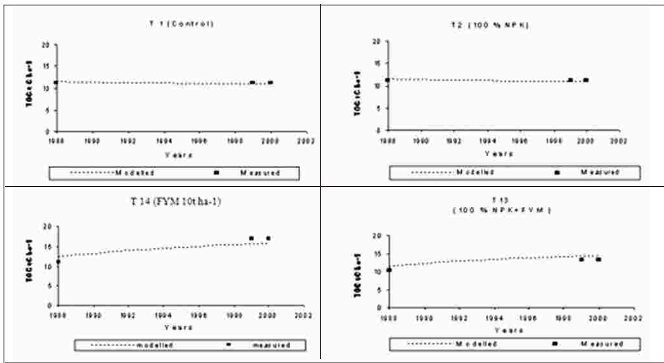
Changes in soil carbon reserves as influenced by different ecosystems and land use in India (NPCC)

T. Bhattacharyya, P. Chandran, M.V. Venugopalan, D.K. Pal, S.K. Ray, C. Mandal, Dipak Sarkar, P. Tiwary, Ankush M. Nimje, Dipanwita Dasgupta, Dipalee V. Balbuddhe

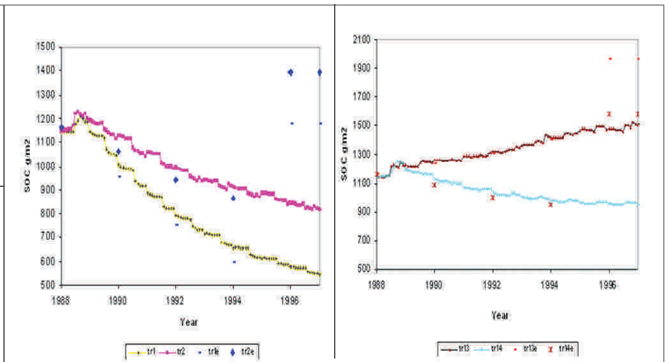
Eleven long term fertilizer experimental sites in black soil region were selected for evaluating three models viz. Roth C, Century and InfoCrop. Rothamsted C and Century C models were evaluated for five Long Term Fertilizer Trials (Table 4.10). The RothC and Century C models were improvised to synchronize with humid tropical climate. Weather files of RothC were accounted for June instead of January. Century crop file was parameterized to suit the agronomic managements of most of the crops in humid tropical climate. RothC could simulate changes in TOC with RMSE values ranging from 3.57 to 14.64% for Nabibagh, and 0.59 to 3.17% for Akola. FYM alone or in combination with fertilizer increase TOC appreciably in Nabibagh and Akola. However, TOC remained almost similar over years for the control (no fertilizer or manure) and 50% NPK treatments in all the sites. An attempt was made to find out impact of global warming on soil carbon reserves using RothC (Fig. 4.12). It is found that the negative impact of global warming on TOC content seems more when soil is treated as a single layer rather than a combination of 5 different layers. Since soils are composed of multiple layers, threat of increased temperature due to global warming will always be minimized if RothC is modeled considering soils on multiple layers. InfoCrop model simulates yield correctly for the commonly practised cropping patterns and popular crops like cotton, soybean, wheat, kharif rice, maize etc and requires further calibration for sorghum, millets, and winter rice. Changes in temperature and CO_2 concentration have pronounced impact on potential yield as compared to water limited yield simulated by InfoCrop model. Response from 1532 farmers, representing 28 districts of 9 states, on the perception of climate change, attributes and signatures of climate change, and common methods of combating climatic aberrations were compiled and analysed to develop a compendium.

Table 4.10 Predicted TOC trend for selected LTFE sited using RothC and Century C model

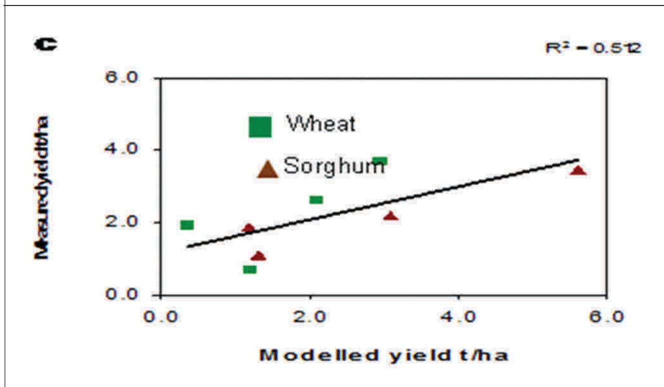
RothC ($tCha^{-1}$)					Akola cropping systems	Century C ($tCha^{-1}$)				
Years					Cropping System	Years				
1990	2000	2015	2030	2050	(Soybean- Wheat)	1990	2000	2015	2030	2050
7.90	6.97	6.40	5.98	5.55	Control	9.81	4.00	3.2	3.01	2.64
8.26	7.79	7.65	7.56	7.46	NPK	10.08	6.51	7.1	7.23	7.47
13.74	21.76	24.97	29.89	40.50	FYM	12.08	14.00	17.60	20.16	20.60



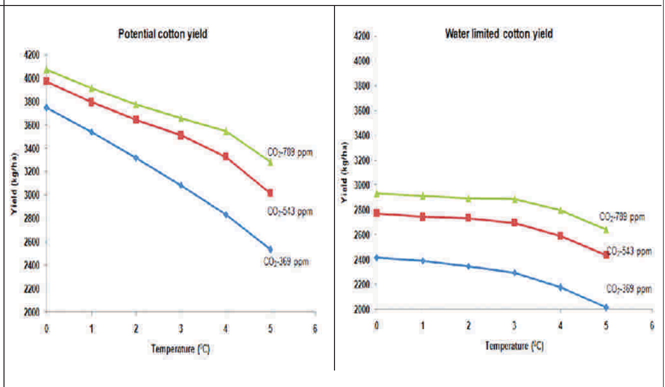
Modelled and measured soil carbon over time in RothC for treatment1 i.e. Control (no fertilizer, no manure) and treatment 2 (NPK), treatment 13 (NPK+FYM), treatment 14(only FYM), in Long Term Fertilizer Experiment trial at Akola.



Simulated cotton yield at Babulgaon (Akola) InfoCrop model output



Modelled vs. measured yield from Century model in semi-arid site of the Akola experimental spots for both sorghum and wheat.



Modelled and estimated soil carbon over time for four management regimes included in the long term fertilizer trial at Akola, Maharashtra

Fig. 4.12 Application of RothC Century and InfoCrop model in LTFE site of black soil region

Assessment and mapping of some important soil parameters including macro and micro nutrients for 13 priority districts of Assam state (1:50,000 scale) towards optimum land use planning

Utpal Baruah, Dipak Sarkar, S.K. Reza, S. Bandyopadhyay, T. Chattopadhyaya, and Dipak Dutta

The main objective of the project is to prepare district-wise maps of pH, organic carbon, available N, P, K and micro-nutrient cations on 1:50,000 scale for agricultural development and land use planning. The base maps (1 km interval grid point) on Police Station map showing village boundary Published by Assam Survey, Govt. of Assam, incorporated by Survey of India toposheets of 1:50,000 scale were prepared for thirteen districts including three newly formed district. A total of 26342 soil samples (0–25 cm) were collected. Soil samples were dried, ground and analyzed for pH, organic carbon, available N, P and K, and DTPA extractable micronutrients for Goalpara, Bongaigaon, Kokrajhar, Bagsa, Chirang, Borpeta, Nalbari, Darrang and Sonitpur districts. The spatial variability map for the Kokrajhar and Bongaigaon districts were prepared using Arc GIS version 9.3.1. Some of the salient findings are described below.

About 91% area of Kokrajhar and 80% area of Bongaigaon district is high in soil organic carbon content. Only about 9% and 13% area of Kokrajhar and Bongaigaon districts respectively is medium in SOC (Fig. 4.13).

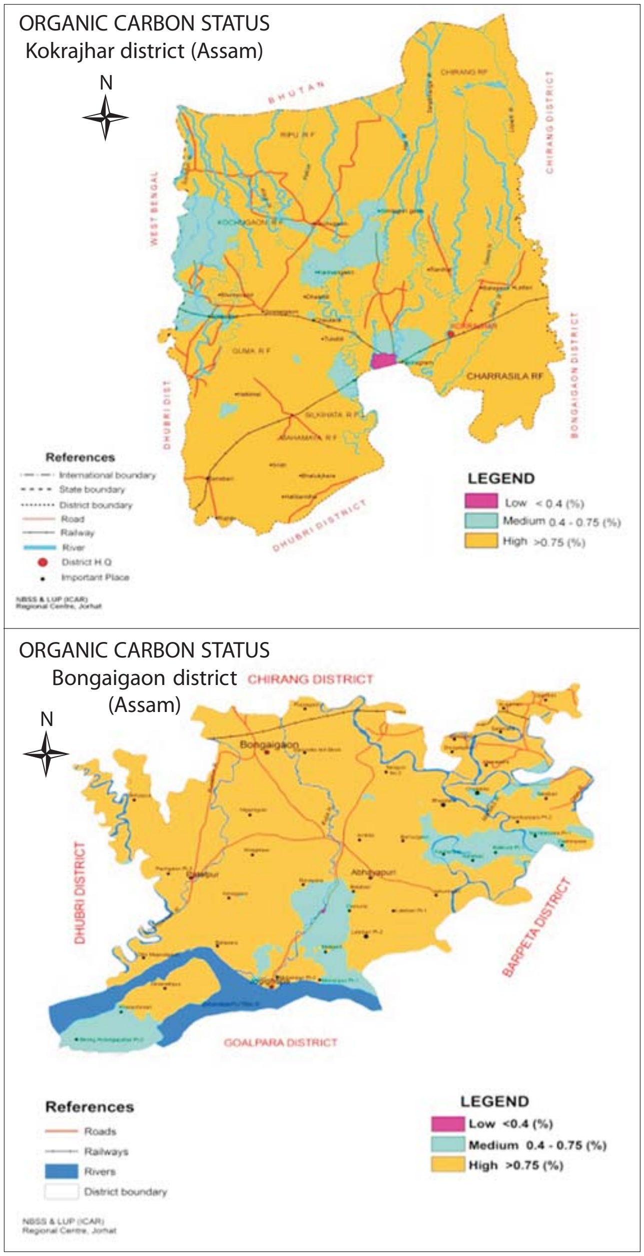


Fig. 4.13 Spatial distribution of soil organic carbon in Kokrajhar and Bongaigaon district of Assam

About 61% and 67% area of Kokrajhar and 86% and 53% area of Bongaigaon district is medium in available N and K, respectively. 34% area of Kokrajhar and 40% area of Bongaigaon districts is low in available K (Table 4.11).

Table 4.11 Area distribution under different classes of nitrogen, phosphorous and potassium

Values in ('000 ha)

	Districts	
	Kokrajhar	Bongaigaon
Available nitrogen (kg ha^{-1})		
Low (<280)	0.5 (0.2)	13.9 (5.5)
Medium (280-560)	189.7 (60.6)	215.5 (85.9)
High (> 560)	122.7 (39.2)	2.4 (0.96)
Miscellaneous	-	19.1 (7.4)
Available potassium (K_2O kg ha^{-1})		
Low (<135)	104.6 (33.5)	100.0 (39.8)
Medium (135-335)	208.3 (66.5)	131.8 (52.5)
High (> 335)	Nil	19.2 (7.6)
Miscellaneous	-	19.1 (7.4)
Available phosphorous		
Low (<34)	61.0 (19.5)	28.9 (11.5)
Medium (34-68)	94.7 (30.3)	124.0 (49.4)
High (> 68)	157.2 (50.2)	78.9 (31.4)
Miscellaneous	-	19.1 (7.4)

About 20% area of Kokrajhar and 12% area of Bongaigaon district is low in soil available phosphorus. About 30% area of Kokrajhar and and 50% area of Bongaigaon districts is medium in available phosphorus (Table 4.11).

Both the district (Kokrajhar and Bongaigaon) were sufficient in Fe, Mn and Cu except 1.3% area of Kokrajhar district is deficient in Mn. About 34% area of Kokrajhar and and 64% area of Bongaigaon district is deficient in Zn.

Preparation of district-wise contingency plan for agriculture and allied sector

D.K. Mandal, S.N. Goswami, Jagdish Prasad, M.S.S. Nagaraju and J.D. Giri

The project was initiated in May 2010 with the objective of preparation of district-wise contingent crop plan in advent of abiotic and biotic stress. NBSS&LUP was assigned to prepare contingent crop plan for districts of Maharashtra and Madhya Pradesh in collaboration with state agriculture universities. First sensitization workshop was held at NBSS&LUP on 19th May 2010 wherein experts from all agricultural universities of Maharashtra, Madhya Pradesh and Gujarat participated. Second workshop regarding the filling up of the proforma developed by CRIDA was organised at NBSS&LUP on 4th October 2010. During the reporting year we have completed the contingent crop plan for 29 districts of Maharashtra and 11 districts of Madhya Pradesh. Computation of soil depth-wise soil area and percentage of TGA was done for each districts of Maharashtra and MP. Agro-climatic and land utilization database were corrected. The crop varieties have been suggested from available literature data for each soil types of district for variation in onset of monsoon date. The animal sciences and fisheries data were incorporated with data available from different sources.

Agroecological regions of Uttar Pradesh (Collaborating project of UPCAR, Lucknow and NBSS&LUP)

Sohal Lal, C. Mandal, D. K. Mandal and S.R. Singh
Coordintors: Director NBSS&LUP and DG, UPCAR

The objective of the project is to delineate Agroecological Region of Uttar Pradesh for resource planning and development. The project was initiated in 2008. Revision of the earlier draft report was carried out as per comments and suggestions from the Government of Uttar Pradesh. Now, Uttar Predesh is sub-divided into 21 zones (Fig. 4.14) based on soil, slope, bio-climate, length of growing period against 10 AEZ by NARP.

Fig. 4.14 Agro-ecological regions of Uttar Pradesh

Assessment and mapping of some important soil parameters including macro and micro nutrients at block levels of Dumka, Jamtara and Hazaribagh district for optimum land use plan

Dipak Sarkar, A.K. Sahoo, S.K. Singh, D.C. Nayak, S. Mukhopadhyay and T. Banerjee

A total of 18,671 samples (0-20 cm) were collected at 500 minterval from 4 and 7 blocks of Jamtara and Dumka districts respectively. Soil samples were analyzed and database for soil parameters including macro and micro nutrients was prepared block-wise in GIS. Spline method of interpolation technique was used to change point data into area feature. Soil pH and phosphorus status of Jamtara block is given in figures 4.15 and 4.16 respectively. Area under different classes of pH and nutrient availability in the block is given in table 4.12.

Table 4.12 Area under different pH and nutrient availability classes in Jamtara block

Parameter	Area ('00 ha)	% TGA
Soil pH (1:2.5)		
Extremely acidic (pH <4.5)	27.5	5.8
Very strongly acidic (pH 4.5 – 5.0)	89.9	19.1
Strongly acidic (pH 5.1 – 5.5)	133.2	28.3
Moderately acidic (pH 5.6 – 6.0)	98.5	20.9
Slightly acidic (pH 6.1 – 6.5)	53.3	11.3
Neutral (pH 6.6 – 7.3)	28.3	6.0
Slightly alkaline (pH 7.4 – 7.8)	7.1	1.5
Miscellaneous	33.2	7.0
Total	471.0	100.0
Organic carbon (%)		
Low (<0.5)	337.4	71.6
Medium (0.5 – 0.75)	100.4	21.3
Miscellaneous	33.2	7.0
Total	471.0	100.0
Available phosphorus (kg ha^{-1})		
Low (<10)	284.3	60.4
Medium (10 – 25)	133.6	28.4
High (>25)	19.9	4.2
Miscellaneous	33.2	7.0
Total	471.0	100.0
Available potassium (kgha^{-1})		
Low (<108)	102.3	21.7
Medium (108 – 280)	258.6	54.9
High (>280)	77.0	16.3
Miscellaneous	33.2	7.0
Total	471.0	100.0

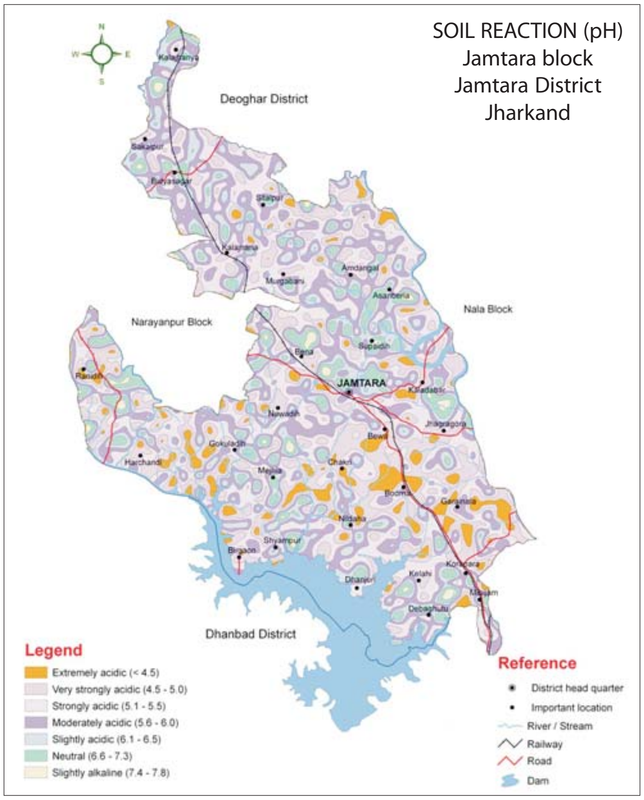


Fig. 4.15 Soil pH status of Jamtara block

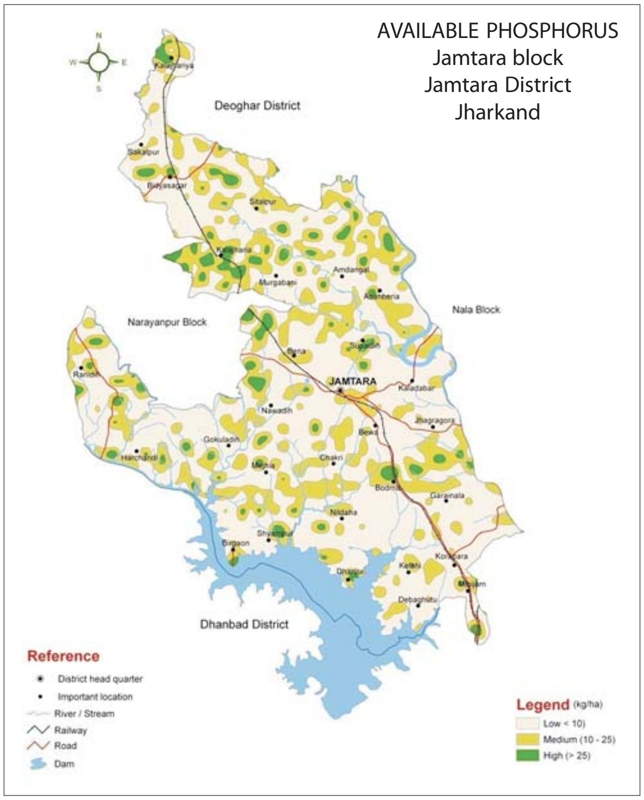


Fig. 4.16 Available phosphorus status of Jamtara block

Assessment and mapping of some important soil parameters including macro and micro nutrients for the state of West Bengal (1:50,000 scale) towards optimum land use plan

Dipak Sarkar, D.C. Nayak, S.K. Singh, A.K. Sahoo, S. Mukhopadhyay, S.K. Gangopadhyay, K. Das, T. Chatopadhyay, D. Dutta, K.D. Sah and T. Banerjee

Area affected with multiple nutrient problems

Phosphorus, potassium and zinc status maps of Birbhum district were superimposed on GIS platform and common areas affected with multi-nutrient problem were delineated. About 40% area of the district was affected with low availability of phosphorus, potassium and zinc (Fig. 4.17). Another 17 to 20 % area was mapped separately under each category having low level of phosphorus and zinc; phosphorus and potassium; and zinc and potassium.

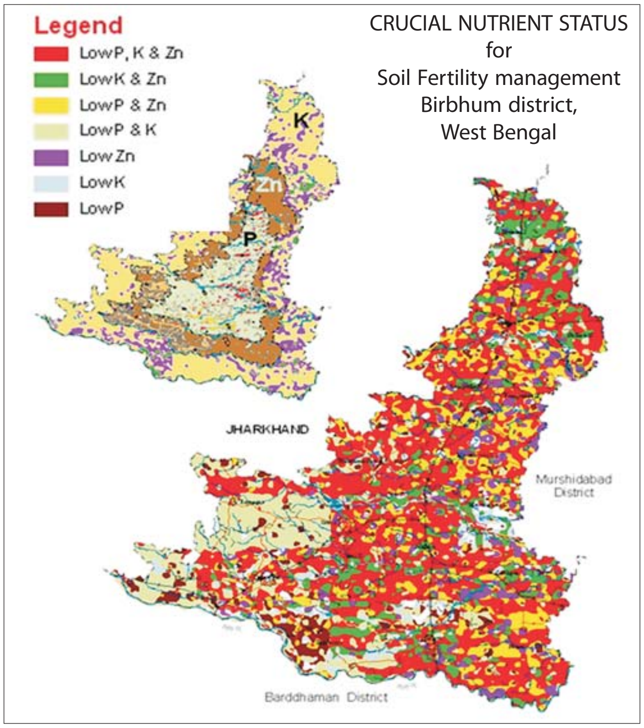


Fig. 4.17 Multi-nutrient deficiency in Birbhum district, West Bengal

Causes for the extensive problem of low level of phosphorus, potassium and zinc alone or in group were analyzed in Nadia district in relation to cropping intensity. Nutrient deficiencies were linked with the generalized cropping intensity delineated. The problems of nutrient deficiency were observed to get intensified with increasing crop intensity (Fig. 4.18).

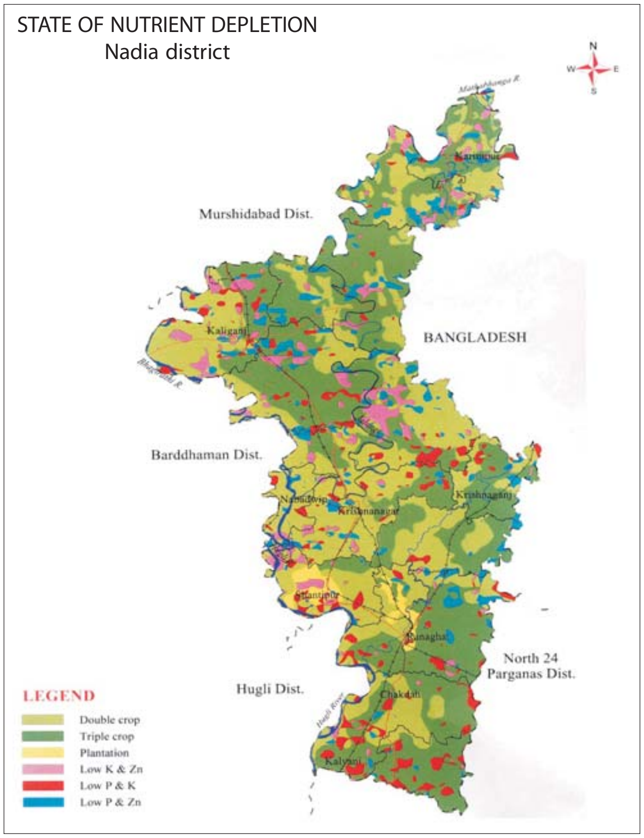


Fig. 4.18 Multiple nutrient deficiency in different cropping intensity in Nadia district, West Bengal

Soil pH and its interaction with particle-size class vis-à-vis availability of soil nutrients: An analysis

Multivariate Analysis of Variance (MANOVA) involving particle-size and soil pH classes as fixed variables; macro and micro nutrients as dependent variables, indicated that neutral to slightly alkaline soils had significantly higher phosphorus and potassium. Slightly acidic to neutral soils were found ideal for sulphur availability (Table 4.13). Interaction of particle-size class and soil pH indicated that phosphorus availability significantly increases from moderately acidic to neutral whereas potassium availability increases from slightly acidic to slightly alkaline soils having fine-loamy and coarse-loamy particle-size classes.

Availability of zinc decreased with increasing pH in fine and coarse-loamy soils. However, the decrease was non-significant between the pH range of 4.5-5.5, 5.5-6.5 and 6.5 to 7.5 in fine loamy soils and between 4.5 to 5.5 and 5.5 to 6.5 in coarse-loamy soils. The relationship was however inconsistent in fine soils. The pH range from 4.5 to 5.5 was found to be ideal for copper availability in fine and fine-loamy soils, whereas pH range from 5.5 to 6.5 was considered good for the availability of copper in coarse-loamy soils. Across the entire range of particle-size class, availability of iron was the best in the pH range of 5.5 to 6.5. Availability of manganese was the highest in the pH range of 4.5 to 5.5 and 5.5 to 6.5 across the soils of different particle-size classes, however, the difference in manganese content in most of the cases was found to be non-significant.

The influence of particle-size class on the nutrient availability indicated that available phosphorus in fine-loamy soils were significantly higher than fine and coarse-loamy soils (Table 4.14). Available potassium was significantly higher in fine and fine-loamy soils than coarse loamy soils. The influence of particle-size class on available sulphur was non-significant. The availability of micro-nutrients was the highest in fine soils and decreased in fine-loamy and coarse-loamy soils (Table 4.15).

Table 4.13 Influence of soil particle size class and pH on mean available phosphorus, potassium and sulphur in Barddhaman district

Particle size class	pH class	pH(aq) (1:2.5 H_2O)	Phosphorus	Potassium	Sulfur
				kg ha^{-1}	
Fine	< 4.5	4.2±0.02	38.2±6.7^{a}	83.0±10.7^{a}	13.6±1.3^{a}
	4.5-5.5	5.01±0.01	54.80±2.8^{b}	174.2±6.4^{b}	19.04±0.64^{b}
	5.5-6.5	5.94±0.007	50.86±1.0^{b}	210.96±2.4^{c}	22.16±0.45^{c}
	6.5-7.5	6.79±0.02	54.90±4.2^{b}	224.9±8.2^{c}	23.90±1.89^{c}
	>7.5	7.74±0.04	88.76±11.25^{c}	224.9±8.2^{c}	23.90±1.89^{c}
Mean (3318)		*5.73±0.02*	*^{a}52.99±1.49*	*^{a}196.2±3.5*	*^{a}20.91±55*
Fine-loamy	< 4.5	4.26±0.02	53.34±16.35^{b}	117.79±18.19^{d}	13.4±1.92^{a}
	4.5-5.5	4.99±0.01	51.65±3.51^{b}	175.98±7.08^{b}	21.21±1.11^{c}
	5.5-6.5	5.88±0.02	54.65±3.3^{b}	213.96±8.28^{c}	23.44±1.27^{c}
	6.5-7.5	6.80±0.03	75.94±9.0^{d}	231.02±13.48^{c}	21.02±1.65^{c}
	>7.5	7.77±0.04	136.70±35.81^{e}	220.80±24.90^{c}	19.76±6.31^{b}
Mean (1868)		*5.56±0.03*	*^{b}58.10±2.74*	*^{a}194.03±4.90*	*^{a}21.56±0.74*
Coarse- loamy	< 4.5	4.27±0.02	38.90±9.87^{a}	112.51±19.22^{d}	15.22±2.73^{a}
	4.5-5.5	4.89±0.02	47.45±3.54^{f}	146.05±7.72^{e}	18.99±1.22^{b}
	5.5-6.5	5.91±0.03	63.39±5.47^{g}	215.61±13.89^{c}	25.74±1.89^{d}
	6.5-7.5	6.83±0.06	78.23±20.75^{d}	211.52±23.34^{c}	22.81±3.74^{c}
	>7.5	7.85±0.10	108.1±31.67^{h}	173.82±27.86^{b}	14.20±5.36^{b}
Mean (997)		*5.26±0.05*	*^{a}53.72±3.12*	*^{b}164.8±6.47*	*^{a}20.45±0.94*

Values suffixed in a column for phosphorus, potassium and sulfur with different superscript are significant at $P<0.01$; Values prefixed in a column with different letters are significant at $p<0.05$.

