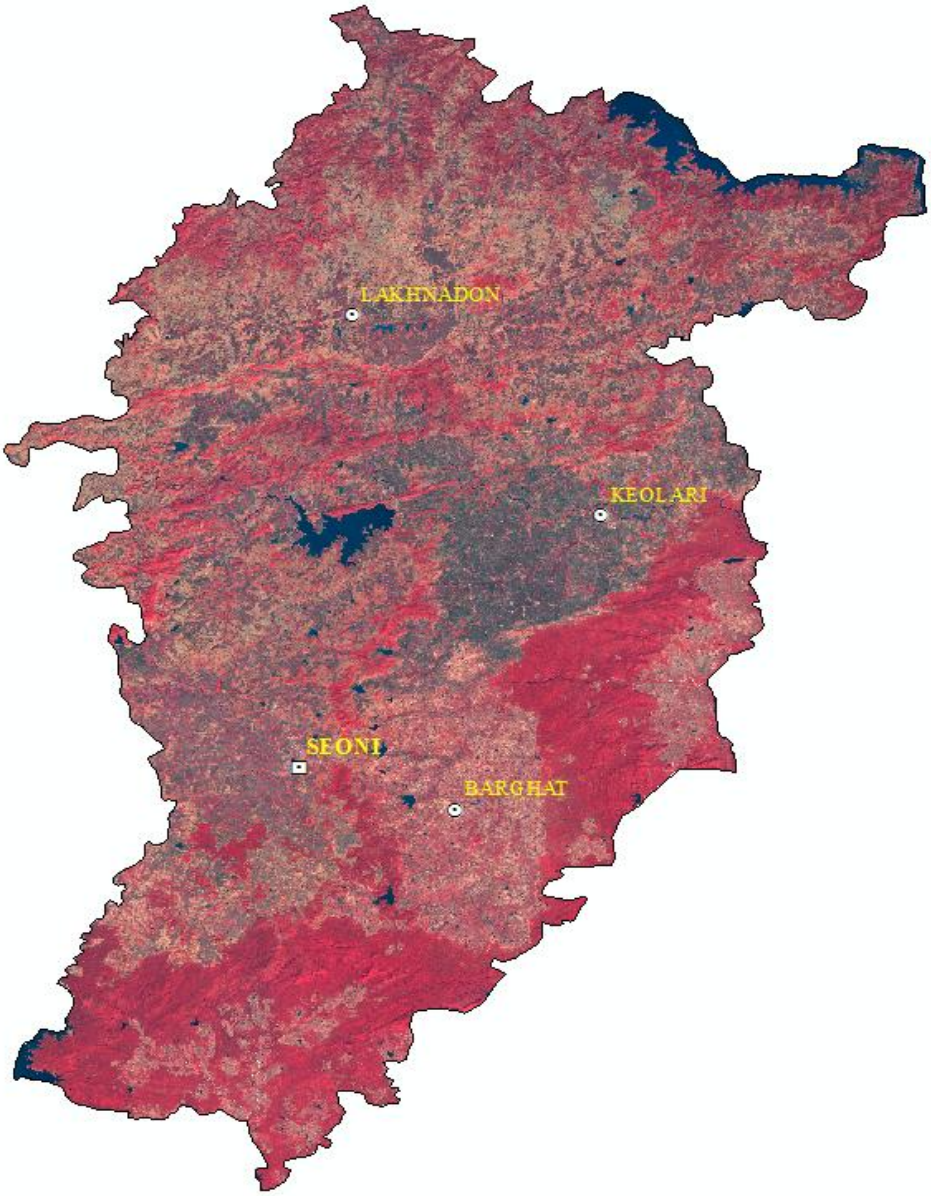
REPORT NO.1020

SOIL RESOURCE INVENTORY FOR LAND USE PLANNING IN SEONI DISTRICT

MADHYA PRADESH



National Bureau of Soil Survey & Land Use Planning

(Indian Council of Agricultural Research)

Nagpur - 440 033, Maharashtra, India

The National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur, a primer Institute of the Indian Council of Agricultural Research (ICAR), was set up in the year1976 with the objective to prepare soil resource maps at state and district level and to provide research inputs in the soil resource mapping and its applications, land evaluation, land use planning ,land resource management and database management using GIS for optimizing land use on different kinds of soils in the country.

The Bureau has been engaged in carrying out agro-ecological and soil degradation mapping at the country, state and district level for qualitative assessment and monitoring the soil health towards viable land use planning. The research activities resulted in identifying the soil potentials and problems and the various applications of the soil survey with the ultimate objectives of sustainable agriculture development. The Bureau has the mandate to correlate and classify soils of the country and maintain National Register of all the established soil series. The institute is also imparting in-service training to staff of the soil survey agencies in the area of Soil Survey, Land evaluation and Soil Survey Interpretation for Land Use Planning. The Bureau in collaboration with Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Dr. P.D.K.V.), Akola is running postgraduate, teaching and research programme in land resource management.

The publication on “Soil Resource Inventory for Land Use planning of Seoni District, Madhya Pradesh” is outcome soil survey programmes in the district. This publication will certainly help in providing wealth of information on soils, their problems and potentials for sustainable land use plans and management requirements.

Citation: D.B. Tamgadge, B.P. Bhaskar, S.R. Singh, S.V. Bobade, M.S. Gaikwad and S.S. Gaikwad (2008). Soil Resource Inventory for Land Use Planning in Seoni District, Madhya Pradesh. Technical Report No. 1020, NBSS&LUP, Nagpur, pp. 154.

TO OBTAIN COPIES OF THIS REPORT,

Please write to:

Director, National Bureau of Soil Survey and Land Use Planning (NBSS&LUP),

Amravati Road, NAGPUR-440 033, India.

Phone : (0712)2500386, 2500664, 2500545 (O), 284631, 284804 (R)

Telefax : +91-0712-2500534

Telegram : SOILANDBRU

E-Mail : director@nbsslup.emet.in

OR

Head, Soil Survey Unit, National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Soil Survey Unit, Amravati Road, Nagpur-440010.

Phone : (0712)-2471421

Telefax : (0712)-2471326

Telegram : SOILCORE

FOREWORD

The challenges ahead in tropical agriculture will be to keep in face with ever increasing demand for food to feed increasing population against the declining soil fertility, per head availability of land and mismanagement of plant nutrients. For sustainable crop yields, it is imperate to develop technologies that maximizes rainfall use efficiency and sustainable land management.

The soil resource inventory programmes are primarily aim at generating enormous data base for designing strategies for agro technology transfer based on analogy of soils. The soil surveys provide scientific needs based on understanding of soil-land scape relations and utilitarian aspects of deriving spatial pattern of soils for land use interpretations. The National Bureau of Soil Survey and Land Use Planning organization is engaged in generating soil maps of different states on 1:250000 scale, of districts at 1:50000 scale and of watersheds/villages/farms on 1:10000/1:5000 scales.

The present publication on **"Soil Resource Inventory for Land Use Planning of Seoni District, Madhya Pradesh"**, is having immense value for land users /managers to aware of different kinds, extent, distribution pattern of soils with respect to their environmental settings, delineated land suitability for agricultural crops and their fertility status for nutrient management plans.

I, personally appreciate Dr. Dipak Sarkar, Director, NBSS&LUP; Dr. Sita Ram Singh, Head, Soil Survey Unit; Dr. B.P. Bhaskar, Senior Scientist, Soil Survey Unit and his team for their efforts in bringing out this publication for the benefit of local agencies involved in land evaluation programmes and to motivate farmers in adopting soil conservation and land evaluation programmes at farm level.

(Dr. A.K. SINGH)

Dy. Director General (NRM)

ICAR, Krishi Bhavan,

New Delhi-110 012

PREFACE

The successful tropical agriculture demands for information and interpretation as the livelihood issues related to land are in focus of the day due to declaration of special economic zones made a way for encroaching cultivable land for extending urban agglomerations and development of infrastructure. This results in hike of prices of land to dizzy heights and farmers are tempted to sale their land. This is becoming a big challenge to improve agriculture and to ensure food sufficiency for the survival of growing population and bad management of soils. The wealth of soil information is needed to educate farmers how to enrich land and monitor changes in character of soil when put to use in different crops. The chances of expanding area under low cost irrigation systems to increase yield is limited in the present scenario. The sustainable strategies must include an integrated approach to maintain soil fertility, promotion of vegetative cover and more productive use of organic nutrients.

The publication on **"Soil Resource Inventory for Land Use Planning of Seoni district, Madhya Pradesh"** mainly deals with geographical distribution of soils, describe characteristics of soils in a given area, classify the soils according to a standard system of classification, plot the boundaries of soils on a map and made predictions about behaviour of soils. The soil map was generated with thirty soil mapping units and evaluated their suitability for sorghum, cotton, soybean, rice and other crops and estimated fertility status of these soils for recommendations.

I appreciate the efforts of Dr. B.P. Bhaskar and his team in bringing out this publication in time. I hope this soil resource database of Seoni district is helpful to local land users/managers to workout "pilots" in land evaluation programme at regional level.

(Dipak Sarkar)

Director

NBSS&LUP, Nagpur

CONTRIBUTORS

A.K. Maji **K.S. Gajbhiye**	: Planning, Coordination and Editing of report
D.B. Tamgadge **B.P. Bhaskar**	**:** Supervision of fieldwork, classification, correlation of soil series, fmalisation of maps and report.
S.R. Singh	**:** General guidance for mapping
M.S. Gaikwad **S.V. Bobade** **S.S. Gaikwad**	**:** Supervision and mapping, compilation of data, writing of draft report, preparation of thematic maps
K.M. Gaikwad **S.B. Bhagat** **S.N. Nandeshwar**	**:** Assistance during field work
S.G. Anantwar **Mrs. S.V. Patil** **R.K. BhalSagar** **S.G. Khapekar**	**:** Laboratory characterisation
N.M. Ramteke **Mrs. U.P. Tijare** **T.L. Khobragade**	**:** Cartographic work
M.M. Khan	**:** Word processing and DTP setting.

ACKNOWLEDGEMENTS

The authors hereby acknowledge the support, co-operation and encouragement from the following officers in brining out the Soil Survey Report of Seoni District, Madhya Pradesh.

- Dr. Dipak Sarkar, Director, NBSS&LUP, Nagpur for providing facilities, suggestions and encouragement for preparing soil survey report.

- Dr. A.K. Maji, Head, Division of Remote Sensing Applications, NBSS&LUP, Nagpur for providing facilities to prepare report, for necessary help during field survey and for his useful suggestions given in finalization of report.

- Dr. S.R. Singh, Incharge, Soil Survey Unit, NBSS&LUP, Nagpur, for assigning the Seoni report and his support in preparing maps for the report.

- Dr. Sohan Lal, Principal Scientist and Incharge Technical Cell, NBSS&LUP, Nagpur for his valuable suggestions and editing of report.

- Shri Rakesh Kumar, Sr. Administrative Officer for administrative help during field investigation.

- Shri P. N. Singh, Sr. Finance & Accounts Officer for timely financial support to the field parties.

- Dr A.P. Nagar, Technical Officer deputed as trainee in soil survey party and for his help.

- Dr A.P. Nagar, Shri S.S. Nimkhedkar and Shri M. C. Patre for providing technical support.

- Shri N.M. Ramteke, Smt. Ujwala Tijare and Shri T.L. Khobragade for cartographic work.

- Shri Prakash Ambekar for designing cover page.

- Dr B.P. Bhaskar, Shri S. V. Bobade Shri S.S. Gaikwad, Shri R.K. Bhalsagar for word processing the report.

- Shri M.M. Khan for DTP setting the report.

- Shri G.B. Topare and Shri A.Z. Sarode for multiplying the copies of the report and maps.

- Shri S.K. Arora, Incharge Printing Section, NBSS&LUP, New Delhi and his association for printing this report.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Meta Data for Seoni District, Madhya Pradesh

Sr.No.	Elements	Scheme	Value
1.	Identification Information	Name of the Dataset	Soils Resource Inventory for Land Use Planning of Seoni District, (Madhya Pradesh)
		Contents	Soil Survey Reports, Maps and Imagery
		Keywords	Soil Survey Report
		Report/Map Language	English
		Map Scale	1:50000
		Survey Year	2003-2005
		Imprint Year	-
		Edit Year	-
		Value-addition Year	2013
		Purpose of Value-addition	To Create Interactive Maps and Reports and Disseminate to the End-User Agencies.
		Access Constraints	Permission Required
		Use Constraints	Permission Required
2.	Contact Information	Generating Agency	NBSS & LUP, Nagpur
		Contact Person	Director, NBSS & LUP, Nagpur
		Mailing Address	National Bureau of Soil Survey & Land Use Planning Sankar Nagar P.O. Amarabati Road, Nagpur - 440 033 Maharashtra, India
		City/Locality	Nagpur, Amarabati Road
		Country	India
		Contact Telephone	+91- 712- 2500386, 2500545
		Contact Fax	+91- 712- 2500534
		Contact Email	director@nbsslup.ernet.in
3.	Spatial Domain	Bound Left	79°12' E
		Bound Right	80°17' E
		Bound Top	22°57' N
		Bound Bottom	21°36' N
		Area/Coverage	
		Projection	UTM
		Datum	WGS 1984
		Unit	Meter
		Administrative Location	State: Madhya Pradesh, District: Seoni
4.	Citation	Data Prepared By	NBSS & LUP, Nagpur (Regional Centre)
		Associated Project	Dr. B.P. Bhaskar&D.B. Tamgadge
		Associated Value- additions	-
		Associated Publications	-
		Coordinator Value- added Publication	-
5.	Storage	Data Format	PDF/GeoPDF
		Data File Size	
		Data Physical Location	\\GIST6\D:\GeoPDF Mapping Project _2013\Seoni
		Download Location	-
6.	Quicklook	Graphic file in jpg format	Y
7.	Image Data	Name of the Satellite	Landsat
		Sensor	ETM+
		Date of Image	15 February 2002 and 29 October 2002
		File Format	TIFF
		Spatial Resolution	30 m
		Image Downloaded From	http://earthexplorer.usgs.gov/
		Credit	USGS
8.	Rights	Copyright	NBSS & LUP, Nagpur
		Distributor Contact	Director, NBSS & LUP, Nagpur

EXECUTIVE SUMMARY

The soil resource inventory in Seoni district involves the assessment of soil morphological features that can be readily interpreted for management requirements. In general, soil surveys are more cost effective in generating spatial pattern of soil bodies to external features for easy mapping over entire landscapes and in predicting by combinations of geomorphology, vegetation, current land use and historical records. The complexity of soil pattern determines the amount of details that can be shown at particular scale of observations. In soil surveys, soils are mapped based on concept that soil is the result of interaction of its environment.

The total geographical area is 8758 sq.km covering 21 toposheets on 1:50000 scale. The Seoni name is derived from a spicy tree named seona dominant in the area and was used to make dholak. The district as a whole lies on a section of the Satpura plateau covering its whole width from south to north. The general heights of the plateau is about 550 m from the mean sea level and lowers down towards the east. It marks the hill ranges along the southern scarps but plateaus are mostly crowded with the hill features along the north western boundary. The district is divided into five natural divisions:

1. **Lakhanadon** plateau

2. Upper Wainganga valley

3. The valley of **Sagar** and Hirvi River

4. The lower Wainganga valley and

5. The southern Lowland.

The climate is dry sub-humid with rainfall of 1385 mm (SW monsoon). Geologically, the district comprises of Tirodi Biotite Gneiss (TBG) and Supracrustal Sausar Group (SSG) in the south-eastern part while major parts are covered with Deccan Traps with few outcrops of lameta, intertrappean beds, laterite cappings and alluvium ranging in age from Meso-Proterozoic to Recent.

A reconnaissance soil survey in Seoni district (21°36' to 22°57' N lat. and 79°12' to 80°17' E long.) was conducted on 1:50000 scale with the objectives of:-

(i) to generate soil map on 1:50000 scale and

(ii) to evaluate soil mapping units for land use plans and fertility assessments.

The analytical free survey approach was used to separate landscapes into natural soil bodies and then characterize the resulting units by sampling. Fourteen landform units were delineated where in upper and lower denudational plateaus cover 37 percent of total area. The fieldwork includes delineation of land form units using toposheets and geological maps of the study area. The soil profiles are studied at intervals of 3 to 6 km or shorter intervals depending upon the soil heterogeneity. The morphological properties of 568 soil profiles occurring on Deccan traps and 383 profiles on granite were recorded. The soils were correlated and identified thirty soil series. Out of thirty, seventeen series occurred on basalt:- **Nadora** (Nd), Khamariya (Ky), **Parasia** (Pa), Chunamati (Ch), Gorakhpur (Go), Arandiya (Ar), Bhimgarh (Bg), Jamunpani (Jp), **Dhenka** (Dk), Chhui (Cu), **Kharsaru** (Kh), **Atari** (At), Masanbarra (Ma), Paddikona (Pd), Luhgsa (Lu), **Sagar** (Sa), **Pipariya** (Pr)) and thirteen series in granite landforms:- **Kanera** (Kn), **Kodajhiri** (Ko), Silghat (Si), **Dhora** (Dh), **Gondatola** (GL), **Jamuntola** (Jm), **Tarali** (Ta), **Khawasa** (Kw), **Pratappur** (Pt), **Rukhad** (Rk), **Sukla** (Sk), **Lakhanadon** (Lk) and **Bisapur** (Bs). These soils were classified in the subgroups of*Entisols*, *Inceptisols*, *Vertisols* and *Alfisols*. ***Dhora***, ***Kanera***, ***Jamuntola*** and *Parasiya* soil series were classified in the subgroups of *Lithic Ustorthents* while **Sukla** series is classified as *Typic Ustorthents*. Masanbarra, **Rukhad**, **Bisapur**, **Khawasa** and

Sagar series with cambic horizons were classified as Typic Haplustepts while Atari series was classified as Vertic Haplustepts, Pipariya, Khamariya and Gorakhpur series as Lithic Haplustepts, Silghat and Lakhanadon series as Dystric Haplustepts and Chhui series as Typic Epiaquepts. The deep, moderately well drained subgroups of Vertisols on Deccan Traps are: - Nodara, Paddikona and Tarali as Typic Haplusterts, Kodajhiri, Lungsa and Bhimgarh series as Ustic Eapiaquerts, and Kharsaru, Dhenka and Jamunpani series as Us tic Epiaquerts. The advanced weathering of rocks in southern hills produced 'typical' tropical soils: red in colour and strongly leached with high base status were classified in the subgroups of Alfisols: - Gondatola as Typic Rhodustalfs, Pratappur and Arandiya series as Udic Haplustalfs and Chunamati as Typic Haplustalfs.

Out of thirty units, nineteen units were under basaltic land forms, remaining eleven units occurred in granitic land forms. The dominant soil mapping units in basaltic land forms were Parasia-Pipariya-Khamariya with rock outcrops (104446.64 ha, 11.92 percent) and Sagar-Paddikona-Khamariya-Parasia (93840 ha, 10.71 percent) where as Khawasa-Sukla-Tarali (56268.lha, 6.42 percent) and Khawasa-Lungsa-Lakhanadon (55279.7 ha, 6.31 percent) on granitic landforms. Thirty soil mapping units defined in terms of soil series association were used for generation soil map and soil survey interpretations for land use and fertility capability.

The eleven land use zones were delineated based on soil site suitability analysis where in arable land is only 57.2 percent. In arable lands, 12 percent of land is suitable for citrus + sorghum + soybean cropping systems while 19 percent is suitable for sorghum + cotton. The allocation of land suitable for wild life and forestry was estimated as 43.8 percent which is in agreement with existing semi-moist forest (l/3rd of total). The high shrink swell soils in northern plateaus (38.71 percent) has potential deficiency of P, K and Zn while loamy or sandy soils in southern hills have low water holding capacity, rapid infiltration and low available K and Zn status. The soils with hard root restricting layers were confined to escarpments, upper plateaus in northern parts and laterite plateaux in southern parts of the district (15.8% of total area). The land resource inventory in the district had clearly brought out the allocation of land, based on soil-site information, for different categories of land use, to identify the fertility constraints and potentials to enhance productivity of local crops. This data base is useful for exchanging soil management information among closely related soils for technology transfer by analogy. The thematic maps related to fertility and land use is helpful for designing land related schemes for agro-forestry development at local level.

1. INTRODUCTION

Soil surveys are basically aimed at providing information about soils, their characteristics and spatial pattern in the given the area. These surveys are made by examining, describing and classifying soils in the field and delineating their areas on maps. The objectives of surveys are both fundamental and applied in nature. The fundamental aspects of survey includes genesis, classification and nomenclature of soils and applied part includes soil data interpretations for use in agriculture, pasture development, forestry and other related subjects like engineering, urban development and recreation. This data base is used for development of land use plans and for analysing fertility potentials of soils for enhancing productivity of locally grown crops. The integration of soil survey information with soil-test crop responses to fertilizer applications under different soil types defined in terms of soil series is useful for judging crop suitability and management levels.

The third order surveys employed in this study are made for land uses that do not require precise knowledge of small areas or detailed information. The field procedures permit verification of boundaries at some field observations. The soils are identified by traversing representative areas and applying information to like areas. Map units include associations, complexes, consociations and undifferentiated groups. The interpretation these units involves the following steps (i) assembling information about the soils and landscapes in which they occur (ii) modelling other necessary soil characteristics from the soil data (iii) deriving inferences, rules and guides for predicting soil behaviour under specific land uses and (iv)integrating these predictions into generalizations for the map unit.

The most generally applied soil management groups are the land capability classification system for fanning and recently defined management groups include fertility classification system. The land capability is primarily based on inherent soil characteristics, external land features and environmental factors that limit land use. The capability grouping is another aspect of survey work closely related to soil correlation which afford specific information about ability of soils to respond to use, management and crop suitability. Fertility capability classification (FCC) is the first technical classification system that groups soils according to their fertility constraints in a quantitative manner. The fertility capability units are derived and defined by modifiers for each mapping unit can lead to the quantification of land qualities in physical terms related to productivity or plant growth. In the present investigation, the Seoni district, a backward and largely inhabited by tribal communities, is selected. The record of famine that gripped the district is briefly given. In1819, severe distress prevailed and recorded that people sold their children and instances were known of human flesh having been consumed. Similarly in 1823-1827, in 1833-34, in 1892-93 and in 1899. The record of famine in the district clearly shows that crop failures are common and recurring phenomenon. It forms one of the priority area in the state for planning and developmental activities.

Soil resource inventory of Seoni district of Madhya Pradesh was conducted at the scale of 1:50,000 during 2003-2005 field seasons with the following objectives.

- To generate soil map on a scale of 1:50,000.
- To characterise the soils and delineate their boundaries and extent.
- To identify the soil series and classify them according to USDA Soil Taxonomy.
- To evaluate soil problems/potentials and interpretation of soil -site data for land use planning.
- To generate thematic maps for use by planners, researchers, administrators, policy makers and extension workers.

1.1 Location and Extent

The Seoni has the origin from the word Seona (Gundina arborea) a spicy of tree belonging to the verbena leal family commonly found in this area. The wood of this tree is specially used for making trumpet (Dholak). Seoni, one of the sounthern districts of Madhya Pradesh, is located between 21°35' to 22°58’ N latitude and 79°12' to 81°18’ E longitude. This district covers 8752 sq.km. It was formed as a separate district after the annexation of this tract to the British Territory in 1818. Later in December 1931, Seoni district was abolished and annexed to Chhindwara district. Seoni was reborn as a district after the formation of new state of Madhya Pradesh on 1st November, 1956. It is bordered by Jabalpur, Narsinghpur and Mandla districts in North, Balaght in East, Chhindawara in West and Nagpur district of Maharashtra, in South (Fig.l).

1.2. Geology

Seoni is a part of ENE-WSE trending Central Indian Tectonic Zone (CITZ) limited by Sone-Narmada South Fault (SNSF) in the north and Central India Suture (CIS) in the north and Central India Suture (CIS) in the south, while Tan Shear Zone (TSZ) is located midway between the two. Geologically, the district comprises of Tirodi Biotite Gneiss (TBG) and Supracrustal Sausar Group (SSG) in the south eastern parts while major parts are covered with Deccan Traps with few outcrops of lameta, intertrappean beds, laterite cappings and alluvium ranging in age from Meso-Proterozoic to Recent. TBG forms the base mand of the Sausar Supracrustal and comprises grey stromatic and/or streaky gneisses with enclaves of high grade metamorphites, pink gneiss with migmatites and amphibolites. SSG is represented by Lohangi Fm, Mansar Fm, Chorbaoli Fm, Bichua Fm. Lithologically, cratonic assemblage consists of metamorphosed quartzite, pelites and carbonate and intrusive syntectonic strongly foliated granite and post-tectonic massive granite. The basement-cover contact was largely obliterated due to intense shearing and /or migmatitic foliation of TBG.

Late cretaceous (Maestrichtian) strata includes the Lameta Group occurring as thin bands and discontinuous patches in the south-eastern parts of the area. These are represented by cherts, cherty modular limestone, variegated clay and shale, deposited in a lacustrine environment,

Along the eastern margin, the Deccan Traps overlie the Lameta sediments and along the southern margin, they are found above gneisses. The cumulative lava pile (430 m) comprise twenty four number of flows which are classified under Amarkantak group. Based on the variation in lithological, textural and physical characteristics, the group is divided into formations such as Mandla, Dhuma, Pipardahi, Linga, Multai, Amarwara and Khamla formations. The thickness of individual flow varies from 5 m to 30 m. The basalt flows are traversed by basic dykes and are separated by wide spread persistent/impersistant fossiliferrous to non-fossiliferrous inter-trappeans. Extensive laterite cappings of varied thickness between 10 to 40 m on flow tops are exposed over an area of 100 sq.km. around Batwri, Amarpur and Chhiriya. The laterite of Kareligarh hill is a capping over boitite gneiss and extends in a NNE-SSW direction of about 3 km length and the width is around 300 m. The average thickness of laterite capping in this locality is about 70 m. The brief description of lithology and characteristics is presented in Table 1.

LOCATION MAP

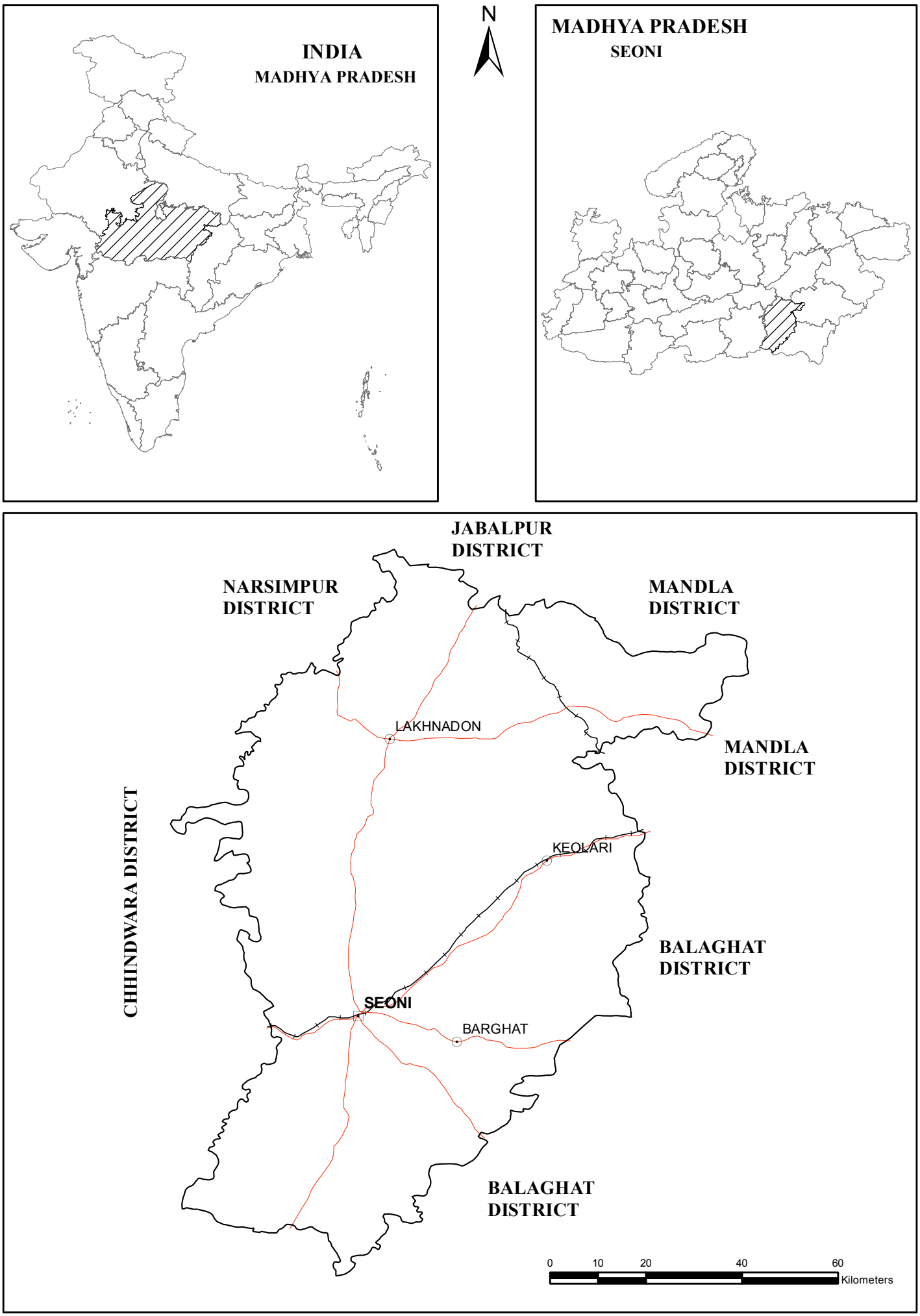


Fig. 1: Location Map

Table 1. Lithology, group and age with its nature and characteristics

Lithology	Strtigraphic status	Group	Age	Nature and characteristics
Alluvium			Quaternary	Soft and unconsolidated sediments
Laterite				Medium to hard, brick red to yellowish brown, ferruginous, consolidated rock
Basic Dykes			Cainozoic	Dark grey, fine to medium grained, hard, compact massive rock
Four basaltic lave flows, simple and compound pahoehoe flows with megacryst flow unit	Khamla Fm	Amarkantak (Deccan trap)	Upper cretaceous to Palaeogene	Dark grey, fine to medium, hard, compact, massive, non-porphyritic to moderately porphyritic
Five to seven simple and compound pahoehoe flowswith megacrystflow at base	Amarward Fm			Dark grey, fine grained hard, compact, massive, non-porphyritic to porphyritic
Two basaltic flows, simple to compound pahoehoe type	Multai Fm			Dark grey, medium grained hard, compact, massive, mega porphyritic in nature
Four basaltic flows , simple to compound type	Linga Fm			Dark grey, fine to medium grained hard , compact, massive, moderately to highly porphyritic:
Two simple basaltic flows	Pipardhi Fm			Dark grey, fine grained hard , compact, massive, ono porphyritic to sparsely porphyritic
Eight basaltic flows, simple and compound, pahoehoe flows with megacrys flow unit	Dhuma Fm		Upper Cretaceous to Palaeogene	Dark grey, fine to medium grained hard , compact, massive, porphyritic in nature
Four basaltic flows, simple to compound pahoehoe flows with megacryst flow unit	MandlaFm			Dark grey, fine to medium grained hard, compact, massive, and moderately to sparsely porphyritic.
Simple and compound basaltic flows	Unclassified	Amarkantak (Deccan trap)		Dark grey, fine grained hard , compact, massive and amygdalodal
Chert, cherty limestone and shale	Intertrappean			
Chert, cherty nodular limestone, variegated clay and shale	Lameta group		Late Cretaceous (Maestrichtian)	Hard, laminated and friable rocks
Granite	Intrusive		Late Meso Proterozoic	Hard, compact, massive porphytic rocks
Foliated granite	Intrusive			Hard, Compact, Foliated rock
Crystalline limestone anddolomite	Bichua Fm			Hard and compact rocks
Muscovite-biotitic schistband quartzitic biotitegranite	Junewani Fm			Soft and flaky rocks, hard and compact rocks
Quartzites and quartze muscovite schist'	Chorboli Fm			Hard and flaky rocks
Muscovite-biotite schist	Mansar Fm	Sausar group	Meso Proterozoic	Soft and flaky rocks
Calc-silicate rocks	Lohangi Fm			Hard and flaky rocks
Grey stromatic and/or streaky gneiss with enclaves of high grade metemorphites/pink gneisswith migmatite/Amphibolites	Tirodi Biotite gneiss			Hard and compact , foliated and banded rocks/hard and compact banded, foliated to massive pink megacrystic K.- feldspar bearing rocks, Hard and compact, dark greenish grey, massive to moderately foliated rocks

1.3 Drainage System

The drainage of the district forms parts of the Narmada and the Wainganga river systems. Narmada occupies about a quarter of the area in the north and the Wainganga occupies about three quarters of the area in the south. The main water dividing lines run from west to east.

The Narmada: This is a westward flowing primary river which forms the north-eastern boundary of the district. It rises from Amarkantak hills in the Shahdol district on the Maikal ranges. It flows through Satpura hills in a zigzag manner and forms the boundary between Seoni and Mandla district. The total length of the river is 1290 km of which a section about 35 km lies along the district boundary.

The Sher: The Sher river rises at Batka 7 km south-east of **Lakhanadon** and flows to the north east. It is joined by the Gurha, the **Kanera**, the Macharewa, the Berurewa and Umar belore it joins the Narmada at Ratikarar in Narsinghpur. Its total length is 113 km.

The Wainganga: The Wainganga is the most important river of the district. It rises from the hill above **Pratappur**. It forms a semicircular course in the district flowing first to the north, bending east and finally to the south along the south eastern boundary. The river flows on a lower plain along the Seoni-Balaghat boundary.

1.4. Climate

The climate of the district is monsoon type with four district seasons starting winter during December to February, summer from March to middle of June, rainy from June to September and retreating monsoon from October to November.

The annual rainfall is 1384.5 mm with variations of 1269.9 mm at **Lakhanadon** to 1474.2 mm at Keolari (Table 2). On an average, there are 69 rainy days (i.e. days with rainfall of 2.5 mm, 10 percent or more) in a year. About 85 percent of the annual rainfall is received during June to September. In the 50 year period from 1901 to 1950, the highest annual rainfall amounting to 132 percent of the normal occurred in 1933. The year 1902 received the lowest annual rainfall which was 60 percent of the normal. The annual rainfall was between 1100 and 1600 mm in 37 years out of 50 years. Temperature begins to rise steadily from about the end of February. May is generally the hottest month with the mean daily maximum temperature at 39.9°C and the mean daily minimum at 24.8°C. The weather in the period April to mid-June is oppressively hot with the maximum temperature on individual days, sometimes reaching 43°C and above. December is the coldest month with the mean daily maximum at 25.5°C and the mean daily minimum at 10.4°C (Table 3). Cold waves in association with passing western disturbances affect the district occasionally during the cold season. The minimum temperature on such occasions drop down to about 3°C. The highest maximum temperature recorded at Seoni was 45.0°C on 9 June, 1942. The lowest minimum was 2.8°C recorded on 7 January, 1937. The soil moisture regime is ustic and temperature regime of hyperthermic.

Table 2.TehsiI wise rainfall (mm) for the period of 1999 to 2003

Tehsil	Rainfall (mm)				
	1999-2000	2000-2001	2001-2002	2002-2003	Average
Seoni	1157.7	900.4	927	1506.7	920
Kurai	1079.0	852.0	1221.0	1275.0	1505
Lakhanadon	1404.0	947.0	915.2	1101.0	1152
Chhapara	1428.8	829.4	1084.6	1440.0	1195.7
Ghansor	776.0	1259.1	625.4	1138.6	970.6
Dhanora	777.8	1259.1	744.4	1184.5	991.45
Keolari	944.	1382.1	1017.6	1192.5	1155.0
Barghat	830.6	1315.2	1506.7	782.8	1109.0

Table 3. Monthly temperature (°C) during 2003

Month	Temperature (°C)			
	Max. average	Max. in a month	Min. average	Min. in a month
January	24.1	27.6	20.6	13.0
February	24.7	29.2	22.0	16.4
March	30.0	34.0	23.3	14.0
April	357	38.0	26.4	20.0
May	38.6	40.6	25.9	18.6
June	32.9	41.6	26.8	23.0
July	27.0	29.8	26.7	24.6
August	26.4	30.2	23.7	23.0
September	25.8	28.4	24.0	22.6
October	26.5	29.6	22.3	18.3
November	25.9	26.9	22.3	19.5
December	22.8	25.3	18.9	14.1

1.5. Natural vegetation

The district is rich in forest wealth especially teak and bamboo. One third (1/3) of the area is covered under the forest. Most of the forest is the tropical dry deciduous mixed teak forest and tropical slightly moist deciduous teak forest. The major forest belt runs from west to east along the hill ranges of the Satpura and south to north along the foot hills of the Seoni town in southern side. The common trees are given below.

Teak	*Tectona grandis*	Bija	*Pterocarous marsupium*
Bamboo	*Dendrocalamus strictus*	Kohu	*Tectona arjuna*
Chandan	*Santalum album*	Jamun	*Syzygium cumini*
Bel	*Aesle marmelos*	Kusum	*Schleichera oleasa*
Panda	*Gardenia latifolia*	Salai	*Boswellia serrata*

Lantana	*Landana aculeate*	Bhirra	*Chloraxylon swietenia*
Chilats	*Acacia pennata*	Kullu	*Sterculla urens*
Saj	*Tectona tomentosa*	Gongal	*Cochlaspermum relisiosum*
Dhaora	*Anageissus latifolia*		

Teak occurs on a variety of geological formations including Archaeans, limestones and sometimes sandstones. But trap appears to be the most favourite associate of teak forest on well drained areas. The wild life consists of Tiger (*Panthera tigris*), Leopards (*Fells paradas*), Wild dogs (*Cuan duichunensis*), Hyaena (*Hyaena straiata*), Jackals (*Canis aurells*), Foxes (*Vulpes benghalensis)*, Bison (*Bihos gaurus*), Sambhar (*Carness unicolor*), Siyal, Chital, Deer and the birds like crow, sparrow, myna, woodpecker and parrot.

1.6 Land utilization

The district has net sown area of 364502 hectares wherein 281255 hectares are in kharif and 179215 hectares under rabi crop (District Statistical Report 2003). The double cropped area is 95968 hectares with irrigation potential of 35.44 percent. The forest cover is 2247.4 km2in the ascending order of Ghansor (14516ha) >Chhapara (12235 ha) >Seoni (8680 ha) (Table 4). The net sown area is high in Seoni tehsil (86957 ha) >Lakahanadon (60811 ha) >Keolari (46603 ha).

Table 4. Tehsil wise Land utilization particulars (ha) in Seoni district

Tehsil	Total geographical area	Forest	Agricultural land not available	Non-agriculture land	Agriculture land	Fallow land	Net sown area	Double cropped area	Gross sown area
Seoni	128659	8680	13513	5441	7290	10828	86957	34439	121396
Kurai	47347	3878	5043	1365	5330	5178	26553	5976	32529
Lakhanadon	111726	15192	8186	3222	5484	18828	60811	9171	69982
Chhapara	68760	12235	9898	1491	3639	6086	35411	12582	47993
Ghansor	77911	14516	5283	2568	6183	9551	39810	55733	45543
Dhanora	50361	4998	3532	1491	2446	7071	30580	6834	37414
Keolari	69411	2253	7321	4071	3459	5704	46603	14187	60790
Barghat	53924	3002	4559	2177	3490	2919	37777	7046	44823

1.7 Population

The total population is 1166608 with a density of 114 persons/sq.km. 89.65 percent of population lives in rural while 10.35 percent in urban areas. The male to female ratio is 1.2 times (Table 5).

Table 5. Population and resource characteristics

Total population	1l,66,608(as per 2001 census)	Literacy (%)	44.49
Male population	507076	Male literacy (%)	
		Female literacy (%)	
Female population	493755	Population density (persons /sq.km)	114
Urban population	120687	Number of Tehsil	06
Rural population	1045921	Number of Blocks	08
Area	8758 sq.km. (924500 ha)	Total number of Villages	1628
		Total No.of Forest villages	29
Area of forest (ha)	327843	Total No.of Un-inhabited villages	14
Net sown area (ha)	3664502	Total No.of inhabited villages	645
Net irrigated area (ha)	45945	Total No.of Gram Panchayat	
Forest (ha)		Ponds	
Land not useful for cultivation (ha)	57335	Tube wells	
		Canals	
Double crop area (ha)	95968	Electric pump	
Total crop area (ha)	460470	Diesel pump	
Kharif crop area (ha)		Tractor	
Rabi crop area (ha)		No. of biogas plant constructed	
Total irrigated area (ha)		No. of Krishi Jot	
Irrigation percentage		Rural Agriculture Development Officer Centre	
No. of irrigation well		Agriculture Development Officer Centre	

1.8 Minerals

The district is endowed with mineral resources as given below.

Minerals	Area
Bauxite	Amargarh, Dulal, Kamkasur, Khapa and Potta
Copper	Antarwani
Gold	Pachdhor and Bavanthadi rivers
Iron	Jatama, Silari
Manganese	Antarwani, Piparwani
Meterite	Piparwani
Mica	Khandasa

2. METHODOLOGY

2.1. Reconnaissance Soil Survey

The Reconnaissance survey procedure (AISLUS, 1971) includes delineation of land forms using toposheets of Survey of India, geology map and soil survey reports in Madhya Pradesh. The land forms include the elements of local sequences of graded erosional land surfaces with respect to local base level contours. The features of physiographic units are usually due to joint product of deep seated forces and complex set of surface processes acted upon a long period of time. The geopedological approach was applied in legend construction and structure of the local physiographic analysis. This approach was used to cover larger areas rapidly by establishing relation between geomorphology and soils. The geoforms are identified at first and defined at landscape level with further subdivision by identifying relief types. The land form map for reconnaissance soil survey on 1:50000 scale covering twenty one toposheets was generated with the delineation of fourteen land forms in basaltic and granitic landscapes of the district. This land form map was used as base map for ground truth, compilation of soil data for generating soil map and other thematic maps (Bridges and Davidson 1982). The boundaries of land units were verified and possibly modified by field investigation. In this approach, the soil surveyor is free to choose sample points to confirm mental model of soil-landscape relationships, draw boundaries and determine mapping unit composition. The soils were identified by traversing representative areas and applying information to like areas. Some additional observations and transects were made for verification. The profiles at intervals of 3 to 6 km or shorter intervals depending upon the soil heterogeneity were studied. The morphological properties of soil profiles were recorded as per Soil Survey Staff (1951) and classified as soil taxonomy (Soil Survey Staff, 1998).

2.2. Soil Series

The lowest category of soil taxonomy and the most basic unit for the most of soil mapping projects. This is also regarded as the largest landscape unit about which all features and characteristics relevant to soil formation are distinguished. Soil series is defined as “a group of soils having soil horizons similar in differentiating characteristics and arrangements within the series control section, except for features of the surface soils and have developed on similar parent material under comparable climate and geomorphic environment”. The differentiae for soil series are mainly the same properties used to define classes in higher categories, but have much narrower ranges. Soil series are used mainly for practical purposes (Sohanlal et al. 1994). These series were described accurately for comparison of series delineations and interpretations. The methodology for correlation of soil series in the field is done as per memorandum on soil correlation (Shankarnarayana et al. 1984). The grouping of soils to identify soil series is done as per outlines given by Reddy et al. (2006). The modal profiles were selected with the help of profile data by comparing the mean/ mode of each morphological properties against thevalues of each profile. The variation in every property may have a maximum deviation of + or - of five percent of the value of a given property.

Profiles showing similar horizontal characters with in narrowly defined limits are grouped together into “series” This is important part of correlating the character of the different profiles studied and fixing the classificational units at series level. The series normally the classification units in which the mapping units in reconnaissance soil surveys were named. The mapping units used generally is the soil associations occurring together in a regularly repeating geographic pattern and delineated by a common boundary. The delineation of soil association boundaries in such surveys was made partly by extrapolation.

2.3. Mapping Units

The mapping units consist of two or three soil series associations. The unit composition comprises of dominant soils represented in delineation by a part of polypedon and is associated with subdominant soils. Several polypedons of components may be represented if map unit consists of two or more dominant components and pattern is such that at least one components is not continuous but occurs as an isolated body. Similarly each inclusion in a delineation is represented by a part of polypedon or several polypedons. The extent is smaller relative to the extent of dominant component. The soil boundaries can seldom be drawn with complete accuracy on soil map with parts and pieces of adjacent polypedon or either included or excluded from delineation.

2.4. Designing Mapping Units

The taxonomic classes provide the basic sets of properties to which the soil map units are defined. They provide the three defined sets of soil properties that have been tested for genetic relationship for interpretative value. Taxa provides a firm base for recognizing the components of potential mapped units in an unfamiliar areas. The names of soil taxa along with one or more modifying terms are used to identical soil series in the map units. For example. Pc (Parasia) - Pd (Paddikona) - Ky (Khamariya).

The kind of mapping units are complex and associations consisting of two or more dissimilar components occurring in the regular repeating pattern. The full total amount of inclusion in the mapping unit that of dissimilarity of any of the major components does not exceed above 15%, if limiting and 25%, if not limiting. A number of inclusions reflect purity of map units (Soil Survey Division Staff ,1995).

2.5. Soil Map

The soils are mapped based on the concept that soil is the result of interaction of its formative environment: S = f (E) generally referred as soil factor equation (Jenny 1961). This equation is generalized to soil landscape paradigm based on the relationships and perceived distribution of soils in landscape units (Hudson 1992).The soil maps have implicit knowledge of how soil types are related with each other and why certain soils are mapped at certain landscape positions. The knowledge embedded in soil maps is useful tofacilitate traditional soil survey updates and for automated soil mapping and classification when soil polypedon boundaries were drawn and implicitly applied multilayer data such as geology, topographic and land use information. The thematic maps on land use plans, fertility capability classification and NPK status were generated through GIS-Arc Info environment. The cartographic generalizations were at 1:250,000 scale.

2.6. Laboratory Analysis

Air dried soil samples passing through 2 mm size sieve was used for laboratory analysis. The particle size analysis was done as per international pipette method described by Sarma et al. (1987) The chemical analysis where in pH, electrical conductivity, organic carbon, calcium carbonate, exchangeable bases and cation exchange capacity were determined as per procedures described by Hesse (1971), Jackson (1973) and Piper (1942). DTPA extractable micronutrients were determined as per Lindsay and Norvell (1978), available N by Subbiah and Asija (1956), P by Olsen et al. (1954) and exchangeable K (Schollenberger and Simon, 1954).

3.
PHYSIOGRAPHY

The Seoni district lies on a section of the Satpura plateau covering 8758 sq.km with elevation of 760 m to 430 m above mean sea level. The plateaus generally lower down towards the east and marks the hill ranges along the southern scarps in Seoni district but the plateaus along north western boundary are crowded with the hills.

The district is divided into five natural divisions such as 1) Lakhanadon plateau, 2) Upper Wainganga valley, 3) The valley of Sagar and Hirvi River, 4) The lower Wainganga valley, and 5) The southern lowland (Guru, 1989).

The Lakhanadon plateau between the Narmada and the Wainganga slopes towards the North with ridges of residual hill stands in between the North flowing tributaries of the Narmada. The Southern hill range starts from the undulating plateaus of Chaurari on Chhindwara district and shoulders the town of Seoni from Mohgaon, known as Kariapahar.

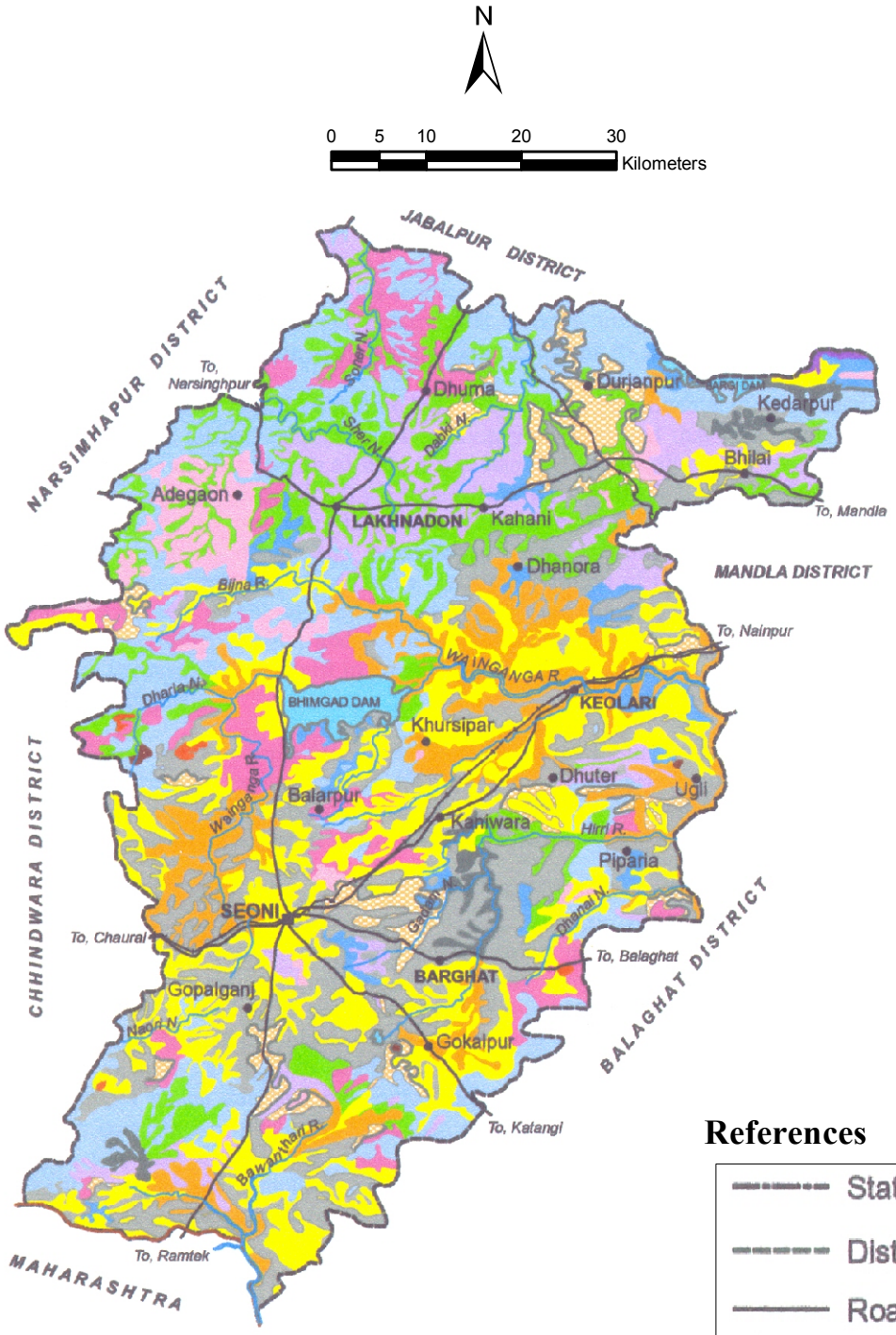
3.1. Extent and Types of Landforms

The landform map for reconnaissance soil survey on 1:50,000 scale covering twenty one toposheets was used to generate the land form of Seoni district. The landforms identified and codified with respect to geology and relief types existing in the area.

Fourteen land forms are delineated and described (Fig.2 & Table 6). The land forms are:

i)	Structural plateaus (2697.92 ha)
(ii)	Middle level plateaus (71594.59 ha)
(iii)	Narrow inter-hill basin (81457.45 ha)
(iv)	Structural hills and ridges (152667.92 ha)
(v)	Undulating plateau (6.85%)
(vi)	Rolling pedilains (6.68%)
(vii&viii)	Upper and lower denudational plateaus (37.22 percent of total area) (ix,x,xi) Steeply sloping denudational escarpments,
(xii,xiii,xiv)	Valleys, Broad interhill basins, gently sloping plains and floodplains (8.91 percent of total area).

Physiography



References

- State boundary
- District boundary
- Road
- Railway
- River or Nala
- Reservoir
- District headquarter
- Tehsil headquarter
- Other villages

Legend

Structural plateau	Lower denudational plateau
Middle level plateau	Steeply sloping denudational escarpment
Narrow inter hill basin	Valley
Structural hills and ridges	Broad interhill basin
Undulating plateau	Isolated hillocks
Rolling pediplains	Gently sloping flood plains
Upper denudational plateau	Ridges

Fig. 2: Physiography

Table 6. Types and extent (ha) of landforms in Seoni district

SI. No.	Types of land forms	Area (ha) (%)
1.	**Structural plateau:** This unit is extensively found in upper northern parts of district. The elevation is between 700 m and above mean sea level. Mostly open scrubbed lands with thin forest cover and surface stoniness more than 35 percent. High drainage density and severely eroded steep land with slopes of 3 to 8 percent. This is widely occur in **Lakhanadon**plateau.	26967.92 (3.08)
2.	**Middle level plateau:** This unit is well distributed in central part of Seoni, Chhapara and Keolari tehsils of Seoni district. The elevation is between 500 and 700 m above mean sea level. This unit is moderately eroded with moderately sloping lands (8-15%). Most of the area under the cultivation of wheat, rice, sugar cane, mustard but at few places, vegetables are grown.	71594.59 (8.17)
3.	**Narrow inter hill basin:** This unit is mostly occur in Ghansur, Kahani, and Hiran sub basins of the Sher and Hiren rivers. This unit occurs at an elevation of 400 to 500 m, gently sloping (3-8%), slightlyeroded, deep soils with high water holding capacity and strong alkalinity.	81457.45 (9.30)
4.	**Structural hills and ridges:** These are linear continuous features with rock out crops and steep stony lands and sparse forest cover. This unit is found in central parts where in the ridges run in east to west wards with rock sheets. At few places cultivation is practised.	152667.92 (17.43)
5.	**Undulating plateaus:** This unit is distributed well in western parts at an elevation of 300 to 400 m above mean sea level. Mostly covered with Bijna reserve forest. Severely eroded, highly dissected and 30 percent of surface covered with stones.	60021.79 (6.85)
6.	**Rolling pediplains:** This unit is having lot of undulations with ups and downs, mostly occur at an elevation of 600 to 700 m, open jungle towards Mohgaon to Barghat, moderate erosion, but at elevation of 420 to 520 m, with gentle slopes running towards east to west of mostly 2nd order streams near Mansur nala.	58546.96 (6.68)
7.	**Upper denudational plateaus:** This unit is in association with isolated hillocks, erosional pediment surfaces and dissected 1st order stream originating from flat top plateaus with 50 percent surface stones and 5 percent rock out crops. Thin forest cover, concentrated mostly in south-western parts of Seoni district, cultivation in patches, elevation in between 500 and 600 m.	170451.3 (19.46)
8.	**Lower denudational plateaus:** This unit is in between Gopalganj and Arharpur where in altitude is 600 to 650 m. This unit is barren rocky surface with open thin forest cover. Cultivation is in patches, highly dissected and moderately eroded.	155511.02 (17.76)
9.	**Steeply sloping denudational escarpment:** This unit has steeply sloping side slopes (30-50% slopes). Mostly occur in association with plateaus, severely eroded and highly dissected. Cultivation is in patches. Surface stoniness is more than 50 percent and rock outcrops are exposed with thin bushy vegetation and covers widely in the district.	17972.74 (2.05)
10.	**Valleys:** This unit is flat, gently sloping (3-8%), strongly associated with river systems of Wainganga of upper and lower reaches. This unit is mostly under cultivation of double crops (rice, wheat, soybean).	14674.54 (1.30)
11.	**Broad interhill basins:** This unit is in between plateaus with gentle slopes, slight erosion, intensively cultivated, occurs in small areas and associated with plateaus and undulating lands.	2526.06 (0.29)
12.	**Isolated hillocks:** This unit is commonly seen in granitic landscapes, mostly covered with stones and rock out crops, thin vegetated	1073.72 (1.23)
13.	**Gently sloping flood plain:** This unit is common in southern lowlands with slopes of 3 to 8 percent. Mostly under cultivation of wheat, arhar and soybean.	60822.35 (6.95)
14.	**Ridges:** This unit is a continuous, residual forms of hills with linear feature. Covered mostly with stones and rocks and are presently used for quarrying stones.	1511.61 (0.17)
	Total	**8475799.98**

4.
SOIL-LANDSCAPE SYSTEMS

The concept of soilscape or 'pedolandscape' was defined as the soil cover or part of the cover, whose spatial arrangement resulted from the integration of a group of arranged soil horizons and other landscape elements. A soil system was a type of soilscape, a toposequence, where the differentiation was linked with a functioning process. A reference relief unit was a catchment or watershed area and the analysis of lateral transfers on, in and through the soils (vertically and laterally) had to be considered to understand the functioning of the landscape units. The systems could be open or closed relative to the flow of water and energy. Soil systems provided a framework to describe the process dynamics of the evolution of a landscape and its associated soils.

The basaltic terrain constitute the oldest cores of continents; they are remnants of mountains that formed more than 60 million years ago and that have since eroded to undulating plains that rise up to only a few hundred meters above the present sea level. The lithospheric plates on which the shields rest move over the Earth's surface at a rate of several centimetres per year. In places, this movement produces weak stretches that become subject to rifting and subsidence. Such locations are preferential sites for formation of sedimentary river basins or for deposition of rocks. The Precambrian era spans 80 percent of the geological history of the Earth and includes many periods of mountain building, erosion and sedimentation. Igneous, sedimentary and metamorphic rocks of Precambrian age exist in great variety but crystalline (plutonic and metamorphic) rocks predominate.

(a) Volcanic Rocks: Topography originated from the fissure eruption of lava flows tend to be horizontally expand due to identical mixture of magnesium silica, aluminium, potassium and iron throughout the district and beyond. Flat-lying lava flows form plateaus fringed by escarpments and stepped hillsides.

Most of the relatively underformed volcanic rocks in the province were erupted from fissures and shield volcanoes during Tertiary time. Basalts, andesites and pyroclastic rocks (air-fall deposits) are probably most common. The lavas are fine textured and closely jointed. Basalt typically displays regular columnar jointing. Mechanical weathering of lavas and pyroclastic rocks proceed in accordance with the arrangement of fracture planes. The presence of open vesicles or spaces left by gas bubbles in many lavas, gives additional opportunities for weathering attack. The physical weaknesses which augment mechanical disintegration also affect chemical weathering. Basalt, consisting of plagioclase feldspar, pyroxene and olivine, is most susceptible, and rhyolite (quartz and feldspar) least susceptible to decomposition. With sufficient time, basalt breaks down completely to clay minerals. The weathering products of lavas are generally fine textured and result from the combined effects of chemical and mechanical weathering.

(b) High-grade metamorphic belts: These are normally narrow belts (only tens of kilometres across) that consist for the greater part of strongly metamorphosed rocks, which originate from sedimentary rocks. The lithology of these belts is diverse withmetamorphosed limestone (marbles) and/or metamorphosed sandstone (quartzites) alongside rocks that are not of sedimentary origin such as metamorphosed basalt flows or dykes (amphibolites) and strongly metamorphosed rocks, e.g. gneiss, granulites and granitoid gneiss. The considerable variation in mineralogical and chemical/physical properties of these rocks explains the wide variety of landforms and soils.

(c) Granite areas: Often associated with either migmatites (i.e. banded rocks formed through partial melting of sediments deep in the crust), or granitoid gneiss. Tropical belt areas were mainly modified by chemical weathering and by fluvial and marine processes. How water could shape the surface in tropical shield areas is largely explained by

- the amount and intensity of precipitation, and
- the presence or absence of a protective vegetation cover.

In areas under rain forest, most precipitation is intercepted by the canopy from where it trickles down to the forest floor and infiltrates into the soil. There, it promotes rapid chemical weathering of rocks because its low ionic strength and comparatively high temperature promote hydrolysation processes. The ‘saprolite’ (i.e. 'rotten rock’) under a rain forest may extend down to a depth of tens or even hundreds of metres. The saprolite is usually less thick on granite (say, 10-20 metres) than on metamorphic rock (40-70 metres). Long periods of strong chemical weathering and little, if any, surface runoff have gradually deepened the weathering front, a process known as 'etching'. The saprolite is normally clayey because feldspars and ferromagnesian minerals have weathered to clay minerals and (sesqui-) oxides. The sand content of the saprolite reflects the content of coarse quartz in the original parent rock. Thoroughly weathered saprolites are chemically very poor, despite their lush (rain forest) vegetation cover.