Table 4.14 Influence of soil particle-size class and pH on mean available Zn, Cu, Fe and Mn in Barddhaman district

Particle-size class	pH class	Zn	Cu	Fe	Mn
Fine	< 4.5	1.64±0.21[a]	2.26±0.31[a]	68.66±12.06[a]	43.37±9.94[a]
	4.5-5.5	1.10±0.09[b]	2.78±0.11[b]	80.16±4.77[b]	52.86±3.18[b]
	5.5-6.5	0.92±0.03[c]	2.69±0.04[b]	90.41±2.30[b]	49.17±1.33[a]
	6.5-7.5	0.80±0.09[d]	2.40±0.16[a]	75.58±7.10[b]	36.11±4.41[c]
	>7.5	1.00±0.38[b]	2.84±0.35[b]	47.56±8.59[c]	26.03±7.48[d]
Mean		*[a]1.00±0.04*	*[a]2.67±0.06*	*[a]83.19±2.82*	*[a]48.03±1.76*
Fine-loamy	< 4.5	1.26±0.33[e]	2.54±0.65[b]	57.56±10.98[d]	39.79±7.83[c]
	4.5-5.5	0.91±0.08[c]	2.26±0.11[a]	66.51±4.62[a]	52.28±3.32[b]
	5.5-6.5	0.89±0.08[c]	2.54±0.13[b]	83.63±6.61[b]	55.49±4.14[b]
	6.5-7.5	0.88±0.15[c]	2.60±0.22[b]	67.95±11.02[a]	39.14±6.20[c]
	>7.5	0.79±0.17[d]	2.46±0.41[a]	52.42±13.28[d]	30.78±11.94[c]
Mean		*[a]0.91±0.05*	*[a]2.41±0.08*	*[b]71.54±3.44*	*[a]50.89±2.31*
Coarse- loamy	< 4.5	1.21±0.26	1.88±0.48[c]	71.81±13.98[b]	44.52±8.05[a]
	4.5-5.5	0.96±0.14[c]	1.95±0.15[c]	66.76±6.13[a]	42.33±3.37[a]
	5.5-6.5	0.93±0.11[c]	2.31±0.21[a]	77.63±11.77[b]	47.12±6.28[a]
	6.5-7.5	0.69±0.11[f]	2.30±0.35[a]	81.27±20.85[b]	44.08±9.71[a]
	>7.5	0.62±0.16[f]	2.24±0.70[a]	67.06±57.11[a]	41.01±47.18[a]
Mean		*[a]0.95±0.09*	*[b]2.06±0.11*	*[b]70.93±5.00*	*[b]43.80±2.72*

Values suffixed in a column for micro-nutrients with different superscript are significant at P<0.01;Values prefixed in a column with different letters are significant at p<0.05.

2.5

Land Evaluation and Land Use Planning

Farm/ Watershed /
District / Region / State / Country

Soil and Land Use Model

Dynamics of land use plan and its impact on soil properties in Nawanshahr district, Punjab state

G.S. Sidhu, Tarsem Lal, Jaya N. Surya, J.P. Sharma and D.K. Katiyar

One hundred twenty farmers were interviewed in different blocks during the field work and socio-economic data was collected through comprehensive questionnaire. Besides, secondary data was also collected to supplement the primary data covering land use and cropping pattern. Data collected have been analysed using the SPSS software and interpreted showing the distribution, variation and temporal change in different socio-economic variables.

According to 2001 census, the total population of the district was 5.06 lakh. The district has experienced 9% growth of population during 1991-2001. The area has the joint family system. Literacy study shows that 16.10% of the farmers are illiterate. 21% farmers have primary education while 29% have middle level and 25% have matric level education.

In the sample survey it was observed that 21% farmers have 1-2 acres of land holdings while 26% farmers have 2-5 acres, 27% farmers 5-10 acres of land holdings and 25% farmers > 10 acres of land. Size of land holdings is comparatively higher in the active flood plain where the land was comparatively cheaper and also the government land was distributed among weaker section on the lease basis. Thirty two per cent workers in the district are engaged in agriculture work. Further data indicate that 70% of the farmers have tractors and others hire the tractors from others.

Twenty four per cent area in the district has groundwater depth upto 50 feet, 52% area has a depth of 50-70 feet, 20% has 80-140 feet and 27% area has ground water depth of >140 feet. Highest depth of ground water table is observed in Saroya block where the entire area has depth of more than 140 feet owing to the terrain feature in the Shiwaliks. Another block where the ground water has highest depth is Balachaur block. Its 43% area has depth of >140 feet.

The major crops grown in Nawanshahr during 1950 and 60s were maize, cotton, blackgram, mungbean, clusterbean sorghum, pearlmillet, groundnut, pigeanpea, sunhemp and sugarcane in *kharif*, whereas rice was taken in low-lying areas in same villages. In *rabi* season, wheat+ gram (mixed), wheat, barley, gram, lentil, mustard, peas, toria were grown. This system was followed upto 1970s. Presently, the rice - wheat cropping is prevalent. Tractors were introduced in cultivation, tube well irrigation increased hybrid seeds and fertilizer use was also increased. under changed situation, farmers shifted their *kharif* crops from maize, sorghum, pearlmillet, mungbean, clusterbean (gaur), groundnut, sunhemp to rice cultivation. In *rabi*, farmers shifted from barley, bengal gram, toria, lentil, and peas to wheat cultivation. In 1960, 2.2% area was under rice which increased to 3% in 1970, 16.40% in 1983-84 and 28.14% in 2006-07. Wheat is the major crop covering highest% (41.11) of cropped area followed by rice (28.14%) in 2006-07. Maize, fodder, sugarcane cover 9.74% , 11.18% and 3.88% of cropped area under maize and wheat decreased and for rice increased during 1983-84 to 2006-07 (Fig.5.1). Area under sugarcane did not change significantly in different blocks and years. Area under vegetables is on the increase which is on account of increasing demand in urban areas.

Data on live-stock shows that buffalos share 40.2% followed by cows Cows (32.3%) and calves (26.4%) of the total livestock population. Pig, horse, ox and he-buffalo have 1% of the total livestock in the area. The variation in the distribution of live stock is not significant. However, Balachaur Block has the highest percentage of buffalos (per farming household livestock index 5.43) and lowest index (1.94) of buffalos in Saroya block. The average index of cows per farmer household is 1.39 and highest in the Banga block (2.11) and lowest in the Saroya block (0.69).

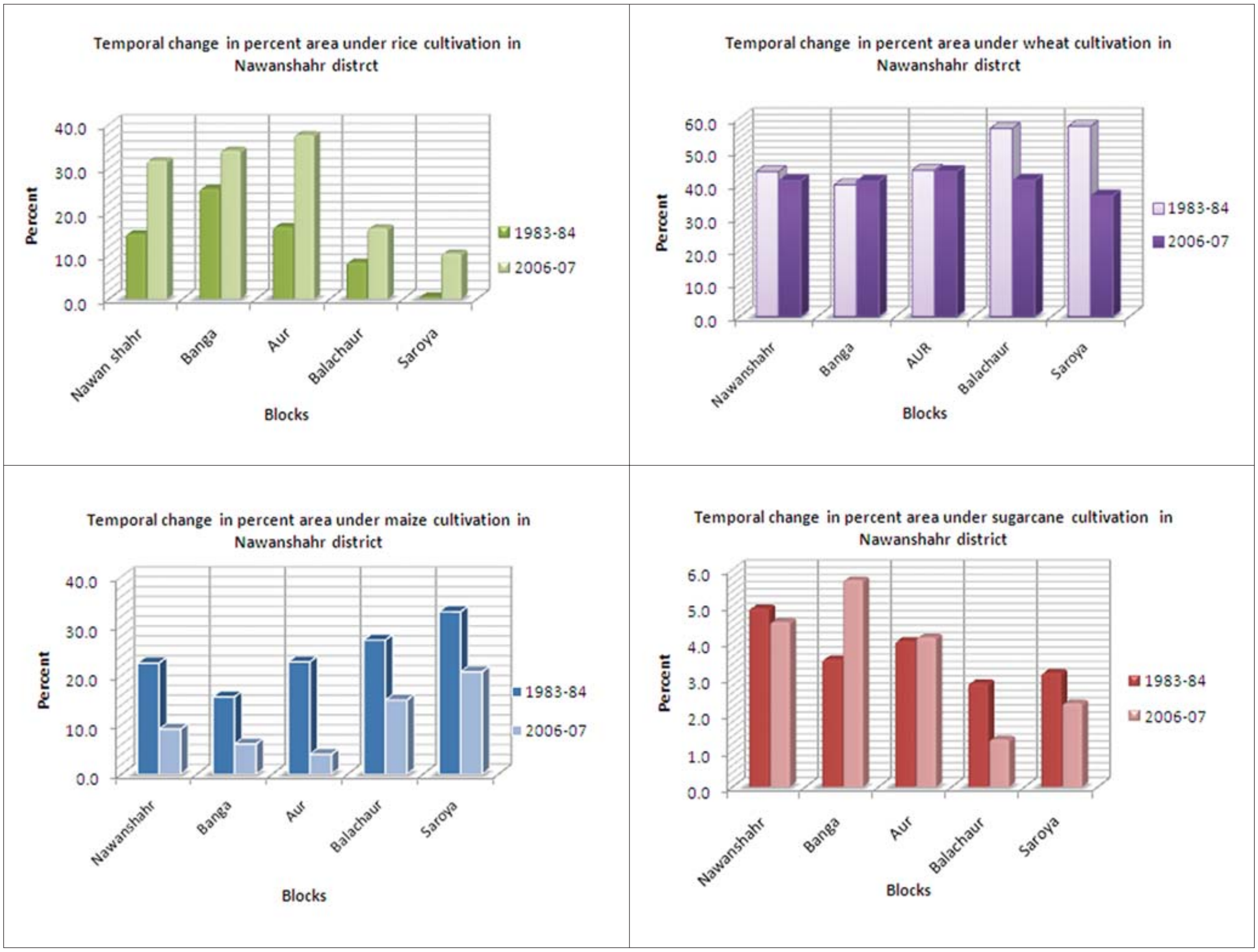


Fig. 5.1 Block-wise shift in cropping pattern from 1983-84 to 2006-07

Dynamics of land use plan and its impact on soil properties in Jalandhar district, Punjab state

G.S. Sidhu, Tarsem Lal, Jaya N. Surya and J.P. Sharma

According to 2001 census, the total population of the district was 10.5 lakh. The district has experienced 10.15% growth of population during 1991-2001. In total 47% of the farming households have 1-3 persons in the family, 37% have 3-6 members, 10% have 6-9 persons and 6% families have >9 persons in the family. Thirty per cent of the farmers are illiterate, 7% farmers have primary education while 36% have middle level and 23% have matric level education. It was observed that 15% farmers had 1-2 acres of land, 32% farmers had 2-5 acres, 30% farmers had 5-10 acres and 22% farmers had > 10 acres of land. Nearly 70% farming households have one male agriculture worker, 21% households 2 male workers and 5% households have 3 male agricultural workers.

The major crops grown in Jalandhar during 1950 and 60s were maize , cotton, green gram, blackgram, clusterbean, sorghum, pearlmillet, groundnut, pigeanpea, sunhemp and sugarcane in *kharif*, whereas rice was taken in low-lying areas in few villages. In *rabi* season wheat+ gram (mixed), wheat, barley, gram, lentil, mustard, peas, toria were grown. This system was followed upto 1970s. From 1970 onwards farmers shifted crops of *kharif* season to rice cultivation and crop *rabi* season to wheat.

Wheat is the major crop covering 44% of cropped area followed by rice (37%) in 2006-07. Other major crops in the area are fodder (11%), sugarcane (3%), and maize (3%). The area under wheat and fodder remained almost same since 1984-85. Area under rice has increased from 22% in 1984-85 to 37% in 2006-07 whereas sugarcane area has increased from 2.6% to 3.08 % . Area under maize has declined from 11.7% in 1984-85 to 3.09% in 2006-07 while under oilseeds it has declined from 2.1 to 0.82 % . Area under pulses has declined from 0.7% to 0.44% during this period.

Nearly 51% farmers have reclaimed their land at one time or the other. Out of the total farmers who reclaimed land, 42% reclaimed their land in 1970s with the start of green revolution. Nearly 35% farmers reclaimed their land in 1980 and 8% reclaimed in 1990. Only 12% farmers reclaimed their land before 1970. About 90% of the land reclamation is concentrated in the old flood plain. It was observed that ground water depth has drastically changed in the district. Block-wise data shows that maximum ground water depth has been changed in Jalandhar east block, where the depth has gone down from 12 feet in 1950 to 74 feet in 2008.

Soils, Land Use and Perspective Land Use Planning of Nagpur District

Arun Chaturvedi, C. Mandal, Rajeev Srivastava, D.K. Mandal, T.N. Hajare, S.N. Goswami, N.C. Khandare and R.S. Gawande

The major findings of this project are as follows:

- If the scheme of notified Nagpur Metropolitan Regional Plan is implemented then nearly 45 per cent of the districts will come under urban land use.
- More than 60 per cent of the area proposed under the Nagpur Metropolitan (Fig. 5.2) Regional Plan is under deep to very deep soils and need to be conserved (Fig. 5.3).

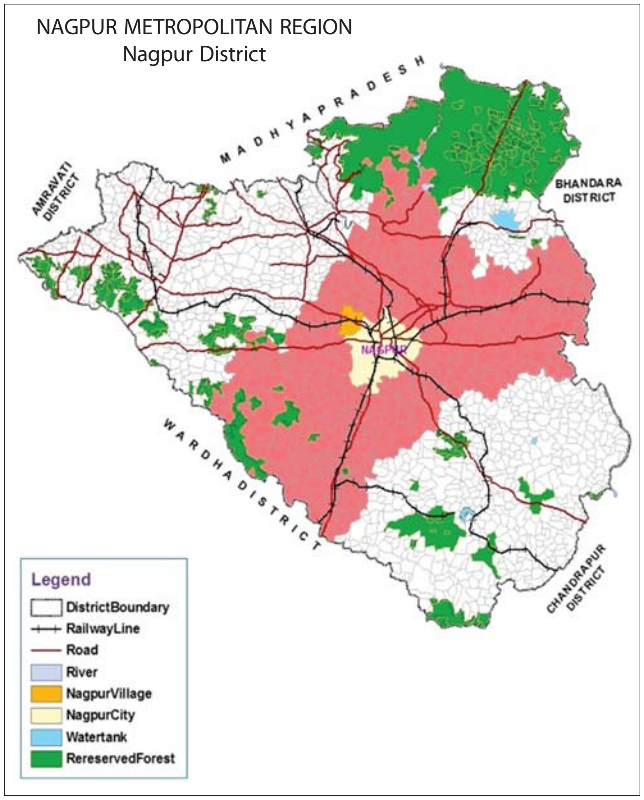


Fig. 5.2 Nagpur Metropolitan Region

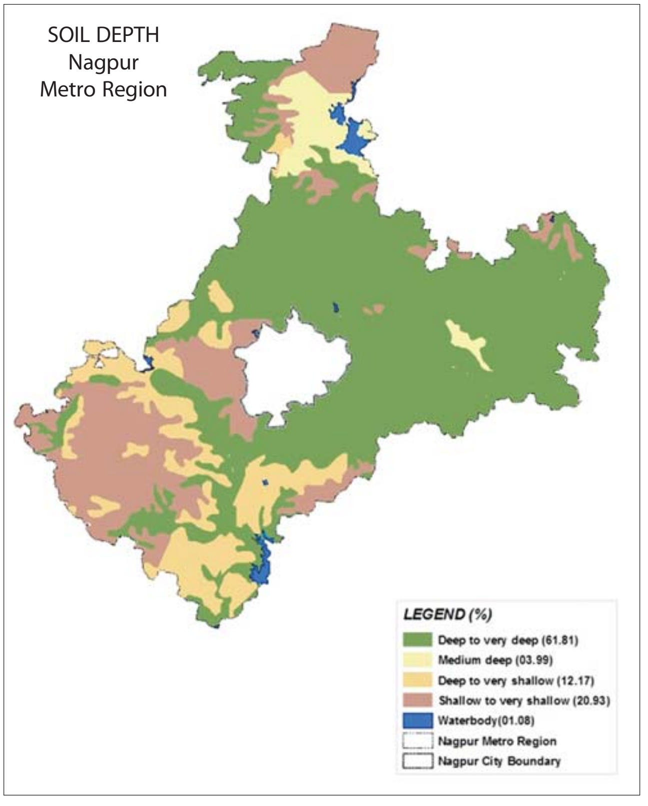


Fig. 5.3 Soil depth map of Nagpur Metro Region

Land use planning for Tirumale sub-watershed (Motaganhalli watershed) in Magadi taluk, Ramangar district, Karnataka

Rajendra Hegde, S.S. Srinivas and A. Natarajan

The project was undertaken to inventorize natural resources of the Tirumale sub- watershed, identify the potentials and constraints and formulate alternate land use plan for integrated development of the sub-watershed.

The Tirumale sub-watershed encompasses two micro watersheds, namely Bairappanapalya and Kadrenapalya covering 14 villages in the region. Total area of two micro-watersheds is 1650 ha. Major crops of the region are ragi (finger millet), coconut, mulberry, vegetables, field bean, etc. Climate of the region is hot moist semi-arid. Average annual rainfall is 996 mm and mean annual temperature of 20 to 27^{o}C. The geology is dominated by granite.

IRS P-6 (LISS IV) image (False Colour Composite) of the watershed area was visually interpreted and demarcated as rocky surfaces, water bodies, summits, upland, mid lands, plantation areas, agricultural lands and other permanent features like roads and settlements. The imagery was enlarged to 1:8000 scale to match with the cadastral map to identify different features. The GOOGLE images of the area were also used to identify the features.

Geo-morphological analysis was carried out, soils occurring on different landforms were studied and horizon-wise soil samples were collected. Composite soil samples were also collected from different land forms and land uses for soil fertility analysis. Thirty two farmers were interviewed to understand the constraints and potentials of the watershed for facilitating profitable farming, soil and water conservation and diversification of farming.

The constraints noticed are 1) considerable area is covered with rock out crops and marginal lands are widespread. 2) Productivity of majority of crops are lower than the state average. 3) Ground water level is going down below 200 meters and efforts for rain-water harvesting and ground water recharging are not noticed. 4) Digging of deep borewells is very rampant and awareness in adoption of water efficient irrigation methods is lacking. Large number of borewells have failed. 5) Some terraces of cultivated fields are too long with multiple slopes and this is causing soil erosion in the region and at places weathered parent materials are exposed. Overgrazing further aggravates the problem. 6) Labour scarcity has become a serious limiting factor in adopting essential package of practices in the region.

The potentials and opportunities are 1) Most of the cultivated fields are already terraced systematically. 2) There is only a need for strengthening the structures where ever they are found weak and damaged to minimize the soil erosion. 3) The rainfed cropping system consisting of ragi (finger millet), pigeon-pea castor, field-bean is very ideal for maintaining the soil health and utilizing the soil resources from different depths of soil profile. 4) In most areas, top soil layer consists of lighter soil texture (sandy loam and sandy clay loam) which allows easy infiltration of water into the soil profile. The sub-surface layers are of heavy texture which store/hold good quantity of soil moisture thus allowing good performance of rainfed crops. 5) Large number of termite hills and failed borewells noticed in the region can be utilized for rain water harvesting and ground water recharging. 6) Nearness of area to Bangalore and suitable climate provide bright scope for the cultivation of high value fruit and vegetable crops. 7) Goat and sheep rearing is a most common enterprise and provides a good source of income. However stall feeding needs to be promoted to prevent the degradation soil and vegetation in village common lands.

Land Use Planning of Diring-Thanglong Micro-watershed of Karbi-Anglong and Golaghat districts of Assam under Hills & Mountain Ecosystem for Integrated Development

S. Bandyopadhyay, S.K. Reza, Dipak Dutta and Utpal Baruah

The major part of study area of the micro-watershed falls in Shilonijan Revenue Circle under Rongmongwe Development Block of Bokajan Sub-division of Karbi-Anglong District and the minor area is situated in Bokakhat Revenue Circle under Golaghat West Development Block of Golaghat District. The operational area of the watershed is 640 ha.

The cropping system of the area is shown in table 5.1. The productivity of rice (both rain-fed and ahu), mustard and black gram is low compared to the district level productivity. This is due to poor and primitive level of farming practices and lack of proper farm mechanization knowledge among the producers. As far as net profits from different crops is concerned rice (rain-fed) and tea give better returns as compared to mustard and black gram.

Table 5.1 Cropping system of the Diring-Thanglong watershed

Landform	Major crops
Hill top	Homestead horticulture and plantation, e.g., arecanut, banana, leafy vegetables, tapioca, gourds, etc. and tea plantation
Moderately steep to steep hill slopes (15% or more)	Tea plantation Jhumming Ahu paddy, vegetables, etc.
Gently sloping Uplands (3-8% slope)	Tea, gourds, tapioca, Ahu paddy, vegetables, tomato, arecanut, banana, etc.
Inter-hill valley (1-3% slope)	Paddy (rainfed), Ahu paddy, mustard, potato, gourds, etc.
Very gently sloping plains	Paddy (rainfed), mustard, potato, blackgram, etc.

Land use planning for North Goa District, Goa – A sub project of network project on district level land use planning and policy issues under different agro-ecosystem of country

Rajendra Hegde, S. Srinivas and S.C. Ramesh Kumar

A study was carried out to identify major constraints affecting coconut cultivation, a promising rural enterprise in North Goa district of Goa state for taking appropriate remedial measures. The economics of coconut cultivation in different LMUs of the district is given in table 5.3. Major constraints affecting coconut production in the district have been identified. Show Damages caused by mining Figs. 5.4 and 5.5 and suitable intervention for improving the productivity have been suggested.

Fig. 5.4 Mining causing ecological damages

Fig. 5.5 Rice fields going out of cultivation due to mining wastes

Table 5.3 Economics of coconut cultivation in major LMUs

Details	Beaches and mud flats (rainfed)	Flat topped hills (rainfed)	Lower hills (rainfed)	Coastal laterites (rainfed)
Trees / acre	65-70	52-60	55-65	75-80
Input costs Rs /acre	3100	3980	3500	3300
Labour cost	3200	4200	3800	4100
Total cost	6300	8180	7300	7400
Yield (nuts /acre /year)	4080	4200	4500	5200
Gross income	16320	16800	18000	20800
Net income	10020	8620	10700	13400
Potential yield (nuts / acre)	6800	6160	6600	8580
Yield gap (nut / acre)	2720	1960	2100	3380
Income loss (Rs / acre)	10880	7840	8400	13520

Major constraints limiting and suggested interventions for improving the coconut productivity.

Sub-optimal nutrient management
Sub-optimal water management during non-rainy season.
Non-descript varieties occupy large areas as compared to high yielding and early bearing varieties.
Senile plantation without proper spacing and excess/sub-optimal population occupy the large areas.
Less profit to farmers due to unattractive price situation.
Suggested interventions for improving coconut productivity
Generation of site-specific land resources data base that will aid in managing the plantations with precision approach.
As region receives heavy rains, devising and updating of site-specific soil and water conservation plans is most essential.
Introduction of suitable and compatible intercrops to enhance farm diversification and profitability.
Senile plantations without proper spacing and excess/sub-optimal population occupy the large areas.

Major constraints limiting coconut productivity

1. Sub-optimal nutrient management and water management during non-rainy season.
2. Non-descript varieties occupy large areas as compared to high yielding and early bearing varieties.
3. Senile plantations without proper spacing and excess/sub-optimal population occupy the large areas.
4. Less profitable to farmers due to unattractive price.

Suggested interventions for improving coconut productivity

1. Generation of site-specific land resources data base for managing the plantations with precision approach, viz. site-specific soil and water conservation plans.
2. Introduction of suitable and compatible intercrops to enhance farm diversification and profitability.

Development of district level land use plan for Bundi district (Rajasthan) under arid and semi-arid eco system – A sub project of network project on district level land use planning

R.S. Singh and R.L. Shyampura

Bundi district (24°59' to 25°23' N, 75°15' to 76°21 E) with an area of 5.82 lakh ha is situated in the south eastern part of Rajasthan state. The land units generated earlier having 49 units, have been further generalized to manageable and meaningful units considering their extent (< 0.50% area of TGA).

The net sown area declined from 44.6 in 1998-99 to 33.2% in 2002-03 with cropping intensity of about 150 per cent. Soybean (16.6%), paddy (15.1%), maize (14.1%), sugarcane and sorghum (2.41) are grown during *kharif* whereas wheat (43.7%), mustard (20.3%) followed by gram (7.0%) are major crops in *rabi*. Black gram and green gram are taken as contingent crops during unfavourable monsoon and its area has been increased significantly in 2002-2003. Lentil, pea, linseed, coriander, fenugreek and taramira also cover sizeable area in the district such as soybean, maize, black gram and sesame are competing with paddy. Coriander is preferred crop over wheat, gram and mustard. Cropping pattern in different tehsil has been shown in table 5.4.

Farming system data have been collected from each of the major land unit in the 3 selected villages (Table 5.5). Three farmers each belonging to marginal (<1ha), small (1-2 ha), medium (2-4 ha) and large (>4 ha) category in a village were selected for socio-economic conditions and farming system and their perception on the production related constraints. A total of 215 farmers were contacted in 9 land units out of 17 LU. Farm household data have been analysed for the yield, benefit cost ratio and net benefit per ha of crops grown in land unit. Land units were further grouped into homogeneous land management units based on similar farming/cropping systems (fig. 5.6).

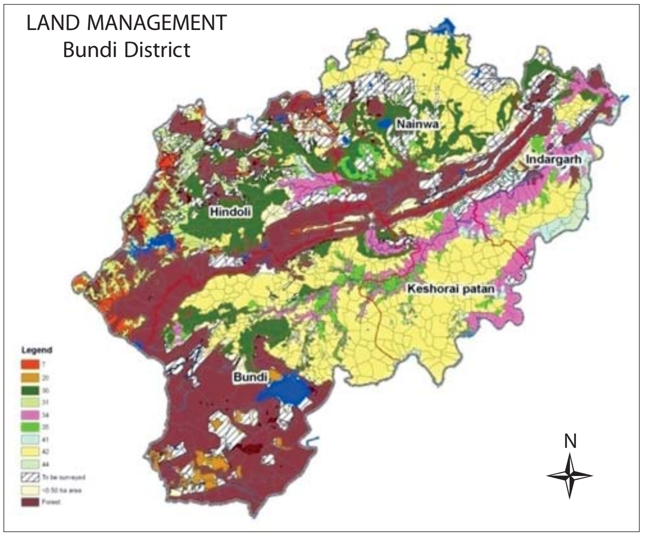


Fig. 5.6 Land management unit in Bundi district

Performance of the current cropping systems is presented in table 5.6. The productivity of maize, mustard, gram and wheat are lowest for sesame/maize-wheat/gram/mustard cropping system in shallow, loamy-skeletal soils (3-8% slope). In general, productivity, benefit cost ratio and net profit per hectare are found to be higher in the LMU 35, 20, 31 and 42 in medium to deep, fine-loamy to fine soils. Benefit cost ratio in respect of fenugreek crop is highest (2.1 – 2.6) whereas per hectare net return is highest in case of garlic and potato crop (Table 5.6). The performance of wheat, coriander and fenugreek crops is better in deep, fine soils of LMU 41 and 44. Lowest net return and benefit cost ratio are observed for maize irrespective of soil and land characteristics. In farmer's perceptions, climatic variability especially rainfall pattern is the most dominant constraint in farming followed by soils, availability of power (electricity), high cost of input, low prices of produce, availability of improved seeds and fertilizer except land management unit 7 wherein soil related constraint is prominent.

Table 5.4 Cropping pattern in tehsils of Bundi district

Land use/Crops	Bundi	Keshoraipatan	Hindoli	Nainwa	Indergarh
Net area sown (% of TGA of Tehsil)	30.25	53.87	39.47	25.36	24.01
Cropping Intensity	147.00	160.00	113.00	130.00	114.00
		Kharif			
		Per cent of net sown area			
Paddy	11.85	3.89	0.08	2.44	0.11
Sorghum	1.12	0.93	2.18	1.41	8.78
Bajra	0.03	0.00	2.69	1.07	5.53
Maize	18.38	2.17	12.15	44.06	3.59
Pigionpea	0.03	0.03	0.00	0.00	1.87
Green gram	0.03	0.03	0.00	0.00	1.87
Black gram	2.87	0.83	56.98	5.32	14.95
Sugarcane	0.44	0.17	2.19	9.09	0.04
Groundnut	0.06	0.01	1.00	0.55	1.50
Sesame	4.61	1.60	3.43	6.15	3.66
Soybean	37.31	63.36	1.36	1.27	7.03
		Rabi			
		Per cent of net sown area			
Wheat	44.52	51.49	11.94	29.41	30.13
Barley	0.54	0.64	0.24	0.64	1.03
Gram	3.90	6.40	3.45	1.84	3.90
Pea	0.07	0.10	0.00	2.02	0.04
Lentil	0.65	0.47	0.88	0.69	0.08
Red Chilli	0.02	0.10	0.05	0.16	0.09
Coriander	1.85	6.30	0.02	0.01	10.70
Cumin	0.03	0.00	0.35	0.00	0.02
Methi (fenugreek)	0.00	2.62	0.00	0.00	1.61
Potato	0.20	0.01	0.01	0.07	0.02
Sugar beat	0.25	0.00	0.02	0.00	0.00
onion	0.00	0.00	0.01	0.00	0.09
Mustard	6.91	13.09	2.70	2.64	10.64
Linseed	0.16	0.13	0.01	0.02	0.16
Taramira	0.09	0.04	0.11	0.30	0.27

Table 5.5 Major land units in Bundi district

LU*	Land Units		Area (ha)	Per cent
	Description of generalized soil unit	Land Use		
2	Shallow (<50 cm), loamy-skeletal on 3-8% slope with LGP of 90-105 days	Agriculture	5790	1.02
5	Shallow (<50 cm), loamy-skeletal on 8-15% slope with LGP of 90-105 days	Ravinous	3106	0.55
6	Shallow (<50 cm), loamy-skeletal on 8-15% slope with LGP of 90-105 days	Agriculture	4580	0.81
7	Shallow (<50 cm), loamy-skeletal on 8-15% slope with LGP of 90-105 days	Open scrub with agriculture	13549	2.4
14	Shallow (<50 cm), loamy on 3-8% slope with LGP of 105-120 days	Agriculture	12008	2.12
15	Shallow (<50 cm), loamy on 3-8% slope with LGP of 105-120 days	Open scrub with agriculture	24414	4.32
19	Medium (50-100 cm), fine-loamy on <3% slope with LGP of 105-135 days	Agriculture	10585	1.87
20	Medium (50-100 cm), fine-loamy on <3% slope with LGP of 105-135 days	Open scrub with agriculture	5823	1.03
30	Deep (>100 cm), fine-loamy on <3% slope with LGP of 120-135days	Agriculture	59993	10.61
31	Deep (>100 cm), fine-loamy on <3% slope with LGP of 120-135days	Open scrub with agriculture	17228	3.05
34	Deep (>100 cm), fine-loamy on 3-8% slope with LGP of 105-135days	Ravinous	35302	6.25
35	Deep (>100 cm), fine-loamy on 3-8% slope with LGP of 105-135days	Agriculture	17358	3.07
37	Deep (>100 cm), fine-loamy on 8-15% slope with LGP of 120-135days	Ravinous	5861	1.04
41	Deep (>100 cm), fine on <3% slope with LGP of 120-135days	Ravinous	10110	1.79
42	Deep (>100 cm), fine on <3% slope with LGP of 120-135days	Agriculture	147830	26.15
44	Deep (>100 cm), fine on 3-8% slope with LGP of 120-135days	Ravinous	3252	0.58
49	Very shallow soil and Rock outcrops on 3-8% slope with LGP of 90-105days	Open scrub with agriculture	7690	1.36

*Retained original LU numbers.

Table 5.6 Performance of current cropping system in surveyed LMU's of Bundi district

LMU	Crops	Farmer's Field Yield (q/ha)	B:C	Net Benefit/ha	Production System-Primary
7	Maize	14.5	0.07	1076	
	Sesame	4.0	0.79	15970	
	Wheat	34.0	0.97	13270	
	Mustard	16.0	1.09	18730	Sesame/maize-wheat/mustard/gram
	Gram	3.0	0.11	15940	
20	Maize	24.9	0.22	4660	
	Sesame	2.0	2.11	12575	
	Groundnut	15.6	1.13	20625	
	Soybean	19.6	1.15	21970	
	Garlic	59.4	0.86	100960	
	Gram	14.1	0.86	15330	
	Mustard	18.8	1.4	23790	
	Potato	200	0.89	61225	Maize/soybean/sesame/groundnut-
	Taramira	9.0	1.67	9200	wheat/gram/mustard/taramira/potato/garlic
	Wheat	42.8	0.82	25040	
30	Paddy	37.7	0.83	16500	
	Soybean	15.7	0.5	14140	Paddy/soybean-wheat
	Wheat	42.3	1.06	24730	

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31	Maize	18.3	0.16	3160	
	Gram	16.0	0.43	9100	
	Lentil	19.0	1.78	38880	
	Mustard	16.5	1.44	22865	Maize-wheat/mustard/lentil
	Wheat	43.5	0.77	22885	
34	Soybean	8.6	0.38	4800	Soybean-wheat/mustard
	Wheat	29.5	0.52	12720	
35	Maize	17.7	0.11	2305	
	Soybean	15.3	0.85	15910	
	Mustard	16.6	1.91	20280	Soybean/maize-wheat/mustard
	Wheat	38.7	0.95	22990	
41	Sesame	6.7	2.3	17600	
	Soybean	10.7	0.77	11115	
	Coriandar	15.0	1.5	23340	
	Gram	12.5	1.04	15140	Soybean/sesame-
	Fenugreek	18.8	2.59	39130	wheat/coriander/fenugreek/gram
	Wheat	38.8	0.99	24780	
42	Soybean	15.6	1.19	18510	
	Garlic	50.0	1.97	24900	Soybean-wheat/garlic
	Wheat	39.4	1.35	26300	
44	Sesame	2.8	0.76	4580	
	Coriandar	14.5	1.23	22775	Sesame-wheat/fenugreek/coriander
	Fenugreek)	14.5	2.05	30830	
	Wheat	33.3	1.2	22445	

Development of district level land use plan for Nadia district in West Bengal under irrigated ecosystem – A sub project of network project on district level land use planning

A.K. Sahoo, D.C. Nayak, T. Banerjee and S.K. Singh

Twenty four land units were delineated in Nadia district by spatial integration of land features, soils, present land use and administrative divisions. Land units were converted into fifteen land management units (LMUs) (Fig. 5.7) on integration with four prevailing major production systems viz. jute and rice; jute/rice and wheat/pulse/oil seed; sugarcane and jute/cereals/pulses/oil seed; fruit crops and jute/cereals based production systems.

Legends

LMU 1 Jute/rice/vegetables-based production systems on fine silty, calcareous, moderate to imperfectly drained soils with moderate to severe flooding of flood plain

LMU 2 Fruit crops/rice/jute/vegetables-based production system on fine silty, calcareous, imperfectly drained soils with moderate flooding of flood plain,

LMU 3 Jute/rice//pulses/oilseed/vegetables/flowers-based production system on coarse silty, calcareous, imperfectly drained soils with severe flooding of flood plain,

LMU 4 Jute/rice/vegetables-based production system on fine, calcareous, moderately drained soils of meander plain

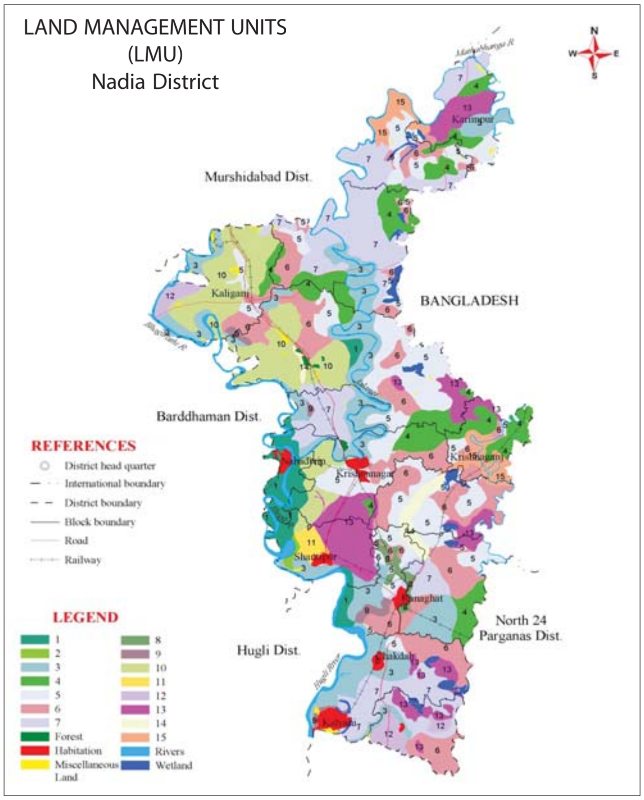

Fig. 5.7 Land Management Units identified in Nadia district, West Bengal

LMU 5 Jute/rice/pulses/oilseed/vegetables-based production system on fine, poor to imperfectly drained soil with moderate flooding of meander plain

LMU 6 Jute/rice/vegetables-based production system on fine, poor to imperfectly drained soil with moderate flooding of meander plain

LMU 7 Jute/rice/wheat/oilseed/vegetables-based production system on fine-loamy, calcareous, poorly drained soils of meander plain

LMU 8 Fruit crops/rice/jute/vegetables-based production system on fine-loamy, calcareous, poorly drained soils of meander plain

LMU 9 Sugarcane/rice/jute/vegetables-based production system on fine-loamy over sandy, calcareous, poorly drained soils (flooding) of meander plain

LMU 10 Sugarcane/rice/jute/vegetables-based production system on fine-silty, poorly drained soils of meander plain

LMU 11 Fruit crops/rice/jute/vegetables/flowers-based production system on fine-silty, poorly drained soils of meander plain

LMU 12 jute/ rice /vegetables/flowers-based production system on fine-silty, calcareous, poorly drained soils of meander plain

LMU 13 Jute/rice/pulses/oilseed/vegetables-based production system on fine, poorly drained soils with severe flooding of low lying and marshy area

LMU 14 Jute/rice/wheat/ pulses/oilseed/vegetables /flowers-based production system on fine loamy, poorly drained soils with moderate flooding of river valley

LMU 15 Jute/rice/wheat/ pulses/oilseed/vegetable/ flowers-based production system on fine-loamy, calcareous, imperfectly drained soils with moderate flooding of river valley

Development of district level land use plan for Mysore district, Karnataka state – A sub project of network project on district level land use planning

V. Ramamurthy, K.M. Nair, S.C. Ramesh Kumar, S. Srinivas, L.G.K. Naidu, and S. Thayalan

Under the National Network project on land use planning, a study was undertaken in Mysore district, Karnataka to develop district level land use plans. Mysore is predominantly an agrarian district with geographical area 676382 ha. The district has been divided into 12 Land Management Units (LMUs) by spatial integration of external land features, soils, agro-ecology, land use and production systems. Each LMU was evaluated for their potentials and limitations. Socio-economic and crop production data (Table 5.7) was collected from 342 farmers covering major soils, production systems and different categories of farmers have been linked to LMUs. Methodology used for linking the LMUs with census data is presented in the following flow diagram (Fig. 5.8).

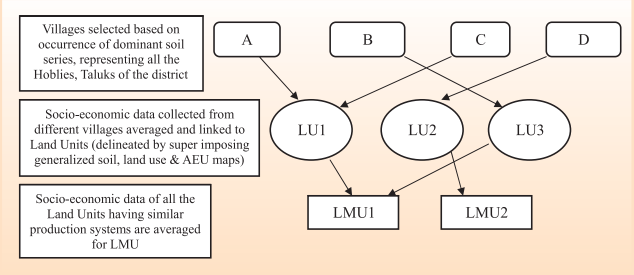

Fig. 5.8 Linking of socio-economic data to LMUs

Table 5.7 Socio-economic status of LMUs

LMU	No.of households	Total population	SC (%)	ST (%)	Credit Societies	Rainfe d areas	Irrigated area	Culturable wastelands	Area not under cultivation
1	59006	288449	26	16	193	34202.3	24583.3	11256.7	8516.9
2	49859	236827	22	13	124	16588.7	25691.9	4885.6	7348.4
3	3092	16164	18	10	14	1613.2	1612.0	434.4	786.0
4	2494	14137	16	1	10	2282.3	305.8	585.0	868.0
5	31786	166150	17	7	159	34182.1	7216.9	7575.4	8032.3
6	5482	27450	22	9	21	5680.4	1480.0	1089.4	1716.2
7	33064	161738	24	20	141	32294.2	3005.4	9610.2	11797.5
8	10318	48891	21	19	48	9401.9	2336.5	3283.6	3580.9
9	35122	174437	16	14	139	34241.4	5074.4	9167.0	4877.8
10	5869	28430	27	2	18	4680.5	1602.2	832.2	893.5
11	30352	148323	22	11	88	29728.1	6436.6	6264.1	3873.2
12	32955	157543	18	10	79	28682.7	4785.1	2882.2	4718.9

Among the rainfed LMUs, area under wastelands is more in LMU 7, 9 and 5. Enhancement of vegetative cover on wastelands need to be taken up in these LMUs to check soil erosion.

Considering the natural resources and socio-economic indicators potentials and limitations of each LMU, land use planning options are proposed (Table 5.8).

Identification of potential areas at taluk level

One of the demands from the stakeholders was that they need information at taluk or hobli wise suitable areas of different crops for effective implementation of different crop-specific schemes. Hence, LMUs were evaluated for all the important crops of the district. Tobacco land suitability map is presented as an example in Fig. 5.9.

Table 5.8 Proposed land use planning options for rainfed LMU 4 and 5

LMU	Existing crops	Option 1	Option 2	Option 3	Option 4	Option 5
4	Tobacco-ragi/ HG/FB, Ragi+ FB, HG, Maize	Horse gram is most suitable	Ragi +FB with proper SWC measure and INM	Green gram/ HG-ragi with SWC measures	Baby corn/sweet corn for green cobs instead of grain maize– provide green fodder for huge cattle population and economically viable (Rs. 10,000/ ha as against Ragi-Rs. 4000/ha)	Mod. Sloping lands can be put to establish silvi – pasture as goats are dominant livestock
5	Tobacco-ragi/ HG/FB/ cowpea, Maize/cowpea-ragi, Ragi+FB/ Redgram, Maize, GN	Tobacco, Ragi, Maize, GN are most suitable	In Tobacco, INM, IPM need to be populaized	Suitable crops need to be grown with INM and SWC measures	Baby-corn/sweet corn for cobs-ragi/grain maize-pulses, Fodder cowpea-ragi/ Tobacco + H.gram (fodder)	Planting of Napier hybrids/ MPTs on bunds need to be encouraged. Wastelansds needs to seeded with improved grass and legumes

Note: HG-Horse gram; FB- Field bean; GN-Groundnut; SWC-Soil and water conservation

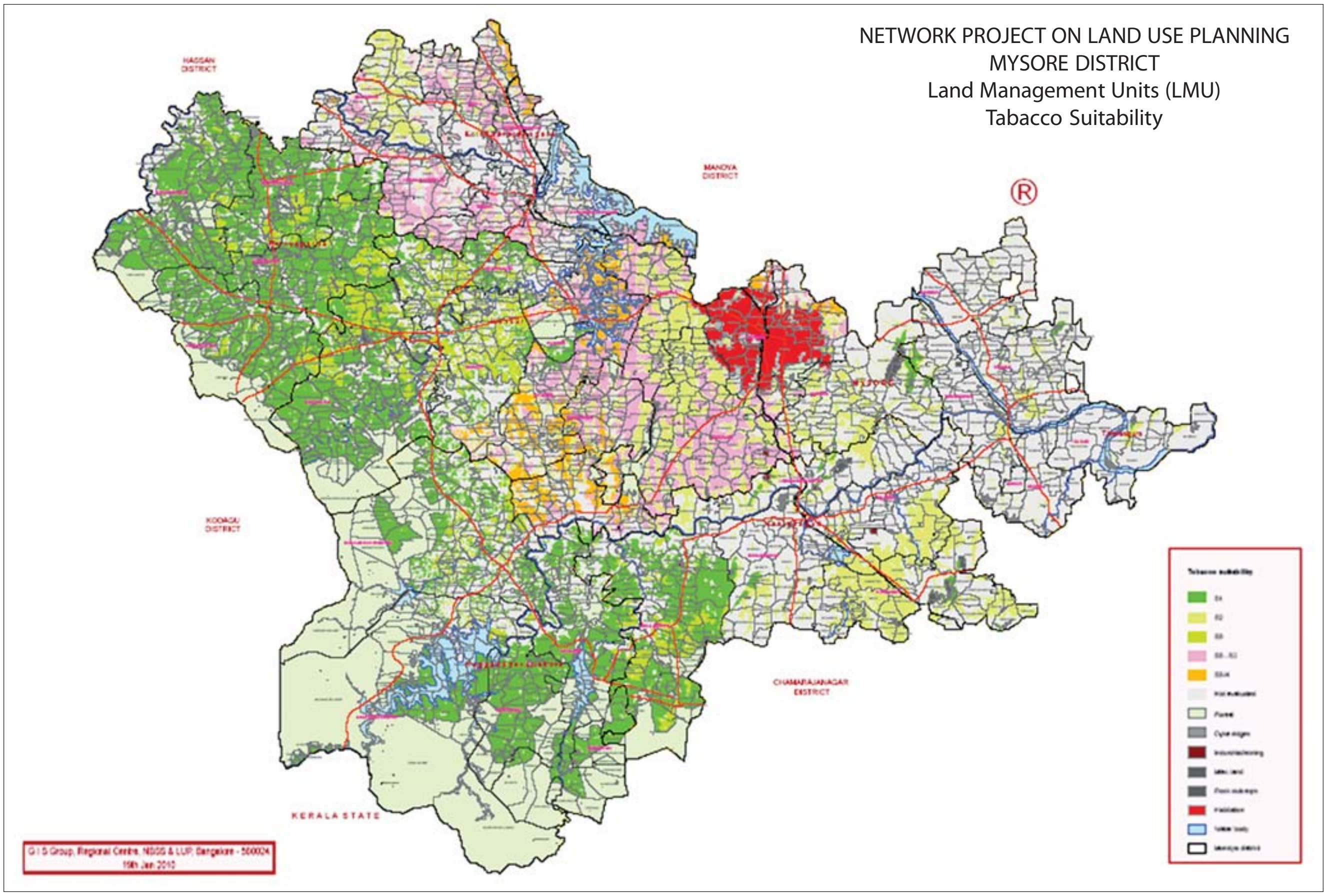

Fig. 5.9 Suitable areas for tobacco production in Mysore district

Tobacco is mostly grown as rainfed crop in Mysore district and area target was 82950 ha for the year 2010-11. Land suitability indicated that highly suitable soils are occurring in LMU 5 (48990 ha) and LMU 7 (72335 ha), comprising of Periyapatna, HD Kote and Hunsur taluks of the district. At present tobacco is being grown extensively in HD Kote, Periyapatna and Hunsur and in moderate way in K.R.Nagar, Nanjanagudu and T. Narsipur. H.D. Kote is having five hoblies, of which Kandalike, HD Kote hoblies are having 32817 ha highly suitable area and Hampapura hobli is having 2872 ha moderately suitable area for tobacco cultivation (Fig. 5.10). The stakeholders like Tobacco board and State Agricultural Department need to focus in H.D.Kote, Periyapatna and Hunsur only for area expansion of tobacco and implementation of INM and IPM programmes.

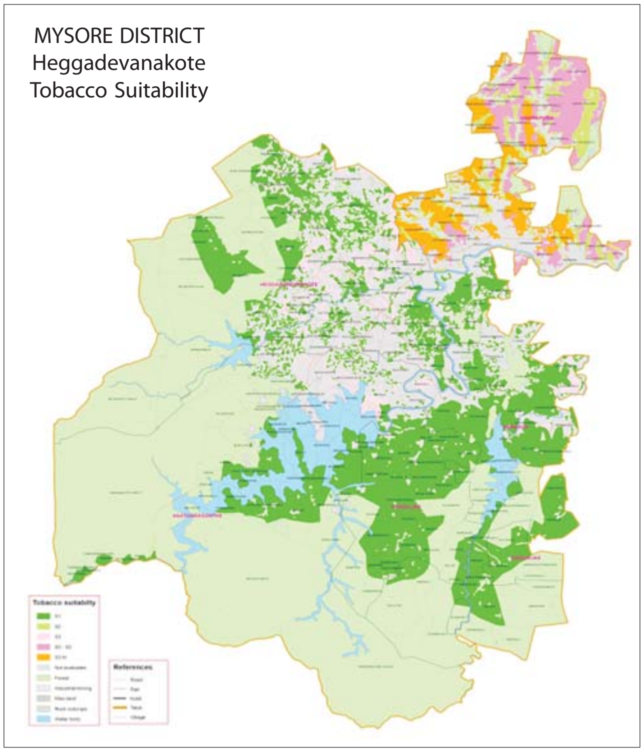

Fig. 5.10 Suitable areas for tobacco production in H.D. Kote of Mysore district

Land use option analysis through multiple goal linear program (MGLP)

Land use options under various policy issues are explored by using the linear programming technique. The MGLP model consists of three components (i) input-output relations of production activities, (ii) a set of constraints, and (iii) objective functions derived from policy issues for the region. The goals set for area allocation to different components of agriculture in Mysore district are as follows.

1. Maximum net returns (no constraints on minimum area crop allocation)
2. Maximum net returns with minimum area under cereals
3. Maximum net returns with minimum area under cereals + pulses
4. Maximum net returns with minimum area under cereals + pulses + Oilseeds
5. Maximum net returns with minimum area under cereals + pulses + oilseeds + commercial crops (excluding field bean and horse gram)
6. Maximum net returns with fertilizer constraints

Area allocation for each goal has been presented in Table 5.9. The expected net returns for the district varied from 65,713 to 28, 384 million under different objectives and to achieve this, different combination of crops have been suggested by the model.

Table 5.9 Area allocation for different crops in each LMU as per goals

Goals	Max. Net Returns (No constraint on minimum crop area allocation)	Max. NR with mini. area under cereal crops	Max. NR with mini. area under cereal + pulses	Max. NR with mini. area under cereal + pulses + oilseeds	Max. NR with mini. area under cereal + pulses + commercial crops (Excluding FB & HG)	Max. NR with fertilizer constraint
NR (mil)	65713.2	36909.6	33869.2	32816.4	31463.6	28384.3
LMU 1		Paddy (42.9) Banana (57.1)				
LMU 2	Banana (100)	Paddy (100)	Paddy (100)	Paddy (100)	Paddy (100)	Paddy (100)
LMU 3	Tomato (100)	Paddy (100)	Paddy (100)	Paddy (100)	Paddy (100)	Paddy (100)
LMU 4	Tobacco (100)	Tobacco (100)	Ragi (100)	Ragi (100)	Ragi (100)	Ragi (3.4) H.Gram (96.6)

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						Tobacco (86.6)
LMU 5	Tobacco (100)	Tobacco (100)	Tobacco (100)	Tobacco (100)	Tobacco (100)	Maize (13.4)
LMU 6	Tobacco (100)	Tobacco (100)	Tobacco (100)	Tobacco (100)	Tobacco (100)	Ragi (100)
			Tobacco (47.3)	Tobacco (24.9)	Tobacco (21.5)	cotton (61.3)
			Ragi (27.8)	Ragi (36.4)	Ragi (26.7)	Ragi (13.8)
				Sesamum (13.8)	Sesamum (13.8)	
LMU 7	Tobacco (100)	Tobacco (100)	F.Bean (24.9)	F.Bean (24.9)	F.Bean (37.9)	Maize (24.9)
LMU 8	Cotton (100)	Sorghum (100)	Sorghum (100)	Sorghum (100)	Sorghum (100)	Ragi (100)
		Ragi (91.3)	Ragi (80.5)	Ragi (67.0)	Ragi (36.3)	Cotton (2.2)
LMU 9	G.Nut (100)	G.Nut (8.7)	Cowpea (19.5)	Cowpea (33.0)	Cowpea (63.7)	G.Nut (13.5)
						Cowpea (84.3)
LMU 10	Maize (100)	Maize (100)	Maize (100)	Maize (100)	Maize (100)	Maize (100)
		Maize (43.1)	Maize (43.1)	Maize (43.1)	Maize (43.1)	Maize (25.4)
LMU 11	Maize (100)	Sorghum (0.3)	Sorghum (0.3)	Sorghum (0.3)	Sorghum (0.3)	Sorghum (0.3)
		Ragi (56.7)	H.Gram (56.7)	H.Gram (56.7)	Ragi (56.7)	H.gram (74.3)
LMU 12	G.Nut (100)	G.Nut (100)	Cowpea (51.6)	G.Nut (10.8)	Cotton (72.8)	Cotton (72.8)
			H.Gram (48.4)	Cowpea (40.8)	G.Nut (10.8)	H.gram (27.2)
			H.Gram (48.4)	Cowpea (16.4)		

Identification of prime agricultural lands

Prime agricultural land is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. In Mysore district, LMUs were grouped into prime irrigated lands, prime rainfed lands (Fig. 5.11) and marginal lands by considering landform, soil depth, gravelliness, erosion, LGP and productivity of crops. All irrigated LMUs (LMU 1, 2 and 3) were grouped in to irrigated prime lands, rainfed LMUs (LMU 5, LMU 6, LMU 7, LMU 9, LMU 11, LMU 12) having medium deep to deep soil with LGP of 120 days and above, slight to moderate erosion and yield gap of crops less than 25% were grouped in to prime rainfed lands. LMUs having shallow soils with less than 120 days LGP and moderate to severely eroded soils were grouped in to marginal lands (LMU 4, LMU 8, LMU 10).