Many shield areas in tropical regions include vast, dissected etch-plains with solitary elevated remnants that are either bare, dome-shaped granite hills (‘inselbergs’) such as the 'sugar loaf, or heaps of huge granite boulders known as 'tors'. The etch-plains consist of deep, flat or undulating, residual weathering crust dissected by a network of V-shaped valleys that are only a few metres deep. Where the natural drainage pattern is widely spaced, remnants of the original flat surface may still be in place but only rounded, convex hills remain in areas with more densely spaced gullies. Note that natural drainage patterns are normally conditioned by underlying bedrock: low ridges and depressions form upon differential etching and stripping of weathering-resistant rocks.

The occurrence of isolated inselbergs and tors amidst vast expanses of undulating lowland is more common. It tend to be broad and shallow as a result of colluviation and slope wash. The widespread occurrence of laterite plateaus' near Seoni, is an indication of climate fluctuations in the past. In the (now) semi-arid tropics, much plinthite has subsequently hardened to 'ironstone'. Many plateaux are weathering residues protected by an ironstone cap. In places they formed through relief inversion of iron-cemented valley fills. It is generally true that regions with crystalline rocks have symmetrical hills with sharp crests and rectilinear slopes, separated by steep V-shaped valleys. Joints and faults in the underlying rocks determine the drainage pattern.

The advanced weathering of rocks in the sub-humid tropics produced 'typical' tropical soils: red in colour and strongly leached. Additional features: they are deep, finely textured, contain no more than traces of weatherable minerals, have low-activity clays, less than 5 percent recognisable rock structure and gradual soil boundaries. Differences between soils in the sub-humid tropics can often be attributed to differences in lithology and/or (past) moisture regime. Here some examples of soil-landscape systems existing in seoni district are discussed with sketch diagrams.

A. Transect -1, Keolari - Dhonora area

The soil transect running to a distance of 30 km in NW - SE aspect near Keolari-Dhanora area represents typical basaltic terrain. This landscape consists of three distinct landforms such as (i) undulating plateau with isolated hillocks at elevations of 460 to 500m (ii) upper denudational plateaus with flat benches at an elevations of 440-460m with sharp and deep ‘V’ shaped gorges and (iii) lower denudational plateaus with flat benches at an elevations of 430 to 460 m. The basaltic terrain formed more than 60 million years ago and eroded to undulating plains that rise up to only a few hundred meters above the present sea level. Flat-lying lava flows form plateaus bounded by escarpments and stepped hillsides. The Lithic Ustorthents are dominant in Undulated plateau tops but on short benches, the occurrence of Vertic Haplustepts is observed (P3, Fig.3). Lithic/Vertic Haplustepts are upper denudational plateaus with very wide flat benches. Vertic Haplustepts (P6), Chromic Haplusterts (P7) and Lithic Ustorthents (P8 & P9) are found in lower parts having broad ‘U’ shaped land forms.

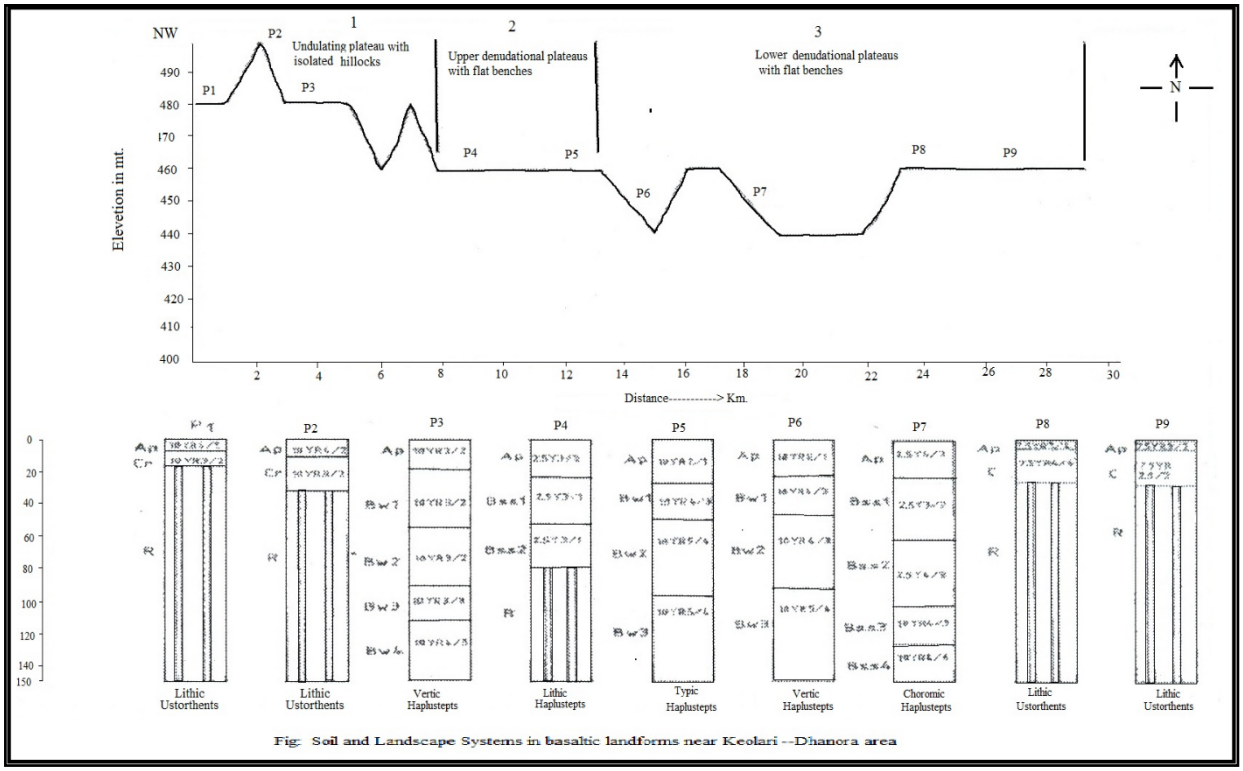


Fig 3. Soil-Landscape systema in basaltic landforms near Keolari –Dhanora area

B. Transect-2 in basaltic terrain near Sirkapur forest

The soil transect near sirkapur forest is 24 km long and its slopes are running in NW-SE aspect with three dominant landforms such as (i) upper denudational plateaus (>750 m) (ii) Rolling pediplains (750-640 m) and (3) Undulating plateaus (640-580 m). The elevation ranges from 800 to 600 m above mean sea level. The upper denudational plateaus are severely eroded with flat on top but have severely eroded side slopes of short slope lengths (<50 m). This unit has dominant soil subgroups of Lithic Ustorthents and Typic Haplusterts. The rolling pediplains have benches lowered with smooth and wide V shaped pits and ridges. This unit has moderately strongly sloping with > 150 m slope length. This unit has Typic/Aquic/Lithic Haplustepts. The undulating plateaus in lower topographic positions are severely dissected with short and narrow benches of varied sizes and shapes.

C. Transect-3 on granite-laterite landforms near Harharpur-Pandarai

This soil transect is 16 km long from NW-SE on laterite plateauex running with deep benches in between 620 to 520 m and at distal end granitic landform at 540m.This transect has three landforms such as structural plateaus, upper denudational and lower denudational plateaus. The soils on laterites have deep red, clay enriched subsoils with 2.5YR or 7.5 YR hues and are classified under Lithic Ustorthents and Typic Rhodustalfs. The soils on upper denudational and lower denudational plateaus are Lithic Ustorthents, Typic Haplustalfs and Typic Haplustepts.

5.
OCCURRENCE OF SOILS ON LANDFORMS

The occurrence of soils with respect to land forms include grouping of soils according to geology and then classify the soils with respect to land forms. In the first step, the total observations are grouped into four as per geology. The total observations recorded in basalt is 568, out of it 117 profiles are studied in upper denudational plateaus and 97 in lower denudational plateaus. Similarly 383 profiles studied in granite, of it 115 in upper and 68 profiles in lower denudational plateaus (Table 7).

The X^2 analysis is worked out to calculate expected frequencies of soils when grouped in broad land forms such as uplands and valleys. The redundancy of data is evident and lay emphasis on designing sampling schemes for surveys in order to draw inferences from field data (Table 8 & 9).

Table 7. Number of soil profiles with respect to geology

Physiongraphic units	Basalt	Granite	Laterite	Sandstone	Total
1. Structural plateaus	21	19	01	--	41
2.Middle level plateaus	58	20	--	--	68
3.Narrow inter hill valleys	70	30	--	--	100
4.Structural hills and ridges	59	56	--	--	115
5.Undulating plateaus	41	17	--	--	58
6.Rolling pediplains	32	27	01	--	60
7.Upper denudational plateaus	117	115	06	--	238
8.Lower denudational plateaus	97	68	01	--	166
9. Steeply sloping escarpments	19	06	--	--	25
10. Valleys	07	04	--	--	11
11. Broad inter hill basins	04	05	--	--	09
12.Isolated hills and hillocks	02	03	--	--	05
13.Gently sloping flood plains	36	13	--	--	51
14.Ridges	02	--	--	--	02
15.Old flood plains	03	--	--	--	03
Total	**568 (59%)**	**383 (39.8%)**	**09 (0.94%)**	**02 (0.21%)**	**962**

Table 8. Observed and Expected occurrence of soils (X^2 distribution) in basalt

SI. No.	Soils	Observed			Expected		X^2 values	
		Upland	Valleys	Total	Upland	Valleys	Upland	Valleys
1.	Lithic Ustorthents	194	60	254	191.84	60.96	0.0252	0.0151
2.	Typic Ustorthents	35	07	42	31.92	10.08	0.3859	0.941
3.	Typic Fluvaquents	03	00	03	2.28	0.72	0.2273	0.72
4.	Typic Ustifluvents	01	00	01	0.76	0.24	0.0757	0.24
5.	Typic Haplustepts	67	31	98	74.48	23.52	0.751	2.3788
6.	Dystric Haplustepts	08	01	09	6.84	2.16	0.196	0.6299
7.	Typic Epiaquepts	10	01	11	8.36	2.64	0.322	1.0188
8.	Vertic Haplustepts	20	13	33	25.08	7.92	1.028	3.2583
9.	Ustic Epiaquepts	04	00	04	3.04	0.96	0.303	0.96
10.	Udertic Haplustepts	02	00	02	1.52	0.48	0.152	0.48
11.	Lithic Haplustepts	22	08	30	22.8	7.20	0.028	0.0888
12.	Fluventic Haplustepts	03	01	04	3.04	0.96	0.0052	0.0166
13.	Vertic Epiaquepts	01	00	01	0.76	0.24	0.0758	0.240
14.	Aquic Haplustepts	04	00	04	3.04	0.96	0.303	0.096
15.	Udic Haplustepts	01	00	01	0.76	0.24	0.0757	0.0240
16.	Aerie Haplustepts	00	01	01	0.76	0.24	0.760	2.406
17.	Typic Haplusterts	34	09	43	32.68	10.32	0.0533	0.1688
18.	Aerie Epiaquepts	01	00	01	0.76	0.24	0.0757	0.2400
19.	Chromic Haplusterts	02	00	02	1.52	0.48	0.151	0.4800
20.	Ustic Epiaquerts	04	04	08	6.08	1.92	0.711	2.2533
21	Leptic Haplusterts	01	00	01	0.76	0.24	0.0757	0.2400
22.	Udic Haplusterts	12	03	15	11.4	3.6	0.0315	0.1000
	Total	**429**	**139**	**568**			**4.5767**	**11.07**

Table 9. Observed and Expected occurrence of soils in granite

SI. No.	Physiography/Soils	Upland	Valleys	Total	Upland	Valleys	E	Valleys
1.	Lithic Ustorthents	79	14	93	79.05	13.95	0.0031	0.0017
2.	Typic Ustorthents	79	16	95	80.75	14.25	0.0379	0.2149
3.	Aerie Fluvaquepts	01	00	01	0.85	0.15	0.0264	0.1500
4.	Typic Haplustepts	80	16	96	81.6	14.4	0.0313	0.1777
5.	Dystric Haplustepts	30	07	37	31.45	5.55	0.0668	0.378
6.	Vertic Haplustepts	08	--	08	6.80	1.20	0.2177	1.20
7.	Lithic Haplustepts	03	--	03	2.55	0.45	0.0724	0.45
S.	Aquic Haplustepts	02	--	02	1.70	0.30	0.247	0.30
9.	Udic Haplustepts	01	--	01	0.85	0.15	0.0264	0.15
10.	Typic Haplusterts	44	--	47	39.95	7.05	0.4105	2.326
	Total	**327**	**56**	**383**	**39.95**	**7.05**	**0.4105**	**53484**

6.
SOIL MORPHOLOGY

4.1. Soils on Basaltic Landforms

a) Soils with A horizons

The soils with A horizon on basaltic terrain include Dhora and Parasia series. These soils occur on structural hills and ridges (Parasia)) and narrow inter hill basins (Dhora). The A horizon in Dhora series is dark brown with 7.5YR hue and have clay texture with medium weak subangular blocky structures and lithic contact within 9 cm. The Parasia series have 12 cm thick reddish brown Ap horizons, sandy clay loam textured and weak subangular blocky structures (Table 10).

(b) Soils with A/ Ap & Bw horizon sequences

This group includes seven series such as Chhuhi, Pipariya, Gorakhpur, Masanbarra, Sagar, Lakhanadon and Khamariya series. The Ap horizon is greyish brown (Chuhi series, Papirya & Gorakhpur), to dark greyish brown (Massanbarra & Sagar) and dark brown (Lakhanadon & Khamariya)) with a thickness of 3 to 9 cm (Lakhanadon, Khamariya, Gorakhpur, Papiriya & Masanbarra) but varies from 12 to 15 cm in Chhui, Atari and Sagar series. The cambic B horizons are very dark grey (Cu) or olive brown to very dark brown, (At, Na, Sa, Pr) and very dark to dark reddish brown in Lakhanadon and Khamariya series. The B horizons have medium, moderate, subangular blocky structures with very sticky and plastic consistency. The solum thickness is more than 150 cm (Cu, Al) but varied to 60-90 cm (Ma, Sa & Lk) and less than 50 cm (Pr, Go, Kh).

(c) Soils with Ap-Bw-Bss horizon sequence

The major morphological makers of deep black soil are linear and normal gilgai, cyclic horizons, surface cracking upon desiccation and slickensides (Soil Survey Staff, 1994). The differences in degree of expression of any morphological characteristic reflect differences in chemical, physical, mineralogical and environmental conditions. The soils of Seoni district exhibits typical morphological features of deep black soils Nadora, Bhimgarh, Jamunpani, Denka, Kharsaru, Paddikona, Lungsa, Kodaijhari and Tarali series. The gilgai micro relief features are not prominent in this sub-humid region wherein these soils are under cultivation but reported the occurrences of the gilgai features in the area receiving the rainfall of 1000 mm/year (Sehgal & Bhattacharyya, 1998). These soils have A horizon of dark greyish brown (Nadora, Kharsaru, Kodaijhari, Dhenka, Bhimgarh) to light olive brown (Jamunpani) or very dark brown (Paddikona) and dark brown Tarali. The Bss horizons have slickenside with large wedge shape aggregates having a polished and shinny appearance. The appearance of slickenside at deeper layers in the regions of high rainfall (31 to 105 cm) and shallow or depth at drier regions (22 to 65 cm) were reported in this region by Vadivelu & Challa (1985). A slickensided zone is 42 to 150 cm and above in all soils except in Kharasu series where this zone starts at 25 to 81 cm in lower denudational plateaus. These vertisols are very deep or deep having solum thickness of more than 100 cm.

4.2. Soils on granitic land forms

a) Soils with A horizon

The soils with A horizon are Kanera, Jamuntola and Sukla series. The Kanera and Jamuntola series occurring on structural plateaus and denudational plateaus have 12 cm thick dark brown A horizons with sandy loam or sandy clay loam texture and medium weak subangular blocky structures. The Cr horizon is appeared at 12 cm. The Sukla series occur on isolated hillocks have 18 cm thick, dark yellowish brown A horizon with clay loam and fine weak subangular blocky structures.

(b) Soils with A and Bw horizon sequences

The soils with A, Bw horizon sequence are Bisapur, Rukhad, Khawasa and Silghat series. The A horizon is dark brown (Bs) to light yellowish brown (Rk),or dark yellowish brown (Kw) and pale brown (Si). The thickness of A horizon is 10 to 17 cm, loamy sand to sandy loam textured and subangular blocky structures. The Bw horizon is dark brown with 7.5YR hue (Bs & Si) to yellowish brown to dark yellow brown with 10 YR hue (Rh & KW) and loamy sand to sandy loam (Bs, Rh, Kw) or sandy clay loam (Si) textured. The structure is weak subangular blocky to granular, loose, friable, non sticky and non plastic. These soils have 5 to 15 percent of coarse fragments in B horizons. The solum thickness is more than 100 cm.

(c) Soils with Ap -Bt horizons

The soil series include Gondatola, Pratappur, Chunamati and Arandiya series. These soils are mostly occurred in southern parts of Seoni district where laterite and granite are dominant. These soils have dark reddish brown Ap horizons with a thickness of 14 to 19 cm except in Arandiya series where A horizon thickness is 9 cm, sandy loam textured, yellowish brown to pale brown. The Bt horizons are dark red with 2.5 YR hue and a thickness more than 100 cm in Gondotola series, very dark grey to olive brown with 2.5 Y hue and more than 150 cm in Pratappur series. The Bt horizons are dark yellowish brown to yellowish brown with 10 YR hue and more than 90 cm thick in case of Arandiya series. These horizons have clay to sandy clay texture and medium, weak, subangular block structures. The consistency is slightly hard, slightly sticky and slightly plastic.

Table 10. Morphology and site characteristics of soils in Seoni district

Soil series/land use	Depth (cm)	Horizon	Colour	Texture	Structure	Other features
Nadora Wheat+gram+ soybean	0-19	Ap	10YR4/2	C	Mlsbk	
	19-26	Bwl	10YR4/2	C	M2sbk	Cambic, presence of pressure faces and shiny surfaces
	26-62	Bw2	10YR4/3	C	M2sbk	Cambic, presence of pressure faces and shiny surfaces
	62-90	Bssl	10YR4/4	C	M2sbk	Slickensided zone with wedge shaped aggregates
	90-105	Bss2	10YR4/4	CL	Mlsbk	Slickensided zone with wedge shaped aggregates
Khamariya Wheat+red gram	0-9	Ap	7.5YR3/4	C	Mlsbk	
	9-25	Bwl	7.5YR3/3	C	Mlsbk	Cambic 15 to 20 percent coarse framents
	25-50	Bw2	7.5YR3/3	C	Gr, loose	
Dhora Forest	0-9	A	7.5YR3/3	C	Mlsbk	Lithic contact at 9 cm, slightly acid
Parasiya	0-12	Ap	5YR4/3	SCL	Mlsbk	Lithic contact at 12 cm,

Millets+maizc						moderately acid
Chunamati Rice+wheat+gram	0-18	Ap	7.5YR3/2	C	Mlsbk	
Gorakhpur	0-9	Ap	2.5Y3/1	C	M2sbk	
Wheat+red gram	9-23	Bwl	2.5Y2.5/1	C	M2sbk	Lithic contact within 40 cm.
	23-39	Bw2	2.5Y2.5/1	CL	M2sbk	
	0-9	Ap	10YR5/4	SL	Mlsbk	
Arandiya	9-35	Bt1	10YR4/4	SCL	gr	Coarse fragments 5 to 10 percent
Rice+wheat+gram	35-58	Bt2	10YR4/3	SCL	gr	
	58-97	Bt3	10YR5/6	SCL	gr	increase with depth, slightly acid to neutral
Bhimgarh	0-14	Ap	2.5Y3/2	C	M2abk	Cambic, presence of shiny
Wheat+gram+	14-33	Bwl	2.5Y3/2	C	M2abk	pressure faces, intersecting
mustard +red gram	33-53	Bw2	2.5Y3/2	C	C3abk	slickensides with angular blocky
	53-85	Bssl	2.5Y3/2	C	C3abk	structures
	85-140	Bss2	2.5Y3/2	C	C3abk	
Jamunpani	0-24	Ap	2.5Y4/3	C	M2sbk	Slightly acid Cambic horizon
Soybean+redgram	24-62	Bwl	2.5Y3/2	C	Clabk	with shiny pressure faces
	62-113	Bssl	2.5Y3/2	C	C2abk	intersecting slickensides,
	113-127	Bss2	2.5Y4/3	C	M2sbk	moderately alkaline
	127-150	Bss3	2.5Y4/6	SCL	Mlsbk	
Dhenka	0-11	Ap_	2.5Y4/2	C	M2sbk	Slightly to moderately alkaline
Redgram+ sugarcane+	11-34	Bwl	2.5Y3/1	C	Mlsbk	Cambic with pressure faces
soybean+wheat	34-65	Bssl	2.5Y3/1	C	Mlsbk	
	65-103	Bss2	2.5Y4/2	C	Mlsbk	
	103-150	Bss3	2.5Y4/2	C	Mlsbk	
Kanera Soybean+potato+ sugarcane	0-12	Ap	7.5YR3/4	SCL	Mlsbk	**Kanera** Soybean+potato+ sugarcane

Chhui	0-15	Ap	2.5Y4/2	C	Mlsbk	
Pasture	15-63	Bwl	2.5Y3/I	C	M2sbk	
	63-104	Bw2	2.5Y3/1	C	M2sbk	
	104-150	Bw3	2.5Y4/2	SC	Mlsbk	
Kharsaru	0-25	Ap	2.5Y3/2	C	M2sbk	Intersecting slickensides, neutral
Redgram+soybean	25-53	Bssl	2.5Y3/2	C	M2sbk	
	53-81	Bss2	2.5Y3/2	C	Mlsbk	to moderately alkaline with depth
Kodajhiri	0-19	Ap	2.5Y4/2	C	Mlsbk	Intersecting slickensides, neutral
Rice+wheat+gram	19-42	Bwl	2.5Y3/2	C	M2sbk	
+peas	42-76	Bssl	2.5Y3/2	C	M3abk	to moderately alkaline with depth
	76-123	Bss2	2.5Y3/2	C	M3abk	
	123-150	Bss3	2.5Y3/2	C	M3abk	
Atari	0-14	Ap	2.5Y5/3	C	M2sbk	Cambic with wedge shape
Rice+wheat	14-45	Bwl	2.5Y4/3	C	M2sbk	aggregates
	45-90	Bw2	2.5Y3/2	C	M2sbk	
	90-150	Bw3	2.5Y3/2	C	Mlsbk	
Masanbarra	0-7	Ap	10YR3/2	SI	Mlsbk	Cambic, strongly acid
Forest	7-25	Bwl	10YR4/1	SCL	Mlsbk	
	25-52	Bw2	2.5Y5/3	SCL	Mlsbk	
	52-68	Bw3	2.5Y6/3	SCL	Mlsbk	
	68-90	Bw4	2.5Y5/3	SCL	Mlsbk	
Paddikona	0-10	Ap	10YR2/2	C	M2sbk	Cambic
Rice+wheat+ gram	10-30	Bwl	10YR2/2	C	M2sbk	Intersecting slickensides, slightly
	30-50	Bw2	10YR2/1	C	C3abk	alkaline
	50-90	Bssl	10YR2/1	C	C3abk	
	90-150	Bss2	10YR2/1	C	C3abk	
Lungsa	0-8	Ap	2.5Y4/2	C	M2sbk	Cambic

Redgram	8-59	Bwl	2.5Y3/1	C	M2sbk	Slickensides with subangular
+Iinseed+ sunhemp	59-93	Bssl	2.5Y3/1	C	M2sbk	blocky structure, moderately
+sugarcane	93-140	Bss2	2.5Y3/2	C	M2sbk	alkaline
Sagar	0-12	Ap	10YR3/2	C	M2sbk	Cambic, slightly alkaline
Soybean+Rice+	12-32	Bwl	10YR3/2	C	M2sbk	
sorghum	32-46	Bw2	10YR3/1	C	M2sbk	
	46-60	Bw3	10YR3/1	C	Mlsbk	
Lakhanadon	0-3	Ap	7.5YR3/2	SCL	Mlsbk	Coarse fragments upto 16 per
Pasture	3-13	Bwl	7.5YR3/2	SCL	Mlsbk	cent
	13-30	Bw2	5YR3/3	SL	Mlsbk	
	30-54	Bw3	5YR3/3	SL	Flsbk	
Pipariya	0-5	Ap	2.5Y4/2	CL	Flsbk	Lithic contact within 50 cm
Forest	5-16	Bwl	2.5Y5/2	Cl	Mlsbk	
	16-35	Bw2	2.5Y6/1	CL	Mlsbk	
Silghat	0-11	Ap	10YR5/2	SCL	Mlabk	Cambic horizons with base
Rice	11-21	Bwl	7.5YR3/2	SCL	Mlabk	saturation less than 60 percent
	21-42	Bw2	7.5YR3/2	SL	Gr	
	42-80	Bw3	7.5YR3/2	SL	Gr	
	80-110	Bw4	7.5YR3/2	LS	Gr	
Jamuntola Rice+wheat+ gram	0-13	Ap	10YR3/3	SL	M1sbk	Lithic contact within 50cm
Tarali	0-22	Ap	10YR3/3	C	Mlsbk	Cambic
Rice+wheat+ gram	22-56	Bwl	10YR3/3	C	M2sbk	Slickensided zone with wedge
	56-82	Bssl	10YR3/2	C	M3abk	shaped aggregates
	82-110	Bss2	10YR3/2	C	M3abk	
	110-161	Bss3	10YR3/2	C	M3abk	
Khawasa	0-13-	A	10YR4/4	S1	Mlsbk	Cambic B horizons with
Forest	13-31	Bwl	10YR4/4	S1	Mlsbk	subangular blocky aggregates

	31-60	Bw2	10YR4/3	S1	Mlsbk	
	60-96	Bw3	I0YR4/4	S1	Mlsbk	
	96-140	Bw4	10YR4/4	S1	Mlsbk	
Pratappur	0-19	Ap	10YR3/2	C	Mlsbk	Argillic B horizons with
Rice+wheat+ gram+	19-44	Btl	10YR3/1	C	M2bk	moderate medium to strong
pigeon pea+potato	44-75	Bt2	2.5Y4/4	C	M3sbk	aggregates
	75-111	Bt3	2.5Y4/4	C	M3sbk	
	111-153	Bt4	2.5Y4/4	C	M3sbk	
Rukhad	0-16	A	10YR6/4	Ls	fisbk	Cambic horizons with fine
Forest	16-49	Bwl	10YR5/4	Ls	fisbk	structural aggregates and loamy
	49-78	Bw2	10YR4/4	Ls	fisbk	sand textures.
	78-108	Bw3	10YR4/4	Ls	fisbk	
Bisapur	0-17	A	7.5YR3/2	S1	fl sbk	Cambic horizons with fine
Forest	17-46	Bwl	7.5YR3/4	S1	fl sbk	structural aggregates and sandy
	46-78	Bw2	7.5YR3/4	S1	f1 sbk	loam textures
	78-120	Bw3	7.5YR3/4	S1	f1 sbk	
Sukia	0-18	A	10YR4/4	Cl	f1 sbk	
Forest	18-34	Ac	10YR4/4	Cl	fisbk	
Gondatola	0-14	Ap	2.5YR 3/4	c	ml sbk	Argillic Bt horizon with moderate
Rice+wheat+ gram	14-43	Btl	2.5YR 3/4	c	ml sbk	
	43-78	Bt2	2.SYR 3/6	c	m2sbk	medium aggregates
	78-122	Bt3	2.5YR 3/6	sc I	ml sbk	

7.

PARTICLE SIZE DISTRIBUTION & CHEMICAL CHARACTERISTICS

7.1. Particle Size Distribution

(a) Soils with A horizon

The texture is considered as an important characteristic for assessing water retention capacity and for determining the time of tillage operations. The soils on basalt have fine particle size with 35 percent (Parasia) to 48 percent clay (Dhora), silt of 22 to 25 percent and sand of 26 to 46 percent. The water retained at -33 kPa is 33 to 27 percent and at - 1500 kPa is 18.8 to 13.1 percent.

The soils on granitic have 40 percent clay (Sukla series) with water retention of 15.1 percent at -33 kPa and 8.83 percent at -1500 kPa. The Kenara series with clay of 30 percent retain 24.5 percent water at -33 kPa and 11.4 percent at -1500kPa. The Jamuntala series with 20 percent clay and 75 percent sand retain 14.2 water at -33 kPa and 6.9 percent at -1500 kPa (Table 11). The particle size class is loamy mixed as clay content is 18 to 27 percent and have coarse fragments more than 15 percent but Sukla series have clayey the particle size (Soil Survey Staff, 1998).

(b) Soils with A and Cambic B horizons

The soils on basaltic teirain have a clay content more than 50 percent with depth (Chhui series, Sagar series, Khamaria series, Gorakhapar series, Pipariya series and Lakhanadon series). The clay distribution with depth is increased in Sagar, Lakhanadon, Piparia, Chhui, Gorakhapar and Khamaria series. The sand content is less than 20 percent and silt content of 15 to 32 percent with depth. Partical size class is fine. The water retention at -33 kPa is 36 to 24 percent and at -1500 kPa is 10 to 20 percent.

The Masanbarra soils have fine loamy particle size with 19.6 percent clay in Ap horizon to 29.5 percent in Bw2 horizons. The water retention is 9.9 to 16.3 percent at -33 kPa and 4.2 to 7.3 percent at -1500 kPa.

The soil in the granitic terrain have fine loamy particle size class (Bisapur and Silghat series). The clay content of 16 to 19 percent in Bisapur series and 28 to 32 percent in Silghat series. The water retention shows a slight increase with depth and having its values in between 18.3 to 6.6 percent at -33kPa and 9 to 3 percent at -1500 kPa.

The coarse loamy particle size is recorded in Khawasa and Rukhad series with a clay content of less than 16 percent and sand content of more than 80 percent and silt of 2 to 6 percent. The water retention capacity is 13.8 to 9 percent at -33 kPa and 4 to 7 percent at -1500 kPa.