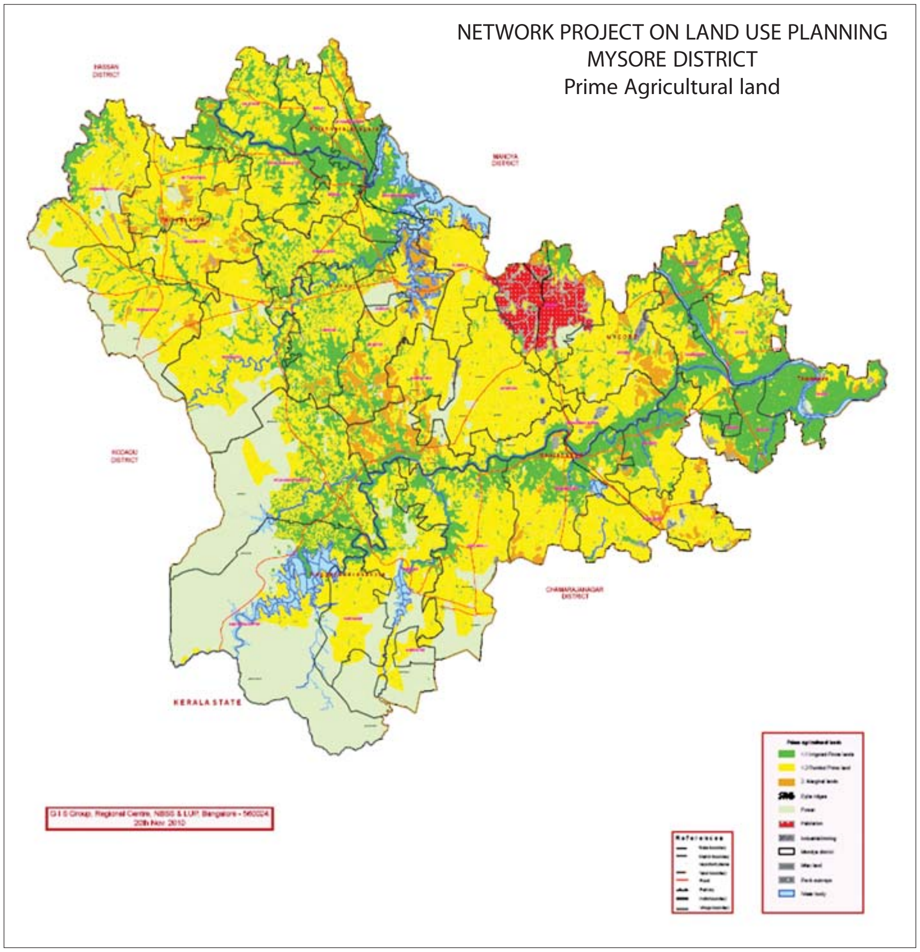


Fig. 5.11 Prime agricultural lands in Mysore district

Assessment of stakeholder needs and economic evaluation of land use types for land use planning of Mysore and North Goa Districts

S.C. Ramesh Kumar, V. Ramamurthy and Rajendra Hegde

A study was carried out in Mysore which is predominantly an agrarian district. Majority of the work force in the district is cultivators or agricultural labourers, their number being 3,97,957 and 2,50362, respectively. Together, they constitute about 60 per cent of the work force.

The land use pattern (Table 5.10) reveals that out of the total Geographical (676382 ha), 9.3% is under forests and remained constant over one decade. Land put to non-agricultural uses increased from 61622 (9.11 %) to 67028 (9.91%) with an annual increase of 14 ha. The projected area under non-agricultural use during 2024-25 will be 86026 ha. The barren and uncultivable land is decreasing from 50056 ha (7.4 %) to 43528 ha(6.44) with an annual decrease of 254 ha. The projected area under barren and uncultivable land use during 2024-25 will be 42812 ha. There is a increasing trend in current and other fallows over the previous years. The projected area under current fallow land is 35678 ha and other fallow land 39730 ha by the year 2024-25. The net sown area is decreasing at 4940 ha per year during 2001-2009 and the projected net sown area will be 346661 ha by 2024-25. The main sources of irrigation in the district are canals (101398 ha), tanks (18821 ha), wells (20537 ha), bore-wells (7985 ha) and others(398 ha) during 2009.

Table 5.10 Land use changes in Mysore district, Karnataka

Particulars of land use	1990-91	2000-01	2008-09	Change(ha) (2001-09)	Annual Change(ha)	Projected area (ha) 2024-25
Total Geographical Area(TGA in ha)	676382	676382	676382			676382
Forest	62851 (9.29)	62851 (9.29)	62851 (9.29)	0	0.0	62851
Non agricultural uses	61622 (9.11)	66904 (9.89)	67028 (9.91)	124	13.8	86026
Barren and uncultivable lands	50056 (7.40)	45812 (6.77)	43528 (6.44)	-2284	-253.8	42812
Cultivable waste lands	26080 (3.86)	21460 (3.17)	21455 (3.17)	-5	-0.6	18142
Permanent pasture and grazing lands	64759 (9.57)	56256 (8.32)	59591 (8.81)	3335	370.6	53420
Miscellaneous trees & plantation	6767 (1.00)	6866 (1.02)	6891 (1.02)	25	2.8	6445
Current fallows	21788 (3.22)	11105 (1.64)	35890 (5.31)	24785	2753.9	35678
Others fallows	22553 (3.33)	11705 (1.73)	33693 (4.98)	21988	2443.1	39730
Net sown area	359906 (53.21)	393423 (58.17)	348961 (51.59)	-44462	-4940.2	346661
Area sown more than once	103635 (15.32)	93566 (13.83)	218907 (32.36)	125341	13926.8	326025
Gross cropped area(GCA)	463541 (68.53)	486989 (72.00)	567868 (83.96)	80879	8986.6	625578

Dynamics of cropping pattern

Over the years (1990-2009) the per cent of area under ragi and sorghum (millets) to total gross cropped area are declining and in turn total area under the cereals is decreasing from 46 to 41 per cent (Table 10). The per cent area under total pulses is increasing from 15 to 20 per cent and oilseed crops are declining. The area under fruits and vegetables are gradually increasing. Horticulture provides excellent opportunity to raise the income of farmers even in dry tracts. It provides higher unit productivity and greater scope for value addition. The percentage of area under cotton and mulberry to total cropped area declining over the years. The area under tobacco is increasing over the years (Table 5.11).

The projected cropping patterns shows that by 2024-25 there will be an increase in area under rice (115646 ha), maize (248002 ha), green gram (4598 ha), sugarcane (32396 ha) and area under fruit crops (75019 ha). The decline in area will be among ragi, sorghum, redgram and area under mulberry crops.

Table 5.11 Dynamics in cropping patterns in Mysore district (% to Gross cropped area)

Particulars of cropping pattern	1990-91	2000-01	2008-09
Rice	16.7	22.5	20.0
Ragi	18.2	16.3	12.5
Sorghum	6.5	3.2	3.7
Maize	0.1	3.3	5.0
Other cereals	4.0	0.0	0.0
Total cereals	*45.5*	*45.2*	*41.3*
Green gram	0.2	0.2	0.3
Red gram	1.0	1.3	0.7
Others pulses	13.6	15.4	19.5
Total pulses	*14.9*	*16.9*	*20.4*
Total oil seeds	*2.3*	*5.0*	*3.3*
Sugar cane	1.7	1.9	2.5
Condiments	5.5	0.7	0.0
Fruits	0.2	1.1	1.1
Vegetables	0.5	0.6	0.5
Cotton	11.7	12.6	9.6
Mulberry	4.4	2.8	1.0
Total Commercials crops	*24.0*	*19.8*	*14.0*
Total other crops	*13.4*	*13.1*	*20.3*

The present level of human population during 2000-01 is about 25.9 lakhs and it is likely to be increased to 28.2 lakhs by 2024-25(Fig. 5.12). As per the ICMR nutritional standards the present level of food production (2008-09) is not sufficient to meet the present food requirement. There will be huge shortage of cereals and millets and oils and the production in pulses, sugar and fruits and vegetables will be surplus during 2024-25 (Table 5.12).

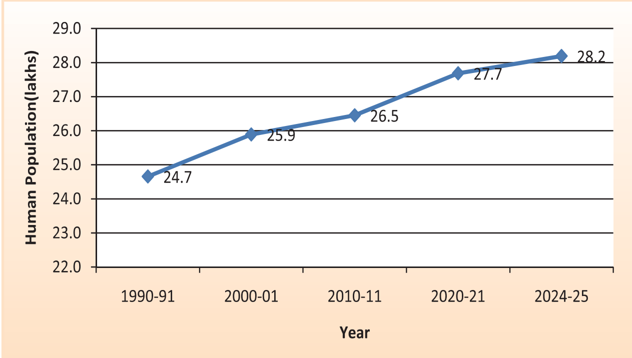


Fig. 5.12 Projected human population in Mysore district, Karnataka

Table 5.12 Projected food requirement for Mysore district (Tonnes)

Year	Cereals & millets	Pulses	Oils	Sugar	Fruits & vegetables
1990-91	401382	28799	8100	16199	65697
2000-01	421462	30239	8505	17010	68984
2024-25	458926	32927	9261	18522	75116
Present production(t) in 2008-09	328231	44213	6538	318573	115196

Development of district level land use plan for Almora district, Uttrakhand under Hill and Mountain ecosystem – A sub project of network project on district level land use planning

S.K. Mahapatra, Jaya N. Surya, J.P. Sharma and G.S. Sidhu

The soil map of Almora district was developed on the basis of physiography and soil properties i.e. soil depth, texture and slope. The generalized soil map contains 18 units. The land use/land cover map was prepared on the basis of digital IRS data received from NRSA, Hyderabad (Fig. 5.13). Major area belong to forest and grasslands. Cultivated area is mainly occurring in the valleys and terraces.

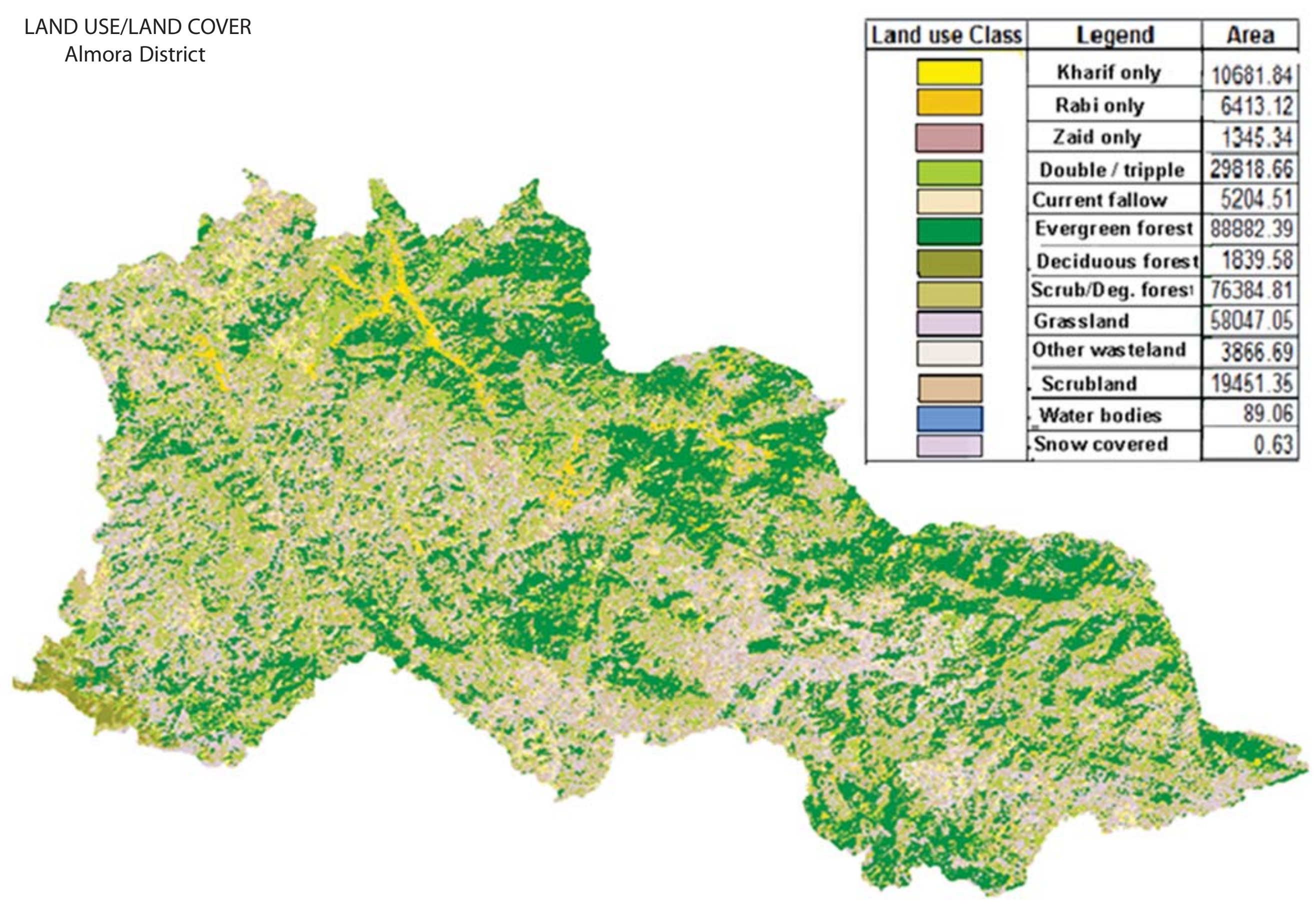


Fig. 5.13 Land use/land cover map of Almora district

Development of district level land use planning of Jorhat District, Assam under rainfed ecosystem – A sub project of network project on district level land use planning

S. Bandyopadhyay, S.K. Reza and Utpal Baruah

A comprehensive inventory of bio-physical and socio-economic resources of Jorhat district has been done. The bio-physical resources comprised soil and land use information (tables 5.13 and 5.14). Eight Land Management Units (LMU) have been identified each of which represents unique features of soil, land use and production system. Each LMU has been evaluated for suitability of different crops in relation to the cropping pattern of Jorhat district (Table 5.15). The socio-economic appraisal was done based on farm level household information. The constraints and potentials of each LMU have been evaluated. Alternative land use options have been suggested for different LMUs.

Table 5.13 Land use-land cover units (at level-II as per CLUMA, 2006)

Land Use-land Cover Units	Land Use-land Cover Classes (Level-II)	Area in ha (% of TGA)
I	Urban Built-up	3313 (1.2)
II	Rural Built-up with homestead horticulture & plantation	53784 (18.9)
III	Paddy cultivated land (rain fed)	66248 (23.2)
IV	Multi-cropping land	32324 (11.4)
V	Tea gardens	29899 (10.5)
VI	Open Forest	1439 (0.5)
VII	Hilly forested land	25488 (8.9)
VIII	Miscellaneous	10539 (3.7)
IX	Rivers & Channel bars	59683 (20.9)
X	Wet land (X)	2383 (0.8)
	Total	285100 (100)

Table 5.14 Generalized Soil Mapping Units

Soil Map Units	Area in ha (% TGA)	Description
A	12662 (4.4%)	Well drained fine-loamy to clay loam soils on densely forested hills
B	16766 (5.9%)	Moderately well drained loamy to sandy loam soils on piedmonts and gently sloping uplands
C	39942 (14.0%)	Poorly to somewhat poorly drained sandy loam and loam soils on very gently sloping lands and nearly level plains
D	24545 (8.6%)	Poorly drained silty clay loam and clay loam soils on very gently sloping and nearly level plains
E	25595 (9.0%)	Moderately well drained fine loamy soils on very gently sloping lands
F	11664 (4.1%)	Imperfectly drained silt loam soils on gently to very gently sloping lands
G	55186 (19.4%)	Poorly drained silt loam soils on flood plains
H	42170 (14.8%)	Imperfectly drained sandy loam soils on active flood plains
Rivers and Channel bars	56570 (19.8)	—
Total	285100 (100)	—

Table 5.15 Problems and potentials of LMU 5

Constraints	Alternate options for Marginal Farmers	Alternate options for Small Farmers	Alternate options for Medium Farmers
1. Low soil pH due to high exchangeable-Al and low base saturation restricts crop growth	1. Rice-based farming with backyard livestock	1. Rice-based farming with backyard livestock	1. Tea plantation (gently to very gently sloping uplands)
2. Lack of availability of labours	2. Homestead tea plantation in gently to very gently	2. Tea plantation in gently to very gently sloping lands	2. Rice-based integrated farming in plains with livestock and short term (rainfed) aquaculture
3. Aggression of monkeys and elephants in crop fields			
4. Poor level of management of farm resources due to lack of knowledge sloping lands			

Development of district level Land Use Plan for Gondia district, Maharashtra – A sub project of network project on district level land use planning

T.K.Sen, S.Chatterji, T.N.Hajare, S.N.Goswami, N.G.Pati, P.N.Dubey, A.Chaturvedi and Dipak Sarkar

Soil survey work of Gondia district has been undertaken for refining soil boundaries in the soil map of Gondia curved out from the earlier soil map of Bhandara District. A total of 25 distinct physiographic units were identified. The soils from master profiles representing each of these physiographic units were collected. The soils are being processed and analyzed. Village overlay map has been prepared (Fig. 5.14). Land use land cover map of Gondia district has also been prepared using NRSA data (Fig. 5.15). Development of Land Management Unit (LMU) is in progress.

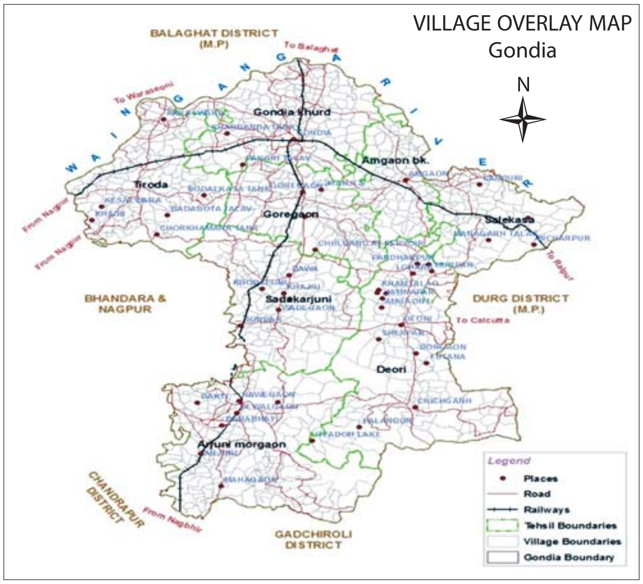


Fig. 5.14 Village overlay map of Gondia

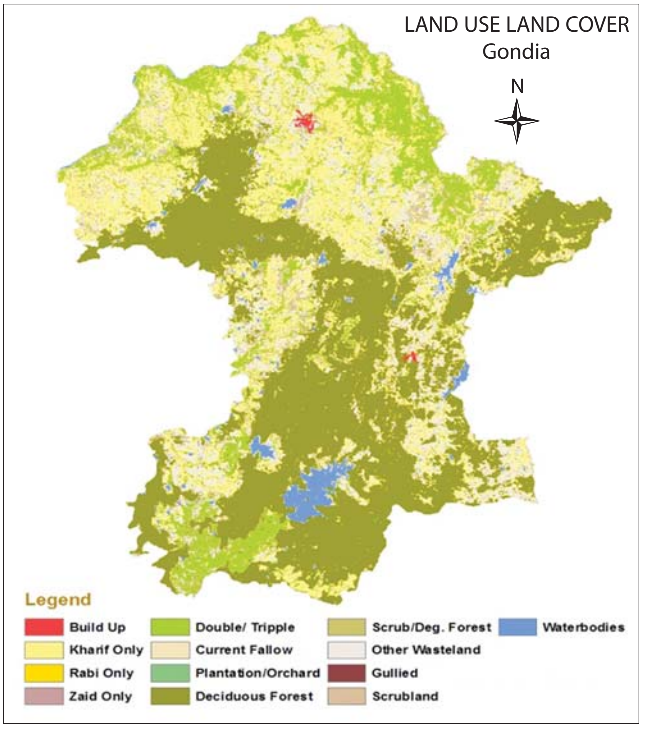


Fig. 5.15 Land use land cover map of Gondia

Efficient land use based integrated farming system for rural livelihood security in Aurangabad, Dhule and Gondia districts of Maharashtra (NAIP – Component 3)

Arun Chaturvedi, T.N. Hajare, N.G. Patil, T.K. Sen, S. Chatterjee, S.N. Goswami, M.S.S. Nagaraju, B.P. Bhaskar and G.P. Obi Reddy

The project was implemented in participatory mode. Interventions specific to clusters were implemented. Paddy yield significantly through selection of variety, fertilizer doses and other managements including water management. There were 214 beneficiaries for this interventions in Gondia cluster. The Khamans, Sindewahi – 1, HMT, Jaysriam and IR 64 (early variety) yielded 32.6, 24.8, 25.5, 30.7 q ha^{-1} during 2010-11 against local check variety (16.20 q ha^{-1} which is nearly stagnant for 20 years). This evaluation curtailed the seed rate from 30 kg acre^{-1} to 5 kg acre^{-1} with an additional (compound) income of over Rs. 16080/- against traditional farming.

Through slogan of seeing and believing, farmers came forward to reap higher yield of gram by little modification in implement viz. indigenous (deshi) plough into seed drill and/or line sowing against broadcasting of seed. Nearly 180 beneficiaries produced on an average 4.68 q ha^{-1} of gram (2010-11) against 1.61 q ha^{-1} local variety grown under traditional agro-managements. This intervention enhanced cropping intensity by 30% and an additional income of Rs. 6462 per ha.

A unit of 6 goats (5 does +1 buck) was provided to 24 landless labourers and marginal farmers. The number of animals has gone up by 51 during the last three months. Animal health check-up, de-worming, vaccination (foot and mouth diseases) and AI (Artificial Insemination) camps were organized in each village of both the clusters of Gondia district in synergy with officials from the State Animal Husbandry Department. A group of farmers (18) were provided with 60000 fingerlings of improved and disease-free fish seeds of Catla, Rohu and Mrigal and that fetched an income of Rs. 49467/- till February 2011.

Farmers from nearby 10-12 villages attended the farmers' day at Deori (Nov 1, 2010) and Goregaon (Nov 2, 2010). They visited the demonstration and participated in the discussion on package of practices. Public representatives (Panchayat Samiti, Zilla Parishad, MLA) and district Collector, state officials from various department witnessed the activity and achievements. Similar activity was conducted in Goregaon clusters on 2nd Nov, 2010. Dissemination of knowledge for value addition and micro-enterprises at Gondia district were arranged for bamboo craft, incense stick (agarbatti) and broom making and bee keeping, and sericulture (25th to 29th October 2010 at Goregaon and 28th to 31st March 2011 at Deori). The group of farmers and farm women were trained for these enterprises.

As per need and time selected farmers in all the six villages were trained in pisciculture, value addition to different commodities, micro enterprises, market linkages, sericulture, bamboo craft, bee-keeping, broom and incense stick (agarbatti) making. Numbers of crop-specific trainings were also conducted. State departments, SAUs and other agencies were also involved in this work.

Generation of Soil Database for Khulgad Watershed Development in Almora District, Uttarakhand (DST project)

C.S. Walia, R.P. Dhankar, J.N. Surya and J.P. Sharma

Soil resource of Khulgad watershed has been mapped at 1:12500 scale, characterized classified, interpreted and evaluated for land use. More than 40% area of watershed is cultivated and about 14% of the area can safely be cultivated. Rest of the area (27%) is suitable for restricted cultivation by adopting intensive soil and water conservation measures but has high potential for developing alternative land uses such as pastoral, agro-pastoral, horti-pastoral and silvi-pastoral farming Agri-horticulture will be more profitable for class III and IV lands. The yields of major crops grown in the watershed are low and even well below the state average apparently due to decline in soil productivity, lack of awareness among the farmers about modern agricultural technology and absence of irrigation facilities. Water harvesting techniques and soil and water conservation training should be imparted with larger holdings both at farm and village level. Alternative occupations like cattle and goat rearing, resin and fuel wood collection silk worm rearing and wood crafts may be popularized especially for marginal and landless farmers. More than 50% area is severely to severely degraded due to soil erosion. The immediate concern is to restore the productivity and carrying capacity of soils by growing grasses and forest species and also by adopting the soil and water conservation measures. The area under protected forests can easily be doubled by fresh plantation on degraded lands for improving ecological balance and potential of soils.

Soil Resource distribution, characterization and evaluation for Cotton based cropping systems in irrigated eco-system in Northern India

C.S. Walia, S.P. Singh, R.P. Dhankar, Jagat Ram and D. Martin

The soil resource of Sirsa district of Haryana have been mapped at 1:50, 000 scale, characterized, classified, interpreted and evaluated for cotton cultivation. The sandy soils occupy 32% having low productivity of cotton due to poor fertility, high infiltration rate, rapid permeability and high consumptive use of water for crops. These soils may be put to oilseeds, pulses, millets and fodder crops. Winter vegetables with liberal fertilization and irrigation may be grown in areas near to town. Agroforestry is recommended for high productivity and profitability. Coarse loamy soils occupy about 45% of TGA and suitable for cotton based cropping system under irrigation. Active sand dune areas occupy about 7% may be stabilized by growing grasses, trees and shrubs to protect the land from degradation and for moisture conservation.

Soils should be least disturbed in summer particularly sandy soils as they are prone to wind erosion. Zero tillage is suggested for such soils. Field experiments to be conducted for cotton on dominant soil series to develop prediction models for suggesting management needs and suitability of these soils for various cropping systems. Agronomic and soil management needs for recently introduced Bt cotton (hybrids) may be worked out on soil series basis and demonstrated to farmers. Balanced fertilization (includes both macro and micronutrients) based on soil test need to be followed for higher crop productivity. Integrated use of fertilizers, FYM, farm waste, crop residues may be encouraged to maintain soil health and higher crop productivity. Application of N-fertilizers in split doses is suggested.

3

Education

3.1 Post Graduate Education in Land Resource Management (LRM)

A post graduate teaching and research programme is being conducted by the National Bureau of Soil Survey and Land Use Planning Nagpur in collaboration with Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Dr. PDKV), Akola since 1987. Subsequently, this activity was introduced at Regional Centre, Kolkata in collaboration with BCKV, Mohanpur in 1999; at Regional Centre, Bangalore with UAS, Bangalore in 2002 and at Udaipur with RAU, Udaipur in 2004. Besides, the scientists of Regional Centre, Jorhat are participating as visiting faculty of Department of Soil Science, AAU, Jorhat.

At the HQrs, Nagpur, this programme is coordinated by the Division of Land Use Planning. The programme (at the HQrs, Nagpur) witnessed two major developments, namely, signing of revised memorandum of understanding (MOU) between the two institutions and revision of course curriculum of both M.Sc. and Ph.D. programmes. The new curriculum is both comprehensive and contemporary.