(c) The soils with cambic B horizon and slickenside zones (BSS)

The series include in this category are Nadora, Bhimgarh, Kharsaru, Jamunpani, Dhenka, Paddikona and Lungsa series. The water retention is generally above 35 percent at -33 kPa and 15 to 30 percent at -1500 kPa. These soils shows an increasing trend of clay with depth having strong visible slickenside zones in subsurface areas. The vertisols where the clay content ranges between 40 to 60 percentbut it may be as high as 80 percent reported

in Indian soil (Murthy et al. 1982). The clay value as reported in Seoni soils is an agreement with the reported values elsewhere. So there is no consistence pattern with depth in clay distribution as stated by Thompson et al. (1982). The soils with fine particle size class are Tarali and Kodajhiri series where in the claycontent is between 30 and 60 percent. The clay content shows increasing trend with the depth and has a direct influence on water retention characteristics with its value 22 to 38 percent at -33 kPa and 12 to 21 percent at -1500 kPa.

(d) Soils with A and arglic B horizon (Bt)

These soils have three particle size class such as very fine, (Pratappur series), fine (Gondatola Chunamati) and fine loamy (Arandiya). The Pratappur series have a clay content more than 80 percent in Bt horizon and 68 percent clay in Ap horizon. The sand content is 5 to 4.2 percent up to 100 cm and silt content of 26 to 8.4 percent. The water retention at -33kPa shows increasing trend with depth from 35 to 55 percent and 19 to 27 percent at -1500 kPa. The Chunamati series have more than 60 percent clay in A and Btl layers and then decreases to 37 percent in Bt3 layer. The surface layers have a water retention of 36 percent at -33 kPa in A and Bt layers and subsequent decreases up to 21 percent in succeeding layers. The water retention at -1500 kPa shows a similar trend with its value vary from 16 to 10 percent.

The Gondatola series shows increase in clay content from 41 percent in Ap horizon to 58 percent in Bt layers. The silt content decreases with depth (33 to 10 percent) while sand content is irregular with depth (15 to 41 percent). The water retention is 17 to 25 percent at- 33 kPa and 10 to 1.8 percent at -1500 kPa. The Pipariya series have fine loamy partical size with an increase in clay content from 15 to 31 percent in Bt layers. The soils have more than 60 percent sand throughout depth and 5 to 7 percent silt with depth. The water holding capacity is 11 to 15 percent at -33 kPa and 3.6 to 7 percent at -1500 kPa.

The relationship between particle size distribution, organic carbon and soil water retention characteristics were worked out and derived regression equation to approximate water retention characteristics. Soil water held at -33 kPa was strongly related with sand, silt, clay and organic carbon in basaltic soils (R^2 =0.95**) and in granitic soils (R^2=0.76**) but poorly related with soil water held at -1500 kPa. The equation were given below:

A. Basaltic shrink-swell soils

(i) Soil water retention at -33 kPa (%) = 0 + 0.059 (sand%) + 0.39 (silt%) + 0.39 (Clay %) -2.58 (organic carbon %) (R^2 =0.95**)

(ii) Soil water retention at -1500 kPa (%) 47.75-0.46 (sand %) -0.19 (silt%) -0.32 (clay %) -1.31 (organic carbon %) (R^2=0.47**)

B. Granitic red soils

(i) Soil water retention at -33 kPa (%) = -330.75 + 3.33 (sand %) + 3.46 (silt %) + 3.82 {clay %) - 2.59(organic carbon %) (R^2 =0.76)

(ii) Soil water retention at: -1500 kPa (%) = -888.9+8.89 (sand%) + 8.84 (silt%) +9.13 (clay%) + 10.43 (organic carbon%) (R^2=0.22).

7.2. Chemical Characteristics

(a) Soil with A hoziron

The Dhora (Dh) and Parasia (Pc) series are slightly acid with organic carbon of 1.3 (Parasia) to 2.93 percent (Dhora). The Ca is dominant on exchangeable complex (9.4 cmol/kg) (Pc) and (15.47 cmol/kg Dh) followed by Mg, Na and K. These soils have base saturation more than 65 percent with a CEC of 19 to 27 cmol/kg.

The soils on granite are moderately acid (Sukla), slightly acid (Kenra) and neutral (Jamuntala) in reaction. The organic carbon is more than 1 percent with the base saturation more than 60 percent. Among exchangeablebases, Ca is dominant with 5.9 to 6.9 cmol/kg except in Kenara series where it is 28.5 cmol/kg with a CEC of 55.31 cmol/kg (Table 11). The CEC is 10 to 14 cmol/kg in Sukla and Jamuntala series.

(b) Soils with Ap- Bw horizons

The fine textured basaltic soils with Ap-Bw horizons are slightly to moderately alkaline with increasing from 0.6 (Atari) to 1.23 percent (Khamariya), exchangeable calcium of 30 to 40 cmol/kg in (Sagar, Gorakhpur, Atari, Khamariya, Lakhanadon, Chhui, Pipariya series) and Mg of 10 to 14 cmol/kg in a cambic B horizons. The exchangeable K and Na is 0.32 to 0.25 cmol/kg with depth and cation exchange capacity of 46 cmol/ kg. The fine loamy textured Masanbarra series is slightly acid throughout depth with decreasing organic carbon (2.1 to 0.56%) and irregular trends of exchangeable cations. Ca is dominant with values of 5.2-8.8 cmol/kg, exchange Mg of 8.2 to 2.4 cmol/kg and cation exchange capacity of 7.6 to 12 cmol/kg.

(c) Soils with cambic and slickensided zones

These soils are fine textured (Nadora, Bhimgarh, Jamunpani, Dhora, Paddikona, Lungsa and Kharsaru) and mostly occur in basaltic terrain. These soils are slightly acid tomoderately alkaline and shows increasing trend with depth. The organic carbon content shows decreasing trend with values of 0.07 to 1.09 percent. Among exchangeable bases, calcium is dominant followed by Mg, Na and K. The CEC of soils is 37.2 to 66.8 cmol/kg.

The soils on granitic land forms (Tarali and Kodahiri series) are fine textured and are slightly acid to moderately alkaline with depth. The organic carbon decreases with depth and its values vary from 0.27 to 0.99 percent. The distribution of exchangeable bases is irregular with Ca as dominant cation in exchange sites. The CEC is between 22.4 and 35.0 cmol/kg.

d) Soils with argillic horizons

These soils are very strongly acid to moderately acid with base saturation more than 60 percent. The exchangeable Ca is more than 30 cmol/kg in Bt layers (Prattappur and Chunamati series)but its content is 4.5 to 10 cmol/kg in case of Gondatola and Arandiya series. The Pratappur and Chunamati soils are slightly acid to slightly alkaline with CEC of 27 to 42 cmol/kg and exchangeable K of 0.53 to 0.80 cmol/kg.

C. Cation exchange capacity of basaltic soils was strongly related with silt, clay and organic carbon and derived multiple regression equation for approximation as:

CEC relation in basaltic soils was expressed as:

(i) CEC (cmol (+) kg^{-1} - 1.0035 (silt %) + 0.4386 (clay %) - 5.74 (organic carbon %) (R2 =0.95** F = 457)

The CEC relation in granitic soils was expressed as:

(ii) CEC (cmol (-f-) kg^{-1} = -1.62 + 0.3036 (silt %) + 0.4826 (clay %) - 3.0155(organic carbon %) (R2 -0.67**, F-21.4).

Table 11. Particle size distribution and chemical properties of soil

Soil Series	Depth (cm)	Particle-size distribution (< 2mm. %)			pH	EC	OC	Exchangeable bases				CEC	Base saturation (%)
						Dsm^{-1}	(%)	Ca	Mg	Na	K		
		Sand	Silt	Clay				……Cmol (+) kg^{-1}……					
I.Nandora	0-19	6.2	28 8	65.0	8.2	0.09	0.62	47.3	1.56	029	0.67	51.5	96
	19-26	6.0	29.5	64.5	8.3	0.09	062	46.0	1.58	0.32	0.63	50.7	97
	26-62	5.0	28.5	66.5	8.2	009	0.62	47.4	1 80	0.31	0.59	51.5	97
	62-90	5.6	289	65.5	8.2	0.10	0.48	45.9	2.14	032	0.63	49.3	99
	90-105	24.3	24.2	51.5	8.1	0.10	0.48	47.0	2.71	0.29	0.45	50.7	99
2.Khmariya	0-11	18.9	21.5	59.6	6.4	0.10	1.23	34.3	15.6	0.54	0.46	50.9	87
	11-23	16.5	19.9	63.6	6.8	0.22	0.95	3S.7	13.9	0.55	0.32	50.4	82
	23-35	28.8	21.3	49.9	6.9	0.08	0.75	38.3	13.7	0.59	0.29	53.0	92
3. **Dhora**	0-9	26.4	25.8	47.8	61	0.10	2.93	15.5	7.6	0.19	0.21	23.5	85
4. Parasiya	0-12	46.4	20.1	33.5	6.1	0.06	1.29	94	2.5	0.77	0.52	13.6	67
5. Chunamati	0-18	12 4	15.8	64.8	6.8	0.06	0.93	37.4	2.2	0.19	0.53	42.0	95
	18-39	17.6	16.6	65.8	7.1	0.03	0.74	38.2	1.6	0.16	0.38	43.0	94
	39-60	49.4	11.1	39.5	7.1	0.04	0.67	27.3	1.4	0.19	0.42	33.4	87
	60-90	43.4	18.1	39.9	8.2	0.11	0.34	26.4	0.9	0.16	0.28	27.9	90
6. Gorakhpur	0-9	9.5	25.8	64.7	6.4	0.12	0.82	28.3	11.9	0.81	1 02	51.3	81
	9-23	12.7	17.5	62.8	6.7	0.05	0.51	31.0	12.4	0.75	1.00	54.0	84
	23-39	55,6	15.6	28.8	7.2	0.05	0.12	37.4	13.6	0.74	0.77	58.2	90
7. Arandiva	0-9	77.7	69	15.4	5.7	0.06	0.67	4.5	0.4	0.07	0 12	6.0	85
	9-35	68.1	7.3	24.6	6.3	0.08	052	88	0.8	0.09	0.13	10.8	90
	35-58	62.8	5.5	31.7	6.6	0.04	0.52	10.0	4 4	0.14	0.24	14.6	101
	58-97	65.3	5.9	28.8	6.5	0.02	0.30	8.0	5.6	0.11	0.15	14,6	94
8. Bhimgarh	0-14	2.7	25.5	71.8	8.0	0.17	0.81	39.2	3.4	0.11	0.88	48.9	90
	14-33	4.2	25.9	69.9	8.0	0,17	0.67	40.6	3.5	0.16	0.81	48.2	93
	33-53	2.5	24.8	72.7	8.0	0.16	0.52	40.9	6.1	0.26	0.74	52.2	92
	53-85	2.3	220	75.7	8.0	0.14	0.45	38.7	7.2	0.27	0.75	48.9	96
	85-140	2.6	21.0	76.4	80	0.14	0.44	40.8	8.2	0.26	0.74	53.1	94
9 Jamunpani	0-24	7.4	24.8	67.8	6.3	0.05	008	30.2	8.8	0.41	0.81	44.4	90
	24-62	5.7	22.4	71.9	6.7	0.03	0.53	33.2	8.3	0.43	0.81	45.8	93
	62-113	4.3	20.2	75.5	7.0	0.04	0.52	42.4	10.8	0.46	0.61	58.0	93
	113-127	22.5	23 7	53.8	8.2	0.13	0.15	56.0	9.4	0.43	0.37	66.8	99
	127-150	48.3	27.3	24.4	8.3	0.13	007	41.5	6.6	0.40	0.26	50.5	96
10. Dhenka	0-11	14.9	26.6	58.5	7.5	0.18	0.75	34.4	5.6	050	0.42	42.6	96
	11-34	10.2	23.8	66.0	7.9	0.10	0.61	32.8	9.2	0.46	0.44	46.9	91
	34-65	8.9	293	61.8	7.9	0.12	0.54	37.6	9.2	0.56	0.42	48.7	98
	65-103	8.9	27.8	63.3	8.0	0.14	047	34.3	16.0	0.60	0.47	55.6	92
	103-150	8.2	26.1	65.7	8.0	0.14	0.47	392	10.8	0.68	0.48	54.8	93
11.Chhui	0-15	14.3	32.2	53.5	7.0	0.10	0.96	22.1	7.7	1.20	0.41	33.0	95
	15-63	13.5	29.2	57.3	8.0	0.12	0.89	21.1	9.9	3.09	0.28	34.2	100
	63-104	25.7	21.9	52.4	8.7	0.32	0.74	13.5	13.4	4.81	0.25	304	104
	104-150	44.4	14.7	40.9	8.7	0.27	0.27	11.5	13.8	3.01	0.20	28.2	101
12. Khrasaru	0-25	9.8	22.7	67.5	6.9	0.04	0.80	30.8	10.8	0.41	0.81	43.8	97
	25-53	7.4	22.2	704	7.2	0.03	078	31.6	10.4	0.45	0.76	45.4	95
	53-81	30.1	14.3	55.6	7.8	0.09	0.50	34.8	14.8	0.52	0.76	52.0	97
13. Atari	0-14	31.8	22.7	45.5	6.4	0.28	0.61	20.9	3.9	0.38	0.76	28.8	89
	14-45	32.7	22.5	44.8	7.7	0.14	0.41	17.6	2.5	039	0.22	23.0	90
	45-90	28.2	23.1	48.7	7.9	0.10	0.34	22.0	29	0.47	0.41	30.4	84
	90-150	26.5	23.3	S0.2	8.0	0.14	0.34	24.7	3.5	0.46	0.29	32.9	90
14. Masanbarra	0-7	74.5	5.9	19.6	5.1	0.26	2.10	6.0	2.4	0.07	0.09	10.8	79
	7-25	695	6.5	24.0	5.3	0.09	0.77	8.4	2.4	0.05	0.04	11.8	92
	25-52	61.5	9.0	29.5	5.1	0.02	0.28	5.2	0.8	0.07	0.06	7.6	82
	52-68	59.3	13.2	27.5	5.3	0.01	0.37	7.6	2.4	007	0.05	10.8	93
	68-90	63.2	13.1	23.7	5.3	0.01	0.56	8.8	2.0	009	0.06	12.0	83

15.Paddikona	0-10	13.9	22.7	63.4	7.0	0.16	1.09	33.2	8.84	0.07	0.56	47.18	90
	10-30	14.7	20.7	64.6	7.3	0.22	0.94	35.0	9.45	0.10	0.53	48.44	93
	30-50	12.8	20.0	67.2	7.6	0.24	0.90	35.2	9.94	0.12	048	47.44	95
	50-90	11.4	19.8	68.8	7.7	0.21	0.85	34.3	10.39	0.18	054	49.96	91
	90-150	9.8	19.4	69.8	7.6	0.29	0.81	33.9	10.78	0.26	0.54	47.83	95
16. Lungsa	0-8	22.0	20.0	58.0	6.1	0.05	0.67	21.9	8.74	0.62	0.56	37.2	85
	8-59	15.2	20.2	64.6	6.7	0.04	0.48	28.1	9.28	0.69	0.56	37.2	103
	59-93	13.7	18.8	67.5	7.0	0.05	0.46	33 1	10.37	0.70	0.61	43.4	103
	93-140	9.3	20.8	69.9	7.8	0.15	0.47	38.9	9.83	0.77	0.56	58.2	85
17. Sagar	0-12	18.6	25.4	56.0	6.4	0.09	1.07	33.6	7.2	0.53	0.56	40.0	101
	12-32	16.9	19.9	63.2	6.7	0.06	0.68	32 0	11.6	0.50	0.38	46.8	92
	32-46	19.7	22.1	58.2	7.0	0.06	0.54	30.4	10.0	0.48	0.32	45.2	93
	46-60	58.8	13.0	28.2	7.4	0.07	0.20	36.0	12.4	0.56	0.21	44.2	103
18	0-3	39.1	22.8	38.1	6.4	0.16	1.84	18.6	11.74	0.56	1.00	33.8	94
Lakhnadon	3-13	38.1	21.0	40.9	6.6	0.08	0.56	20.1	12.45	0.43	0.18	46.0	72
	13-30	35.8	23.2	41.0	6.8	0.06	0.55	24.1	14.75	0.47	0.31	41.6	95
	30-54	72.4	14.4	13.2	7.0	0.07	0.42	19.6	10.17	0.64	0.34	38.2	80
19. Pipariya	0-5	42.2	28.6	29.2	6.6	0.11	1.05	25.8	10.20	0.42	0.37	43.4	85
	5-16	35.9	27.5	36.6	6.9	0.07	0.98	26.8	10.68	0.36	0.20	49.4	70
	16-35	33.8	35.1	37.1	7.0	0.08	0.42	30.5	11.91	0.26	0.28	53.8	79
20. Kanera	0-12	49.2	19.9	30.9	6.3	0.09	1.0	28.5	13.89	0.34	0.43	55.3	78
21. Kodajhiri	0-19	23.4	21.1	55.5	8.0	0.22	0.99	19.4	10.13	1.28	0.62	32.2	97
	19-42	24.2	18.4	57.4	8.4	0.18	0.62	19.3	11.53	2.61	0.40	34.1	99
	42-76	22.4	23.1	54.5	8.5	0.18	0.49	15.4	12.6	3.53	0.40	31.2	102
	76-123	21.5	21.7	56.8	8.7	0.29	0.49	15.5	14.27	5.10	0.44	34.4	103
	123-150	18.9	24.6	56.5	8.8	0.41	0.48	16.3	16.68	7 08	0.56	35.0	116
22. Silghat	0-11	57.7	13.6	28.7	5.5	0.05	1.27	4.71	0.41	0.30	0.12	7.8	71.0
	15-21	59.8	7.7	32.5	59	0.02	0.88	5.49	0.71	0.31	0.14	9.4	70.0
	21-42	68.8	4.7	26.5	5.9	0.01	0.69	6.75	1.69	0.32	0.12	11.2	79.0
	42-80	70.9	4.8	24.3	6.3	0.02	0.44	2.96	0.38	0.27	0.14	6.2	60.0
	80-110	69.0	5.4	25.6	6.8	002	0.18	3.18	0.53	0.29	0.17	6.8	61.0
23.Jsmuntola	0-13	75.2	4.0	20.8	6.9	0.14	0.99	6.91	1.44	0.31	0.40	10.2	89.0
24. Tarali	0-22	30.8	18.7	50.5	6.7	0.06	0.62	15.9	4.21	0.05	0.40	22.4	92.0
	22-56	23.4	18.6	58.0	7.7	0.07	0.34	20.3	4.52	0.07	0.47	31.5	82.0
	56-82	24.5	189	56.6	8.0	0.11	0.34	25.9	5.64	0.06	0.46	33.0	98.0
	82-110	22.4	10.2	67.4	8.0	0.11	0.27	25.1	5.80	0.06	0.45	32.4	97.0
	110-161	26.4	15.9	57.7	8.0	0.13	0.27	25.1	7.55	0.08	0.49	34.1	97.0
25. Khawasa	0.13	79.7	4.9	15.4	5.8	0.03	0.49	3.3	0.92	0.11	0.13	5.39	82.0
	13-31	80.3	4.8	14.9	6.4	0.03	0.43	5.2	0.84	0.09	0.07	6.73	93.0
	31-60	80.3	3.8	15.9	6.6	0.03	0.35	5.3	0.90	0 13	009	6.96	920
	60-96	81.3	3.4	15.3	6.9	0.04	0.21	5.7	0.89	008	0.09	7.12	95 0
	96-140	79.2	4.3	16.4	7.0	0.05	0.21	5.5	1.09	0.04	0.05	6.74	98.0
26. Pratappur	0-19	5.0	26.7	68.3	6.3	0.06	0.90	35.4	9.22	0.13	0.52	37.5	94.0
	19-44	4.6	18.5	76.9	6.9	0.06	0.97	33.1	7.31	0.18	0.53	42.0	88.0
	44-75	4.4	9.2	86.4	7.5	0.11	0.49	39.5	8.53	0.24	0.53	42.6	103.0
	75-111	4.2	8.4	87.4	7.2	0.08	0.34	38.4	6.99	0.27	0.45	40.3	103.0
	111-159	17.9	8.6	73.5	7.3	0.07	0.24	40.6	7.78	0.30	0.49	46.7	97.0
27. Rukhad	0-16	84.1	1.6	14.3	5.8	0.03	0.99	4.1	1.30	0.18	0.23	9.71	60.0
	16-49	83.6	1.5	14.9	5.7	0.01	0.83	4.4	1.29	0.18	0.17	9.49	64.0
	49-78	83.3	2.1	14.6	5.6	0.01	0.63	4.4	1.18	0.18	0.17	9.66	59.0
	78-108	77.3	5.9	16.8	5.7	0.01	0.90	6.7	1.22	0.19	0.18	11.6	72.0
28. Sukla	0-18	45.3	14.7	40.0	5.7	0.03	1.10	6.0	2.02	0.02	0.20	13.6	61.0
	18-34	44.3	15.7	40.0	5.8	0.02	0.74	7.3	2.04	0.03	0.15	14.2	61.0
29. Bisapur	0-17	75.6	8.0	16.4	6.5	0.07	1.11	6.9	1.33	Tr	0.05	9.50	89.0
	17-46	75.0	5.4	19.6	5.9	0.02	0.56	3.9	1.04	Tr	0.13	7.60	66.0
	46-78	75.9	5.6	18.5	6.0	0.01	0.35	3.3	0 88	0.01	0.10	6.51	66.0
	78-120	75.6	4.6	19.8	5.9	0.01	0.34	3.7	0.95	0.01	0.12	7.90	60.0
30.Gondatola	0-14	25.2	33.8	41.0	4.9	0.01	1.11	5.0	1.96	0.01	0.12	13.6	52.1
	14-43	15.7	25.9	58.4	5.1	0.01	0 91	7.8	2.90	0.03	0.14	18.0	60.4
	43-78	25.8	16.0	58.2	5.5	0.02	0.62	7.9	2.86	0.06	0.16	16.7	64.3
	78-122	41.1	10.8	48.1	5.7	0.01	0.49	6.9	2.30	0.05	0.12	13.8	67.2

8.
SOIL CLASSIFICATION

The thirty soil series are classified depending on diagnostic surface and subsurface horizons, physical and chemical characteristics as per the Soil Survey Staff (1998). These soils are placed in the subgroups of Entisols, Inceptisols, Vertisols and Alfisols (Table 12).

Table 12. Classification of soils in Seoni district

Soil Sub-groups	Soil Series	Diagnostic Character	
		Surface	Sub-surface
1.Lithic Ustorthents	Kanera, Jamuntola, Parasia, Dhora	Ochric having munsel colour value of 3 and above. These horizons are too thin and does not have rock structure.	Lithic contact within a 50 cm of solum depth.
2.Typic Ustorthents	Sukla	Ochric epipedon	Paralithic contact more than 50 cm depth.
3.Typic Haplustepts	Masanbarra, Rukhad, Bisapur, Khawasa, Sagar, Lakhanadon	Ochric epipedon with low organic matter content.	The cambic horizon is 15 cm or more thick with dominant colour on ped faces with value of 3 or less and chroma of 2 or less. These horizons have clay content >30%.
4.Vertic Haplustepts	Atari	Ochric epipedon	In vertic sub group, the surface cracks more than 2cm to a depth of 50 cm or below.
5.Lithic Haplustepts	Pipariya, Khamariya, Gorakhpur	Ochric epipedon	Lithic contact within 50 cm depth.
6.Dystric Haplustepts	Silghat	Ochric epipedon	Cambic subsurface horizon with Dystric properties where in base saturation is less than 60% between Ap horizon and 75 cm below the mineral soil surface.
7.Typic Epiaquepts	Chhui	Ochric epipedon	These soils are saturated with water in one or more layer within 100cm and has one or more unsaturated within upper boundary above the depth of 200cm and below saturated layer. These soil have a chroma of 2 or less within 50 cm of mineral soil surface.
8.Typic Haplusterts	Paddikona, Tarali, Kodajhiri, Nadora, Lungsa, Bhimgarh	Ochric epipedon	Slickensided zone appears below 60cm with angular blocky aggregates.
9. Ustic Epiaquerts	Kharasaru, Jamunpani, Dhenka	Ochric epipedon that have aquic conditions for sometime in normal years and have chroma of 2 on the faces of peds.	These soils are mostly under irrigation and doubled cropped area and localized near dam sites. These soil shave episaturated with cracks of 5 mm or wider through a thickness of 25 cm or more with in 50 cm of mineral surface for 90 or more cumulative days per year.
Ustic Endoqaquerts	Kodajhiri, Lungsa, Bhimgarh	Ochric	Have cracks in normal years that are 5 nun or more wide, through a thickness of 25 cm or more with in 50 cm of the mineral surface for 90 or more cumulative days per year.
10.Typic Haplustalfs	Chunamati	Ochric epipedon with organic carbon of 0.93 percent.thickness of 16cm and clay of 64 percent and pH of 6.8.	Argillic, an illuvial clay enriched horizons.
11. Udic Haplustalfs	Arandiya, Pratappur	Ochric	Argillic with base saturation more than 60 percent.
12. Typic Rhodustalfs	Gondatola	Ochric	Very deep red 2.5YR 3/6 with increase of clay content more than 6 percent as compared to elluviai A horizons which have 40 percent clay.

9.
BRIEF DESCRIPTION OF SOILS

Thirty soil series identified in Seoni district are correlated with some of the series identified and described in Madhya Pradesh by Tamgadge et al. (1999). Brief description is given below but details of series description is given in Appendix 1.

1) **Arandiya series** is the member of fine-loamy, mixed, hyperthermic family of Udic Haplustalfs. This soil has light yellowish brown (10YR 6/4) to brown (10YR 5/3) sandy loam Ap horizons and dark yellowish brown (10YR 4/4) sandy clay loam B horizons with brown (10YR 4/3) to yellowish brown (10YR 5/6) C horizon and hard murrum. They occur on very gently slopping rolling pediplain at an elevation of 620 m. These soils are mostly under cultivation of paddy, wheat and soybean.

2) **Atari series** is the member of fine, mixed, hyperthermic family of Vertic tiaplustepts. This soil has greyish brown (2.5Y 5/2) clayey Ap horizons and very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2) clayey Bw horizons. They occur on moderately steeply sloping on steeply sloping denudational escarpments at an elevation of 500 m. They are mostly under cultivation of paddy and wheat.

3) **Bhimgarh series** is the member of very-fine, montmorillonitic, hyperthermic family of Ustic Endoaquerts. This soil has very dark greyish brown (2.5Y 3/2), clayey Ap horizon and very dark greyish brown (2.5Y 3/2 M) clay textured Bss horizons with intersecting slickensides. They occur on gently sloping upper denudational plateau at an elevation of 500 m. They are mostly under cultivation of wheat, gram, masur and Red gram.

4) **Bisapur series** is the member of fine-loamy, mixed, hyperthermic family of Typic tiaplustepts. This soil has dark brown (7.SYR 3/2) sandy loam A horizon and weathered Cr horizon. They occur on very gently sloping flood plain at an elevation of 600 m. They are mostly under forest.

5) **Chhui series** is the member of fine, mixed, hyperthermic family of Typic Eqiaquepts. This soil has dark greyish brown (2.5Y 5/2) to very dark greyish brown (2.5Y 4/2) clayey Ap horizons and very dark grey (2.5Y 3/1) to dark greyish brown (2.5Y 4/2) clayey to sandy clay Bw horizons. They occur on gently sloping lower denudational plateaus at an elevation of 480 m above MSL. They are mostly under pasture lands.

6) **Chunamati series** is the member of fine, mixed, hyperthermic family of Typic Haplustalfs. This soil has dark brown (7.5YR 3/2), clayey Ap horizon and dark brown to brown (7.5YR 3/2 to 7.5YR 4/2) clay to sandy clay B horizons with weathered Cr horizons. They occur on gently sloping undulating plateau at an elevation of 560 m mean sea level. They are mostly under cultivation of rice, wheat and soybean.

7) **Dhenka series** is the member of very-fine, montmorillonitic, hyperthermic, very deep family of Ustic Epiaquerts. This soil has greyish brown (2.5Y 5/2) clayey Ap horizons and very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2) clayey Bss horizons with intersecting slickensides. They occur on undulating sloping lower denudational plateaus at an elevation of 480 m. They are mostly under cultivation of Red gram, sugarcane, soybean, wheat and rice.

8) **Dhora series** is a member of the loamy, mixed, hyperthermic, extremely shallow family of Lithic Ustorthents. This soil has dark brown (7.5YR 3/3), clayey A horizon and hard rock with in 50 cm. They occur on gently sloping narrow interhill basins at an elevation of 540 m mean sea level. They are mostly under forest.

9) **Gondatola series** is the member of fine, mixed, hyperthermic family of Typic Rhodustalfs. This soil has very dark reddish brown (2.5Y 3/4), clayey Ap horizons and dark red (2.5YR 3/6) clayey B horizons and weathered Cr horizon. They occur on moderately sloping rolling pediplains at an elevation of 620 m mean sea level. They are mostly under cultivation of rice, wheat, gram and vegetables crops.

10) **Gorakhpur series** is the member of fine, mixed, hyperthermic family of Lithic Haplustepts. This soil has very dark gray (2.5Y 3/1), clayey Ap horizon and very dark grey (2.5YR 3/1) clayey B horizon followed by very dark grey (2.5Y 3/1) sandy clay loam Cr horizon underlained by weathered parent material in R horizon. They occur on very gently sloping undulating plateau with moderately well drained soils at an elevation of 720 m mean sea level. They are mostly under cultivation of Red gram, wheat and rice.

11) **Jamunpani series** is the member of very-fine, montmorillonitic, hyperthermic family of Ustic Epiaqerts. This soil has olive brown (2.5Y 5/3), clayey Ap horizon and very dark greyish brown (2.5Y 3/2) clayey Bss horizon with intersecting slickensides and olive brown (2.5Y 4/4) clayey to sandy clay B horizons. They occur on gently sloping upper denudational plateaus. They are mostly under cultivation of soybean and pigeonpea.

12) **Jamuntola series** is the member of loamy, mixed, hyperthermic, very shallow family of Lithic Ustorthents. This soil has dark brown (10YR 3/3), sandy loam A horizons and weathered Cr horizon. They occur on gently sloping denudational plateaus at an elevation of 428 m. They are mostly under forest.

13) **Kanera series** is a member of the fine, mixed, hyperthermic family of Lithic Ustorthents. This soil has dark brown (7.5YR 3/4), sandy clay loam Ap horizon and weathered Cr horizon. They occur on moderately steeply sloping structural plateaus at an elevation of 620 m and above mean sea level. They are mostly under cultivation of wheat, soybean, sugarcane, potato, coriander and other vegetable crops.

14) **Khamariya series** is a member of fine, mixed, hyperthermic family of Lithic Haplustepts. This soil has dark brown (7.5YR 3/4), clayey A horizon and dark brown (7.5YR 3/4) clayey Cr horizon. They occur on very gently sloping structural plateaus at an elevation of 640 m and above mean sea level. They are mostly under cultivation of Red gram, paddy and wheat.

15) **Kharsaru series** is the member of fine, montmorillonitic, hyperthermic family of Ustic Epiaquerts. This soil has very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2) clayey Ap horizons and very dark grey (2.5Y 3/1) clayey Bss horizons with intersecting slickensides. They occur on moderately sloping lower denudational plateau at an elevation of 460 m. They are mostly under cultivation of pigeonepaand soybean.

16) **Khawasa series** is the member of coarse-loamy, mixed, hyperthermic family of Typic Haplustepts. This soil has dark yellowish brown (10YR 4/4) sandy loam A horizon and brown to dark yellowish brown (10YR 4/3, 4/4) sandy loam Bw horizon. They occur on moderately sloping lower denudational plateaus at an elevation of 400 m. They are mostly under forest.

17) **Kodajhiri series** is a member of the fine, montmorillonitic, hyperthermic family of Ustic Endoaquerts. This soil has dark greyish brown (2.5Y 4/2), clayey Ap horizon and very dark grayish brown (2.5Y 3/2) clayey Bss horizons with intersecting slickensides. They occur on moderately steeply sloping middle level plateaus at an elevation of >420 m above MSL. They are mostly under cultivation of rice, wheat, gram, peas and arhar.

18) **Lakhanadon series** is the member offine, mixed, hyperthermic, moderately shallow family of Typic Haplustepts. This soil has dark brown (7.5YR 3/2) clay loam Ap horizon and dark brown (7.5YR 3/2) to dark reddish brown (5YR 3/3) clay to sandy loam Bw horizons and Cr horizon. They occur on moderately sloping isolated hillocks at an elevation of 570 m. They are mostly under pasture.

19) **Lungsa series** is the member of very-fine, montmorillonitic, hyperthermicp family of Ustic Endoaquerts. This soil has greyish brown (2.5Y 5/3) clayey Ap horizon and very dark grey (2.5Y 3/1) clay textured Bw horizons. They occur on very gently sloping valley bottom at an elevation of 500 m. They are mostly under cultivation of Red gram, linseed, lakhodi, sun hemp and sugar cane.

20) **Masanbarra series** is the member of fine-loamy, mixed, hyperthermic family of Typic Haplustepts. This soil has very dark greyish brown (10YR 3/2) sandy clay Ap horizon and grey (10YR 6/1) to white (10YR 8/1) loamy sand to sandy clay loam Bw horizons with hard rock. They occur on steeply sloping denudational escarpments with well drained soils at an elevation of 420 m. They are mostly under forest.

21) **Nadora series** is a member of very-fine, montmorillonitic, hyperthermic family of Typic HaplustSrts. This soil has dark yellowish brown (10YR 4/4), clayey A horizon and dark greyish brown (10YR 4/2) clayey B horizons with weathered Cr horizon. They occur on gently sloping structural plateaus at an elevation of 600 m and above mean sea level. They are mostly under cultivation of wheat, gram, soybean, paddy and millets.

22) **Paddikona series** is the member of very-fine, montmorillonitic, hyperthermic family of Typic Haplusterts. This soil has very dark brown (10YR 2/2) clayey A horizon and black (10YR 2/1) clayey with intersecting slickensides. They occur on very gently sloping valley bottom at an elevation of 440 m. They are mostly under cultivation of wheat, gram and pigeon pea.

23) **Parasia series** is a member of the loamy, mixed, hyperthermic family of Lithic Ustorthents. This soil has reddish brown (5YR 4/3), sandy clay loam Ap with weathered Cr horizon. They occur on steeply sloping structural hills and ridges at an elevation of 500 m above mean sea level. They are mostly under cultivation of maize and kodo kutki crops.

24) **Pipariya series** is the member offine, mixed, hyperthermic, shallow family of Lithic Haplustepts. This soil has dark greyish brown (2.5Y 4/2) sandy clay loam A horizon and dark greyish brown (2.5Y 4/2) to light grey (2.5 6/1) clay loam Bw horizons. They occur on moderately steeply sloping ridges at an elevation of 620 m. They are mostly under forest.

25) **Pratappur series** is the member of fine, mixed, hyperthermic, very deep family of Udic Haplustalfs. This soil has very dark greyish brown (10YR 3/2) clayey Ap horizon and very dark grey (10YR 3/1) and olive brown (2.5Y 4/4) clayey B horizons. They occur on moderately sloping lower denudational plateaus at an elevation of 620 m. They are mostly under cultivation of paddy, wheat and gram.

26) **Rukhad series** is the member of coarse-loamy, mixed, hyperthermic, deep family of Typic Haplustepts. This soil has dark yellowish brown (10YR 4/4) to light brownish grey (10YR 6/2) loamy sand to A horizon and dark yellowish brown (10 YR4/4), loamy sand to sandy loam Bw horizon with weathered Cr horizon. They occur on very gently sloping broad inter hill basin at an elevation of 530 m. They are mostly under forest.

27) **Sugar series** is the member of fine, mixed, hyperthermic, moderately shallow family of Typic Haplustepts. This soil has very dark greyish brown (10YR 3/2) clayey Ap horizons and very dark grey to very dark greyish brown (10YR 3/1 to 10YR 3/2) clayey Bw horizons with hard rock. They occur on

very gently sloping broad inter hill basin at an elevation of 580 m. They are mostly under cultivation of soybean, paddy and jowar.

28) **Silghat series** is a member of the fine-loamy, mixed, hyperthermic family of Dystric Haplustepts. This soil has pale brown to brown (10YR 6/3), clayey A horizon and dark brown (7.5Y 3/2) clayey B horizon with hard rock. They occur on moderately sloping middle level plateau at an elevation of 500 m mean sea level. They are mostly under cultivation of paddy, wheat, gram and soybean.

29) **Sukla series** is the member of clayey, mixed, hyperthermic, shallow family of Typic Ustorthents. This soil has dark yellowish brown (10YR 4/4) A horizon and weathered Cr horizon. They occur on moderately sloping isolated hillocks moderately to at an elevation of 570 m. They are mostly under forest.

30) **Tarali series** is the member offine, montmorillionitic, hyperthermic family of Typic Haplusterts. This soil has dark brown (10YR 3/3), clayey Ap horizon and dark brown (10YR 3/3) to very dark brown (10YR 3/2) clayey Bss horizons with intersecting slickensides. They occur on moderately sloping denudational plateau at an elevation of 540 m. They are mostly under cultivation of rice, wheat, gram and vegetables.

10.
SOIL MAPPING UNITS

A mapping unit is collection of areas defined and named the same in terms of their soil components or miscellaneous areas or both. Each map unit differs in some respect from all others in the survey area and is uniquely identified on a soil map. Each individual area on the map is delineation. In Reconnaissance soil survey of Seoni district, thirty mapping units, with its delineations and brief descriptions are given below and presented in table 13 and Fig.4.

1. Parasia-Paddikona-Khamariya

These soils occur on structural hills and plateaus of Lakhanadon. The soils are well to excessively drained with neutral reaction. The slopes are mostly I to 3 percent but ranges up to 8 percent in few places. This association covers an area of 43504.72 hectares.

Parasia soils are dominant and have reddish brown, sandy clay loam horizons and neutral to slightly acid reaction. Paddikona is very deep on very gentle slopes and have dark brown clay surface horizons while sub surface soils are black, clay textured and moderately well drained. Khamariya occurs on the very gently sloping structural plateaus. This soil has dark brown surface horizon, sandy clay loam textured and neutral. The subsurface is very dark brown to reddish brown and sandy clay loam to loamy sand textured.

2. Parasia-Pipariya-Khamariya

These soils mostly occur on ridges or structural plateaus. The association covers an area of 104446.64 hectares.

Parasia soils are dominant on structural plateaus with slightly acid reaction. This soil is in association with Pipariya and Khamariya. Pipariya soils are slightly acid to neutral in reaction and has greyish brown to brown surface layer with sandy clay loam texture and grey, sandy clay loam subsurface horizons. Khamariya soils are dark brown sandy clay loam to loamy sand with slightly acid Ap horizon and very dark brown to dark reddish brown and loamy sand B horizons.

3. Sagar-Paddikona-Khamariya

This association is generally found in the northern parts of the district in low lying areas of broad inter hill basin and valley bottom. This unit covers 93840 hectares (10.7 percent of total area).

Sagar soils are dominant with very dark greyish brown, clay textured, neutral at surface and very dark grey, clay textured and neutral at subsurface horizon. Paddikona is the subdominant with very dark brown, clay textured and neutral surface horizon and black, clay textured and neutral subsurface horizons. Khamariya are dark brown, clay loam textured slightly acid in surface horizon and reddish brown, loamy sand and neutral subsurface horizons.

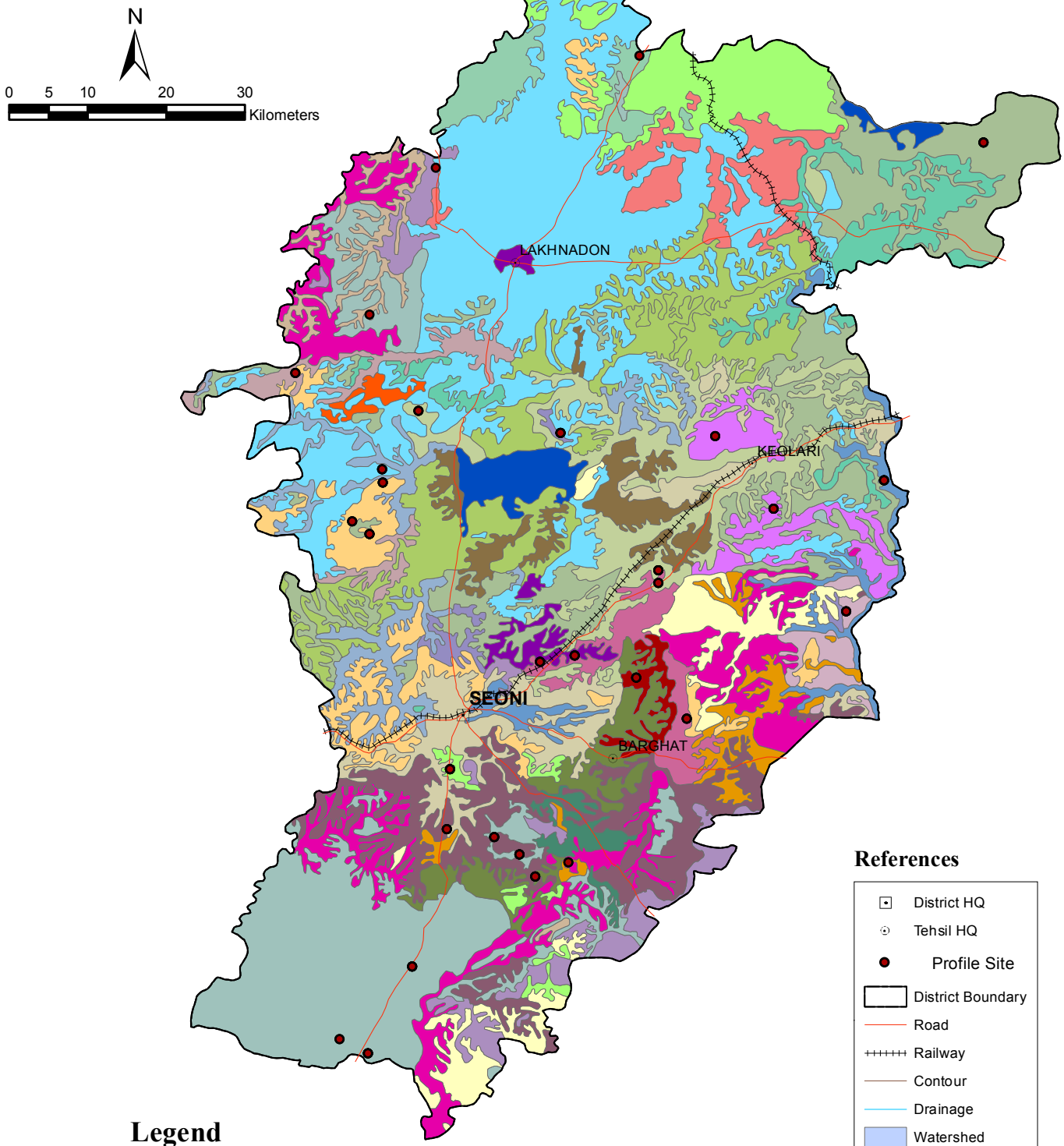
4. Atari-Parasia-Bhimgarh

This association is mostly found in the northern parts of Lakhanadon plateau in the district. This unit covers 24538.32 hectares.

Atari, dominant soil series, have light olive brown, clay textured, slightly acid surface horizon and olive brown to very dark greyish brown clay textured, neutral subsurface horizons. This soil is associated with the Parasia series is a member of the loamy, mixed, hyperthermic, very shallow family of Lithic Ustorthents. This soil has

SEONI

Soil Series Association



References

- District HQ
- Tehsil HQ
- Profile Site
- District Boundary
- Road
- Railway
- Contour
- Drainage
- Watershed

Legend

- Arandiya-Kharsaru-Bhimgarh-Nadora
- Atari-Lungsa-Kharsaru
- Atari-Parasia-Bhimgarh
- Bhimgarh-Khamariya-Atari
- Dhenka-Paddikona-Kharsaru
- Dhenka-Sukla-Khawasa-Nadora
- Dhora-Sukla-Pratappur
- Gorakhpur-Sagar-Paddikona
- Jamuntola-Gondatola-Kharsaru-Rukhad
- Kanera-BisapurJamuntola-Roc outcrop
- Khamariya-Atari-Parasia-Roc outcrop
- Kharsaru-Gorakhpur-Lakhanadon
- Kharsaru-Jamunpani-Chunamati-Parasia
- Khawasa-Lungsa-Lakhanadon
- Khawasa-Sukla-Tarali
- Kodajhiri-khawasa-Sukla
- Lakhanadon-Pipariya-Sagar-Lungsa
- Nadora-Sagar-Dhora
- Parasia-Masanbarra-Khamariya-Roc outcrop
- Parasia-Paddikona-Khamariya
- Parasia-Pipariya-Khamariya
- Pipariya-Sagar-Jamunpani
- Pratappur-Gondatola-Khawasa-Rukhad
- Sagar-Atari-Lungsa
- Sagar-Bhimgarh-Dhenka
- Sagar-Jamuntola-Bisapur
- Sagar-Jamuntola-Rukhad
- Sagar-Paddikona-Khamariya-Parasia
- Silghat-Atari-Chhui
- Tarali-Kodakhiri-Jamuntola
- Reservoir

Fig. 4: Soil Series Association

reddish brown (5YR 4/3), sandy clay loam textured Ap horizons and weathered Cr horizon. They occur on gently sloping structural hills and ridges at an elevation of 500 m and above. They are mostly under cultivation of maize and kodo kutki crops. Bhimgarh series, occurring on very gently sloping denudational plateaus, have very dark greyish brown, clay textured, alkaline A horizons and very dark greyish brown, clay textured and slightly alkaline subsurface horizons.

5. Khamariya-Atari-Parasia

Khamariya soils are dark brown, clay loam, slightly acid surface horizons and reddish brown, loamy sand and neutral subsurface horizons. This soil is associated with Atari and Parasia series. Atari, subdominant soil series, have light olive brown, clay textured, slightly acid surface horizons and olive brown to very dark greyish brown, clay textured and neutral subsurface horizons. This soil is associated with Parasia series having reddish brown, sandy clay textured and slightly acid Ap horizons.

6. Nadora-Sagar-Dhora

This soil association is mostly occur in interhill basins and structural plateaus of basaltic terrain.

The Nadora series is a member of fine, mixed, deep, hyperthermic, family of Vertic Haplustepts. This soil has dark yellowish brown (10YR 4/4), clayey A horizons and dark greyish brown (10YR 4/2), clayey B horizons. They occur on gently sloping structural plateaus and are mostly under cultivation for wheat, gram, soybean, paddy and millets. This soil is associated with Sagar and Dhora. This unit covers 65.61km^2. The Sagar has very dark greyish brown (10YR 3/2), clayey Ap horizons and very dark grey to very dark greyish brown (10YR 3/1 to 10YR 3/2), clayey Bw horizons. They are mostly under cultivation of soybean, paddy and jowar. The Dhora series is very shallow, well drained and slightly acid with a base saturation more than 85 percent and organic carbon of 2.93 percent and has dark brown (7.5YR 3/3), clayey A horizons.

7. Lakhanadon- Pipariya-Sagar-Lungsa

This unit has four soil series association such as Lakhanadon, Pipariya-Sagar-Lungsa soils and cover an area of 257.12 km^2. These soils are moderately deep to deep, well drained with slightly to moderately alkaline but at few places slightly acid.

The Lakhanadon series has dark brown (7.5YR 3/2), clay loam Ap horizons and dark brown (7.5YR 3/2) to dark reddish brown (5YR 3/3), clay to sandy loam Bw horizons. They occur on gently sloping isolated hillocks and are mostly under pasture. This soil is in association with Pipariya series that has dark greyish brown (2.5Y 4/2), sandy clay loam A horizons and dark greyish brown (2.5Y 4/2) to light grey (2.5Y 6/1), clay loam Bw horizons. The Sagar series and Lungsa series have greyish brown (2.5Y 5/3) to light olive brown Ap horizons and dark grey (2.5Y 3/1), clayey Bw horizons. They are mostly under cultivation of pigeonpea, linseed, lakhodi, sunhemp and sugarcane.

8. Pipariya-Sagar-Jamunpani

This unit covers 259.865 km^2 and has three soil series association as described below.

Pipariya series is shallow, well drained and slightly acid surface and neutral B horizons. This soil has dark greyish brown (2.5Y 4/2), sandy clay loam A horizons and dark greyish brown (2.5Y 4/2) to light grey (2.5 6/1), clay loam Bw horizons. Sagar series is moderately deep and slightly acid to slightly alkaline soil in association with very deep, moderately well drained, Jaraunpani series that has greyish brown (2.5Y 5/3), slightly acid and clay textured Ap horiozon and neutral or moderately alkaline, dark grey (2.5Y 3/1), clayey Bw horizons. They are mostly under cultivation of Red gram, linseed, lakhodi, sunhemp and sugarcane.

9. Gorakhpur-Sagar-Paddikona

This unit covers 112.36 hectares and has three soil associations such as Gorakhpur (shallow)-Sagar(moderateIy deep) and Paddikona(very deep).

The Gorakhpur series is slightly acid to neutral with very dark grey (2.5Y 3/1), clayey Ap horizons and very dark grey (2.5YR 3/1) clayey B horizons. They are mostly under cultivation of redgram, wheat and rice. The Sagar series is moderately deep and slightly acid to slightly alkaline and is in association with very deep, moderately well drained Jamunpani series that has greyish brown (2.5Y 5/3), slightly acid and clay textured Ap horiozon and neutral or moderately alkaline, dark grey (2.5 Y 3/1) clayey Bw horizons. They are mostly under cultivation of Red gram, linseed, lakhodi, sunhemp and sugarcane. The Paddikona series is very deep, neutral to slightly alkaline with very dark brown (10YR 2/2), clayey A horizons and black (10YR 2/1), clayey B horizons with intersecting slickensides. They are mostly under cultivation of wheat and gram.

10. Arandiya-Kharsaru-Bhimgarh-Nadora

This unit covers 346.96 hectares with four soil series association of Arandiya (moderately deep) - K harasaru (moderately deep) - Bhimgarh (very deep) -Nadora (deep).

The Arandiya series is well drained, slightly acid to neutral, light yellowish brown (10YR 6/4) to brown (10YR 5/3), sandy loam Ap horizons and dark yellowish brown (10YR 4/4), sandy clay loam B horizons. There soils are mostly under cultivation of paddy, wheat and soybean. This soil is in association with the Kharsaru series having very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2), clayey Ap horizon and very dark grey (2.5Y 3/1), clayey Bss horizon with intersecting slickensides. This soil is neutral to slightly alkaline in reaction and occur on very gently sloping lower denudational plateaus. They are mostly under cultivation of Red gram and soybean.

The Bhimgarh series is very deep, moderately well drained, slightly alkaline, very dark greyish brown (2.5Y 3/2), clayey Ap horizon and very dark greyish brown (2.5Y 3/2 M), clayey Bss horizons with intersecting slickensides. This soil is in association with moderatly alkaline Nadora series having dark yellowish brown (10YR 4/4), clayey A horizons and dark greyish brown (10YR 4/2) and clayey B horizons.

11. Atari -Parasia-Lungsa- Kharsaru

This unit covers 67.42 hectares and consists of four series association as: Atari, Parasia, Lungsa and Kharasaru.

Atari, the dominant soil series, have light olive brown, clay textured, slightly acid surface horizons and olive brown to very dark greyish brown, clay textured, neutral subsurface horizons. This soil is associated with Parasia series having reddish brown, sandy clay textured and slightly acid Ap horizons. Lungsa series is greyish brown (2.5Y 5/3), clayey Ap horizon and very dark grey (2.5Y 3/1), clayey Bw horizon and the Kharsaru series is very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2) clayey Ap horizon followed by very dark grey (2.5Y 3/1) and clayey Bss horizons with intersecting slickensides.

12. Silghat-Atari-Chhui

This unit covers 11414.74 hectares and has three soil series association as Silghat-**Atari**-Chhui.

The Silghat series is dominant and have loamy top soil and subsoil type, good water holding capacity and low ability to retain nutrients for plants mainly K, Ca and Mg. Moisture is limiting during dry season. Germination

problems are often experienced if first rains are sporadic. This soil has pale brown to brown (10YR 6/3), clayey A horizon and dark brown (7.5Y 3/2), clayey B horizons. They are mostly under cultivation of paddy, wheat, gram and soybean cultivation. This soil is in association with Atari, having light olive brown, clay textured, slightly acid surface horizons and olive brown to very dark greyish brown, clay textured, neutral subsurface horizons. The Chhui have dark greyish brown (2.5Y 5/2) to very dark greyish brown (2.5Y 4/2), clayey Ap horizon and dark grey (2.5Y 3/1) to dark greyish brown (2.5Y 4/2) and clayey to sandy clay Bw horizons. They occur on gently sloping lower denudational plateaus and are mostly under pasture.

13. Dhenka-Paddikona-Kharsaru

This unit covers 49527.2 hectares (5.65 percent of total area) and has three series association.

Dhenka (very deep, slightly to moderately alkaline) - Paddikona (very deep) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Kharasaru series has clayey top soil and substrata type with ustic soil moisture regime and high “P” fixation capacity. They occur on very gently sloping lower denudational plateaus and are mostly under cultivation of wheat and gram.

14. Sagar -Bhimgarh- Dhora

This unit covers 13212.86 hectares (1.5 percent of total area) and has three soils series association.

Sagar (Sa) and Bhimgarh (Bg) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc and is associated with Dhora series having clay top soil, hard root restricting layers, dry more than 90 cumulative days per year, high “P” fixation, low “K” reserves and have gravels more than 35 percent.

15. Kharasaru-Jamunpani-Chunamati-Parasia

This unit covers 16808.1 hectares (1.92 percent of total area) and has soil associations of Kharasaru-Jamunpani-Chunamati - Parasia.

The Kharsaru series is fine textured, moderately deep having very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2) Ap horizons and very dark grey (2.5Y 3/1) Bss horizons with intersecting slickensides. This soil is in association with the very deep, fine textured Jamunpani series with olive brown (2.5Y 5/3), clayey Ap horizons and very dark greyish brown (2.5Y 3/2), clayey Bss horizon with intersecting slickensides, the Chunamati series with fine texture and moderately deep, dark brown (7.5YR 3/2), clayey Ap horizons and dark brown to brown (7.5YR 3/2 to 7.5YR 4/2), clayey to sandy clay B horizons and the very shallow Parasia series having reddish brown (SYR 4/3), and sandy clay loam Ap horizons.

16.Bhtmgarh-Kharsaru-Atari

This unit covers 3955.44 km^2 (0.45 percent to the total area) with Bhimgarh-Kharasaru-Atari series association.

The Bhimgarh series is deep, very dark greyish brown (2.5Y 3/2), clayey Ap horizons and very dark greyish brown (2.5Y 3/2 M), clayey Bss horizon with intersecting slickensides. This soil is in association with the moderately deep and fine textured Kharsaru series having very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2), clayey Ap horizons and very dark grey (2.5Y 3/1) clayey Bss horizons with intersecting slickensides. Atari have light olive brown, clay textured, slightly acid surface horizon and olive brown to very dark greyish brown, clay textured and neutral subsurface horizons.

17. Kharasaru-Gorakhpur-Lakhanadon

This unit covers 17617.82 hectors (2.01 percent of total area) with Kharasaru-Gorakhpur-Lakhanadon.

The Kharsaru series is moderately deep with very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2), clayey Ap horizons and very dark grey (2.5Y 3/1) and clayey Bss horizons with intersecting slickensides. This soil is in association with the Gorakhpur series of fine, shallow with very dark grey (2.5Y 3/1), clayey Ap horizons and very dark grey (2.5YR 3/1) and clayey B horizons with a lithic contact below 50cm. The Lakhanadon series is coarse-loamy, moderately shallow with dark brown (7.5YR 3/2) clay loam Ap horizons and dark brown (7.5YR 3/2) to dark reddish brown (SYR 3/3) and clay to sandy loam Bw horizons.

18. Parasia- Masanbarra- Khamariya-Rockoutcrops

This unit covers 21812.2(2.49 percent of the total area) and has three soil series association such as Parasia-Masanbarra-Khamariya-rockoutcrops.

The Parasia series is loamy, very shallow and slightly acid with reddish brown (5YR 4/3), sandy clay loam Ap horizons and weathered Cr horizon. This soils is in association with coarse loamy, deep, strongly acid Masanbarra series having very dark greyish brown (10YR 3/2), sandy clay Ap horizon and grey (10YR 6/1) to white (10YR 8/1) and loamy sand to sandy clay loam Bw horizons. The Khamariya series is loamy, shallow and slightly acid to neutral with dark brown matrix (7.5YR3/4).

19. Sagar-Atari- Lungsa

This unit covers 6022.5 hectares (0.69 percent) with soil association of the fine, moderately shallow and slightly acid or slightly alkaline

Sagar and Atari series have light olive brown, clay textured, slightly acid surface horizon and olive brown to very dark greyish brown, clay textured neutral subsurface horizons. This soil is associated with deep Lungsa series having greyish brown (2.5Y 5/3), clayey Ap horizons and very dark grey (2.5Y 3/1) and clayey Bw horizons.

20 Sukla-Jamuntola-Bisapur

This unit covers 50487.8 hectares (5.76 percent) with loamy, shallow Sukla series having dark yellowish brown (10YR 4/4) A horizons and weathered Cr horizon. The associated Jamuntola series have dark brown (10YR 3/3), sandy loam A horizons and Bisapur series having dark brown, loamy sand Ap horizons and dark brown cambic B horizons with loamy sand textures.

21. Kodajhiri-Khawasa-Sukla

This unit covers 25796.6 hectares (2.95 % of the total) with Kodajhiri as dominant series having greyish brown (2.5Y 4/2), clayey Ap horizons and very dark greyish brown (2.5Y 3/2) clayey Bss horizon with intersecting slickensides. This soil is associated with coarse loamy, deep, Khawasa series having dark yellowish brown (10YR 4/4), sandy loam A horizon and brown to dark yellowish brown (10YR 4/3, 4/4) sandy loam Bw horizons and loamy, shallow, Sukla series with yellowish brown (10YR 4/4) A horizons and weathered Cr horizon.

22. Dhenka-Sukla-Khawasa -Nadora

This unit covers 45841.7 hectares (5.23 percent) with Dhenka series as dominant having greyish brown (2.5Y 5/2), clayey Ap horizons and very dark greyish brown (2.5Y 3/2) to dark greyish brown (2.5Y 4/2) clayey Bsshorizons with intersecting slickensides. This soil is in association with loamy, shallow Sukla series with dark yellowish brown (10YR 4/4) A horizons and coarse loamy, deep Khawasa series with dark yellowish brown (10YR 4/4), sandy loam A horizons and brown to dark yellowish brown (10YR 4/3, 4/4), sandy loam Bw horizons and Nadora series with yellowish brown (10YR 4/4), clayey A horizons and dark greyish brown (10YR 4/2) and clayey B horizons.

23. Jamuntola -Gondatola-Khawasa~Rukhad

This unit covers 17438.2 hectares (1.99 percent) and has four series association.

The coarse-loamy, very shallow, Jamuntola series has dark brown (10YR 3/3), sandy loam A horizons and is associated with fine, deep, Gondatola series with very dark reddish brown (2.5Y 3/4), clayey Ap horizons and dark red (2.5YR 3/6), clayey B horizons. The Khawasa series is coarse-loamy, deep with dark yellowish brown (10YR 4/4), sandy loam A horizons and brown to dark yellowish brown (10YR 4/3, 4/4) sandy loam Bw horizons. The Rukhad series has dark yellowish brown (10YR 6/4), loamy sand textured A horizons to dark yellowish brown (10YR 4/4) and loamy sand or sandy loam cambic B horizons.

24. Pratappur -Gondatola -Khawasa-Rukhad

This unit covers 13303.17 hectares (l.52 percent) with four series association.