The programme has two major components i.e. Teaching and Research

Achievements	Nagpur		Bangalore		Kolkata		Udaipur		Total	
	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.	M.Sc.	Ph.D.
Degree awarded up to 2009-10	107	12	-	-	-	-	-	-	-	-
On Roll		04	-	-	-	-	-	-	-	-
Degree awarded up to 2010-11	107	13	-	-	-	-	-	-	-	-
On Roll	6	5	2							

3.1a HQrs. Nagpur

3.1a(i) Post Graduate Teaching

Courses offered for M.Sc. programme

Course No.	Title	Credit	Course Leader & Associates
Soils-516	Introduction to Land Resource Management	(1+1)	**Course Leader : Dr. T.K. Sen** Associates : Dr. Rajeev Srivastava Dr. S. Chatterji Dr. P. Chandran Dr. J.D. Giri Dr. M.S.S. Nagaraju Dr. S.N. Goswami Dr. G.P. Obi Reddy Er. P. Tiwary
Soils-517	Land Evaluation	(2+1)	**Course Leader : Dr. D.K. Mandal** Associates : Dr. T.K. Sen Dr. Jagdish Prasad Dr. S. Chatterji Dr. S.N. Goswami Dr. J.D. Giri Ms. Pushpanjali
Soils-518	Land resource constraints and their management	(1+1)	**Course Leader : Dr. Jagdish Prasad** Associates : Dr. Rajeev Srivastava Dr. D.K. Mandal Dr. S.K. Ray Dr. B.P. Bhaskar Dr. T.N. Hajare Dr. N.G. Patil
Soils-591	Seminar	(0+1)	**Course Leader : Dr. S. K. Ray** Associates : Dr. M.S.S. Nagaraju Dr. K. Karthikeyan
Courses offered for Ph.D.			
Soils -608	Advanced Soil Genesis	(2+0)	**Course Leader : Dr. T. Bhattacharyya** Associates : Dr. S.K. Ray Dr. P. Chandran Dr. Jagdish Prasad Dr. B.P. Bhaskar
Soils -609	Advance Soil Mineralogy	(2+1)	**Course Leader : Dr. T. Bhattacharyya** Associates : Dr. S.K. Ray Dr. P. Chandran Dr. Jagdish Prasad
Soils-610	Land Evaluation for Land Use Planning	(2+1)	**Course Leader : Dr. S. Chatterji** Associates : Dr. T.K. Sen Dr. Jagdish Prasad
Soils-611	Remote Sensing and Geographical Information System for Land Resource Management	(2+1)	**Course Leader : Dr. Rajeev Srivastava** Associates : Dr. J.D. Giri Dr. M.S.S. Nagaraju
Soils	Visual and digital interpretation techniques in soil mapping	(2+1)	**Course Leader : Dr. Rajeev Srivastava** Associates : Dr. J.D. Giri Dr. M.S.S. Nagaraju
Soils-691	Seminar	(0+1)	**Course Leader : Dr. S.K. Ray** Associates : Dr. M.S.S. Nagaraju Dr. K. Karthikeyan

3.1a (ii) Research

M.Sc. Programme

The following M.Sc. (LRM) students were admitted in 2008 at Dr. PDKV, Akola and later joined NBSS&LUP in July, 2009 for their specialized course in LRM and have completed their courses and have submitted their theses.

S. No.	Name of student	Name of Guide	Thesis Title
1.	Mr. Ninad S. Wagh	Dr. D.K. Mandal	Characterization of soils and agro-climate of sunflower growing areas in eastern Vidarbha
2.	Mr. Ganesh H. Bamble	Dr. M.S.S. Nagaraju	Characterization and evaluation of land resources in Saraswati watershed of Buldhana district of Maharashtra
3.	Ms. Nilima S. Sadanshiv	Dr. S. Chatterji	Application of crop model for quantification of yield gap of cotton in Wardha district of Maharashtra
4.	Ms. Ashvini H. Kolhe	Dr. P. Chandran	Characterization and genesis of red, swell-shrink soils of Hingoli district of Maharashtra

Ph.D. Programme

The following students have submitted their theses

S. No.	Name of student	Name of Guide	Thesis Title
1.	Ms. Preeti C. Solanke	Dr. Rajeev Srivastava	Spectral reflectance characteristics of Vertisols and associated soils in Nagpur district of Maharashtra
2.	Mr. B.S. Bhople	Dr. D.K. Pal	Layer charge characteristics of some Vertisols clay of Maharashtra and its relationship with soil properties and management

The following M.Sc. (LRM) students were admitted in 2009 at Dr. PDKV, Akola who later joined NBSS&LUP in June, 2010 for their specialized courses in LRM. They have completed their course work and at present engaged in research work for their theses. Name of the students and their guides along with the respective thesis title is mentioned below:

S. No.	Name of student	Name of Guide	Thesis Title
1.	Mr. Mane Vishal Yadao	Dr. S.K. Ray	Bulk density and its relationship with other parameters of soils of Vidarbha, Mahaarashtra
2.	Mr. Pachpor Swapnil D.	Dr. M.S.S. Nagaraju	Characterization and evaluation of land resources for management of Savali watershed of Wardha district of Maharashtra using IR6-P6 Resourcesat-1 data and GIS
3.	Ms. Bali Archana Keshav	Dr. S. Chatterjee	Yield gap analysis of soybean of some selected soils of Nagpur district, Maharashtra
4.	Mr. Jadhav Satish Parshuram	Dr. D.K. Mandal	Studies on soils of soybean-based cropping system Raisod, tahsil of Washim district.
5.	Mr. Gaikawad Suryakant S.	Dr. Jagdish Prasad	Characteristics and spectral reflectance properties of typical Vertisols of Vidarbha, Maharashtra
6.	Mr. Naveen Reddy Loka	Dr. P. Chandran	Red and black soil associations in Chandrapur district of Maharashtra

The following Ph.D. (LRM) students were admitted in 2009 at Dr. PDKV, Akola, who later joined NBSS in October, 2010 for their specialized courses in LRM. They are undergoing the course work along with research work. Names of the students and their guide along with their thesis title are mentioned below:

S.No.	Name of student	Name of Guide	Thesis Title
1.	Ms. Jaya N. Giri	Dr. Dipak Sarkar	Forms of soil phosphorus in relation to the weathering indices and soil maturity in hot semi-arid eco-region of Maharashtra
2.	Ms. Sarika D. Patil	Dr. T.K. Sen	Assessment of carbon stocks and sequestration potential for forest to paddy converted land use system in Gondia district of Maharashtra
3.	Mr. D.G. Padekar	Dr. T. Bhattacharyya	Soil-quality as influenced by land use management with special reference to irrigation in selected tahsil of Amravati district, Maharashtra

The salient findings of the research work carried out by the MSc. (LRM) students of 2008 batch are given below :

- **Characterization and evaluation of land resources in Saraswati watershed of Buldhana district of Maharashtra**

  Student : Mr. Ganesh H. Bamble

  Chairman : Dr. M.S.S. Nagaraju

The study was carried out in Saraswati Watershed of Mehkar tehsil Buldhana district, Maharashtra to characterize the land resources namely land use/land cover, physiography and soils using IRS-P6, ISS-111 data. The soils were evaluated for land capability, irrigability, soil productivity and soil-site suitability for cotton, pigeonpea and soybean. The results of the present investigation have been summerised below.

Visual interpretation of false colour composite of IRS-P6 LISS-111 data supported by adequate field data is found to be most effective and useful for mapping physiography, soils and land use/land cover. The information generated from remote sensing data is integrated with Geographical information system (GIS) for generation of various thematic maps (land capability and irrigability, soil productivity, soil suitability for cotton, pigeon-pea and soybean) in the watershed which helps in land resources management and agricultural planning of the watershed.

- **Characteristics and genesis of red swell-shrink soils of Hingoli district of Maharashtra**

  Student : Ms. Ashwini Hemchandra Kolhe

  Chairman : Dr. P. Chandran

The characteristics and genesis of swell-shrink soils of Hingoli district of Maharashtra was taken up for the present study with the following objectives.

- To characterize the red swell-shrink soils of Hingoli district for their morphological, physical, chemical and mineralogical properties.
- To elucidate the genesis of red swell-shrink soils developed from the Deccan basalt.

Conclusions

- The formation of associated red and black soils has been influenced by the difference in their topographic position and the progressive changes in the landscape with time. Difference in their properties thus has been reflected in their morphological, physical, chemical and mineralogical characteristics.
- The surface drainage conditions of pedon-1 have been relatively free than other soils. The presence of large quantity of smectite and its transformation to kaolin is possible only under humid climate of the geological past. The black soils (pedon 3 and 4) continued to exist in the micro-depressions and valleys because of the retention of the characteristics of smectite minerals.
- The ferruginous (red) swell-shrink soils were developed in the material of the bole beds (red boles) which had not been exposed to humid climate of the past. These soils also contain palygorskite mineral which are rich in Mg^{2+} ions. Consequently, there is an increase in exchangeable Mg which causes dispersibility of clay particles forming a 3D mesh in the soil matrix. Such soils on irrigation shows drainage problem a predicament for crop production.

- The presence of palygorskite along with smectite in the pedon 2 and its absence in other associated soils of the semi-arid climate indicate that this mineral is non-pedogenic and cannot be considered as an index mineral of arid climate.

❑ **Application of a crop model for quantification of yield-gap of cotton in Wardha district, Maharashtra.**

Student : Ms. Nilima Subhash Sadanshiv

Chairman : Dr. S. Chatterji

The yield gap analysis provides quantified gaps of yield in farmers' field and identifies the bio-physical and socio-economic factors responsible for the same. Validated crops models are most reliable tools of simulating yields (potential, water limited and actual) and thereby quantifying yield gap. The present study has been undertaken with the main objectives of applying Info Crop simulation model to quantify yield gaps of cotton and identify their biophysical causes in nine selected cotton-growing soils of Wardha district, Maharashtra.

In Info Crop simulation model can be successfully used to quantify the yield potential and yield gaps associated with yield reducing soils factors and crop management for this cotton growing soils of Wardha district.

❑ **Characterization of soil and agro-climate of sunflower-growing areas in eastern Vidarbha**

Student : Mr. Ninad Sanjay Wagh

Chairman : Dr. D.K. Mandal

To characterize sunflower-growing Vertisol environment the soils were characterized and yield were correlated with soils of Bhiwapur and Umred tehsil of Nagpur district. The climate of observation sites was characterized through climatic water balance studies. The analysis indicated that sunflower grows well in rainfall ranging from 1024 mm to 1309 mm. The maximum growing season temperature varies from 29 to 33^{o}C and mean minimum growing season temperature varies from 11 to 19^{o}C. The moisture indices varies from -29.4 to -9.25 representing dry sub humid climate type. The length of moisture availability period for shrink-swell soil varies from 150 to 210 days. The soil bulk density varies from 1.45 to 1.52 mg m^{-3}. Soil pH varies from 8.2 to 8.7, EC < 1 dSm^{-1}, OC < 1%, $CaCO_3$ < 5%, Ca:Mg ratio varies 1.8 to 2.6. CEC of the soil varies from 49 to 51 cmol(p+)kg^{-1}, BS varying from 85 to 89%, ESP < 1%. The highest yield (> 700 kg/ha) was recorded in soils having clay content ranging from 50 to 65 per cent. These soils are slightly alkaline, high base saturated (>85%) and low in $CaCO_3$ content (<5%) and high AWC.

- Mrs. Chetana K. Likhar, M.Sc. (Ag.) LRM student won Zonal award (West Zone) of the Indian Society of Soil Science 2010 for the best presentation of her M.Sc. dissertation on "Characterization and productivity assessment of some orange-growing soils developed on different parent materials in Nagpur district, Maharashtra".

Post graduate education in land resource management (LRM)

The Regional Centre, Kolkata undertakes a collaborative programme with Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal on Post Graduate teaching in Soil Science and Agricultural Chemistry with specialization in land resource management (LRM). The programme is continuing with BCKV since 1999. Two courses namely **Soil Genesis and Classification, Remote Sensing and its Application** jointly offered by BCKV and NBSS & LUP Kolkata for M.Sc. (Ag.) students.

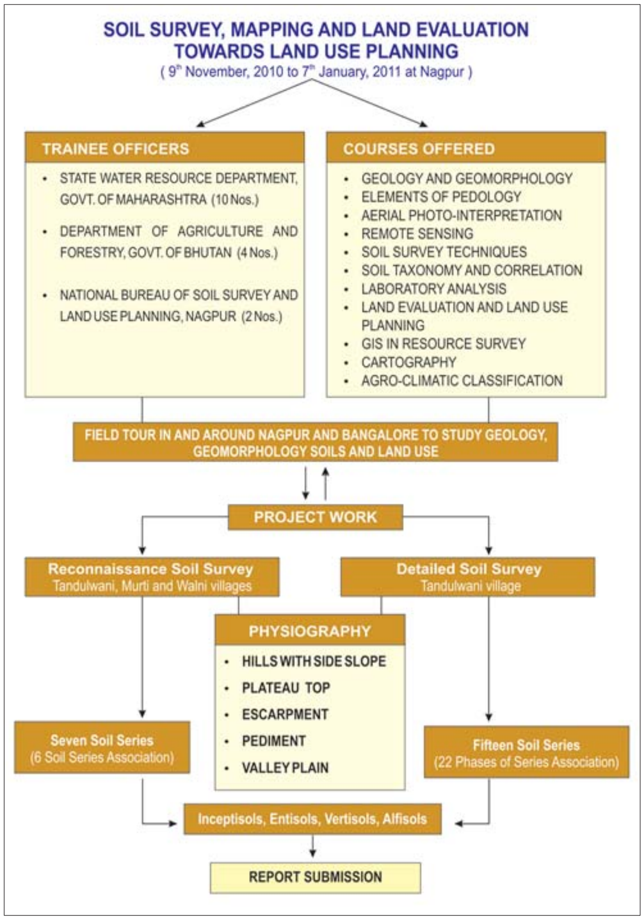
Others

- Dr. (Mrs) C. Mandal a recognized guide for Ph.D. programme in Social Science faculty of Nagpur University guided one Ph.D. student (thesis submitted) and four others are working with her for their research work.

- Dr. S. K. Singh, Principal Scientist and Head guided Mr. Anupam Ghosh, M. Tech students of SRM University for his six month internship on topic of Land use and land cover change in the coastal region of West Bengal.

TRAINING IMPARTED

During this period Bureau has organized many training programmes sponsored by ICAR, NNRMS (ISRO) and other agencies. Beside this Bureau has also organized training programme on Soil Survey, Mapping and Land Evaluation towards Land Use Planning.



Training programme was inaugurated by Dr. A.K. Joshi, General Manager, RRSSC, Nagpur and presided over by Dr. Dipak Sarkar, Director, NBSS&LUP, Nagpur

Human Resource Development in Remote sensing and GIS in Natural Resource Management- NNRMS (ISRO) - NBSS&LUP Collaborative Training Programme

NNRMS (ISRO) and NBSS&LUP jointly formulated a series of training programmes at different Regional centers and Head Quarters of NBSS&LUP. The main objectives of the joint effort are (i) capacity building in the field of RS and GIS application in natural resources management, (ii) enhance expert manpower to cater to the needs of agricultural universities, state departments and district developmental agencies, and (iii) to pave the way for inter institutional collaboration towards spatial database creation and management.

During the reporting period, four training programmes have been conducted at regional centres and Head quarter, Nagpur and trained 75 officers from ICAR, SAU's, CAU's and state universities.

List of NNRMS (ISRO) sponsored training programmes organized during the reporting period

S.No.	Title of Training programme	Duration (21 days)	Organized at	National Co-ordinator	Regional Co-ordinator	Programme Co-ordinator
1	Application of Remote Sensing and GIS in Natural Resource Management	11th Nov.– 1st Dec. 2010	NBSS&LUP (RC), Bangalore	Dr. Dipak Sarkar	Dr. L.G.K. Naidu	Dr. S. Srinivas
2	Application of Remote Sensing and Geographical Information System for Land Use Planning	10th – 31st Jan. 2011	NBSS&LUP (RC), Jorhat	Dr. Dipak Sarkar	Dr. Utpal Baruah	Dr. S.K. Reza
3	Application of Remote Sensing and GIS in Soil Resource Studies towards Land Use Planning	2nd –22nd Feb. 2011	NBSS&LUP (RC), Kolkata	Dr. Dipak Sarkar	Dr. S.K. Singh	Dr. A.K. Sahoo
4	Geoinformatics in Land Resource Management	9th – 29th March 2011	GIS Section, NBSS&LUP, Nagpur	Dr. Dipak Sarkar	-	Dr. G.P. Obi Reddy

From left Dr. A.K.Sahoo Principal Scientist and programme co-ordinator; Dr. Atanu Raha IFS, Principal Conservator of forest Govt. of West Bengal; Dr. Saroj Kumar Sanyal Vice Chancellor BCKV Mohanpur Nadia; Dr. Dipak Sarkar Director NBSS&LUP, and Dr. S.K. Singh Head Regional Centre and regional co-ordinator during the inaugural programme of the training

Dr. Uday Raj, General Manager of RRSC, Bangalore inaugurating the training on 11th November 2010 and Dr. L.G.K. Naidu, Head, Regional Centre, Bangalore and others on the dais

Dr. Dipak Sarkar, Director, NBSS & LUP, National Coordinator addressing during the Inauguration of the training programme on 9th March 2011. The Chief Guest, Dr. A.K. Joshi and Dr. G. P. Obi Reddy programme coordinator are look on.

Trainee officer receiving the certificate from Dr. Davendra Pradhan Regional Director Doppler weather station RADAR, IMD Kolkata guest of Honour; Dr.Pritish Nag Director NATMO Kolkata and Dr. Dipak Sarkar Director NBSS&LUP Nagpur were present on the occasion.

The training programme on Application of Remote Sensing and GIS in Natural Resource Management sponsored by the NNRMS, Indian Space Research Organisation (ISRO), Department of Space, Govt. of India was started on 11 November, 2010 at, Regional Center, Bangalore. Dr. Uday Raj, General Manager of RRSC, Bangalore was the Chief Guest for the Inaugural function. Total 19 trainees from different states namely Karnataka, Tamilnadu, Kerala and Andhra Pradesh and from different disciplines like soil science, agronomy, pathology/entomology, Computer Science, Agriculture Engineering and Civil Engineering attended this programme.

- ICAR sponsored Summer school training program on "Advances in land resources appraisal techniques for precision farming in Indian farming situations" during 14-7-2010 to 3-8-2010 at Bangalore. Total 25 trainee officers from SAUS, State Agricultural Departments and ICAR Institutes participated.
- ICAR sponsored Summer school training program on "Crop modeling for land use planning" during 5 -25th July 2010 at NBSS & LUP (ICAR), R. C. Udaipur. Total 21 officers were trained.
- A training on "Soil survey and land evaluation" was organized at Regional Centre, Bangalore for officers of Kerala Government during 30th Aug. to 19th Sept., 2010.

Training Received

International Training under NAIP

Under the project entitled, "Geo-referenced soil information system for land use planning and monitoring soil and land quality for agriculture" funded by NAIP, Component-4, Dr. P. Chandran, Principal Scientist was deputed to International Soil Reference and Information Centre (ISRIC), Environmental Science Group (ESG), Wageningen UR, The Netherlands from 17th Jan. to 1st Mar. 2011. The purpose of this visit was to understand the technical knowhow to develop of database on soils, climate and land use in SOTER-GIS environment and linking the information in a map to prepare soil and other thematic maps. This baseline database can be utilised for understanding many other processes occurring in the soils and also used for modelling purposes, soil quality research, soil carbon stock studies, etc.

Dr. G. P. Obi Reddy, Sr. Scientist & Incharge GIS Section had undergone the NAIP (ICAR) sponsored training/collaborative research programme in 'Geoinformatics' under HRD (Component – 1) at Department of Earth Systems Analysis (ESA), International Institute of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, The Netherlands from 3rd May to 31st July, 2010. The aim of the NAIP (ICAR) sponsored training/collaborative research programme was to acquire the advance knowledge in the field of Geoinformatics. During the programme, the scientist gained the advanced skills in digital terrain analysis, extraction of various terrain primary and secondary variables and integrated using object oriented multi-resolution segmentation technique in characterization and automatic delineation of district landform units for regional soil landscape modeling. During the programme the scientist also gained the advanced skills through hands on training in Arc GIS, ELWIS, ERDAS and E-Cognition softwares.

- Dr. S. Dharmurajan and Nirmal Kumar, Scientist, Dr. D.K. Katiyar (Tech. Officer T-6), Sh, V.N. Parhad, Sh. P. S, Butte, Sh. Harjeet Singh Tech. Officers (T-5), Dr. Debabrata Das, Tech. Asstt. (T-4), Sh. A. K. Maitra, Kuldeep Singh, Tech. Asstt. (T-3) participated in "Soil Survey Training Programme for Scientists and Technical Officers of the Bureau" at Regional Centre, Bangalore during 27th April to 21 May, 2010.
- Dr. S. Dharmurajan, Ms. R. Vasundhara and Sh. R. Naitam, Scientist attended 3 months training programme on "Remote sensing and GIS technology and applications" organized by National Remote Sensing Centre, ISRO, Hyderabad from 8th November, 2010 to 28th January, 2011.
- Dr. (Mrs.) Tapati Banerjee, Scientist attended the training programme on "SAS Statistical Package" at CRIJAF, ICAR, Barrackpore from 14.02.2011 to 19.02.2011.
- Sh. Pronobesh Mondal T-2 (D-Man), Sh. S. Sarkar, T-2 (field Asstt.), Sh. M. M. Roy, Driver (T-4) attended the Hindi Training Course (Praveen) from July-November, 2010 at GSI, Kolkata.
- Sh. Nirmal Kumar, Scientist attended two days installation training on "Strengthening Statistical computing for NARS" held at CIFE, Mumbai during June 16 – 17, 2010.
- Nirmal Kumar, Scientist attended 30 days "Trainers training Programme on Strengthening Statistical computing for NARS" held at CIFE, Mumbai during July 12 – August 13, 2010.
- Nirmal Kumar, Scientist, GIS section attended 5 day training programme on "Introduction to RISAT Applications" at RRSC, Nagpur from 14th to 19th February, 2011.
- Dr. (Mrs.) Jaya Niranjane Surya, Sr. Scientist attended a training programme on "Creative writing on Agriculture" held at Indian Institute of Mass Communication, Orissa from 10th to 15th May 2010.
- Dr. Rajeev Srivastava, Dr. J.D. Giri and Dr. M.S.S. Nagaraju attended training on Scan Ex Image Processor V 3.0 software during 22nd to 24th April 2010.
- Dr. J.D. Giri, Dr. M.S.S. Nagaraju and Ms. Vasundhara R. attended training on "Introduction to RISAT and its Applications" at RRSC- Central Nagpur from February, 14th to 19th 2011.

4

Technology Assessed and Transferred

- The district and theme based atlases and district soil resource reports provide database on natural resources to formulate soil and water conservation programme, watershed management and crop planning.
- Pedological studies on soil genesis and mineral transformation helps comprehending basics of soil information to develop model for understanding soils of the Indo-Gangetic Plains (IGP) and Black Soil Regions (BSR).
- Evaluation of soil-site suitability criteria for specific crop will benefit in selecting appropriate crops and cropping systems in a given area to ensure sustainability
- To reduce the emission of CO_2, carbon capture and storage (CCS) technology is an important option. NBSS&LUP has developed the model to show that soil can act as a potential medium for CCS.
- Soil, carbon and crop modelling techniques help in preparing set of management interventions for better crop planning.

5

Section and Unit

5.1 PROJECT MONITORING AND EVALUATION CELL

The following jobs were undertaken and accomplished

- Monitoring day-to-day Technical/Scientific work and achievements of the Bureau
- Collection, storing and dissemination of scientific and technical information on soils to the various institutes as per demand
- Maintenance of scientific/technical files, consultancy projects and QRT files
- Necessary action on various technical papers/letters received from Director
- Preparation of Bureau's reports for DARE and ICAR Annual Report
- Preparation of monthly, quarterly target and progress report
- Monitoring of progress of research project of each scientists (six monthly) i.e. from Jan-June 2010 and July-Dec. 2010
- Preparation of scientific papers and slides for presentation by the Director at National/ International seminars and workshops organized by the different Scientific Societies/Institutions
- Preparation of material for Directors' Conference
- Providing audio visual support during seminars/ workshops
- Preparation of tables, charts and other display materials on the activities of the Institute
- Preparation of ATR on decisions taken during different meetings and proceedings of such meetings
- Compilation and finalization of Annual Report of the Institute

- Technical inputs for finalization of publications of the research bulletins, technical reports etc.
- Preparation of newsletters (half yearly) of the Institute
- Preparation of material for ICAR News and Reporter
- Organization of research review and other meetings at Institute level
- Inputs on the preparation on publication "Glorious 30 Years of NBSS&LUP"

Monitoring of Bureau's research projects mentioned below.

- On going projects (Institutional) : 62
- DST sponsored : 03
- Externally aided consultancy projects : 07
- NAIP Projects (5)
  - As Consortium Lead Institute : 02
  - As Consortium Partner : 03

5.2 LIBRARY & DOCUMENTATION UNIT

Library Resource Development

The library procured 324 documents including 260 books and 64 annual reports. The total collection of the library is 15319 which also includes bound journals. The library subscribed to 15 foreign and 31 Indian journals for Hqrs. Besides 16 journals were also procured for the libraries of the regional centres. Total collection of bound journals as on 31.3.2011 was 3113. Nearly 818 readers visited the library. Totally 3550 documents were issued, 3728 documents were returned and 5623 documents were consulted.

Documentation Services

Current Titles Announcement Service (CTAS)

It is a fortnightly in-house publication based on current journals available in the library. The photocopy of the content pages of journal issues are distributed to all the Centres/Divisions/Sections of the Bureau. This keeps scientific and technical staff abreast of the latest information received in library. About twenty four issues were brought out during the year 2010.

Library Automation Software

Library Automation Software (SOUL : Software for University Libraries) developed by the UGC is being used for library automation work. Data input of each book in the software is completed. Generation of Barcode labels for each book is also completed. Computerised issue – return service is in operation.

CD-ROM Service

International bibliographic database viz CABI, AGRIS, and AGRICOLA in CD-ROM are added during the year under report. Tulsient CD Mirror Server has been installed and is under LAN, the CD-ROM data bases are accessed by 10 nodes spread over two buildings of the Bureau. The CD-ROM databases are available for (i) CABI Database (1972 to present)- CABI, U.K.; (ii) AGRIS Database (1975 to present)- FAO, Rome; (iii) AGRICOLA Database (1970 to present)- USDA, USA and (iv) SOIL CD (1973 to present) CABI, U.K.

These databases have been extensively used by researchers, M.Sc., Ph.D. students and also by others from Nagpur. The user agencies have been informed about availability of these databases. Search and retrieval services have been provided with nominal charges; in print form or through Floppy Diskettes.

ISBN to NBSSLUP Publications

NBSSLUP publishes wide variety of publications in the form of annual report; research/technical bulletins, various scale maps of India and different states. The ISBN/ISSN numbers are allocated to 147 NBSS publications till this period and copies of each publication are sent to concerned agencies for inclusion in their database. The publications are sent to esteemed journals, abstracting/indexing services for review purpose in order to achieve wider information dissemination.

News Paper Clipping Service

The library is receiving 7 newspapers and two periodicals. The relevant cuttings pertaining to topical interest are brought to the notice of all.

Centralised Services

The Unit provides centralised services like photocopying comb/thermal binding and lamination of documents/map sheets. Photocopying Services are also being extended to library visitors.