The fine, very deep, neutral to slightly alkaline Pratappur series is dominant with very dark greyish brown (10YR 3/2), clayey Ap horizons and very dark grey (10YR 3/1) and olive brown (2.5Y 4/4) clayey B horizons. This soil is in association with Gondatola series having very dark reddish brown (2.5YR 3/4), clayey Ap horizons and dark red (2.5YR 3/6), clayey B horizons, The Khawasa series have dark yellowish brown (10YR 4/4), sandy loam A horizons and brown to dark yellowish brown (10YR 4/3, 4/4), sandy loam Bw horizon. The Rukhad series has dark yellowish brown (10YR 6/4), loamy sand textured A horizons to dark yellowish brown (10YR 4/4) and loamy sand or sandy loam cambic B horizons.

25. Sukla-Jamuntola-Rukhad

This unit covers 67506.26 hectares (7.7 percent of the total) with dominant Sukla series having dark yellowish brown (10YR 4/4) A horizons, the Jamuntola series with dark brown (10YR 3/3), sandy loam A horizons and the Rukhad series with light yellowish brown, loamy sand A horizons (10YR 6/4) and dark yellowish brown (10YR 4/4), loamy sand or sandy loam B horizons..

26. Kanera-Bisapur-Jamuntola-Rock out crops

This unit covers 11236.20 hectares (1.28 percent) with dominant Kanera series having dark brown (7.5YR 3/4), sandy clay loam Ap horizons, the Bisapur series having dark brown (7.5YR 3/2) sandy loam A horizons, the Jamuntola series with dark brown (10YR 3/3), sandy loam A horizons and rockout crops. They occur on gently sloping denudational plateaus and are mostly under forest.

27. Khawasa-Sukla-Tarali

This unit covers 56268.10 hectares (6.42 percent) with the dominant Khawasa series having dark yellowish brown (10YR 4/4), sandy loam A horizons and brown to dark yellowish brown/brown (10YR 4/3, 4/4), sandy loam Bw horizons. This soil is associated with the Sukla series having yellowish brown (10YR 4/4) A horizons and weathered Cr horizon. They occur on moderately sloping isolated hillocks and are mostly under forest and the Tarali series with dark brown (10YR 3/3), clayey Ap horizons and dark brown (10YR 3/3) to very dark brown (10YR 3/2) clayey Bss horizons with intersecting slickensides. They occur on very gently sloping denudational plateaus and are mostly under cultivation of rice, wheat, gram and vegetables.

28. Tarali-Kodajhiri-Jamuntola

This unit covers 5572.9 hectares(0.64 percent) with the dominant series Tarali, fine, very deep having dark brown (10YR 3/3), clayey Ap horizons and dark brown (10YR 3/3) to very dark brown (10YR 3/2), clayey Bss horizons with intersecting slickensides. This soil is associated with Kodajhiri series having dark greyish brown (2.5Y 4/2), clayey Ap horizons and very dark greyish brown (2.5Y 3/2), clayey Bss horizons and Jamuntola series with dark brown (10YR 3/3), sandy loam A horizons.

29. Khawasa-Lungsa-Lakhanadon

This unit covers 55279.7(6.31 percent) with Khawasa as dominant series having dark yellowish brown (10YR 4/4), sandy loam A horizons and brown to dark yellowish brown (10YR 4/3, 4/4), sandy loam Bw horizons. This soil is associated with the Lungsa series having light olive brown (2.5Y 5/4), clayey Ap horizons and very dark greyish brown/very dark grey (2.5Y 3/2, 3/1), clayey Bw horizons and Lakhanadon series with dark brown (7.5YR 3/2), sandy clay loam Ap horizons and very dark brown (7.5YR 2.5/2) to dark reddish brown (5YR 3/3), sandy clay loam to sandy loam Bw horizons. They are mostly under pasture.

30. Dhora-Sukla-Pratappur

This unit covers 9168.13 hectares (1.05 percent) with Dhora as dominant series, having dark brown (7.5YR 3/3), clayey A horizons and hard rock. This soil is associated with Sukla series having dark yellowish brown A horizons and Pratappur series having very dark greyish brown(10YR3/2), clay textured Ap horizons and very dark grey(10YR3/l) to olive brown(2.5Y4/4), clay enriched argillic Bt horizons with very fine iron nodules.'

The thematic maps on Slope, Parent Metirials,Surface Form, Depth, Drainage, Ersion, Pertical Size, Texture, Soil Reaction (pH), and Taxonomyare shown in Fig. 5 to 14, respectively.

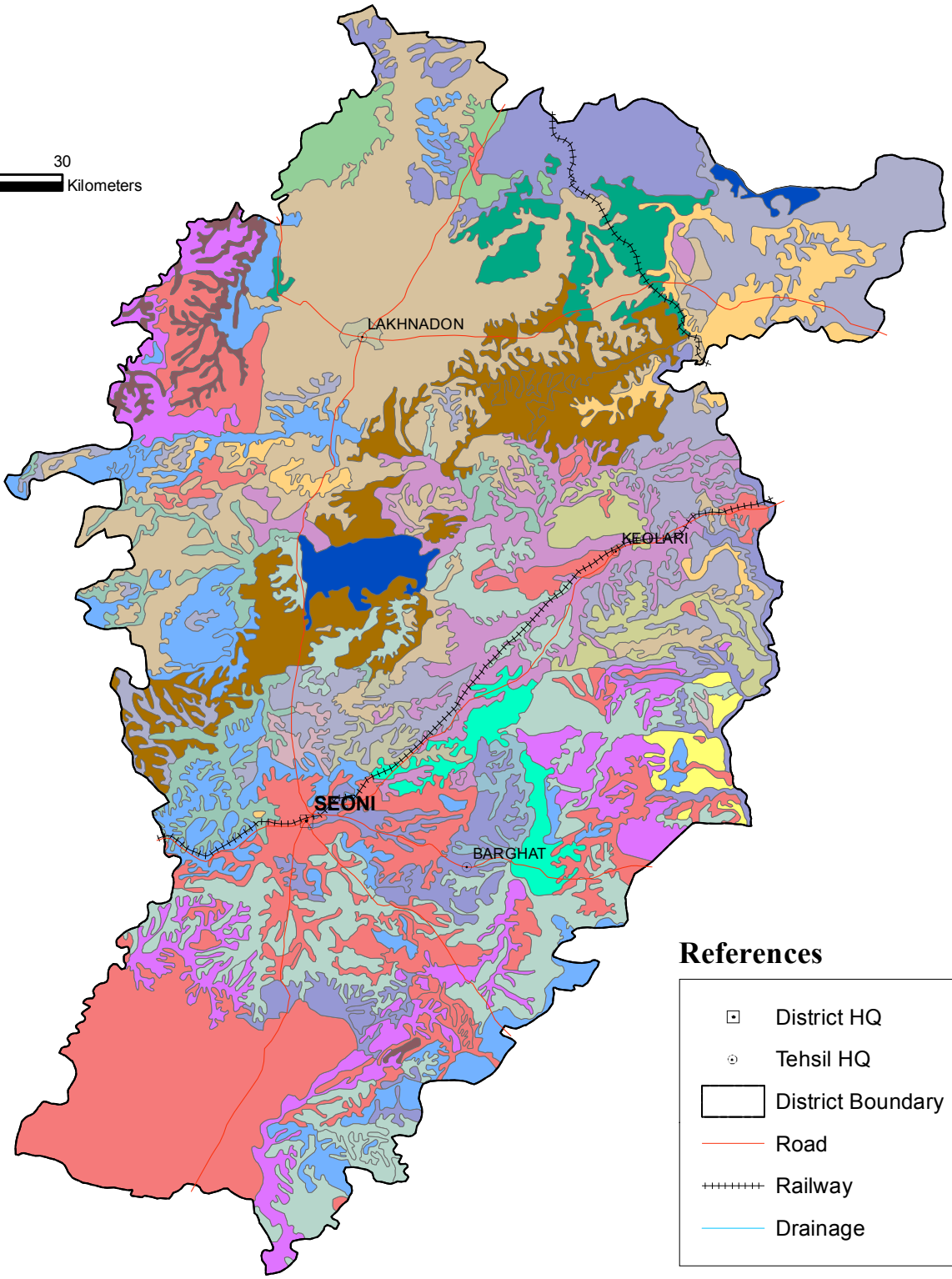
SEONI

Slope

N

0 5 10 20 30

Kilometers



References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

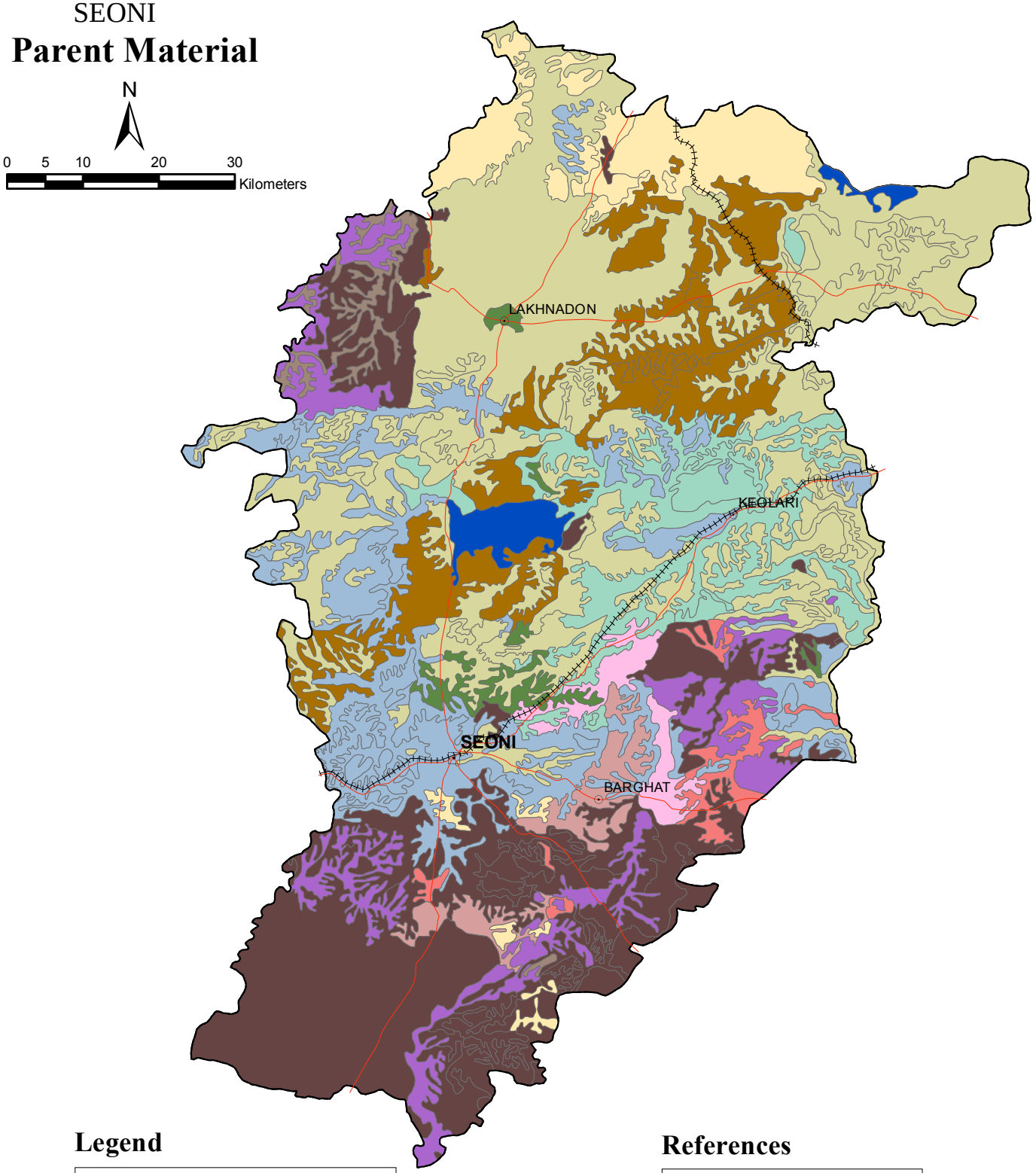
Legend

- Gently sloping
- Gently sloping-Moderately steep sloping-Very gently sloping
- Gently sloping-Very gently sloping-Moderately sloping
- Gently sloping-Moderately sloping
- Gently sloping-Moderately-Moderately sloping
- Gently sloping-Very gently sloping-Moderately sloping-Steeply sloping
- Moderately sloping
- Moderately sloping-Very gently sloping
- Moderately sloping-Gently sloping
- Moderately sloping-Gently sloping-Very gently sloping
- Moderately sloping-Gently sloping-Steeply sloping
- Moderately sloping-Moderately steep sloping
- Moderately Steep sloping-Steeply sloping-Moderately sloping
- Moderately Steep sloping-Very gently sloping-Moderately sloping
- Moderately sloping-Moderately steep sloping-Gently sloping
- Moderately sloping-Moderately steep sloping-Steeply sloping-Rock out crop
- Moderately steep sloping-Very gently sloping-Gently sloping-Rock out crop
- Steeply sloping-Moderately sloping
- Steeply sloping-Very gently sloping-Moderately sloping
- Steeply sloping-Moderately sloping-Rock out crop
- Reservoir

Fig. 5: Slope

SEONI

Parent Material



Legend

- Basalt
- Basalt-Weathered basalt
- Granite-Basalt-Weathered basalt
- Granite
- Granite-Rock outcrop
- Granite-Laterite-Basalt
- Granite-Laterite
- Granite-Weathered basalt-Basalt
- Weathered basalt
- Weathered basalt-Granite
- Weathered basalt-Basalt
- Weathered basalt-Basalt-Rock outcrop
- Reservoir

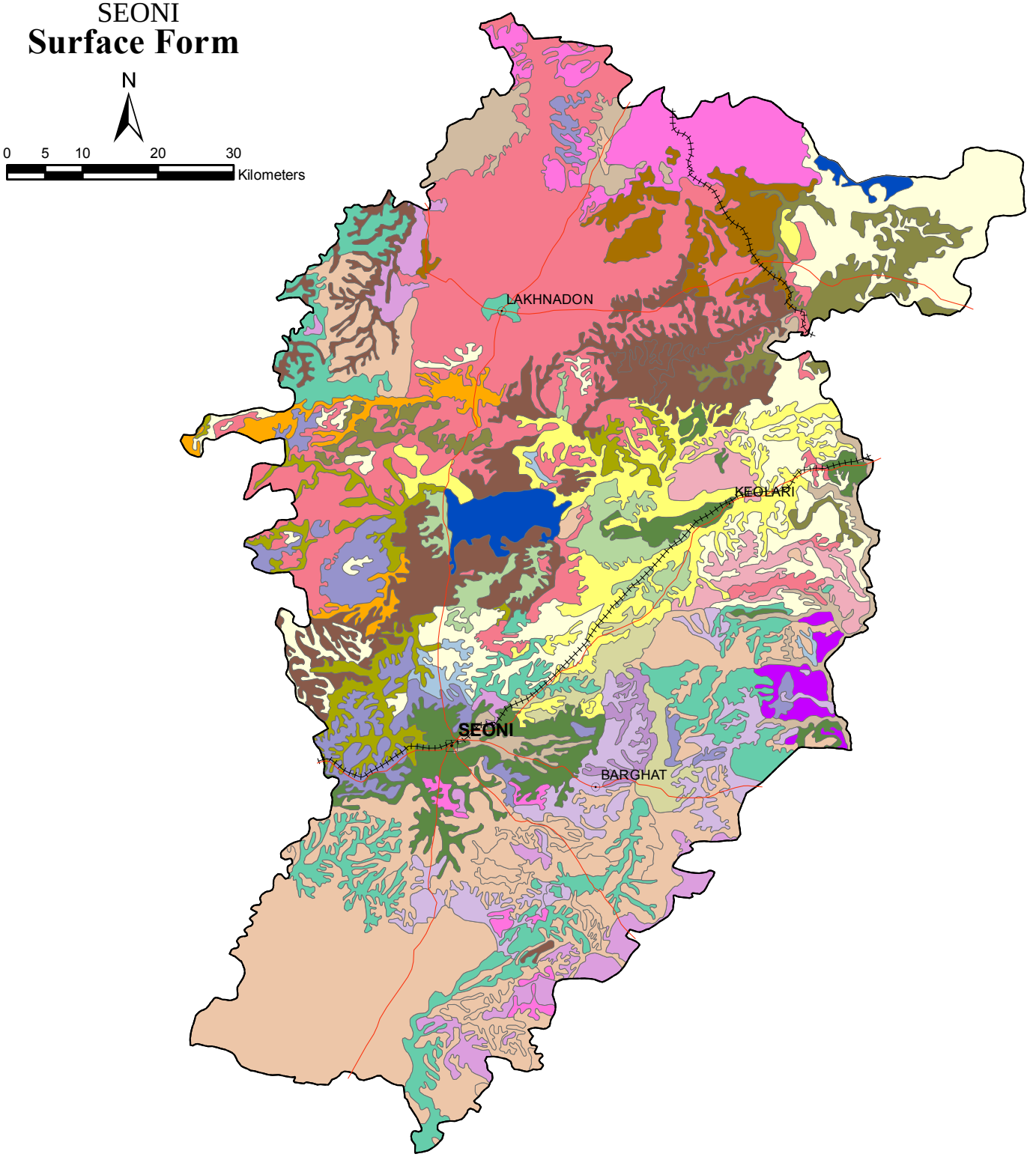
References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

Fig. 6: Parent Material

SEONI

Surface Form



Legend

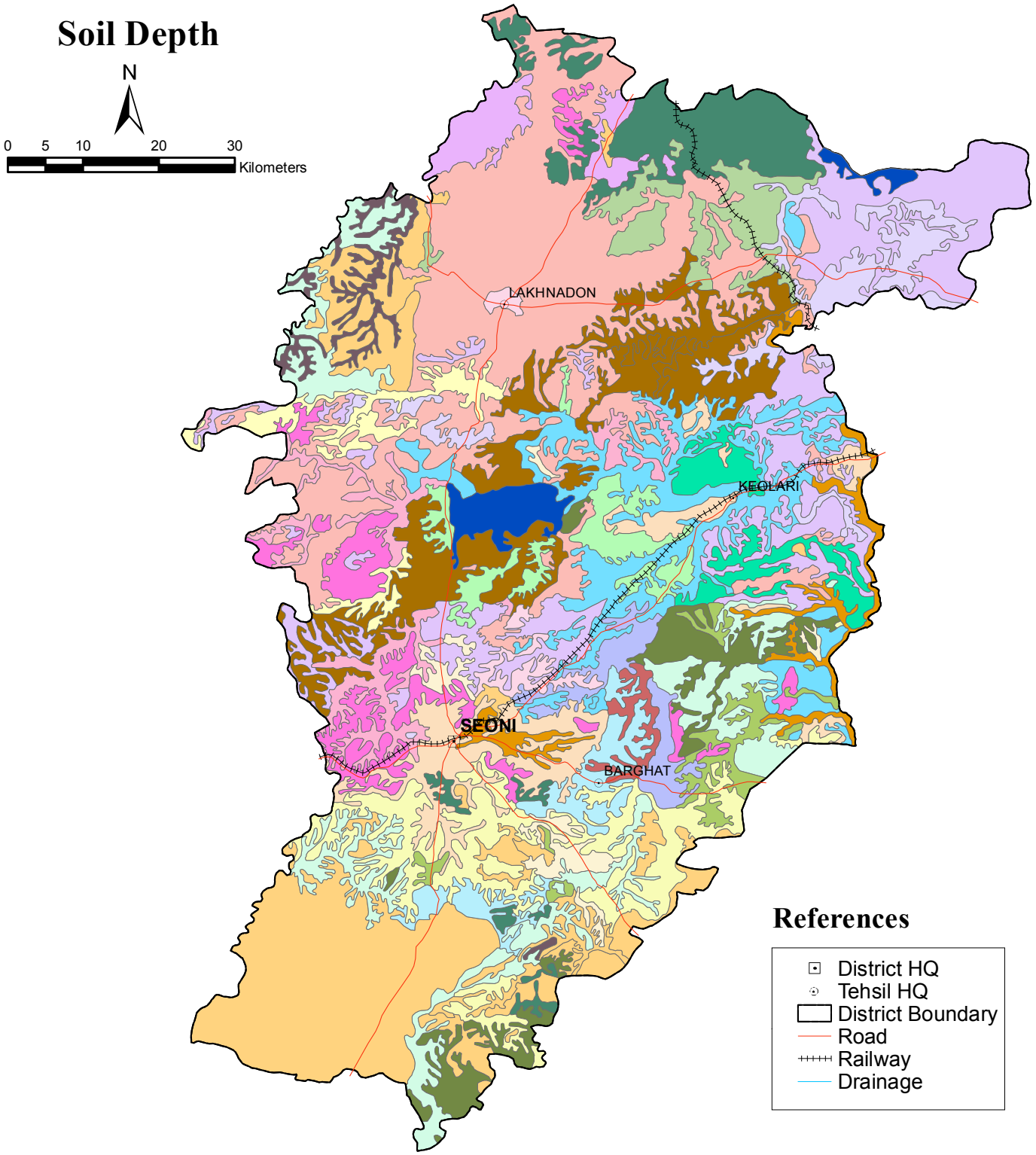
- Plateau
- Plateau-Level
- Plateau-Steep
- Plateau-Undulating-Hill
- Plateau-Ridges-Valleys
- Plateau-Rolling
- Plateau-Steep-Gently sloping
- Plateau-Steep-Hill-Roc outcrop
- Plateau-Undulating
- Plateau-Valleys
- Ridges-Plateau
- Ridges-Steep-Plateau-Roc outcrop
- Ridges-Valleys-Plateau
- Rolling-Plateau
- Steep-Hill-Plateau
- Steep-Valleys-Plateau
- Undulating-Plateau
- Undulating-Valleys-Plateau
- Undulating-Valleys
- Valleys-Plateau
- Valleys-Steep
- Valleys-Plateau-Ridges
- Reservoir

References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

SEONI

Soil Depth



References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

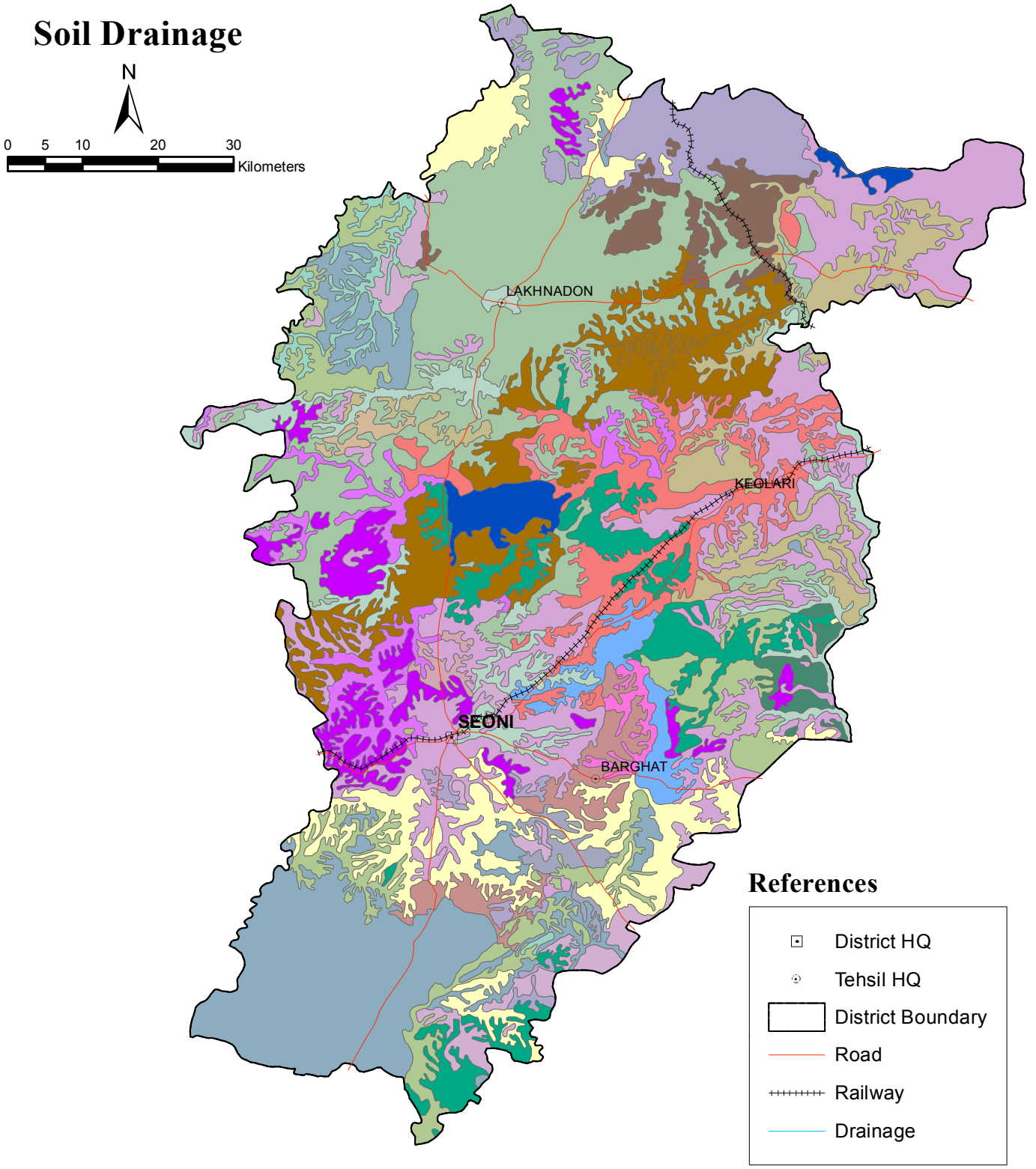
Legend

- Extremly shallow-Shallow
- Extremely shallow-Shallow-Very deep
- Extremly shallow-Very deep-Shallow
- Extremly shallow-Mod. deep-Shallow-Rock outcrop
- Very shallow-Deep-Shallow-Rock outcrop
- Shallow-Deep
- Shallow-Deep-Mod. deep
- Shallow-Mod. shallow-Very deep
- Shallow-Very deep-Very shallow-Rock outcrop
- Mod. shallow-Shallow-Very deep
- Mod. shallow-Very deep-Extremly shallow
- Mod. shallow-Very deep
- Mod. shallow-Very deep-hallow-Extremly shallow
- Mod. deep-Shallow-Mod. shallow
- Mod. deep-Very deep-Deep
- Mod. deep-Very deep-Very shallow
- Deep-Very deep
- Deep-Mod. shallow-Extremly shallow
- Deep-Very shallow-Very deep
- Deep-Very deep-Mod. shallow
- Very deep-Very shallow
- Very deep-Shallow
- Very deep-Shallow-Deep
- Very deep-Mod.deep
- Very deep-Deep-Shallow
- Very deep-Deep
- Reservoir

Fig.8: Soil Depth

SEONI

Soil Drainage



References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

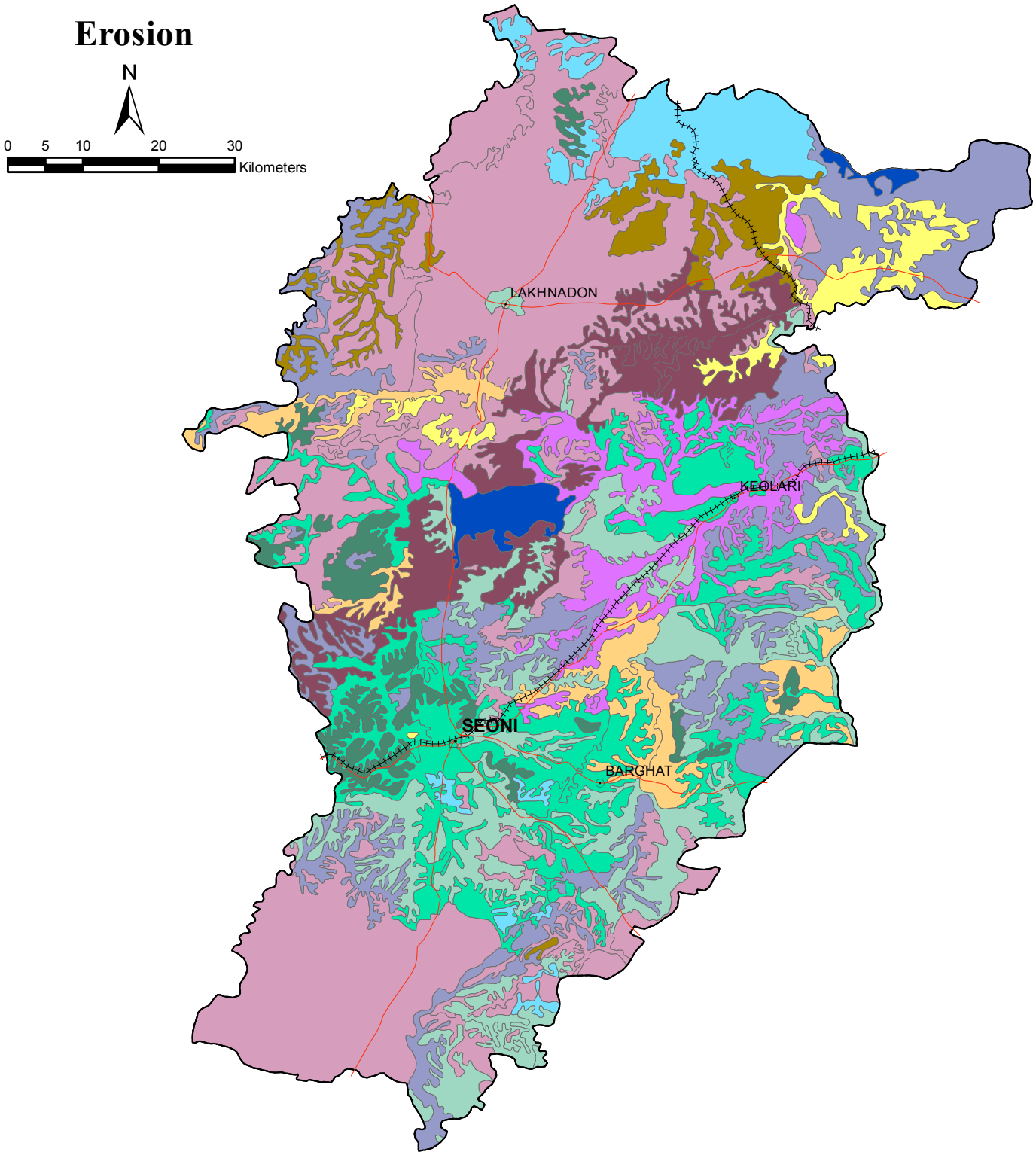
Legend

- Very poor-Well
- Very poor-Mod. well-Well
- Poor-Well-Mod. well
- Poor-Somewhat excessive-Mod. well
- Mod. welll
- Mod. well-Well
- Mod. well-Well-Very poor
- Mod. well-Very poor
- Mod. well-Well-Somewhat excessive
- Mod. well-Somewhat excessive
- Mod. well-Very poor-Somewhat excessive
- Well-Mod. well
- Well-Mod. well-Somewhat excessive
- Well-Somewhat excessive
- Well-Very poor-Poor
- Well-Very poor-Well-Rock outcrop
- Well-Rock outcrop
- Somewhat excessive-Mod. well
- Somewhat excessive-Mod. well-Well
- Somewhat excessive-Mod. well-Very poor
- Somewhat excessive-Well
- Somewhat excessive-Well-Mod. well
- Somewhat excessive-Well-Rock outcrop
- Reservoir

Fig.9: Soil Drainage

SEONI

Erosion



Legend

- Slight-Moderate
- Slight-Severe-Moderate
- Moderate
- Moderate-Slight
- Moderate-Slight-Severe
- Moderate-Severe
- Severe-Moderate
- Severe-Slight-Moderate
- Severe-Moderate-Slight
- Moderate-Rock outcrop
- Severe-Moderate-Rock outcrop
- Reservoir

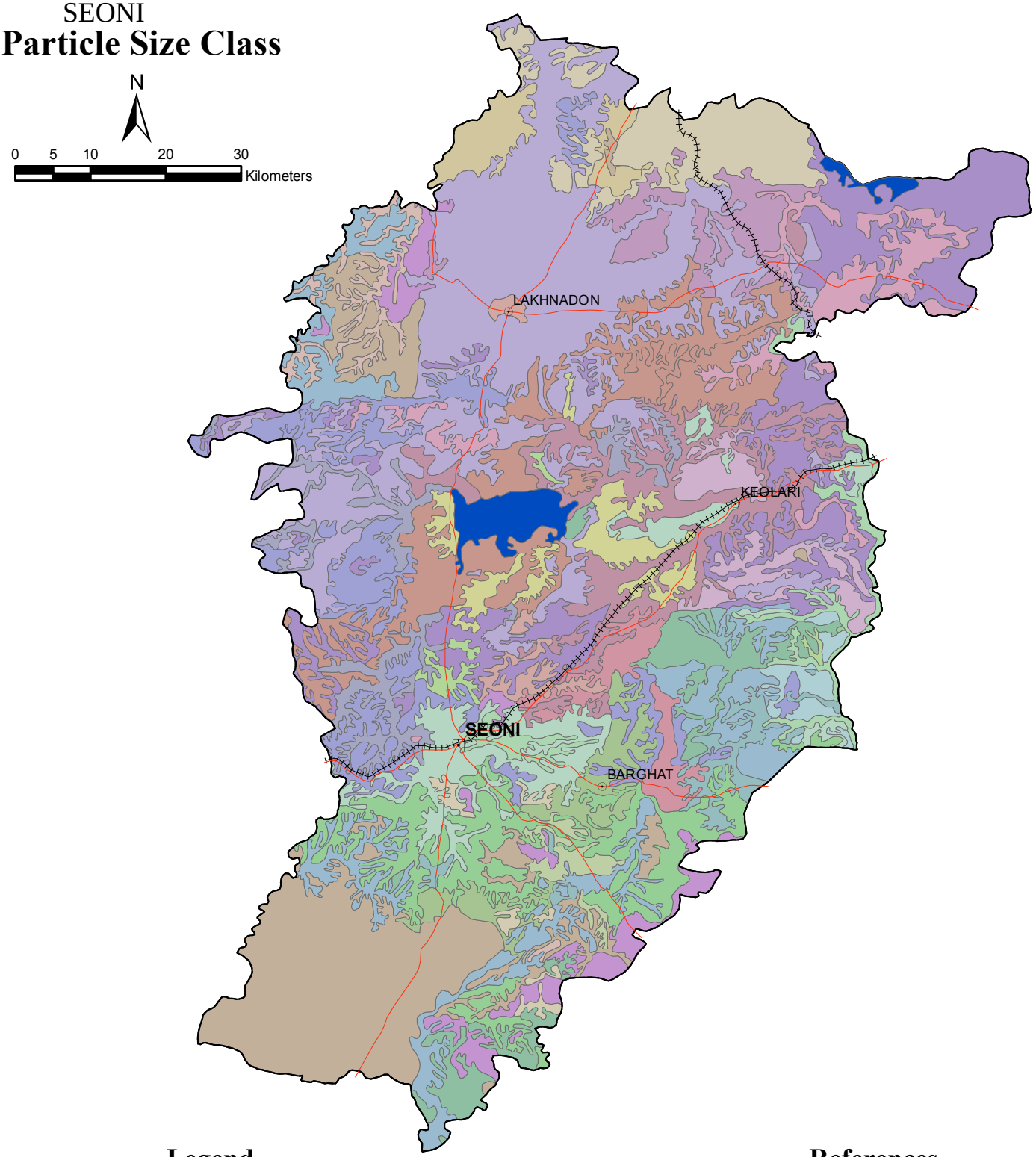
References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

Fig.10: Erosion

SEONI

Particle Size Class



Legend

- Clayey-Loamy-Coarse loamy
- Clayey-Loamy-Fine loamy
- Coarse loamy-Clayey-Fine
- Coarse loamy-Very fine-Fine
- Fine loamy-Fine
- Fine-Very fine
- Fine loamy-Fine-Very fine
- Fine
- Fine- Very fine-Loamy
- Fine-Coarse loamy-Clayey
- Fine-Loamy
- Fine-Loamy-Rock outcrop
- Fine-Loamy-Very fine
- Fine-Very fine Fine
- Fine-Very fine-Loamy
- Fine-Very fine-Loamy
- Loamy-Clayey-Very fine
- Loamy-Fine loamy-Fine-Rock outcrop
- Loamy-Fine loamy-Loamy-Rock outcrop
- Loamy-Fine-Coarse loamy
- Loamy-Fine
- Loamy-Very fine-Fine
- Very fine-Clayey-Coarse loamy
- Very fine-Fine-Coarse loamy
- Very fine-Fine
- Very fine-Fine-Loamy
- Very fine-Fine
- Reservoir

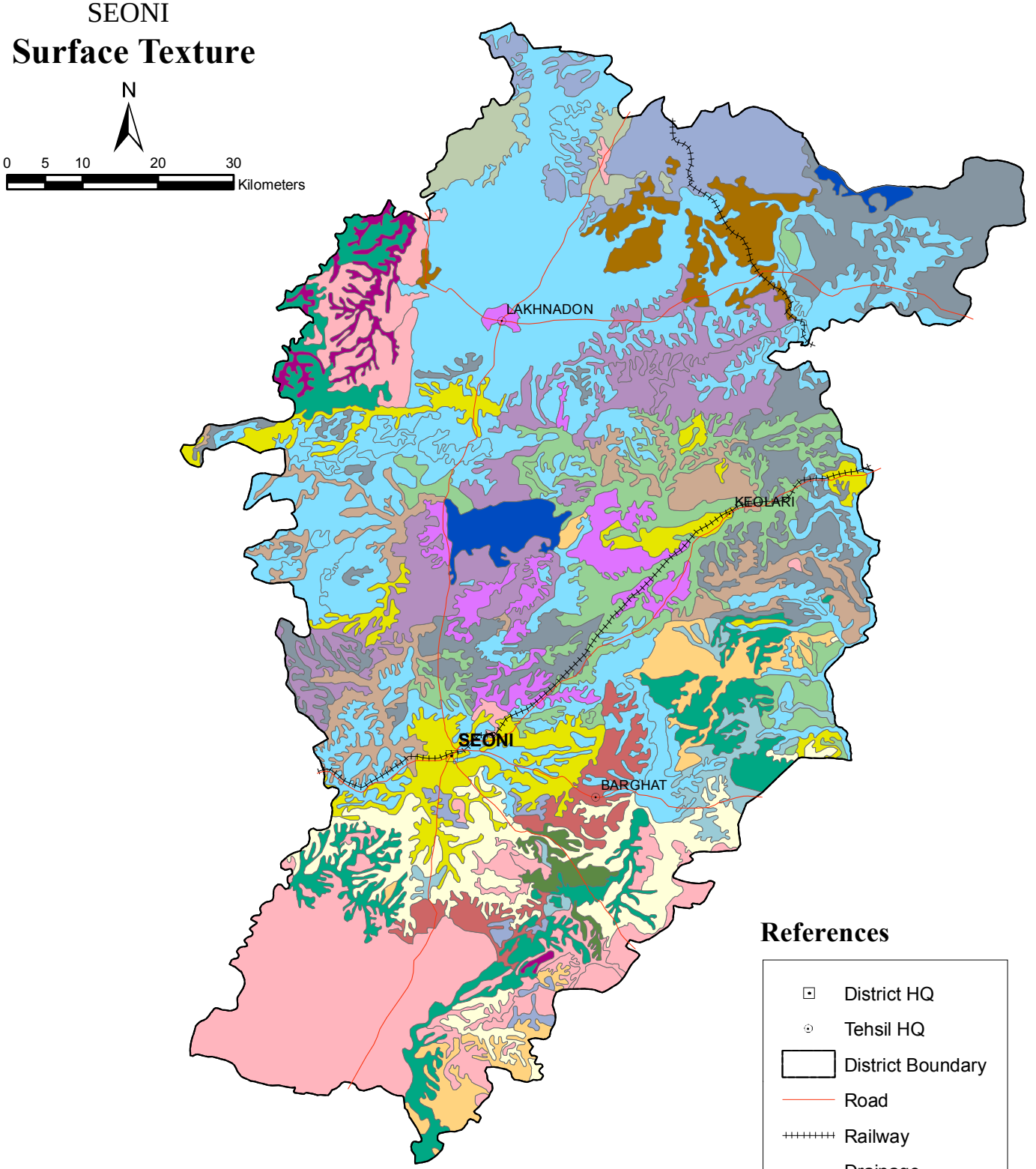
References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

Fig. 11: Particle Size Class

SEONI

Surface Texture



References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

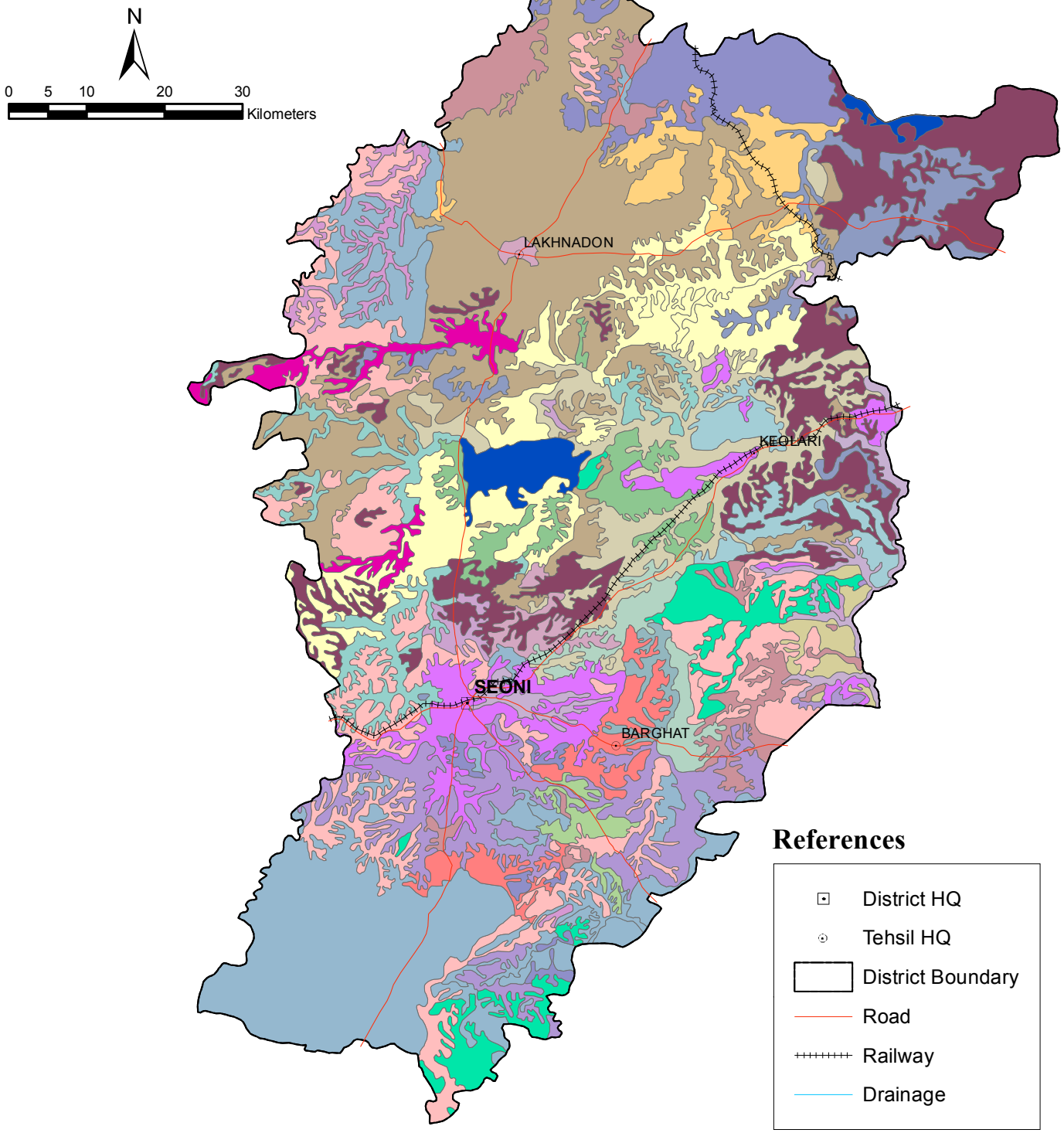
Legend

- Clayey-Clay loam-Rock out crop
- Clayey
- Clayey-Clay loam
- Clayey-Sandy loam-Loamy sand
- Clayey-Loamy
- Clayey-Loamy-Sandy loam
- Clayey-Sandy clay loam
- Clayey-Sandy loam
- Fine-Clayey-Sandy loam
- Loamy-Sandy loam-Loamy sand
- Sandy clay loam-Clayey-Rock out crop
- Sandy clay loam-Clayey-Sandy clay loam
- Sandy clay loam-Loamy sand-Rock out crop
- Sandy clay loam-Clayey
- Sandy loam-Clayey
- Sandy loam-Clayey-Loamy sand
- Sandy loam-Clayey-Sandy clay loam
- Sandy loam-Loamy-Fine
- Reservoir

Fig. 12: Surface Texture

SEONI

Soil Reaction (pH)



References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

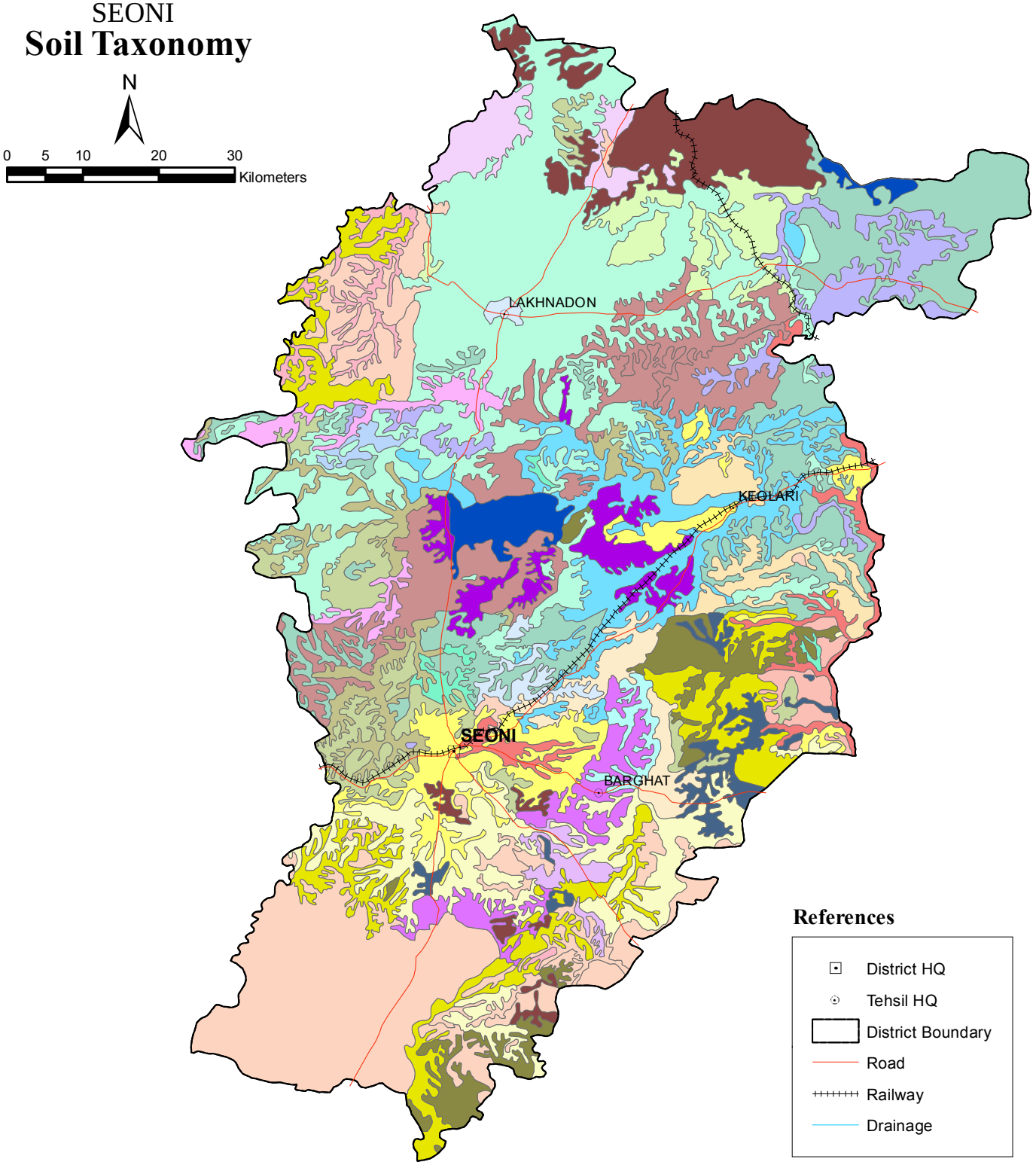
Legend

- Mod acidic-Neutral
- Mod acidic-Mod alkaline-Slightly alkaline
- Mod acidic-Neutral-Slightly acidic
- Mod acidic-Slightly acidic-Neutral
- Mod acidic-Slightly acidic-Neutral-Rock outcrop
- Mod alkaline-Mod acidic-Slightly acidic
- Mod alkaline-Neutral
- Mod alkaline-Slightly acidic-Mod acidic
- Mod alkaline-Slightly acidic
- Mod alkaline-Slightly alkaline-Neutral
- Mod alkaline-Slightly alkaline-Slightly acidic
- Neutral-Mod acidic-Neutral
- Neutral-Slightly acidic
- Neutral-Slightly acidic-Slightly alkaline
- Neutral-Slightly alkaline-Slightly acidic-Rock outcrop
- Slightly acidic-Mod acidic
- Slightly acidic-Mod acidic-Slightly alkaline
- Slightly acidic-Neutral-Mod alkaline
- Slightly acidic-Neutral
- Slightly acidic-Neutral-Rock outcrop
- Slightly acidic-Slightly alkaline-Neutral
- Slightly acidic-Slightly alkaline
- Slightly alkaline- Mod alkaline-Neutral
- Slightly alkaline-Mod alkaline-Slightly acidic
- Slightly alkaline-Mod alkaline
- Slightly alkaline-Neutral-Neutral-Mod acidic
- Reservoir

Fig. 13: Soil Reaction (pH)

SEONI

Soil Taxonomy



Legend

- Dystric Haplustepts-Vertic Haplustepts-Typic Epiaquerts
- Lithic Haplustepts-Typic Haplustepts-Typic Haplusterts
- Lithic Haplustepts-Typic Haplustepts-Ustic Epiaquerts
- Lithic Ustorthents-Lithic Haplustepts-Ustic Epiaquerts
- Lithic Ustorthents-Typic Haplustepts-Lithic Ustorthents-RO
- Lithic Ustorthents-Typic Haplustepts-Ustic Epiaquerts-RO
- Lithic Ustorthents-Typic Haplusterts-Ustic Epiaquerts
- Lithic Ustorthents-Typic Ustorthents-Ustic Haplustalfs
- Typic Haplustepts-Lithic Haplustepts-Typic Haplustepts-Ustic Endoaquerts
- Typic Haplustepts-Typic Haplusterts-Ustic Endoaquerts-Lithic Ustrothents
- Typic Haplustepts-Typic Ustorthents-Typic Haplusterts
- Typic Haplustepts-Ustic Endoaquerts-Lithic Ustrothents
- Typic Haplustepts-Ustic Endoaquerts-Typic Haplustepts
- Typic Haplustepts-Vertic Haplustepts-Ustic Endoaquerts
- Typic Haplusterts-Typic Haplustepts-Lithic Ustorthents
- Typic Haplusterts-Ustic Endoaquerts-Lithic Ustorthents
- Typic Ustorthents-Lithic Ustorthents-Typic Haplustepts
- Udic Haplustalfs-Typic Rhodustalfs-Typic Haplustepts
- Udic Haplustalfs-Typic Rhodustalfs-Ustic Epiaquerts-Typic Haplustepts
- Udic Haplustalfs-Ustic Epiaquerts-Ustic Endoaquerts-Typic Haplustepts
- Ustic Endoaquerts-Typic Haplustepts-Typic Ustorthents
- Ustic Endoaquerts-Ustic Epiaquerts-Vertic Haplustepts
- Ustic Epiaquerts-Lithic Haplustepts-Typic Haplustepts
- Ustic Epiaquerts-Typic Haplustepts-Ustic Epiaquerts
- Ustic Epiaquerts-Typic Ustorthents-Typic Haplustepts-Typic Haplusterts
- Ustic Epiaquerts-Typic Haplustalfs-Lithic Ustrothents
- Ustic Epiaquerts-Vertic Haplustepts-Lithic Ustorthents-RO
- Vertic Haplustepts-Lithic Ustorthents-Ustic Endoaquerts
- Vertic Haplustepts-Ustic Endoaquerts-Ustic Epiaquerts
- Reservoir

Table 13. Description, extent and taxonomy of soil mapping units

SI. No.	Soil mapping unit	Brief description of soils	Soil Taxonomy	Area	
				ha	%
1	Pa-Pd-K Parasia (Pa)	Very shallow, somewhat excessively drained, sandy clay loam soils on a structural hills and ridges and steeply sloping denudational escarpment (30-50%slope). These soils are mostly used for the cultivation of millets on hill slopes.	Loamy, mixed hyperthermic family of Lithic Ustorthents	42389	4.84
	Paddikona (Pd)	Very deep, moderately well drained, clay soils on valley bottom, undulating plateau, broad and narrow inter hill basin (1-3% slope). The soils are under the cultivation of wheat, gram red gram and soybean.	Very-fine, montmorillonitic hyperthermic family of Typic Haplusterts		
	Khamariya (Ky)	Shallow, well drained, clay soils on structural hills and plateaus (1-3% slope). These soils are under the cultivation of sorghum and red gram.	Fine, mixed, family of Lithic Haplustepts		
2.	Pa-Pr-Ky Parasia (Pa)	Very shallow, somewhat excessively drained, sandy clay loam soils on a structural hills and ridges and steeply sloping denudational escarpment (30-50% slope). These soils are mostly used for the cultivation of millets on hill slopes.	Loamy mixed hyperthermic family of Lithic Ustorthents	101768	11.62
	Pipariya (Pr)	Shallow, somewhat excessively drained, clay loam soils on undulating and pediment plains (3-5% slope). These soils are under forest of Teak, Tendu, Saja and Char.	Fine, mixed family of Lithic Haplustepts		
	Khamariya (Ky)	Shallow, well drained, clay soils on structural hills and plateau (1-3% slope). These soils are under the cultivation of sorghum and red gram.	Fine, mixed, hyperthermic family of Lithic Haplustepts		
3.	Sa-Pd-Ky-Pa Sagar (Sa)	Moderately shallow, well drained, clay on broad inter hill basin and valley bottom (1-3% slope). These soils are under the cultivation of sorghum, red gram, paddy and soybean.	Fine, mixed hyperthermic family of Typic Haplustepts	91434	10.44
	Paddikona (Pd)	Very deep, moderately well drained, clay soils on valley bottom, undulating plateau, broad and narrow inter hill basin (1-3% slope). The soils are under the cultivation of wheat, gram, red gram and soybean.	Very-fine montmorillonitic hyperthermic family of Typic Haplusterts		
	Khamariya (Ky)	Shallow, well drained, clay soils on structural hills and plateau (1-3% slope). These soils are under the cultivation of sorghum and red gram.	Finemixed hyperthermic family of Lithic Haplustepts		
	Parasia (Pa)	Very shallow, somewhat excessively drained, sandy clay loam soils on a structural hills and ridges and steeply slopping denudational escarpments (30-50% slope). These soils are mostly used for the cultivation of millets on hill slopes.	Loamy mixed hyperthermic family of Lithic Ustorthents		