Library Services through LAN

Local Area Network (LAN) has been established in the Bureau. Five Computer nodes have been provided for access to library information system using bibliographic searching with various query modes. E-mail and Internet facility has also been provided to two computers. Browsing of international libraries through Internet is in full operation. Down-loading of subscribed online electronic journals are being done using Internet facility. In future library will go for subscription of more number of electronic journals. CD-ROM reading/writing facility has been installed in the library for downloading electronic journals, articles and access to publisher's catalogues. Online agricultural statistics database "Indiastat.com" was subscribed during the reported period. The readers have made extensive use of this database.

On-line Portals/Journals through CeRA (NAIP)

CeRA (Consortium of e-Resources in Agriculture) is Consortium of e-journals (full text),a project under NAIP, ICAR and provided access to 123 libraries of National Agriculture Research System (NARS) for the years 2008-10. NBSS&LUP is also one of the beneficiary of this initiative. Presently a total of 1342 on-line journals are available on CeRA of following publishers.

i. **Springer link:** It is a platform of Springer and provides on-line access to 1314 journals on different subjects published by Springer.

ii. **Annual Reviews:** Annual Reviews are authoritative, analytic reviews on 34 focused disciplines within the Biomedical, Life Sciences, Physical Sciences, and Social Sciences. Users can access the full text of articles from 1990 onwards.

iii. **CSIRO (Australia):** Australia's Commonwealth Scientific and Industrial Organization (CSIRO) provides access to full text of articles.

iv. **American Society of Agronomy :** 6 journals

v. **Oxford University Press:** 30 journals

vi. **Wiley & Blackwell:** 80 journals

Document Delivery System under CeRA

As per guidelines of CeRA, photocopy of the article requested by the participating institutes is being provided to the libraries / members. It is continuous process. This facility is also extended to our five Regional Centres. The above e-resources can be accessed by visiting URL: http://www.cera.jccc.in through NBSS&LUP LAN.

5.3 PRINTING SECTION

The following jobs were undertaken and accomplished

A. Technical Bulletin

1. Soil Erosion in Himachal Pradesh
   Print Order – 300 copies
   NBSS Publ. 132
   Volume of work – VI + 54 pages

B. Annual Report

1. - NBSS & LUP Annual Report (2009-2010)
   - Print Order – 500 copies
   - Volume of work – XX + 200 pages

C. Brochure

1. - Training Programme
   - Print Order – 800 copies
   - Volume of work – VI + 20 pages
2. Services Offered
   Print Order – 1000 copies
   Volume of work – IV + 12 pages

D. Newsletter

1. - NBSS&LUP Newsletter (Jan.-June 2010)
   - Print Order – 350 copies
2. NBSS&LUP Newsletter (July-Dec. 2010)
   - Print Order – 350 copies

E. Stationery items

1. Pedon Description form
2. Complimentary slip
3. Director's Letterhead
4. Regional Centre, Kolkata Letterhead

5.4 PUBLICATION SALE UNIT

Sale of NBSS Publications for the period from 1.4.2010 to 31.3.2011

A. SRM Map and Bulletin

Sr. No.	Name of SRM Map + Bulletin	Old bal. Map/ Bulletin	Sold Map/Bulletin	Amount Received
1	West Bengal	307/479	3 set + 3 bull	7500/-
2	Pon.& Karaikal	532/155	1 set + 1 bull	1000/-
3	Gujarat	454/367	6 set + 6 bull	15000/-
	Gujarati version	166	-	-
4	Haryana	467/598	5 set + 5 bull	7500/-
5	Punjab	613/584	5 set + 5 bull	7500/-
6	Tamil Nadu	137/202	4set + 4bull	10000/-
7	Karnataka	715/761	2 set + 2 bull	5000/-
8	Kerala	767/734	1 set + 1 bull	2500/-
9	Orissa	360/328	4 set + 4 bull	10000/-
10	Bihar	835/801	2 set + 2 bull	5000/-
11	Rajasthan	357/219	3 set + 3 bull	10500/-
12	Meghalaya	763/756	5 set + 5 bull	5000/-
13	Maharashtra	179/0	10 set	30000/-
	Marathi version	177	32 bull	3200/-
14	Arunachal Pradesh	780/751	5 set + 5 bull	7500/-
15	Manipur	678/646	2 set + 2 bull	2000/-
16	Himachal Pradesh	342/313	3 set + 3 bull	4500/-
17	Madhya Pradesh	355/266	9 set + 9 bull	54000/-
	Hindi version	348	10 bull	1000/-
18	Sikkim	184/153	2 set + 2 bull	5000/-
19	Andaman - Nicobar	880	1 bull	500/-
20	Jammu & Kashmir	387/367	3 set + 3 bull	7500/-
21	TripuraSoils of Tri (B.V.)	188/60/18529	3 set + 6 bull	7500/-
22	Assam	746/976	2 set + 2 bull	3000/-
23	Nagaland	741/226	2 set + 2 bull	2000/-
24	Uttar Pradesh	346/309	6 set + 6 bull	21000/-
25	Andhra Pradesh	458/308	3 set + 3 bull	13500/-
26	Lakshadweep	857	1 bull	500/-
27	Delhi	842/924	1 set + 1 bull	1000/-
28	Goa	887/872	1 set + 1 bull	1500/-
29	Mizoram	275/241	2 set + 2 bull	2000/-
30	Soil Map of India	745/744	4 set + 4 bull	26000/-
A	**Map+Bull**	**14487 set + 16066 bull**	**99 set + 136 bull**	**2,79,700/-**

B. Technical Bulletin: 1.4.2010 to 31.3.2011

Sr. No.	Name of Research Tech. Bulletin	Old balance Tech. Bulletin	Sold Tech Bulletin	Amount Received
1	AESR-Bull. No. 35	200/172	6 bull	12000/-
2	Soil Series Criteria & Norms-36	108	21bull	525/-
3	Soil Climatic Database -53	234	3bull	1800/-
4	Soil Climatic Envi. in India-58	628	19 bull	1900/-
5	Soil Based Land Use Planning Series-63	701	4 bull	400/-
6	Soil Monoliths-64	204	5 bull	500/-
7	Madhubani-76	97	1 bull	150/-
8	Bhopal Atlas-77	295	2 bull	600/-
9	Soil Series of M.P-78	89	11 bull	2200/-
10	Soil Series of M.S-79	184	20 bull	3000/-
11	Guna Atlas-80	299	2 bull	400/-
12	Agro-ecological assessment of soil reso.of Rajasthan-81	245	33 bull	1650/-
13	Soil Erosion of M.S.-82(E.V.)	191/191	7 set	2800/-
	Soil Erosion of M.S.-82(M.V.)	133	21 bull	2100/-
14	Climatic change and polygenesis in Vertisols-no. 83	278	13 bull	650/-
15	Soil Series of Chhattisgarh-85	43	4 bull	600/-
16	Significance of min.- NBSS RS-1	74	23 bull	2875/-
17	Soil Resource Atlas Betul Distt. no- 86	292	1 bull	250/-
18	Sukli Bull.No.87	234	3 bull	225/-
19	Soils of Hugli-No.88	59	2 bull	240/-
20	Soil Series of WB-89	39	4 bull	480/-
21	Dhar Atlas-90	295	1 bull	250/-
22	Soil Series of Goa-92	104	2 bull	250/-
23	Soil Resource Atlas Bilaspur-95	50	3 bull	1050/-
24	Soil Series of Rajasthan-96	65	7 bull	1575/-
25	Soil Erosion Map of Tripura-97	391/183	3 set	450/-
26	Soil Series of Bihar-98	236	4 bull	600/-
27	Soils of Ajmer dist. Bull. No.99	46	2 bull	450/-
28	Soil Resource Atlas Chhindwara Distt. 100	53	1 bull	350/-
29	Soil Series of Assam-101	235	2 bull	400/-
30	Soil Erosion. Rajasthan-102	333/415	1 set	400/-
31	Soil Ero.of Chhattisgarh-103	507/504	4 set	800/-
32	Jagdalpur Atlas-104	84	3 bull	1050/-
33	Soil Series of Sikkim-105	203	3 bull	450/-
34	Soil Erosion of M.P-106	545/572	6 set	1500/-
35	Soil Resource Atlas Jorhat -107	403	1 bull	250/-
36	Salt affected Etah dist. no.108	347	4 bull	800/-
37	Soil Series of Nagaland.-109	246	2 bull	200/-
38	Soil Series Tripura-111	85	4 bull	400/-
39	Soil Series of Delhi -112	177	2 bull	300/-
40	Udaipur bull. No.113	202	32 bull	6400/-

Sr. No.	Name of Research Tech. Bulletin	Old balance Tech. Bulletin	Sold Tech Bulletin	Amount Received
41	A.P. Erosion,-114	70/36	3 set	1200/-
42	Wardha Atlas-116	27	-	-
43	Assam Erosion-118	341/433	2 set	200/-
44	Soil Series of Orissa -119	107	4 bull	600/-
45	Soil Series of Gujarat-120	286	9 bull	1800/-
46	Soil Series of Meghalaya-121	175	5 bull	750/-
47	Soil Erosion of Bihar-125	665/250	-	-
48	Soil Erosion of Orissa-126	468/150	8 set	1600/-
49	Soil Series of Medak distt (A.P.) no.127	26	2 bull	200/-
50	Benchmark soils of A.P.-128	402	6 bull	600/-
51	Manual soil-site suitability-criteria for Major crops-129	204	59 bull	11800/-
52	Land use planning of Cherrapunji-131	105	2 bull	200/-
53	Soil Series of Manipur-134	522	2 bull	200/-
54	Land Resources of Medak dist.-791	53	1 bull	350/-
55	Soil Reso.for land use planning Balaghat dist.M.P.-827	625	2 bull	200/-
56	Gujarat Erosion Map-	735	-	-
57	Karnataka Erosion Map	948	-	-
58	Soil Erosion of W.B (bull)-.117	214/262	5 set	1000/-
59	Soil Resource-Jalna dist-122	141	-	-
60	Soil Series of Kerala, no.136	249	2 bull	300/-
61	Management of Acid soils in NEH Region	1511	3 bull	225/-
62	Soil of Bhilwara no-135	354	2 bull	500/-
63	Soil Erosion Manipur (bull)-138	389	-	-
64	Optimising Land Use of Birbhum Distt. (W.B.) -130	357	7 bull	1400/-
65	Land Resource Management N.B.S.S -133	457	16 bull	4000/-
66	Soil Loss of Kerla Map	499	-	-
67	Soil Loss of Tamilnadu Map	249	-	-
68	Perspective Land Use Plan of Puducherry publl.no142	33	7 bull	3500/-
69	Mineralogy of Benchmark Soil W.B Bull.no.139	155	7 bull	1750/-
70	Soil Based Agro Technologies for Livelihood Improvement no.144	393	14 bull	2800/-
71	Soil Loss of Uttarakhand	250	-	-
72	Soil Loss of Jharkhand	250	-	-
73	Soil Survey Manual publ.no. 146	378	16 bull	24000/-
74	Field Guide for Soil Survey	435	50 bull	12500/-
75	Soil Taxonomic Database of India publ.no.143	498	-	-
76	Soils of Puruliya W.B. publ.no.599	488	-	-
77	Soil Erosion of Himachal Pardesh publ.no.132	300	-	-
B	**Total**	**25761 bull**	**526**	**1,24,945/-**
C	Payment received from HRC			1,75,060/-
	Grand Total (ABC)			**5,79,705/-**

(Rupees Five lakhs seventy nine thousand seven hundred five only)

List of New Publication received during the year 2010-11

Sr. No.	Name of the publication	Publ. No.	Printed copies
1.	Soil Taxonomic Database of India	143	498
2.	Soils of Puruliya Dist. W.B. for Optimizing Land Use	599	488
3.	Soil Erosion of Himachal Pardesh	132	300

During the period from 01.04.2010 to 31.03.2011 organized two Sales and Publication Committee meeting and fixed the prices of new publication and reviewed the cost of old publications.

Organized the Exhibition cum-sale stall at following places.

1. National Seminar on Issues in Land Resource Management ISSLUP, held at Nagpur from 08-10 October 2010.
2. Agri Expo-Haritkranti-2010,held at Baramati, Maharashtra from 01-04, November 2010.
3. 75th Annual Convention of Indian Society of Soil Science held at IISS Bhopal from 14 to 17 November, 2010.
4. Rashtriya Kisan Mela on Citrus at NRCC, Nagpur from 04 and 05, March, 2011
5. Agrovision 2011 at Reshimbag Ground, Nagpur from 04 to 07 March. 2011

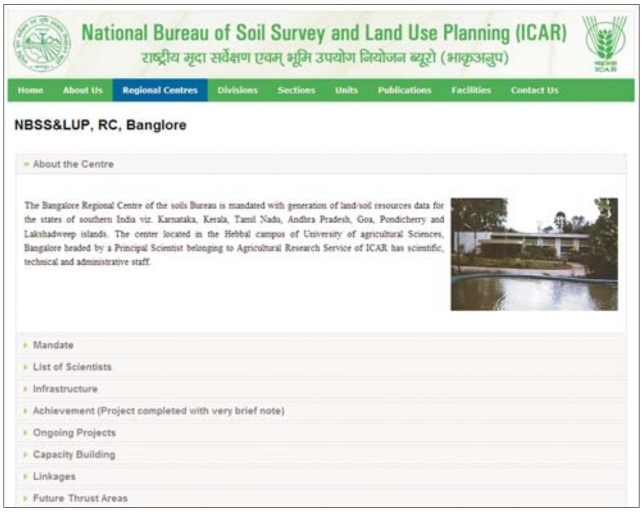
5.5 ARIS CELL

Agricultural Knowledge Management Unit (AKMU) (ARIS Cell)

The assigned activities and work done during the reporting period in ARIS Cell is summarized below.

1. Maintenance and management of LAN Networking in the institute
   - Maintained and managed the LAN networking of the Institute by modernization
   - Now uninterrupted internet and E-mail services in the institute on round the clock basis is provided updated the internet bandwidth from 512 Kbps to 2 Mbps lease line (1:1) to provide better internet and email services. Installed Cyberoam and Symantec antivirus for all the users in the institute.
2. Design and Developing the New Website as per the ICAR Guidelines
   - As per the ICAR guidelines, the new website (www.nbsslup.in) has been designed and developed in consultation with Phoenix Multi Media solutions, Nagpur collected all information and conducted interactive discussion with web designers on the structure of the website.
   - The institute Website has been designed and developed in Joomla software environment as per the protocols and standards provided by ICAR.
   - A special Images Gallery has been created to accommodate the images of events and meetings. Facilities were created at ARIS Cell to upload the Website content at any time. Website is hosted on Linux server and is protected from external threats and hacking. Logos and all information copyright protected.
   - Search engine has been created to get the connation from Google and Yahoo search.
   - Various analysis report can be generated about the website, like from which country, city site is viewed on particular date, which page is more viewed on internet, total no. of visitors with their specific region can be viewed and many more from google analytics.
   - Email service on Google Apps server has been provided to video chat, voice chat. 7 gb space per user id is provided. Maximum 50 email ids can be created.

Front page view of the newly designed and developed institute website



The view of the centre wise contents provided in newly designed website

3. Development of Mail Server nbsslup.ernet.in

- Installed of the new system with OS (Redhat Enterprise Linux 4 Update 8) Setting up the system hostname and network configuration as required.
- Creation of user accounts and mailboxes for the users on new mail server. Creation of mail user accounts on the mailing system.
- Creation of script for mail migration from the existing mail server into the new one.
- Stopping mailing services on the existing mail server. Taking backup of the existing mail server.
- Import mails from the old mail system to the new mail server.
- Monitored the mail migration process from the existing system to the new one for proper transfer of messages.
- Change over of the mail system and making the new mail system live.
- Configuration of antivirus and antispam for the mail system.
- Configured antivirus and antispam packages required for the mail server. Also did monitoring of the mail system for its proper functioning.
- Configuration of backup scripts for automated backup of the mail system.
- Configured backup scripts to backup of the mailing system for later use. The backup of the mail system is kept onto three different places for security.
- Configuration of scripts for updation of antivirus and antispam components in the system.
- Automated scripts are written onto the server that run on the specific time for the updation of the mail servers antivirus and antispam signatures.

4. Maintenance and Updation of PERMISnet-II

- Personnel Management Information System Network (PERMISnet-II) has been using to upload the institute information and it contains personal, professional and referential attributes of personnel along with information on plan wise cadre strength of the institute.
- During the reporting period, the details of institute personal, cadre strength have been uploaded.

5. Maintenance of Video conferencing system

- Maintenance of IP based video conferencing system was installed in the institute.
- Connect video conferencing system to the network for online communication.
- Maintenance of video conferencing system with frequent checks of incoming/outgoing link.
- Provide services to ensure uninterrupted end-to-end interaction during the important meetings.
- Maintaining the dedicated lease line of 512kbps (128kbps x 4) for Video conferencing system

5.6 CARTOGRAPHY UNIT

The cartography unit is extending support services for digital cartography work of the Institute as:

District contingent plan:

- Land Resource Atlas of Vidarbha region of Maharashtra
- Agro-ecological region of Uttar Pradesh (collaborating project of UPCAR and NBSSLUP)
- Other miscellaneous work

As a centralized service centre the following work has been undertaken:

- Final art works/cover page design
- Glorious 30 years of NBSS and LUP
- NBSS and LUP catalogue
- Agenda notes of IMC meeting
- Souvenir ISSLUP
- Dharati 2009

Map redesigned for offset printing (CMYK)

- Soil loss of Bihar and Himachal Pradesh

Exhibition poster:

- Exhibition of posters for Agrovision held at Nagpur
- Twelve poster designed and printed for the different national symposium and seminar.
- Designing of certificates, banners, invitations cards etc. for various programmes and seminars of the Bureau.
- Staff identity card designing and preparation (150 nos.)
- Sign board for ICAR residential campus, Nagpur

Digitization work:

- Soil and location of Yavatmal districts
- Soil map of Sikkim
- Base map of Himachal Pradesh, Punjab and Haryana.
- Relief map of India
- State wise location map of Bench mark soils.

Maps published:

- Soil loss of Jharkhand, Bihar, Orissa and West Bengal were published in collaboration with CSWRTI, Dehradun.
- Documentation of diagrams in digital mode. It includes all soil scape diagrams, soil-physiographic relationship diagrams, water balances and other diagrams prepared by NBSS are being redrawn in Corel Draw software format. About 50 nos. have already been completed. It will form part of digital map library

Plotting, Scanning and other printing jobs under taken during the reported year includes.

- Total 4442 color prints (A3 and A4 size) were brought out pertaining to different media cover page. Research papers, cover pages, photographs, project documents proforma, Annual Report, Thesis, Report, Brochure, PPT printouts, Maps, Programme and soil series proforma.
- 5 copies of Yavatmal and Hayatnagar farms and other posters in Ao size.

Xeroxing:

About **44373** copies (monocolour) and **50708** copies (colour) was done during the reported period.

5.7 हिन्दी अनुभाग

राजभाषा अधिनियम, 1963 और उसके अंतर्गत बने राजभाषा नियम, 1976 के अनुपालन एवं राजभाषा विभाग (भारत सरकार) भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली द्वारा समय-समय पर जारी किए जाने वाले 'वार्षिक कार्यक्रम' में निर्धारित लक्ष्यों को पूर्ण करने के उद्देश्य से ब्यूरो (मुख्यालय), नागपुर, में 'हिन्दी अनुभाग' कार्यरत है।

हिन्दी प्रकाशन : वार्षिक हिन्दीकृषि पत्रिका 'मृदा दर्पण' एवं वार्षिक हिन्दी पत्रिका 'धरती' का संपादन/प्रकाशन कार्य।

हिन्दी सप्ताह का आयोजन: ब्यूरो (मुख्यालय), नागपुर तथा उसके 5 क्षेत्रीय केन्द्रों (नई दिल्ली/उदयपुर/बैंगलुरू/कोलकाता एवं जोरहाट) में 'हिन्दी सप्ताह समारोह' (दिनांक: 14-20 सितम्बर, 2010) का

आयोजन किया गया और इस सप्ताह के अंतर्गत राजभाषा (हिन्दी) से संबंधित विभिन्न प्रतियोगिताओं का भी आयोजन बड़े उत्साहपूर्ण वातावरण में किया गया, जिसमें संस्थान के अधिकांश अधिकारियों/कर्मचारियों ने सक्रिय रूप से भाग लिया।

संयुक्त राजभाषा कार्यान्वयन समिति की बैठकें: संस्थान में राजभाषा (हिन्दी) की प्रगति एवं त्रैमासिक रिपोर्ट की समीक्षा करने हेतु तथा राजभाषा विभाग (भारत सरकार)/भारतीय कृषि अनुसंधान परिषद्, नई दिल्ली द्वारा जारी 'वार्षिक कार्यक्रम' में 'क', 'ख' एवं 'ग' क्षेत्रों हेतु निर्धारित लक्ष्यों को पूर्ण करने के उद्देश्य से समय-समय पर उक्त समिति की बैठकों का आयोजन।

हिन्दी कार्य निरीक्षण/मार्गदर्शन: राजभाषा (हिन्दी) कार्य निरीक्षण/मार्गदर्शन समिति द्वारा क्षेत्रीय केन्द्र, उदयपुर का दिनांक: 26 जुलाई, 2010 को हिन्दी कार्य निरीक्षण/मार्गदर्शन हेतु दौरा किया गया।

प्रोत्साहन योजना: वर्ष 2010 में अपना सरकारी काम-काज मूल रूप से हिन्दी में कर रहे अधिकारियों/कर्मचारियों को 'प्रोत्साहन योजना' के अंतर्गत निम्नानुसार नकद पुरस्कार वितरित किये गए।

1.	श्रीमती एस.के. हयात पी.एस.	प्रथम-1	₹ 800/-
2.	श्रीमती विमल खराये उच्च श्रेणी लिपिक	प्रथम-2	₹ 800/-
3.	श्री एम.एम. भगत क्षेत्रीय सहायक (टी-2)	द्वितीय-1	₹ 400/-
4.	श्री टी.टी. रामटेके निम्न श्रेणी लिपिक	द्वितीय-2	₹ 400/-
5.	श्री आर.एम. तोहगाँवकर वाहन चालक (टी-5)	द्वितीय-3	₹ 400/-
6.	श्री एम.डी. कड़क वाहन चालक (टी-3)	तृतीय-1	₹ 300/-
7.	श्री आर.एन. झांबरे वाहन चालक (टी-3)	तृतीय-2	₹ 300/-
8.	श्री अम्बालाल भोई वाहन चालक (टी-1)	तृतीय-3	₹ 300/-
9.	श्री ए.एन. पवार वाहन चालक (टी-5)	तृतीय-4	₹ 300/-

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Awards and Recognitions

- Dr. A.K.Sahoo, Principal Scientist has been elected as a fellow of the National Environmental Science Academy (NESA), New Delhi during the year 2010.

- Dr. K. D. Sah, Senior Scientist has been elected a Fellow of the Institution of Chemists (India) during the year 2010.

- S.K. Reza, U. Baruah, Dipak Sarkar and D.P. Dutta obtained the Best Poster presentation Award at National Seminar on "Issues on Land Resource Management: Land degradation, Climate Change and Land Diversification" for the poster entitled '*Spatial heterogeneity of soil-DTPA extractable micronutrients in piedmont area of Chirang district of Assam: A Geo-statistical approach*" organized by ISSLUP, at NBSS & LUP, Nagpur held on 8-10th October, 2010.

- Dr. S.K. Mahapatra, Principal Scientist was awarded Distinction Certificate by Cabinet Secretariat, Government of India for attending Workshop on Result Framework Document (RFD) held at Vigyan Bhawan, New Delhi on January 22, 2011.

- Dr. T. N. Hajare received Senior Scientist Gold Medal Award 2010 in appreciation of the research contribution for advancement of scientific knowledge in the field of bio informatics and life sciences on 13th December, 2010 during IIIrd International Consortium of contemporary Biologists and Madhawi-Shyam Educational Trust, Ranchi, Jharkhand organized by ICBRD &NRMCU-10.

- Dr. N. G. Patil, A. Chaturvedi, T. N. Hajare, A. Gattani, Layant Borkar, Mamta Mokde and Anju Nair received Best Poster Award in the poster entitled, *'Issues in Water Management and Sustainability of Agriculture in Gondia District'* during National Seminar on Issues in Land Resource management: Land degradation, Climate Change and Land use diversification held at Nagpur (8-10 Oct. 2010).

- Dr. Jagdish Prasad was nominated as Member on the Institute Management Committee of National Institute of Abiotic Stress Management (ICAR), Malegaon, Baramati, Pune for a period of three years w.e.f. 04.10.2010 to 03. 10 .2013
- Dr. Jagdish Prasad was nominated as Member in the Editorial Board (2010-2011) of Indian Society of Soil Science, New Delhi.
- Dr. Jagdish Prasad was appointed as a member on the Board of studies in Soil Science & Agricultural Chemistry, Banaras Hindu University for a period of two years with effect tow 24.07. 2010.

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9th National Seminar on *"Recent Outlook on Sustainable Agriculture , Livelihood Security and Ecology of Coastal Region"* organized by Indian Society of Coastal Agricultural Research (ISCAR), CSSRI, RRS, Canning Town, West Bengal at Calangute, Goa from October 27-30, 2010.

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Interface Meeting for *Development of Agriculture and Allied Sectors* in Nagaland on 4th Feb, 2011.

Baruah. U and Dutta .D (2011) Soil Resources of Nagaland towards Land Use Planning in Compendium of Status Papers, pp 20-21.

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Mahapatra, S.K., Sharma, J.P., Martin D. and Sharma R.D. (2010). Soil resource assessment of Kumaon Himalayan Mountains of India. Abstract : 1.4.1, Pp 37-39.

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National workshop on *MDS of health indicators for soil resources under varied Agro-climatic Water regimes in India,* January 29-30, 2011 at DWM Bhubaneswar

Ashutosh Kumar, Srivastava, Alok K., Sidhu, G.S., Bhattacharyya, T. and Sarkar, Dipak (2011) Microbial analysis and enzymatic dynamics of IGP soil : A case study for Land Use Planning.

National Conference on *Watershed management on Sloping Lands for Environment and Livelihood Security,* held at Shillong during 11-13 Nov. 2010

Chaturvedi, T. N. Hajare, N. G. Patil, Layant Borkar, and Mamta Mokde (2010). BMP for Paddy-A competent alternative to SRI: A Case Study from Central India.

Hajare, T. N., A. Chaturvedi, N. G. Patil, Layant Borkar, A. Gattani, Mamta Mokde and Anju Nair (2010). Lessons from Tribal Dominant High rainfall Region of Central India in Utilizing Surface Water Resources to Augment Income.

8

Participation of Scientist in Conferences, Meetings, Workshops, Seminars, Symposia etc. in India and Abroad

State Level Conference on Science and Technology for Sustainable Development IISC, Bangalore during 17-19th April 2010

Dr. Rajendra Hegde

Mass Media Support for Popularization of Agricultural Technology (NAIP Project) during 26-27th July 2010

Dr. Rajendra Hegde

Dr. V. Ramamurthy

National Seminar on "Issues in Land Resource Management: Land Degradation, Climate Change and Land Use Diversification organized by Indian Society of Soil Survey and Land Use Planning at NBSSLUP, Nagpur during 8 to10 October, 2010

Dr. Dipak Sarkar, Dr. S. K. Singh , Dr. L.G.K. Naidu, Dr. A. Natarajan, Dr. U. Baruah, Dr. R.L. Shyampura, Dr. S. Thayalan, Dr. R.S. Singh, Dr. A. Chaturvedi, Dr. Rajeev Srivastava, Dr. T. Bhattacharyya, Dr. (Mrs.) C. Mandal, Dr. G.S. Sidhu, Dr. T.H. Das, Dr. A.K. Sahoo, Dr. S.K. Gangopadhyay, Dr. D.S. Singh, Dr. V. Ramamurthy, Dr. S.C. Ramesh Kumar, Dr. Anil Kumar, Dr. S. Bandyopadhyay, Dr. S.K. Reza, Dr.G.P. Obi Reddy, Er. Pramod Tiwary, Dr. Jagdish Prasad, Dr. S.K. Ray, Dr. B.P. Bhaskar, Dr. P. Chandran, Dr. S.K. Mahapatra, Dr. J.D. Giri, Dr. D.K. Mandal, Dr. S.N. Goswami, Dr. S. Chatterjee, Dr. T.K. Sen, Dr. N.G. Patil, Dr. T.N. Hajare, Dr. M.S.S. Nagaraju, Dr. R.S. Nasre, Mrs. Pushpanjali, Mr. S.S. Nimkhedkar, Dr. A.P. Nagar, Mr. Prakash Ambekar, Dr. B.A. Dhanorkar, Mr. A.K. Barthwal, Mr. S.V. Bobade, Dr. P. Raja, Dr. A.M. Nimkar, Dr. N.C. Khandare

9th National Seminar on "Recent Outlook on Sustainable Agriculture , Livelihood Security and Ecology of Coastal Region" organized by Indian Society of Coastal Agricultural Research (ISCAR), CSSRI, RRS, Canning Town, West Bengal at Calangute, Goa during October 27-30, 2010

Dr. Dipak Sarkar

Dr. S.K. Singh

Dr. K.D. Sah

National Conference on Watershed management on Sloping Lands for Environment and Livelihood Security, held at Shillong during 11-13 Nov. 2010

Dr. A. Chaturvedi

Dr. T.N. Hajare

Dr. N.G. Patil

ISSS National Seminar on "Development in Soil Science – 2010" at IISS, Bhopal during November 14 to 17, 2010.

Dr. C.S. Walia, Dr. S.K. Mahapatra, Dr. S.K. Ray, Dr. N.C. Khandare, Dr. S. Chatterjee, Dr. D.C. Nayak, Dr. A.K. Sahoo, Dr. K. Das, Dr. T.P. Verma

Annual Convention and National Seminar of ISRS Prediction of Soil Organic Carbon in Spatial Scale from Hyperspectral Remote Sensing data in the held at Lonavala, Pune during Dec. 1-3, 2010.

Dr. G.S. Sidhu

Dr. Jaya Surya

National Seminar on" Resource Management Approaches towards Livelihood Security" organized by Indian Society of Agronomy, New Delhi, at UAS, Bangalore from 2nd to 4th Dec. 2010

Dr. L.G.K. Naidu

Dr. V. Ramamurthy

Dr. Rajendra Hegde

National symposia on "Potash: Yield and Quality of High Potash Requiring Commercial Crops" organized by IPNI and UAS, Dharwad at Dharwad during 17-18th Jan 2011

Dr. Dipak Sarkar

Dr. L.G.K. Naidu

Dr. G.S. Sidhu

Dr. V. Ramamurthy

National Seminar "Bhoomi conference 2011" on Climate Change, Farm Sustainability and Good Life at Bangalore organized by Bhoomi networks, Bangalore during 21st and 22nd January 2011

Dr. Rajendra Hegde

National Workshop on MDS of Health Indicators for Soil Resources under Varied Agro-climatic Water Regimes in India at DWM Bhubaneswar during January 29-30, 2011

Dr. Dipak Sarkar

Dr. G.S. Sidhu

Interface Meeting for Development of Agriculture and Allied Sectors in Nagaland on 4th Feb, 2011.

Dr. U. Baruah

Dr. D. Dutta

16th National Symposium on Application of Clay Science Agriculture, Environment and Industry, held at NBSS&LUP, Nagpur during February 18 to 19, 2011

Dr. Dipak Sarkar, Dr. G.S. Sidhu, Dr. L.G.K. Naidu, Dr. C.S. Walia, Dr. B.P. Bhaskar, Dr. Mrs. C. Mandal, Dr. P. Raja, Dr. U. Baruah, Dr. D.K. Pal, Dr. Rajeev Srivastava, Dr. T. Bhattacharyya, Dr. S.K. Ray, Dr. Jagdish Prasad, Dr. D.K. Mandal, Dr. D. Dutta, Dr. Mrs. P.L.A.Satyavathi, Dr. S.G. Anantwar, Dr. N.G. Patil, Dr. K.M. Nair, Dr. Anil Kumar K.S., Dr. S. Bandyopadhyay

Workshop on Soil Biology and Agriculture organized by Kerala state planning Board at Trivandrum on 14-03-2011

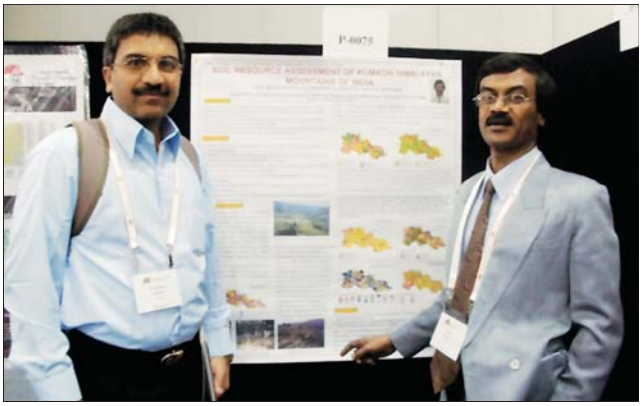
Dr. K.M. Nair

Dr. V. Ramamurthy

Abroad

World Congress of Soil Science, Brisbane, Australia

- Dr. S.K. Mahapatra, Principal Scientist attended 19th World Congress of Soil Science, held at Brisbane Australia during August 1-6, 2010.



Dr. S.K. Mahapatra, Principal Scientist presenting poster in 9th World Congress of Soil Science held at Brisbane, Australia

9

Approved On-going Projects

THEME A – Inventorising Natural Resources

1. **Assessment of land and soil resources of Malappuram district (part) of Kerala at 1:50,000 scale for land use planning**

   K.S. Anil Kumar, S. Thayalan, K.M. Nair, S.Srinivas, Rajendra Hegde, S.C. Ramesh Kumar and L.G.K. Naidu

2. **Land resource inventory for farm planning in different agro-ecological regions of India**

   A.Natarajan, Jaya N. Surya, R.S.Meena S.K.Reza, S.Bandyopadhyay, S.Dharmarajan, Pushpanjali, K.Karthikeyan, T.P.Verma and Dipak Sarkar

3. **Land resource inventory for farm planning in Chikarsinkere Hobli, Maddur Taluk. Mandya District, Karnataka – a sub-project of Land resource inventory for farm planning in different agro-ecological regions of India**

   R.S. Meena, A.Natrajan S. Thayalan, S.C.Ramesh Kumar, V. Ramamurthy, S. Srinivas

4. **Soil resource inventory and land evaluation of Aurangabad district, Bihar (1:50,000 scale) for land use planning**

   S.K. Gangopadhyay, K. Das, S. Mukhopadhyay and SK Singh

5. **Soil resource inventory and land evaluation of Rohtas district, Bihar (1:50,000 scale) for land use planning**

   DC Nayak, AK Sahoo, T. Banerjee, S. Mukhopadhyay, SK Singh

6. **Land resource inventory for farm planning in Chinchura-Mogra and Polba-Dadpur block, Hugli district, West Bengal**

   S. Dharumarajan, S.K. Gangopadhyay, T. Banerjee and S.K. Singh

7. **Correlation of Soil Series of Eastern States (West Bengal, Bihar, Jharkhand, Orissa, Sikkim and A& N Islands)**

   A.K. Sahoo, D.C. Nayak, T. Banerjee and S.K. Singh

8. **Soil Resource Mapping of Sultanpur district of Uttar Pradesh for perspective Land use planning**

   C.S.Walia, Tarsem Lal and G.S. Sidhu

9. **Land Resource Inventory for Farm Planning in Lakhan Majra Block of Maham - Rohtak Tehsil, Rohtak District, Haryana**

   Jaya N. Surya, G.S.Sidhu, Tarsem Lal, S.K. Mahapatra, C.S.Walia and Dharam Singh

10. **Soil Resource Mapping of Mathura District, Uttar Pradesh for Perspective Land Use Planning (1:50,000 scale)**

    S.K. Mahapatra, Jaya N Surya, Tarsem Lal, G.S. Sidhu, J.P. Sharma and R.D. Sharma

11. **Land Resource Inventory of East Lahing Gaon Panchayat of East Jorhat Development Block, Jorhat District, Assam (Sub project Land Resource Inventory for Farm Level Planning in Different Agro-ecological Regions of India)**

    S. Bandyopadhyay, S.K. Reza and Utpal Baruah

12. **Land Resource Inventory of Katonigaon Panchayat of Titabar Block, Jorhat District (Part of Land Resource Inventory for Farm Planning in different Agro-ecological Regions of India)**

    S.K. Reza, S. Bandyopadhyay, A. Natarajan and Utpal Baruah

13. **Study of crop moisture availability of soils during post- *kharif* period in Sibsagar district of Assam**

    Dipak Dutta, S.K. Reza and U. Baruah

14. **Soil Resource Inventory and Land Evaluation of Chittaurgarh district for Land Use Planning**

    T.P. Verma, J.D. Giri, R.S. Meena, R.K. Naitam and R.L. Shyampura

15. **Land resource inventory for farm planning Jhalarapatan block of Jhalawar district in Rajasthan**

    R.S. Meena and G.L. Meena

16. **Land use planning of Chanavada II watershed for integrated development**

    R. Naitam and T.P. Verma

17. **Land use planning of Bhadesar tehsil, Chittorgarh district, Rajasthan**

    T.P. Verma and R.S. Singh

18. **Land Resource Inventory for Farm Planning in Parseoni mandal of Parseoni taluka, Nagpur District, Maharashtra**

    Pushpanjali, K. Karthikeyan, C. Mandal, Jagdish Prasad, J.D. Giri and Malathi Bommidi

19. **Reconnaissance Soil Survey in Yavatmal District of Maharashtra on 1: 50,000 scale**

    B.P. Bhaskar, M.S. Gaikwad, S.V. Bobade, A.M. Nimkar, S.S. Gaikwad, V.N. Parhad and K.M. Gaikwad

20. **Reconnaissance soil survey, mapping and classification of soils of Jabalpur district, Madhya Pradesh**

    Jagdish Prasad, A.M. Nimkar, S.S. Gaikwad and C. Mandal

21. **Detailed Resource Soil Survey of Hayatnagar Research Farm of CRIDA, Hyderabad**

    P. Chandran, S.K. Ray, P. Raja, A. M. Nimkar, D. K. Pal, T. Bhattacharyya, C. Mandal , M.S.S. Nagaraju and Dipak Sarkar

22. **Soil Correlation and Classification, Benchmark soils and agrotechnology transfer**

    Dipak Sarkar, T. Bhattacharyya et.al.

23. **Generation of soil information Data Base of IARI Farm (Collaborative Research Project with IARI, New Delhi)**

    S.K. Mahapatra and G.S. Sidhu

THEME B – Remote Sensing, GIS and Cartography

1. **Soil based approach towards rational land use planning using Remote Sensing and GIS**

   S. Mukhopadhyay, SK Singh

2. **Integrated approach of remote sensing and GIS in land resources characterization and evaluation of land resources in Saraswati watershed of Buldhana district of Maharashtra**

   M.S.S. Nagaraju, Rajeev Srivastava, A.K. Maji and A.K. Barthwal

3. **Natural resource assessment using RS and GIS – a case study in Badajorenala micro watershed in Utkal plain of Orissa**

   K. Das, S.K. Singh, T. Banerjee and S. Dharumarajan

4. **Application of Cartosat-1 data for cadastral level soil mapping in basaltic terrain for land resource management**

   M.S.S. Nagaraju, J.D. Giri, Nirmal Kumar, D.S. Singh, S.N. Das, Rajeev Srivastava

5. **Comparative assessment of large scale soil mapping by conventional method and remote sensing techniques: a case study in Parsori micro-watershed, Katol tehsil, Nagpur District, Maharashtra**

   J.D. Giri, M.S.S. Nagaraju, D.S. Singh and Rajeev Srivastava

6. **Development of software modules for land evaluation and agro-climatic analysis**

   S. Srinivas, K.M. Nair, L.G.K. Naidu, Rajendra Hegde and V. Ramamurthy

7. **Digital maps of derived soil quality of different states of India**

   A.K. Maji, G.P. Obi Reddy and Sunil Meshram

8. **Documentation and Storing of Maps and Photographs: Concept of Digital Map Library**

   C. Mandal, Pushpanjali, D.K Mandal, Jagdish Prasad, T Bhattacharyya, R. Srivastava and Dipak Sarkar.

9. **Development of GIS based seamless mosaic of SRTM elevation data of India to analyze and characterize the selected geomorphometric parameters *(Inter institutional project between NBSS&LUP and RRSC, Nagpur)***

   G.P. Obi Reddy, A.K. Maji, S.N. Das and Rajeev Srivastava

THEME C – Basic Pedological Research

1. **Geomorphological analysis and study on landform-soils-landscape relationship in Southern India**

   S. Thayalan, A. Natarajan, K. M. Nair, K.S. Anil Kumar, S.C. Ramesh Kumar, V. Ramamurthy and L.G.K. Naidu

2. **Development of protocols for digestion, standards and methods to determine elements in soil and sediments using Inductively Coupled Plasma Spectrometry (ICP-AES)**

   S.K. Ray, P. Chandran, T. Bhattacharyya, P.L.A. Satyavathi, D.K. Pal, S. G. Anantawar and P. Raja

3. **Ascertaining the pedogenetic processes for the clay enriched Bss horizons of Vertisols**

   P.L.A. Satyavathi, S.K. Ray, P. Chandran, P. Raja, S.L. Durge and D.K. Pal

4. **Estimating Saturated Hydraulic Conductivity, Bulk Density, and other Physical Properties of the Vertisols and Vertic Intergrades from Published Research and Soil Survey Data**

   N.G. Patil, D. K. Pal, C. Mandal and D. K. Mandal

5. **Design and development of spatial soil database and analysis in GIS**

   A.K. Maji, G.P. Obi Reddy and Sunil Meshram

6. **Water retention characteristics and saturated hydraulic conductivity of dominant soil series of Yavatmal district, Maharashtra**

   P.L.A. Satyavathi, Pramod Tiwary, S.K. Ray, P. Chandran, B.P. Bhaskar, Jagdish Prasad and Tapas Bhattacharyya

7. **Genesis and Classification of Benchmark ferruginous soils of India**

   P. Chandran, S.K. Ray, T. Bhattacharyya, D. K. Pal and Dipak Sarkar

THEME D – Soil Survey Data Interpretation and Application

1. **Soil resource data and their interpretation for implementation of river link projects -Ken – Betwa river link project**

   A.K. Maji, G.P. Obi Reddy, S. Thayalan, M.S.S. Nagaraju and A.K. Barthwal

2. **Agro-ecological zoning of Tamil Nadu**

   L.G.K. Naidu, S. Srinivas, A. Natarajan, S. Thayalan and V. Ramamurthy

3. **Development of District Soil Information System (DSIS) on 1:50,000 Scale (50 Districts)**

   G.P. Obi Reddy, C. Mandal, Nirmal Kumar, S. Srinivas, Subrato Mukhopadyay, Tarsem Lal, R.S. Singh, S.K. Reza, Heads of the Rc's and Dipak Sarkar

4. **Soil Survey Data Interpretation and Application Land Resource Management Development of Indian Soil Information System (ISIS) - A GeoPortal**

   G.P. Obi Reddy, Rajeev Srivastava, C. Mandal, Nirmal Kumar, S. Srinivas, Subrato Mukhopadyay, Tarsim Lal, R.S. Singh, S.K. Reza, Heads of the Rc's and Dipak Sarkar

5. **Soil microbial biomass Carbon and Nitrogen in selected soil series of North-Eastern Region as affected by different land uses and varied agro-ecological conditions**

   T. Chattopadhyay, D. J.Nath, D. Dutta, S.K. Reza and U. Baruah

6. **Characterization and Evaluation of Carbon (SOC) & Sulphur Status in soybean growing Areas of Dhar district, Madhya Pradesh to Suggest an Alternative Cropping pattern**

   K.Karthikeyan, Jagdish Prasad, Pushpanjali and Dipak Sarkar

7. **Development of a soil water balance model for shrink-swell soils of Central India**

   P. Tiwary, D. K. Mandal and T. N. Hajare

THEME E – Land Evaluation and Land Use Planning

1. **Land use planning for North Goa District, Goa**

   Rajendra Hegde, S. Srinivas and S.C. Ramesh Kumar

2. **Dynamics of land use plan and its impact on soil properties in Nawanshahr district, Punjab state**

   G.S. Sidhu, Tarsem Lal, Jaya N. Surya, J.P. Sharma and D.K. Katiyar

3. **Dynamics of land use plan and its impact on soil properties in Jalandhar district, Punjab state**

   G.S. Sidhu, Tarsem Lal, Jaya N. Surya and J.P. Sharma

4. **Land Use Planning of Diring-Thanglong Micro-watershed of Karbi-Anglong and Golaghat districts of Assam under Hills & Mountain Ecosystem for Integrated Development**

   S. Bandyopadhyay, S.K. Reza, Dipak Dutta and Utpal Baruah

5. **Soils, Land Use and Perspective Land Use Planning of Nagpur District**

   Arun Chaturvedi, C. Mandal, Rajeev Srivastava, D.K. Mandal, T.N. Hajare, S.N. Goswami, N.C. Khandare and R.S. Gawande

6. **Land use planning for Tirumale sub-watershed (Motaganhalli watershed) in Magadi taluk, Ramangar district, Karnataka**

   Rajendra Hegde, S. S. Srinivas and A. Natarajan

7. **Net-work project on district level Land Use Planning and Policy Issues under different agro-ecosystems of the country**

   National Coordinator: Dr. Dipak Sarkar, Director. Principal Investigator: Dr. Arun Chaturvedi

8. **Development of district level Land Use Plan for Bundi district (Rajasthan) under arid and semi-arid eco system**

   R.S. Singh, R.L. Shyampura etc.

9. **Development of district level land use plan for Nadia district in West Bengal under irrigated ecosystem**

   A.K. Sahoo, D.C. Nayak, T. Banerjee and S.K. Singh

10. **Development of district level land use plan for Mysore district, Karnataka state**

    Ramamurthy, V., Nair, K. M., Ramesh Kumar, S.C., Srinivas, S., Naidu, L.G.K., and Thayalan, S.

11. **Assessment of stakeholder needs and economic evaluation of land use types for land use planning of Mysore and North Goa Districts**

    S.C. Ramesh Kumar, V.Ramamurthy and Rajendra Hegde

12. **Development of district level land use plan for Almora district, Uttrakhand under Hill and Mountain ecosystem**

    S.K. Mahapatra, Jaya N. Surya, J.P. Sharma and G.S. Sidhu

13. **National network sub- project on Development of district level Land Use Plan for Gondia district, Maharashtra**

    T.K. Sen, S. Chatterji, T.N. Hajare, S.N. Goswami, N.G. Pati, P.N. Dubey, A. Chaturvedi and Dipak Sarkar

14. **Development of District Level Land Use Planning of Jorhat District, Assam under Rain-fed Ecosystem**

    S. Bandyopadhyay, S.K. Reza and Utpal Baruah

THEME F – Externally Funded Projects

1. **Georeferenced Soil Information System for Land Use Planning and Monitoring Soil and Land Quality for Agriculture (NAIP)**

   Bhattacharyya, T., Sarkar, Dipak, Mandal, D.K., Jagdish Prasad, Sidhu, G.S., Sahoo, A.K., Nair, K.M., Singh, R.S., Das, T.H., Venugopalan, M.V[1]., Srivastava, A.K.[2], Raychaudhari, Mausumi[3]., Velmourougane, K.[1], Meena, K.K., Mandal, D.K.., Mandal, C., Srivastava, R., Sen, T.K., Chatterji, S., Chandran, P., Ray, S.K., Obireddy, G.P., Patil, N.G., Mahapatra, S.K., Das, K., Singh, A.K. S. Srinivas, Reza, S. K., Tiwary, P., Mrunmayee Lokhande, Wadhai, K. Vishakha Dongare, Mohanty, B., Majumdar, S., Ganjanna, K.V., Garhwar, R.S., Hazarika, D., Sahu, A[1]., Mahapatra[3], S. and Ashutosh Kumar[2]

2. **Development of spectral reflectance methods and low cost sensors for real-time application of variable rate inputs in precision farming (NAIP)**

   Rajeev Srivastava and Dipak Sarkar

3. **Efficient Land Use Based Integrated Farming System for Rural Livelihood Security in Aurangabad, Dhule and Gondia districts of Maharashtra (NAIP)**

   Dipak Sarkar, A. Chaturvedi, T.N. Hajare, N.G. Patil, T.K. Sen, S. Chatterjee, S.N. Goswami, M.S.S. Nagaraju, B.P. Bhaskar and G.P Obi Reddy

4. **Assessment of Quality and Resilience of Soils in Diverse Agro-ecosystems (NAIP)**

   T. Bhattacharyya, D. Sarkar, P. Chandran, S.K. Ray, C. Mandal and B. Telpande

5. **Soils of Thirupuram, Kanjramkulam and Kadinanamkklam Panchayats of Thiruvananthapuram district, Kerala (NAIP)**

   K.M. Nair, S. Thayalan, K.S. Anil Kumar, L.G.K. Naidu and Dipak Sarkar

6. **Nutrient indexing and soil fertility assessment of Kole lands**

   K.M. Nair, K.S. Anil Kumar, S. Srinivas, L.G.K. Naidu and Dipak Sarkar

7. **Soil based plant nutrient management plan for agro-ecosystems of Kerala**

   K.M. Nair, S. Thayalan, S.C. Ramesh Kumar, V. Ramamurthy, K.S. Anil Kumar, S. Srinivas, P. Chandran, Dr. L.G.K. Naidu and Dipak Sarkar

8. **Agro-ecological units of 14 districts of Kerala**

   K.M. Nair, Champa Mandal, Arun Chaturvedi, S.Thayalan, S.C. Ramesh Kumar, V. Ramamurthy, K.S. Anil Kumar, S. Srinivas, L.G.K. Naidu and Dipak Sarkar

9. **Assessment of land resources for growing horticultural crops in selected districts for Tamil Nadu under the National Horticultural Mission project**

   ANatarajan, V. Ramamurthy, S. Thayalan, S. Srinivas, K.V. Niranjana, M. Ramesh, D.H. Venkatesh and L.G.K. Naidu

10. **Interfluve Stratigraphy, Sedimentology and Geochemistry of Central and Southern Ganga Plains (DST)**

    T. Bhattacharrya, P. Chandran, S. K. Ray, P. Raja and P.L.A. Satyavathi,

11. **Generation of Soil Database for Khulgad Watershed Development in Almora District, Uttarakhand (DST)**

    C.S Walia, R.P.Dhankar, J.N Surya and J.P. Sharma

12. **Predicting soil carbon changes under different cropping system in soils of selected benchmark spots in different bioclimatic systems in India (DST)**

    T. Bhattacharyya, S K. Ray, P. Chandran and C. Mandal,

13. **Soils variability mapping and fertility zonation using Hyperspectral data (A collaborative project between NBSS&LUP and SAC, Ahmedabad)**

    A.K. Maji, Rajeev Srivastava, Dipak Sarkar, M.S.S. Nagaraju, D.S. Singh, A.K. Barthwal and R.L. Mehta

14. **Enrichment of land degradation datasets with soils datasets of different states of India (NRSC – NBSS&LUP Collaborative project)**

    G.P. Obi Reddy et al.

15. **Changes in soil carbon reserves as influenced by different ecosystems and land use in India (National Project on Climate Change)**

    T. Bhattacharyya, P. Chandran, M.V. Venugopalan, D.K. Pal, S.K. Ray, C. Mandal, Dipak Sarkar, P. Tiwary

16. **Assessment and mapping of some important soil parameters including macro and micro nutrients for 13 priority districts of Assam state (1:50,000 scale) towards optimum land use planning**

    Utpal Baruah, Dipak Sarkar, S.K. Reza, S. Bandyopadhyay, T. Chattopadhyaya, and Dipak Dutta

17. **Soil Resource Distribution, Characterization and Evaluation for Cotton Based Cropping Systems in Irrigated Eco-system in Northern India**

    C.S Walia, S.P.Singh, R.P.Dhankar,Jagat Ram and D.Martin

18. **Preparation of District-wise contingency Plan for Agriculture and Allied Sector**

    DK Mandal et al

19. **Agroecological regions of Uttar Pradesh (Collaborating project of UPCAR and NBSS&LUP)**

    Sohal Lal, C. Mandal, D. K. Mandal and S.R. Singh

20. **Assessment and mapping of some important soil parameters including macro and micro nutrients at block levels of Dumka, Jamtara and Hazaribagh district for optimum land use plan**

    Dipak Sarkar, A.K. Sahoo et al

21. **Assessment and mapping of some important soil parameters including macro and micro nutrients for the state of West Bengal (1:50,000 scale) towards optimum land use plan**

    Dipak Sarkar, D.C. Nayak, S.K. Singh, A.K. Sahoo, S. Mukhopadhyay, S.K. Gangopadhyay, K. Das, T. Chatopadhyay, D. Dutta, K.D. Sah and T. Banerjee

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Consultancy, Patents, Commercialisation of Technology

The Bureau is undertaking the Soil Nutrient Mapping of different states at 1 to 2 km grid samples. All the samples are geo-referenced. Important soil nutrient maps such as organic carbon, available nitrogen, phosphorus and potassium, micro nutrients and other thematic maps are being prepared and supplied to the sponsoring agencies. These maps and reports are being used by the concerned agricultural departments for input supply regulations and awareness among the farmers to use precious subsidized fertilizer according to the soil/crop requirements. These consultancy projects are being operated for the states of West Bengal, Assam and Jharkhand.

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Meetings

- Dr. Nair Attended CIS meeting pertaining to the NAIP project on 19 April at Nagpur and presented the progress of work.
- Dr. L.G.K. Naidu attended 22nd regional committee meeting of zone VIII from 13th to 15th May, 2010 at IVRI campus, Bangalore.
- Dr. Dipak Sarkar and Dr. L.G.K. Naidu attended the new project discussion with Zuari fertilizers company marketing managers (Mr. Bhakole, Mr. Joshi and Dr. Palaniappan, Consultant) on development of customized fertilizer recommendation for Paddy (Bellary dist), Maize and Sugarcane (Belguam dist) in Karnataka on 21st May, 2010
- Dr. K.S. Anil Kumar attended a meeting at Department of Watershed development, Govt. of Karnataka as core committee member on 31st May, 2010 to finalise training programmes for watershed development implementing personnel.
- Dr. L.G.K. Naidu and Dr. V. Ramamurthy attended review meeting of network project on district LUP at Hq on 15-6-10 and 16.6.10 at Nagpur and presented the progress of the project.
- Dr. Natarajan Presented the project details pertaining to newly prposed project on "Soil Resource Mapping for Farm Planning in India" to the high-level meeting, chaired by the DDG, Dr.A.K.Singh and atteded by the DDG, Dr.M.Moni, NIC, our Director and other officials from ICAR and NIC at New Delhi on 1.6.10.
- Dr. Rajendra Hegde Participated in the meeting of watershed development department regarding the organization of Human resources development programs under IWMP (28-6-2010).
- Dr. Rajendra Hegde Participated in the meeting at UAS (Bangalore) GKVK regarding contingency planning for districts of NARP Zone 5 of Karnataka organised by Associate Director of Research. Provided the feedback on soil information being used for the report preparation.
- Dr. Anil Kumar and Ramesh Kumar visited Chittoor district of A.P. and met Joint Director of Agriculture

and other district officials for finalizing the date conducting for user interaction meet and release of Kuppam Mandal report.

- Dr. L.G.K. Naidu, Dr. A. Natarajan and Dr. V. Ramamurthy had a meeting with Dr.Appavu, Director, NRM, TNAU on 16th July at Coimbatoor and discussed about possibilities of detailed soil survey in TN and assessment of LGP and requested all the agricultural research stations in the state to verify the LGP assessment and convey their suggestions for finalizing the LGP map for TN.
- Dr.V.Ramamurthy and Dr.Rajendra Hedge participated in the Brainstorming session on "Human and animal health through soil health": for preparing a policy paper for NAAS, New Delhi, organized at IIHR, Bangalore from 6th and 7th Sept 2010.
- Dr. Rajendra Hegde and Dr A. Natarajan Participated in a meeting with Principal Secretary, Agriculture, GoK in connection with farm level land resources data base generation (19-1-11).
- Scientists from Rubber Research Institute, Kottayam visited Regional centre on 21-01-11 to discuss about new project proposal for monitoring of soil quality of rubber growing soils.
- Dr. LGK Naidu, Dr Natarajan and Dr. Rajendra Hegde had a meeting with Commissioner and Director for Watershed Development, Govt. of Karnataka to discuss on the "Detailed land resources database generation for Karnataka".
- Dr. K.M. Nair and Dr. V.Ramamurthy attended review meeting of 'Soil based Nutrient Management Plan for Agro-ecosystems of Kerala' at Thiruvanathapuram to review the progress of work under the project – soil sampling by NYK and soil analysis by various labs assigned with the task.

Meetings Attended

i) Meeting with the professors and lecturers Dept. of Soil Science, Dept. of Agronomy and other Scientist of Assam Agricultural University under the Chairmanship of Dr. K.M. Bujarbaruah, Hon'ble Vice-Chancellor of Assam Agricultural University, Jorhat on 17th March, 2010 regarding involvement of scientists of Regional Centre, Jorhat in teaching and research at various courses in the Dept. of Soil Science.

- Dr. Dipak Sarkar
- Dr. Utpal Baruah
- Dr. T.H. Das
- Dr. Dipak Dutta
- Dr. S. K. Reza

ii) Annual Group Meeting on ' AICRP on Micro- and Secondary Nutrients' ICAR held on 13th March, 2011 at Assam Agricultural University (AAU), Jorhat .

- Dr U. Baruah

Meetings (RC Delhi)

- Dr. G.S. Sidhu, Principal Scientist attended CIC meeting on NAIP at Nagpur on April 19 -20, 2010.
- Dr. G.S. Sidhu, Principal Scientist attended NAIP-World Bank Meet on 21-22 May, 2010 held at NASC New Delhi.
- Dr. S.K. Mahapatra, Principal Scientist attended meeting of NSDI held at Khosala Hall, NSDI, East Block – 7, Level 5, Sector 1, R.K. Puram, New Delhi on June 11, 2010.
- Dr. J.P. Sharma, Principal Scientist & Head and Dr. S.K. Mahapatra, Principal Scientist, attended 2nd Review Meeting of Networking Project on Land Use Planning on 15th June, 2010 and Meeting on Identification and Land Use Planning of Micro Watersheds on 16th June, 2010 at NBSS&LUP, Nagpur.
- Dr. S.K. Mahapatra, Principal Scientist, attended the Council Meeting of Indian Society of Soil Science on 19th June, 2010 at IARI, New Delhi.
- Dr. C.S. Walia, Principal Scientist attended consultation meeting on partnership for strengthening the man and biosphere reserves programme in India held at Munnar, Kerala on June 22-23, 2010.
- Dr. J.P. Sharma, Head & Principal Scientist and Dr. G.S.Sidhu, Principal Scientist attended meeting to review NAIP Geosis Progress on 3rd August, 2010 at Delhi.

- Dr. J.P. Sharma, Head & Principal Scientist and Dr. G.S. Sidhu, Principal Scientist attended Organizing Committtee Meeting of CMSI at Division of SSAC, IARI on 5th August, 2010.
- Dr. (Mrs.) Jaya N. Surya, Sr. Scientist attended review meeting of the project "Land resource inventory for farm planning in different Agro-ecological regions of India" at NBSS&LUP, Nagpur on 22nd August, 2010.
- Dr. G.S. Sidhu, Principal Scientist & Acting Head attended Institute Management Committee meeting of Sugarcane Breeding Institute, Coimbatore on 23rd September, 2010.
- Dr. G.S. Sidhu, Principal Scientist attended RAC Meeting on 20th to 21st August and 7th October, 2010 at NBSS&LUP, Nagpur.
- Dr. G.S.Sidhu, Principal Scientist & Head and Dr. S.K. Mahapatra, Principal Scientist attended Soil Correlation Meetings at SLUSI, New Delhi on 17th September and 10th October, 2010.
- Dr. G.S.Sidhu, Principal Scientist & Acting Head attended meeting with DDG (NRM) and Director General & DDG NIC at Delhi on 11th and 13th October, 2010.
- Dr. G.S.Sidhu, Principal Scientist attended CIC & CAC Meetings of NAIP-GEOSIS Project on 31st October and 1st Nov, 2010 at NBSS&LUP, Nagpur.
- Dr.G.S. Sidhu, Principal Scientist and Head, Dr.C.S.Walia and Dr.A. Natarajan, Principal Scientists attended a meeting with Dr.R.S.Paroda, Chairman, Farmers Commission, Govt. of Haryana to discuss about farm level land use planning in Haryana state.
- Dr. C.S.Walia and Dr. S.K. Mahapatra, Principal Scientists attended Annual General Body Meeting of the Indian Society of Soil Science on 15th November at IISS, Bhopal.
- Dr. G.S.Sidhu, Principal Scientist & Head and Dr. S.K. Mahapatra, Principal Scientist attended CIC & CAC Meetings of NAIP Project on 13-14 December, 2010 at NBSS&LUP, Nagpur.
- Dr. G.S. Sidhu, Principal Scientist & Head attended meeting of Research Project Enrichment of Land Degradation Datasets with Soil Dataset at NBSS&LUP, Nagpur on 15th December, 2010.
- Dr. Dipak Sarkar, Director, NBSS&LUP, Nagpur and Scientists of Regional Centre Delhi attended a Meeting with Dr. R.S. Praoda, Chairman, Farmers Commission, Govt. of Haryana on December 22, 2010.
- Dr. G.S. Sidhu, Principal Scientist & Head attended Institute Management Committee meeting of Sugarcane Breeding Institute, Coimbatore on 18th January, 2011.
- Scientists of Regional Centre Delhi attended a Meeting with Director on Lakhan Majra research project on January 25, 2011.
- Dr. G.S. Sidhu, Principal Scientist & Head attended meeting of Research Project Enrichment of Land Degradation Datasets with Soil Dataset at NBSS&LUP, Nagpur on 21st February, 2011.
- Dr. G.S.Sidhu, Principal Scientist & Head, Dr. C.S.Walia and Dr. S.K. Mahapatra, Principal Scientists attended a Meeting on Soil Correlation Activities with UPRSAC, Lucknow, on March 16-17 2011.
- Dr. S.K. Mahapatra, Principal Scientist attended the Council Meetings of the Indian Society of Soil Science on 19th June 2010, 1st November 2010 and 26th March 2011 at Division of Soil Science & Agricultural Chemistry, New Delhi

Meetings (RC Kolkata)

- Dr. D. C. Nayak and Dr. A. K. Sahoo, Principal Scientists attended the Group Meeting with the field worker of the project on Block level soil nutrient mapping at Dumka, Jharkhand at ATMA, Jamtara during 11-12th May, 2010 and at ATMA, Dumka on 13-14thy May, 2010 in presence of scientist of KVK, Dumka and Jamtara and Birsa Agricultural University, Ranchi.
- Dr. S. K. Singh, Principal Scientist and Head attended XXth meeting of OCAR Regional Committee – II held at Port Blair on 14-15 September, 2010 and explained the activities of the centre, especially issues related to effective land use planning and mapping of acid soils in West Bengal.
- Dr. S. K. Singh, Principal Scientist and Head and Dr. A. K. Sahoo, Principal Scientist attended workshop on Block level soil nutrient mapping of Dumka, Jamtara and Hazaribag districts of Jharkhand on

12th April, 2010 at Zonal Research Station, Birsa Agricultural University, Dumka.

- Dr. A. K. Sahoo, Principal Scientist attended 4th CIC meeting of the NAIP project held at NBSS & LUP (ICAR), Nagpur during 19th to 20th April, 2010.
- Dr. A. K. Sahoo and Dr. K. Das, Principal Scientists attended 5th CIC meeting of the NAIP project held at NBSS & LUP (ICAR), Nagpur during 30th and 31st October, 2010.
- Dr. A. K. Sahoo, Principal Scientist attended 2nd Review Meeting of National Network project on land Use planning held at NBSS & LUP (ICAR), Nagpur during 15th and 16th June, 2010.
- Dr. S. K. Singh, Principal Scientist and Head and Dr. A. K. Sahoo, Principal Scientist attended preliminary meeting of Research Advisory Committee held at NBSS & LUP (ICAR), Nagpur during 21st and 22nd August, 2010 and presented achievements and future strategies of research and development of Regional center, Kolkata.
- Dr. A. K. Sahoo, Principal Scientist attended the review meeting for finalization of methodology of the project on "Enrichment of land degradation dataset of NRSC with the soil dataset of NBSS & LUP" during 7th and 8th September 2010 at NBSS & LUP (ICAR), Nagpur.
- Dr. A. K. Sahoo, Principal Scientist attended the review meeting of the project on "Enrichment of land degradation dataset of NRSC with the soil dataset of NBSS & LUP" during 21st February, 2011 at NBSS & LUP (ICAR), Nagpur.
- Dr. A. K. Sahoo, Principal Scientist attended meeting at Zonal Research Station (ZRS), Dumka with Dean, BAU, Scientists and Agriculture Officers of BAU, Ranchi, KVK and ZRS, Dumka alongwith the field workers regarding soil nutrient mapping of Saraiyahat, Kathikund and Gopikanda blocks of Dumka district on 1st March, 2011.
- Dr. A. K. Sahoo, Principal Scientist attended 41st Institute Management Committee Meeting at NBSS & LUP (ICAR), Nagpur on 25th March, 2011 and also the review meeting on "Enrichment of land degradation dataset of NRSC with the soil dataset of NBSS & LUP" on 26th March, 2011 at NBSS & LUP (ICAR), Nagpur.

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Workshop, Seminars, Farmers' Day and other events

A) Workshop

- An Interaction Meet was organized on "Development of district level land use planning of Jorhat (Assam) under rainfed eco-system" involving different stakeholders of Jorhat district at Regional Centre , Jorhat on16.09.2010 under the chairmanship of Dr. K.M. Buzarbaruah, Hon'ble Vice Chancellor of AAU and with other high officials viz. Dr Dipak Sarkar, Director, NBSS&LUP; Director of Research, AAU; Director of Extension Education, AAU; Principal, Extension Education Institute, Jorhat; Professors of Soil Science and Agronomy, AAU; representatives of NABARD; District Agriculture offices; District Fishery office and twenty farmers of different category belonging to different Land Management Units (LMU).

B) Extension Activities

- Regional Centre Delhi participated in "***PUSA KRISHI VIGYAN MELA -2011***" held at IARI, New Delhi, during March 3-5, 2011 and displayed various maps, publications & highlighting activities of the Bureau besides interaction with scientists, farmers and other visitors.
- The Regional Centre, Jorhat participated in Kishan Mela organized by Assam Agricultural University at Titabar on 13th November, 2010. Soil and thematic maps, bulletins etc. were displayed at the stall.
- First Hindi Karyashala on '*Hindi Mein Veagnik Lekho Ke Lyi Computer ka Prayog*" was organized at Regional Centre, Delhi on 22nd October, 2010. For Scientists.
- Second Hindi Karyashala on " *Hindi Rajbhasha Neeti avam Prasahnik Daetva*" was organized on 25th November, 2010 for the staff of Administration Section.
- Third Hindi Karyashala on "*Hindi Mein Vigyan Lekhan*" was organized at Regional Centre Delhi on 26th November, 2010 for the Technical Officers.
- Fourth Hindi Karyashala on "*Rajbhasha Neyam Adhineyam*" was organized at Regional Centre Delhi on 30th December, 2010 for the Field & Technical Assistants.

Participation of NBSS&LUP in Pusa Krishi Vigyan Mela 2011

Inauguration of Mela by Shri Arun Yadav, Hon'ble State Minister of Agriculture, Govt. of India and Dr. S. Ayyappan, Secretary, DARE and DG, ICAR on March 03, 2011

Dr. G.S. Sidhu, Principal Scientist and Head, Regional Centre Delhi and Scientists explaining the visitors about the activities of the Bureau

Dr. S.K. Mahapatra, Principal Scientist and Scientists of Delhi Regional Centre explaining the activities of the Bureau to Shri Arun Yadav, Hon'ble State Minister of Agriculture, Govt. of India and Dr. H.S.Gupta, Director, IARI, New Delhi and other dignitaries who visited the stall of Bureau on March 03, 2011.

Other Institutional Activities

(a) Special Assignments

Dr. S.K. Mahapatra Principal Scientist was deputed by ICAR as a team member to suggest to develop Madhuri Kund Farm of U.P. Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan, Mathura. The objectives of **the assignment** are as follows:

- To assess the assets and facilities available at the Farm
- To recommend for increasing productivity and profitability of the farm (crops/income), and
- Suggest machineries/ implements and other facilities required for development of farm.

The team reached the Madhuri Kund Farm and visited different blocks to evaluate the present farm activities. The team members also discussed with the officials regarding the facilities available at the Farm. Recommendations have been made about technological interventions, governance, infrastructure development and linkage with other organizations for follow up action of the University. Brief report had been submitted to the Secretary, DARE and DG, ICAR.

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Distinguished Visitors

Headquarters, Nagpur

- Dr. S. Ayyappan, Hon'ble Secretary DARE, Government of India and Director General of ICAR along with Dr. A.K. Singh, DDG (NRM), ICAR and other dignitaries on 22nd January, 2011.
- Dr. U.C. Sharma, Member, Research Advisory Council (RAC)
- Dr. Ir Prem S. Bindraban, Director, ISRIC, The Netherlands
- A team of M. Sc. Geography Students from Fergusson College, Pune visited the Section
- Dr. N. P. Tyagi, Member ASRB, New Delhi
- A team of scientists from Bidhan Chandra Kirishi Vishvavidyalaya (BCKV), West Bengal
- Mr. Abinash Chandra, Senior Agriculture Officer, Navada (Bihar)
- Dr. A.L. Pharande, Associate Dean, Collage of Agriculture, Kolhapur
- Dr. Manjit Singh, Associate Professor, PAU, Ludhiana

Regional Centre, Bangalore

- Dr S.A. Patil, Chairman, Karnataka Krishi Mission
- Dr Krishna Manohar Professor(Hort.) UAS Bangalore
- Dr Bhaskar UAS Professor (Agronomy) UAS, Bangalore
- Dr Ramachandra, Professor (Agronomy) and Co-ordinator Weed Control Scheme, UAS (B)
- Dr B.K. Ramachandrappa, Professor & Chief scientist (Dry farming) UAS (B)
- Dr A.N. Ganeshamurthy, Principal Scientist (Soil sci), IIHR, Hessarghatta, Bangalore
- Dr Prakash Rao, Head, CIMAP (CSIR), Yelahanka, Bangalore
- Dr Brahmaprakash Professor (Agri. Microbiology) UAS, Bangalore

- Dr Mohan Naik, Assoc. Professor (Entomology) UASBangalore
- Sri.Udayraj, GM RRSSC, ISRO, Isite campus, Marathahalli, Bangalore
- Dr Rabindra, Director NBAII (ICAR), Hebbal, Bangalore
- Sri Muralidhar, Member, Board of Regents and progressive farmer UAS, Dharwad
- Dr H.B. Raghupathi, Principal Scientist (Soil Sci.) IIHR, Hessarghatta, Bangalore
- Dr Prabhakar, Principal Scientist (Agron.) IIHR, Hessarghatta, Bangalore
- Dr S S Joshi, Shantha Joshi Professor (Retd.) UASBangalore
- Dr Jayachandran, PRO, Indo-American seeds, Channsanda Bangalore
- Dr Mahabaleshwar, Consultant Floriculture, Sunkadakatte, Bangalore

Regional Centre, Kolkata

- Dr. A. K. Singh, DDG (NRM), ICAR, New Delhi
- Rafiqul Islam Mondal, Director SAC Dhaka, Bangladesh
- Mr. AZM Saffiqul Alam, Additional Secretary, PPC Ministry of Agriculture, Govt. of Bangladesh

A meeting of Scientists of Regional Centre, Kolkata with Dr. AZM Saffiqul Alam, Additional Secretary, PPC, Ministry of Agriculture, Govt. of Bangladesh at NBSS & LUP, Regional Centre, Kolkata

- Dr. Pritish Nag, Director, NATMO, Kolkata
- Prof. S. K. Sanyal, Vice Chancellor , BCKV, West Bengal.
- Dr. Pradip Sen, Joint Director of Agriculture (Chemistry), Govt. of West Bengal
- Dr. A.K. Sarkar, Dean (Agriculture), Birsa Agricultural University, Ranchi
- Dr. Atanu Raha, IFS, Principal Chief Conservator of Forest, Govt. of West Bengal
- Dr. D. Pradhan, Director, Doppler Weather Radar, Indian Meterological Department, Kolkata
- Dr. Saugato Hazra, Director, School of Oceano-graphic Studies, Jadavpur University, Kolkata
- Dr. Amal Kar, Head, Division of Natural Resource and Environment, CAZRI, Jodhpur RC Delhi
- Dr. John Elgy Aston University Barminghum, U.K. and Dr. Ajit Singh Nain, Agro-climaterologist, GBPUA&T, Pantnagar
- Dr. Promod Kumar Sahu, Director, Soil Conservation, Bhuvneshwar, Orissa

Regional Centre, Delhi

- Dr. A. K. Singh, DDG (NRM), Dr. S.S. Khanna, Ex V.C. NDUAT, Faizabad, Former Advisor (Agriculture), Planning Commission, Govt. of India, Dr. D.K. Sharma members of QRT of CSSRI, Karnal

Regional Centre, Udaipur

- Dr. B.S. Chundawat, Ex V.C. Sardarkrushinagar-Dantiwada Agriculture University, Gujarat
- Dr. D.K. Das, Ex. Head, Agri. Physics, IARI, New Delhi
- Dr. A.K. Singh, DDG NRM, ICAR, New Delhi

Regional Centre, Jorhat

- Dr. K.M. Buzarbaruah, Hon'ble Vice Chancellor of AAU, Jorhat
- Dr. Tapan Dutta, Agricultural Consultant to Chief Minister of Assam to meet the scientists for discussion regarding "Soil Nutrient Mapping of Assam" Project

- Dr. N. N. Sharma, Director of Research, AAU, Jorhat
- Dr. B.C. Bhowmick, Director of Extension, AAU, Jorhat
- Dr. Mridul Hazarika , Director, Tocklai Experimental Tea Research Station, Jorhat
- Dr. R. K. Rajan, Director, Central Muga Eri Research and Training Institute, Central Silk Board, Lahdoigarh, Jorhat
- Dr. Durgeswar Das, Director of Post Graduate Studies, AAU, Jorhat
- Dr. L. Hazarika, Dean, Faculty of Agriculture, AAU, Jorhat.

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Personnel (Managerial Position)

DR. DIPAK SARKAR
Director

Dr. Arun Chaturvedi Principal Scientist (Geography) and Head	:	*Division of Land Use Planning*
Dr. Rajeev Srivastava Principal Scientist (Pedology) and Head	:	*Division of Remote Sensing Applications*
Dr. T. Bhattacharyya Principal Scientist (Pedology) and Head	:	*Division of Soil Resource Studies*
Dr. L.G.K. Naidu Principal Scientist (Pedology) and Head	:	*Regional Centre, Bangalore*
Dr. J.P. Sharma Principal Scientist (Pedology) and Head (upto 31.8.2010) **Dr. G.S. Sidhu** Principal Scientist (Pedology) and Head (Acting from 1.9.2010 to 8.11.2010) (Regular w.e.f. 9.11.2010)	:	*Regional Centre, Delhi*
Dr. Utpal Baruah Principal Scientist (Geography) and Head	:	*Regional Centre, Jorhat*
Dr. S.K. Singh Principal Scientist (Pedology) and Head	:	*Regional Centre, Kolkata*
Dr. R.L. Shyampura Principal Scientist (Pedology) and Head (upto 31.10.2010) **Dr. R.S. Singh** Principal Scientist (Pedology) and Head (w.e.f. 1.11.2010)	:	*Regional Centre, Udaipur*
Dr. (Mrs) C. Mandal Principal Scientist (Geography) and In-charge	:	*Cartography Unit*
Dr. G.P. Obi Reddy Senior Scientist and In-charge	:	*Geographical Information System Unit (GIS)*
Dr. P. Chandran Principal Scientist (Pedology) and In-charge	:	*Research Coordination and Monitoring Unit (RCMU)*
Sh. G.R. Deshmukh Technical Officer(T-9) and In-charge	:	*Library and Documentation Unit*
Dr. N.C. Khandare Technical Officer (T-9) and In-charge	:	*Sale and Publication Unit*
Sh. S.K. Arora Printing Officer (T-9) and Incharge	:	*Printing Section*
Sh. B.D. Phansal Chief Administrative Officer	:	*Administration*
Sh. O.P. Nagar Senior Finance and Accounts Officer	:	*Finance and Accounts*
Mrs. Bhanu Narayanan Administrative Officer (w.e.f. from 7.2.2011)	:	*Administration*

- +Agro-ecological Assessment of Soil Resources of Rajasthan for Land Use Planning, NBSS Publ.81, 2000.
- +Soil Erosion in Maharashtra, NBSS Publ.82, 2000.
- +Significance of Minerals in Soil Environment of India, NBSS Review Series-1, 2000.
- +Climate Change and Polygenesis in Vertisols of the Purna Valley (Maharashtra) and Their Management, NBSS Publ.83, 2000.
- +A Decade of GIS Aided Research – Highlights, NBSS Publ.84, 2001.
- +Soil Series of Chhatisgarh State, NBSS Publ.85, 2001.
- +Soil Resource Atlas of Betul District (M.P.), NBSS Publ.86, 2001.
- +Soil Based Agro-Technology Transfer in Sukli (Distt. Nagpur), NBSS Publ.87, 2001.
- +Soils of Hugli District for Optimising Land Use, NBSS Publ.88, 2001.
- +Soil Series of West Bengal, NBSS Publ.89, 2001.
- +Soil Resource Atlas of Dhar Dist. (M.P.), NBSS Publ.90, 2001, 100p, ISBN:81-85460-68X.
- #Soil Series of Himachal Pradesh, NBSS Publ.91, ISBN: 81-85460-69-8.
- +Soil Series of Goa, NBSS Publ.92, ISBN:81-85460-70-1.
- +Soil Resource Atlas of Ratlam Distt. (M.P.), NBSS Publ.93.
- +Soils of India, (1:1 M Scale, 11 Sheets Maps) NBSS Publ.94, ISBN:81-85460-72-8.
- +Soil Resource Atlas of Bilaspur Distt. (Chhattisgarh), NBSS Publ.95. ISBN:81-85460-73-6.
- +Soil Series of Rajasthan, NBSS Publ.96. ISBN:81-85460-75-2.
- +Soil Erosion of Tripura: A model for soil conservation and crop performance, NBSS Publ.97. ISBN:81-85460-76-0.
- +Soil Series of Bihar, NBSS Publ.98. ISBN:81-85460-77-9.
- +Soils of Ajmer district for optimising land use. NBSS Publ.99. ISBN:81-85460-78-7.
- +Soil Resource Atlas of Chhindwara Distt. (M.P.), NBSS Publ.100. ISBN:81-85460-79-5.
- +Soil Series of Assam. NBSS Publ.101.
- +Soil Erosion of Rajasthan. NBSS Publ.102. ISBN:81-85460-80-9
- +Soil Erosion of Chhattisgarh. NBSS Publ.103. ISBN:81-85460-81-7
- +Soil Resource Atlas of Jadgalpur (Baster) Distt. (Chhattisgarh). NBSS Publ.104.ISBN:81-85460-82-5
- +Soil Series of Sikkim. NBSS Publ.105.ISBN:81-85460-83-3
- +Soil Erosion: Madhya Pradesh. NBSS Publ.106.ISBN:81-85460-84-1
- +Soil Resource atlas of Jorhat Distt.(Assam). NBSS Publ.107. ISBN:81-85460-85-x
- +Salt affected soils, Etah Distt. (UP). NBSS Publ.108. ISBN:81-85460-86-8
- +Soil series of Nagaland. NBSS Publ.109.ISBN:81-85460-87-6
- #Soil Resource Information & land use planning of Chhattisgarh. NBSS Publ. 110.ISBN:81-85460-88-4
- +Soil Series of Tripura. NBBS Publ. 111.ISBN:81-85460-89-2
- +Soil Series of Delhi. NBSS Publ. 112.ISBN:81-85460-91-4
- +Land use planning of Udaipur distt. Soil resource & agro-ecological assessment. NBSS Publ. 113.ISBN:81-85460-92-2
- +Soil Erosion in Andhra Pradesh. NBSS Publ. 114.ISBN:81-85460-93-0
- #Economic land evaluation for sustainable land management of Rajanukunte watershed, Karnataka. NBSS Publ. 115. ISBN:81-85460-94-9
- +Soil resource atlas of Wardha distt. Maharashtra. NBSS Publ. 116. ISBN:81-85460-95-7
- +Soil Erosion of West Bengal. NBSS Publ. 117.ISBN:81-85460-96-5
- +Soil Erosion of Assam. NBSS Publ. 118.ISBN:81-85460-97-3
- +Soil Series of Orrisa. NBSS Publ. 119.ISBN:81-85460-98-1
- +Soil Series of Gujarat. NBSS Publ. 120.ISBN:81-85460-99-X
- +Soil Series of Meghalaya. NBSS Publ. 121.ISBN:81-89043-00-5
- +Soil Resources of Jalna District (Maharashtra) for optimising land use. NBSS Publ. 122. ISBN:81-89043-01-3
- #Soil Resource for land use planning, Meerut district (U.P.) NBSS Publ. 123. ISBN:81-89043-02-1
- +Soil Reource for land use planning, Etah district (U.P.) NBSS Publ. 124. ISBN:81-89043-03-X
- +Soil Erosion of Bihar, NBSS Publ. 125. ISBN:81-89043-04-8.
- +Soil Erosion of Orissa, NBSS Publ. 126. ISBN:81-89043-05-6.
- +Soil Series of Medak district, Andhra Pradesh, NBSS Publ. 127. ISBN:81-89043-06-4.
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