4.	At-Pc-Bg Atari (At)	Very deep, poorly drained, clay soils on steeply sloping denudational escarpment,structural plateau, structural hills and ridges (15-30% slope). These soils are under forest of Teak, Tendu, Saja and Char.	Fine, mixed, hyperthermic family of Vertic Haplustepts	23909	2.73
	Parasia (Pa)	Very shallow, somewhat excessively drained, sandy clay loam soils on a structural hills and ridges and steeply slopping denudational escarpment (30-50% slope). These soils are mostly used for the cultivation of millets on hill slopes.	Loamy mixed hyperthermic family of Lithic Ustorthents		
	Bhimgarh (Bg)	Deep, well drained, clay soils on upper denudational plateau lower denudational plateau inter hill basin and rolling pediplain (1-3% slope). These soils are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	Very-fine montmorillonitic hyperthermic family of Ustic Endoaquerts		
5.	Ky-At-Pc-Roc Khamariya (Ky)	Shallow, well drained, clay soils on structural hills and plateau (1-3% slope). These soils are under the cultivation of sorghum and red gram.	Fine, mixed hyperthermic family of Lithic Haplustepts	73830	8.43
	Atari (At)	Very deep, poorly drained, clay soils on steeply sloping denudational escarpment, structural plateau, structural hills and ridges (15-30% slope). These soils are under forest of Teak, Tendu , Saja and Char.	Fine, mixed hyperthermic family of Vertic Haplustepts		
	Parasia (Pa)	Very shallow, somewhat excessively drained, sandy clay loam soils on a structural hills and ridges and steeply slopping denudational escarpment (30-50% slope). These soils are mostly used for the cultivation of millets on hill slopes	Loamy, mixed hyperthermic family of Lithic Ustorthents		
6.	Nd-Sa-Dh Nadora (Nd)	Deep, moderately well drained, clay to clay loam soils on broad and narrow inter hill basin (3-8% slope). These soils are mostly used for the cultivation of wheat, gram, red gram and vegetables.	Very-fine, montmorillonitic hyperthermic family of Typic Haplusterts	6393	0.73
	Sagar (Sa)	Moderately shallow, well drained, clay on broad inter hill basin and valley bottom (1-3% slope). These soils are under the cultivation of sorghum, red gram paddy and soybean.	Fine, mixed, hyperthermic family of Typic Haplustepts		
	Dhora (Dh)	Extremely shallow, moderately well drained, clayey, soils on narrow and broad inter hill basins (3-8% slopes). These soils are under forest mainly of teak, palas, khair and tendu.	Loamy, mixed, hyperthermic family of Lithic Ustorthents		
7.	Lk-Pr-Sa-LU Lakhanadon (Lk)	Moderately shallow, somewhat excessively drained, sandy clay loam or sandy loam soils on isolated hillocks, plateau tops and pedi plains (8-15% slopes). These soils are under pasture.	Fine, mixed, hyperthermic family of Typic Haplustepts	25053	2.87
	Pipariya (Pr)	Shallow, somewhat excessively drained clay loam soils on undulating and pediment plain (3-5% slope). These soils are under forest of teak, tendu , saja, char.	Fine-loamy, mixed, family of Lithic Haplustepts		
	Sagar (Sa)	Moderately shallow, well drained, clay on broad inter hill basin and valley bottom (1 -3% slope). These soils are under the cultivation of sorghum, red gram paddy and soybean.	Fine-mixed hyperthermic family of Typic Haplustepts		
	Lungsa (Lu)	Deep, somewhat excessively drained, clayey soils	Very-fine,		

		occur in valleys, inter hill basins and lower denudational plateaus (3-8% slopes). These soils are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	montmorillonitic, hyperthermic, family of calcareous Ustic Endoaquerts		
8.	Pr-Sa-Jp Pipariya (Pr)	Shallow, somewhat excessively drained clay loam soils on undulating and pediment plain (3-5% slope). These soils are under forest of Teak, Tendu, Saja and Char.	Fine, mixed, hyperthermic, Lithic Haplustepts	2532	0.29
	Sagar (Sa)	Moderately shallow, well drained, clay on broad inter hill basin and valley bottom (1-3% slope). These soils are under the cultivation of sorghum, red gram, paddy and soybean.	Fine, mixed hyperthermic family of Typic Haplustepts		
	Jamunpani (Jp)	Very deep, well drained, clay to sandy clay loam soils on upper and lower denudational plateau and structural hills and ridges (3-8% slope). These soils are under sesamum, soybean, red gram, wheat, and paddy and gram cultivation.	Very-fine, montmorollinitic, hyperthermic, Udic Haplusterts		
9.	Go-Sa-Pd Gorakhpur (Go)	Shallow, moderately well drained, clay to sandy clay loam soil on undulating plateau and rolling to very gently sloping pedi plains (1-3% slope). These soils are under the cultivation of red gram, wheat, soybean and gram.	Fine, mixed, hyperthermic family of Lithic Haplustepts	109.48	1.25
	Sagar (Sa)	Moderately shallow, well drained, clay on broad inter hill basin and valley bottom (1-3% slope). These soils are under the cultivation of sorghum, red gram, paddy and soybean.	Fine, mixed hyperthermic family of Typic Haplustepts		
	Paddikona (Pd)	Very deep, moderately well drained, clayey soils on a broad narrow inter hill basin and bottoms (1-3%). These soils are under the cultivation of wheat, gram, red gram and vegetables.	Very-fine montmorillonitic hyperthermic family of Typic Haplusterts		
10.	Ar-Kh-Bg-Nd Arandiya (Ar)	Moderately deep, moderately well drained, sandy loam to sandy clay loam soils on upper denudational plateau and rolling pedi plains (1-3% slope). These soils are under cultivation of paddy, wheat and gram.	Fine-loamy, mixed hyperthermic Udic Haplustalfs.	338.06	3.86
	Kharsaru (Kh)	Moderately deep, well drained, clayey soils on a lower denudational and undulating plateaus and rolling pedi plains (8-15% slope). These soils are under red gram, soybean and wheat cultivation.	Fine, montmorio-llinitic, hyperthermic Ustic Epiaquerts		
	Bhimgarh (Bg)	Deep well drained, clay soils on upper denudational plateau lower denudational plateau inter hill basin and rolling pedi plain (1-3% slope). These soils are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	Very-fine montmorillonitic hyperthermic family of Ustic Epiaquerts		
	Nadora (Nd)	Deep, moderately well drained, clay to clay loam soils on broad and narrow inter hill basin (3-8% slope). These soils are mostlyused for the cultivation of wheat, gram, red gram and vegetables.	Very-fine montmorillonitic hyperthermic family of Typic Haplusterts		
11.	At-Lu-Kh Atari (At)	Very deep, poorly drained, clay soils on steeply sloping denudational escarpment, structural plateau, structural hills and ridges (15-30% slope). These soils are under forest of teak, tendu, saja and char.	Fine, mixed hyperthermic family of Vertic Haplustepts	65.69	0.75
	Lungsa (Lu)	Deep, somewhat excessively drained, clayey soils occur in valleys, inter hill basins and lower denudational plateaus (3-8 % slopes). These soils	Very-fine, montmorillonitic, hyperthermic,		

		are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	family of calcareous Ustic Endoaquerts		
	Kharsaru (Kh)	Moderately deep, well drained, clayey soils on a lower denudational and undulating plateaus and rolling pedi plains (8-15% slopes). These soils are under red gram, soybean and wheat cultivation.	Fine, montmorilloinitic, hyperthermic Ustic Eapiaquerts		
12.	Si-At-Cu Silghat (Si)	Deep well drained sandy clay loam soils on a lower denudational and undulating plateaus and rolling pediplains (8-15% slope). These soils are under red gram, paddy, wheat, gram and soybean.	Fine-lomy, mixed, hyperthennic Dystric Haplustepts	11122	1.27
	Atari (At)	Very deep, poorly drained, clay soils on steeply sloping denudational escarpment, structural plateau, structural hills and ridges (15-30% slope). These soils are under forest of Teak, Tendu , Saja, Char, etc.	Fine, mixed hyperthermic family of Vertic Haplustepts		
	Chhui (Cu)	Very deep, poorly drained, clay sandy clay soils on a lower denudational plateaus undulating plain (3-8 % slopes). These soils are under the pasture land.	Fine, mixed hyperthermic family Typic Epiaquepts		
13.	Dk-Pd-Kh Dhenka (Dk)	Very deep, somewhat poorly drained, clay sandy clay soils on a lower and upper denudational plateaus (3-8% slopes). These soils are under the red gram, paddy, wheat, gram, sugarcane, soybean.	Very-fine, montmorillinitic, hyperthermic Ustic Epiaquerts	48257	5.55
	Paddikona (Pd)	Very deep, moderately well drained, clayey soils on a broad narrow inter hill basin and bottoms (1-3% slopes). These soils are under the cultivation of wheat, gram, red gram and vegetables.	Very-fine montmorillonitic hyperthennic family of Typic Haplusterts		
	Kharsaru (Kh)	Moderately deep, well drained, clayey soils on a lower denudational and undulating plateaus and rolling pedi plains (8-15% slopes). These soils are under red gram, soybean and wheat cultivation.	Fine, montmorillinitic, hyperthermic Ustic Epiaquerts		
14,	Sa-Bg-Dh Sagar (Sa)	Moderately shallow, well drained, clay on broad inter hill basin and valley bottom (1-3% slope). These soils are under the cultivation of sorghum, red gram paddy and soybean.	Fine, mixed hyperthermic family of Typic Haplustepts	12874	1.47
	Bhimgarh (Bg)	Deep, well drained, clay soils on upper denudational plateau lower denudational plateau inter hill basin and rolling pedi plain(1-3% slope). These soils are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	Very-fine montmorillonitic hyperthermic family of Ustic Endoaquerts		
	Dhenka (Dk)	Very deep, somewhat poorly drained, clay sandy clay soils on a lower and upper denudational plateaus (3-8% slopes). These soils are under the red gram, paddy, wheat, gram, sugarcane soybean.	Very-fine, montmorillinitic, hyperthermic Ustic Epiaquerts		
15.	Kh-Jp-Ch-Pc Kharsaru (Kh)	Moderately deep, well drained, clayey soils on a lower denudational and undulating plateaus and rolling pedi plains (8*15%). These soils are under red gram, soybean and wheat cultivation.	Fine, montmorillinitic, hyperthermic Ustic Epiaquerts	16377	1.87
	Jamunpani (Jp)	Very deep, well drained, clay to sandy clay loam soils on upper and lower denudational plateau and structural hills and ridges (3-8% slopes). These soils are under sesamum, soybean, red	Very-fme, montmorollinitic, hyperthermic, Udic Haplusterts		

		gram, wheat, paddy and gram cultivation.			
	Chunamati (Ch)	Moderately deep, well drained, clay to sandy clay soils on undulating pedi plains structural hills and ridges and lower denudational plateaus (3-8 % slopes) These soils are under red gram, soybean paddy and wheat cultivation .	Fine, mixed hyperthermic family of Typic Haplustalfs		
16.	Parasia (Pa)	Very shallow, somewhat excessively drained, sandy clay loam soils on a structural hills and ridges and steeply slopping denudational escarpment (30-50% slope). These soils are mostly used for the cultivation of millets on hill slopes.	Loamy, mixed hyperthermic family of Lithic Ustorthents	3854	0.44
	Bg-Ky-At Bhimgarh (Bg)	Deep well drained, clay soils on upper denudational plateau lower denudational plateau inter hill basin and rolling pedi plain (1-3% slope)). These soils are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	Very-fine montmorillonitic hyperthermic family of Ustic Endoaquerts		
	Khamariya (Ky)	Shallow, well drained, clay soils on structural hills and plateau (1-3% slope). These soils are under the cultivation of sorghum and red gram.	Fine, mixed hyperthermic family of Lithic Haplustepts		
	Atari (At)	Very deep, poorly drained, clay soils on steeply sloping denudational escarpment, structural plateau, structural hills and ridges (15-30% slope). These soils are under forest of teak, tendu , saja and char.	Fine, mixed hyperthermic family of Vertic Haplustepts		
17.	Kh-Go-Lk Kharsaru (Kh)	Moderately deep, well drained, clayey soils on a lower denudational and undulating plateaus and rolling pedi plains (8-15% slopes). These soils are under red gram, soybean and wheat cultivation.	Fine, montmorillinitic, hyperthermic Ustic Epiaquerts	17166	1.96
	Gorakhpur (Go)	Shallow, moderately well drained, clay to sandy clay loam soil on undulating plateau and rolling to very gently sloping pedi plains (1-3% slopes). These soils are under thecultivation of red gram, wheat, soybean and gram.	Fine, mixed, hyperthermic family of Lithic Haplustepts		
	Lakhanadon(Lk)	Moderately shallow, somewhat excessively drained, sandy clay loam or sandy loam soils on isolated hillocks, plateau tops and pedi plains (8-15% slopes). These soils are under pasture.	Fine, mixed, hyperthermic family of Typic Haplustepts		
18.	Pa-Ma-Ky- Roc Parasia (Pa)	Very shallow, somewhat excessively drained, sandy clay loam soils on a structural hills and ridges and steeply slopping denudational escarpment (30*50% slope). These soils are mostly used for the cultivation of millets on hill slopes.	Loamy, mixed hyperthermic family of Lithic Ustorthents	21282	2.43
	Masanbarra (Ma)	Moderately deep, well drained, sandy loam, sandy clay loam soils on a steeply slopping denudational escarpment, structural plateau, structural hilis and ridges (15-30% slope). These soils are under forest of Teak, Tendu, Saja, Char ,etc.	Fine, mixed hyperthermic family of Typic Haplustepts		
	Khamariya (Ky)	Shallow, well drained, clay soils on structural hills and plateau (1-3% slope). These soils are under the cultivation of sorghum and red gram.	Fine-lomy mixed hyperthermic family of Lithic Haplustepts		
19.	Sa-At-Lu	Moderately shallow, well drained, clay on broad	Fine, mixed	5868	0.67

	Sagar(Sa)	inter hill basin and valley bottom (1-3% slope). These soils are under the cultivation of sorghum, red gram paddy and soybean.	hyperthermic family of Typic Haplustepts		
	Atari (At)	Very deep, poorly drained, clay soils on steeply sloping denudational escarpment, structural plateau, structural hills and ridges (15-30% slope). These soils are under forest of Teak, Tendu, Saja, Char, etc.	Fine, mixed hyperthermic family of Vertic Haplustepts		
	Lungsa (Lu)	Deep, somewhat excessively drained, clayey soils occur in valleys, inter hill basins and lower denudational plateaus (3-8% slopes). These soils are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	Very-fine, montmorillonitic, hyperthermic, family of calcareous Ustic Endoaquerts		
20.	Sk-Jm-Bs Sukla (Sk)	Shallow, somewhat excessively drained clay loam soils on a isolated hillock, upper and middle level plateau (8-15% slope). These soils are under teak forest.	Clay, mixed hyperthermic Typic Ustorthents	49193	2.37
	Jamuntola (Jm)	Shallow, somewhat excessively drained sandy loam soils on upper denudational plateau, hills and ridges (3-8% slope). These soils are under forest of teak, tendu, saja, amala and char.	Loamy, mixed hyperthermic family of Lithic Ustorthents		
	Bisapur (Bs)	Deep, well drained, loamy sandy soils on flood plain, inter hill basin, and lower denudational plateau (1-3% slope). These soils are under forest of teak, tendu, Saja, amala and char.	Fine-loamy, mixed hyperthermic family of Typic Haplustepts		
21.	Ko-Kw-Sk Kodajhiri (Ko)	Very deep, well drained on a middle level plateau rolling pediplain and undulating plateau (8-15 % slope). These soils are under Teak forest.	Fine, montmorillimtic, hyperthermic Ustic Endoaquerts	25135	2.87
	Khawasa (Kw)	Deep, moderately well drained, sandy loam soils on lower denudational plateau undulating plateau and rolling plain (8-15% slope). These soils are under forest of teak, tendu, saja, amala and char.	Coarse-loamy, mixed hyperthermic family of Typic Haplustepts		
	Sukla (Sk)	Shallow, somewhat excessively drained clay loam soils on a isolated hillocks, upper and middle level plateau (8-15% slope). These soils are under teak forest.	Clay, mixed hyperthermic Typic Ustorthents		
22.	Dk-Sk-Kw-Nd Dhenka (Dk)	Very deep, somewhat poorly drained, clay sandy clay soils on a lower and upper denudational plateaus (3-8% slopes). These soils are under the red gram, paddy, wheat, gram, sugarcane, soybean.	Very-fine, montmorillinitic, hyperthermic Ustic Epiaquerts	44666	5.10
	Sukla (Sk)	Shallow, somewhat excessively drained clay loam soils on a isolated hillock, upper and middle level plateau (8-15% slope). These soils are under teak forest.	Clay, mixed hyperthermic Typic Ustorthents		
	Khawasa (Kw)	Deep, moderately well drained, sandy loam soils on lower denudational plateau undulating plateau and rolling plain (8-15% slope). These soils are under forest of teak, tendu, saja, amala and char	Coarse-loamy mixed hyperthermic family of Typic Haplustepts		
	Nadora (Nd)	Deep, moderately well drained, clay to clay loam soils on broad and narrow inter hill basin (3-8% slope). These soils are mostly used for the cultivation of wheat, gram, red gram and vegetables.	Very-fine montmorillonitic hyperthermic family of Typic Haplusterts		
23.	Jm-G1-Kh-Rk Jamuntola (Jm)	Shallow, somewhat excessively drained sandy loam soils on upper denudational plateau, hills and ridges (3-8% slope). These soils are under	Loamy, mixed hyperthermic family of Lithic	16991	1.94

		forest of teak, tendu, saja, amala and char.	Ustorthents		
	Gondatola (G1)	Deep, well drained, clay to clay to sandy clay loam soils on rolling plain of lateritic terrain lower and upper denudational plateau of granitic terrain (8-15% slope). These soils are mostly used for the cultivation of wheat, gram, red gram, rice, masur peas and vegetables.	Fine, mixed, hyperthermic family of Typic Rhodustalfs		
	Kharsaru (Kh)	Deep, well drained, clayey soils on a lower denudational and undulating plateaus and rolling pedipiains (8-15% slope). These soils are under red gram, soybean and wheat cultivation.	Fine, montmorillinitic, hyperthermic Udic Haplusterts		
	Rukhad (Rk)	Deep, moderately well drained, loamy sand to sandy loam rolling pedipiains lower denudational and undulating plateaus, broad inter hill basin (1-3% slope). These soils are mostly under Teak forest.	Coarse-loamy, mixed hyperthermic family of Ustic Epiaquerts		
24.	Pt-G1-Kw-Rk Pratappur (Pt)	Very deep, moderately well drained, clay soils on lower denudational plateaus undulating and rolling pedipiains (8-15% slopes). These soils are under red gram, soybean, paddy, gram and wheat cultivation.	Very-fine, mixed, hyperthermic family of Udic Haplustalfs	12962	1.48
	Gondatola (Gl)	Deep, well drained, clay to clay to sandy clay loam soils on rolling plain of lateritic terrain lower and upper denudational plateau of granitic terrain (8-l5%slope. These soils are mostly used for the cultivation of wheat, gram, red gram, rice, masur, peas and vegetables.	Fine, mixed, hyperthermic family of Typic Rhodustalfs		
	Khawasa (Kw)	Deep, moderately well drained, sandy loam soils on lower denudational plateaus undulating plateaus and rolling plains (8-15% slope). These soils are under forest of teak, tendu , saja, amala and char.	Coarse-loamy mixed hyperthermic family of Typic Haplustepts		
	Rukhad(Rk)	Deep, moderately well drained, loamy sand to sandy loam rolling pediplains lower denudational and undulating plateaus, broad inter hill basin (1-3% slope). These soils are mostly under Teak forest.	Coarse-loamy mixed hyperthermic family of Typic Haplustepts		
25.	Sk-Jm-Rk Sukla(Sk)	Shallow, somewhat excessively drained clay loam soils on a isolated hillock, upper and middle level plateau (8-15% slope). These soils are under Teak forest.	Clay, mixed hyperthermic Typic Ustorthents	65773	7.51
	Jamuntola (Jm)	Shallow, somewhat excessively drained sandy loam soils on upper denudational plateau, hills and ridges (3-8% slope). These soils are under forest of Teak, Tendu, Saja, and Amala, Char forest.	Loamy, mixed hyperthermic family of Lithic Ustorthents		
	Rukhad (Rk)	Deep, moderately well drained, loamy sand to sandy loam textured, rolling pediplains lower denudational and undulating plateaus and broad inter hill basins (1-3% slope). These soils are mostly under teak forest.	Coarse-loamy mixed hyperthermic family of Typic Haplustepts		
26.	Kn-Bs-Jm-Roc Kanera (Kn)	Very shallow, somewhat excessively drained, sandy clay loam soils, structural plateaus and ridges (15-30% slope). These soils are under the cultivation of wheat, gram, red gram, rice, masur, peas and vegetables.	Loamy, mixed hyperthermic family of Lithic Ustorthents	10948	1.25
	Bisapur (Bs)	Deep, well drained, loamy sandy soils on flood plain, inter hill basin, and lower denudational	Fine-loamy mixed hyperthermic family		

		plateau (1-3% slope). These soils are under forest of teak, tendu, saja, amala, and char.	of Typic Haplustepts		
	Jamuntola (Jm)	Shallow, somewhat excessively drained sandy loam soils on upper denudational plateau, hills and ridges (3-8% slope). These soils are under forest of Teak, Tendu , Saja and Amala, Char forest.	Loamy, mixed, hyperthermic family of Lithic Ustorthents		
27.	Kw-Sk-Ta Khawasa (Kw)	Deep, moderately well drained, sandy loam soils on lower denudational plateau undulating plateau and rolling plains (8-15% slope). These soils are under forest of teak, tendu saja, amala and char.	Coarse-loamy mixed, hyperthennic family of Typic Haplustepts	54825	6.26
	Sukla (Sk)	Shallow, somewhat excessively drained clap loam soils on a isolated hillock, upper and middle level plateau (8-15% slope). These soils are under teak forest.	Clay, mixed hyperthermic Typic Ustorthents		
	Tarali (Ta)	Very deep, moderately well drained, clay soils on upper denudational plateau and pediplain (8-15% slope). These soils are under the cultivation of wheat, gram, red gram, rice and vegetables.	Fine, montmorillinitic hyperthermic Typic Haplusterts		
28.	Ta-Ko-Jm Tarali (Ta)	Very deep, moderately well drained, clay soils on upper denudational plateau, and pediplain (8-15% slope). These soils are under the cultivation of wheat, gram, red gram, rice and vegetables.	Fine, montmorillinitic hyperthermic Typic Haplusterts	5430	0.62
	Kodajhiri (Ko)	Very deep, well drained on a middle level plateau rolling pediplain and undulating plateau (8-15 % slope). These soils are under teak forest.	Fine, montmorillinitic, hyperthermic Typic Haplusterts		
	Jamuntola (Jm)	Shallow, somewhat excessively drained sandy loam soils on upper denudational plateau, hills and ridges (3-8% slope). These soils are under forest of teak, tendu, saja, amala and char.	Loamy, mixed hyperthermic family of Lithic Ustorthents		
29.	Kw-Lu-Lk Khawasa (Kw)	Deep, moderately well drained, sandy loam soils on lower denudational plateaus, undulating plateaus and rolling plains (8-15% slope). These soils are under forest of teak, tendu, saja, amala and char.	Coarse-loamy, mixed hyperthermic family of Typic Haplustepts	53862	6.15
	Lungsa(Lu)	Deep, somewhat excessively drained, clayey soils occur in valleys, inter hill basins and lower denudational plateaus (3-8% slopes). These soils are mostly used for the cultivation of wheat, gram, masur, red gram and vegetables.	Very-fine, montmorillonitic, hyperthermic, family of calcareous Ustic Endoaquerts		
	Lakhanadon (Lk)	Moderately shallow, somewhat excessively drained, sandy clay loam or sandy loam soils on isolated hillocks, plateau tops and pediplains (8-15% slopes). These soils are under pasture.	Fine, mixed, hyperthermic family of Typic Haplustepts		
30	Dh-Sk-Pt Dhora (Dh)	Extremely shallow, moderately well drained, clayey, soils on narrow and broad inter hill basins (3-8 % slopes) These soils are under forest mainly of teak, palas, khair.	Loamy, mixed, hyperthermic family of Lithic Ustorthents	8933	1.02
	Sukla (Sk)	Shallow, somewhat excessively drained clay loam soils on isolated hillock, upper and middle level plateau (8-15 % slope). These soils are under Teak forest.	Clay, mixed hyperthermic Typic Ustorthents		
	Pratappur (Pt)	Very deep, moderately well drained, clay soils on lower denudational plateaus undulating and rolling pediplains (8-15% slopes). These soils are under red gram, soybean, paddy, gram and wheat cultivation.	Very-fine, mixed, hyperthermic family of Udic Haplustalfs		

11.
SOIL FORMING FACTORS AND PROCESSES

11.1. Vertisols:

In Seoni, these soils are developed on basalts under hot moist climate characterized by a period of sufficient moisture deficit to induce cracking and swelling. These soils occur in areas with slopes of 3 to 15 percent but often subject to intense erosion. These soils in broad and level areas often lack integrated drainage network results to form swamps or marshy lands. The microrelief features are not recorded in survey but micro relief features known as “gilgai” exits. The development of gilgai is due to shrinking and swelling of Vertisols (Hallsworth 1955). On wetting and swelling, the soil mass cannot reoccupy the original volume since surficial material has fallen into the cracks during the rainy season and forced the material to push upwards forming mounds to further release pressure and perpetuating the formation of mounds and depressions (Wilding and Tessier, 1988). The appearance of slickensides in subgroups of Vertisols that occur on old geomorphic surfaces include Nadora, Bhimgarh, Jamunpani, Dhenka, Kharasaru, Paddikona, Lungsa, Kodajhri and Tarali series. These soils have shrink-swell cycles that homogenize solum and convert the soil to vertisol. However, in general, it is believed that most of the Vertisols are young and immature.

Soil forming processes: The five pedogenic processes (Hubble, 1984) common to most of the vertisols are:
(1) Soil movement by shrinking and swelling that cause shearing and consequently the formation of slickensides and the characteristic subsoil structure.
(2) Lateral and vertical movements of soil materials associated with gilgai formation,
(3) Churning which is believed to be a slow process
(4) Formation of organo-mineral complexations and
(5) Weathering and redistribution of new products under conditions of restricted leaching alternating with drying.

The most common soil forming processes linked to Vertisols are: cracking and swelling, self mulching , churning, formation of slickensided zones, sphenoids and bowl structures, kankar formations, dark coloration, formation of smectitic clays and clay translocation. These soils are dark coloured with high organic carbon due to impeded drainage conditions, duration and severity of dry season, composition and parent material (Dudal 1965). These soils in Seoni shows the presence of slickensides due to lateral pressure is more than vertical swelling pressure (Komomik and Zeitlin 1970). This deformation zone appears to be the function of the plasticity of the underlying material at the time when swelling is taking place in the overlying material (Eswaran et al. 1988). These soils have five zones of morphological expressions such as:
Zonel: - surface to 25 cm deep, subject to intense cracking and formation of large prisms, hard when dry and break to form angular blocky aggregates.
Zone2: Approximately 10 to 30 cm thick essentially very hard and coarse angular blocky aggregates.
Zone 3: Variable thickness and merge with zone 5 which is underformed clay. This zone is characterized by sphenoids with tilted axes.
Zone 4: Zone of slickensides with tilted long axes and
Zone 5: Zone of underformed clay which is dry and hard, creating conditions for the formation of slickensides directly above it.

These soils have high pH with sufficient Ca and Mg and presence of relatively impermeable layer at some depth to form or preserve smectites in soil environments. Ca and Mg are dominant on exchangeable complex (40 to 65 percent of the total cations) and have low to moderate Mg and negligible sodium. The small size aggregates and narrower cracks in these soils are due to high exchangeable Ca (Blokhuis 1982; Kaloga 1966) but this type of statement is modified saying that it is the geometry (interconnectivity) rather than the volume of cracks that is attributable to exchangeable cation composition. The self mulching soils in the transect of Little et al. (1992) had two to four times the level of calcium than the non mulching soils and Ca/Mg ratio is greatest in self mulching soils.

Management: Compon ents of management under rainfed conditions include land clearing, soil tillage , land layout, fertility management and water management (Table 14) (Ahmad and Mermut 1996).

Table 14. Management of Vertisols

Land clearing	Soil tillage	Land layout	Fertility and water management
Burning as an aid to land clearing his not hazardous but by mechanical means may expose the soil to erosion by indiscriminate soil disturbance and loosening.	Best time for primary tillage is after harvest when the soil is till moist enough to allow cutting by tillage implements. This allows the ploughed soil to become completely desiccated and for self mulching to occur on rewetting. This may extend in case of rice and sugarcane from dry state to semi inundated state. Deep ploughing to soil loosening to a greater depth is of doubtful in drier climates where vertisols hardlydryout deeply enough to shatter and also leads to subsoil compaction.	**Zonal tillage and flat planting:**-seedlings are dibbled into the soil using machete or planting stick to minimally prepared soil and done towards the wet season when risk of flooding is less. **Ridges:-**Ridges of various shapes are made by hand or with the use of animal power for planting cereals, oilseeds, grain legumes and cotton and extensively used in our country. **Ridges with tied furrows: -** ridges of 1.5 m apart with ties in the furrows at frequent intervals. It conserves rain where it falls and concentrates part of itwhere crop is sown. Large ridges with furrows for growing sugar cane: - it is for both drainage and irrigation **Beds:-** Broad -bed furrow system it involves graded wide beds separated by furrows which drain into grassed waterways and fitted to natural contour of the land. Flat bed with box or rectangularly **Shaped drains: -** flat beds of 3-4 m width are in common on flat landscapes using disc ploughs pulled by tractors, the soil allowed to dry and then harrowed. **Cambered beds: -** are narrower with less camber and are constructed with wheel tractors and small bulldozer blades.	**Fertility management** **Nitrogen:-**level of soil water is key for crop responses to nitrogenous fertilizers Crop responses is more in rainy season > post monsoon period and post rainy season. 40 ppm of NO_3 accumulate to a depth of 1 m hence early planting of cropis good practice in wet season fallow system as common practice in India. **Phosphorus: -**the available P as indicated by olsen's method averages 5 to 8 ppm and response to added P is more. **Exchangeable Potassium: -** the K status is usually goodbut unavailable to crops due to wetting and drying cycles. These soils are deficient in Zinc. **Water management:-** **Flood fallowing: -** It is a technique of high clay soil rejuvenation in sugar cane areas. It was appreciated that the enhancement of anaerobic fermentation produces methane and other gases which escapes to the atmosphere of iron in times of reduction wetting and its oxidation of Fe2* and its precipitation as Fe203. By this treatment there is great improvement in aggregate stability and reduced bulk density. in general

11.2. Alfisols

The soils classified in the subgroups of alfisols are Chunamati, Arandiya, Pratappur and Gondatola series and mostly distributed in southern parts of the district where in granite/laterite landforms are common.

Processes

The weathering of primary mineral components is a prerequisite to accelerate physical and chemical weathering, particularly for hydration, hydrolysis, and oxidation. If the primary minerals are weathering in an alkaline environment then carbonates often initially dominate the weathering products. The release of H+ ions for Ca2+ Mg^{2+}, and a variety of other cations, from the roots of vegetation fosters the process of weathering. Under forest vegetation, most profiles show Ca^{2+} and Mg^{2+} higher in amount in the surface horizon than in horizons below. This may be attributed to recycling through leaf fall and decay or an indication of more intense weathering.

The litter is decomposed to form an A horizon (decomposition, humification, mineralization). There is relatively little accumulation of organic matter in the mineral horizons due to cycling of nutrients in the upper horizons. Biocycling of nutrients from Bhorizons to A is an important process in most forested Alfisols. This explains the high content of bases (Ca, Mg, and K) in the ochric epipedon.

Eluviation of clay (in organic and inorganic form) from the A horizons in the initial material, of clay formed by mineral weathering and illuviated in the underlying B horizon (illuviation), i.e., an argillic horizon is formed (Soil Survey Staff 1975). The process of clay translocation is also called lessivage. An erratic moisture regime favours the formation of an argillic horizon because the processes of weathering and translocation as supported by percolation water and the precipitation of the translocated material by dry moisture conditions.The details of eluviation and illuviation can highlight the complexity of a variety of sub processes involved in the development of Alfisols (Boulet 1978).

Leaching of carbonates from the toplayers appear to be a prerequisite before clay can migrate. The presence of exchangeable calcium (from calcium carbonate) flocculates clay particles, creating particles that are too large to be transported in suspension. Removal of the calcium leaves the solum in a condition favourable for the dispersion of clay particles. When the clay particles are dispersed in an aqueous suspension translocation from the A into the B horizon occurs with or without aid of complexing organic compounds and possibly by migration of Si, Fe and A1 under the influence of percolating water. Fine clays move more readily than coarse clay, therefore, the fine clay to total clay ratios are typically higher in the B horizon (0.6 - 0.8) than in the A (0.3 -0.6). Freshly formed clays tend to move more readily than older clays (Bourgeon and Seghal 1998, Bourgeon 1992).

Organic matter is known to act as an electron donor for the reduction and solubilization of iron oxides which are leached. Sesquioxides do act as a cohesion agent. Furthermore, the presence of organic acids tend to destabilize the soil micro-aggregates and produce dispersible clays which are subsequently leached.

Argillans (clay coatings) are formed in the B horizon, which are often fewer in the upper B compared to the lower B horizon(s). This can be explained by shrink-swell cycles (freezing-thawing, wetting-drying), soil creep, and biologic mixing, which are more intense in the upper horizon. The precipitation of clays, often with sequioxides and organic matter, in the argillic horizon may be brought about by (i) depletion of percolating waters through sorption by peds, (ii) swelling shuts of voids and consequent slowing of percolating water, (iii) sieve action by clogging of fine pores, (iv) flocculation of the negatively charged clay by positively charged iron oxides in the Bt horizon or by calcium in the higher-base saturation lower solum, and (v) low pH which favors flocculation. The accumulation of clay may be masked by other processes such as pedoturbation.

Additionally, there might be in situ formation of clay minerals in the B horizon by weathering of primary minerals such as feldspars, micas, and ferromagnesian minerals or by neosynthesis from illuvial weathering products. In young Alfisols, the illuviation is the dominant process for the formation of an argillic horizon, whereas through time the in situ formation of clays within the argillic horizon becomes more dominant

Management:

The major management properties are: surface compaction in light textured surface horizons and nutrient deficiencies. Some of the serious constraints to crop production in Alfisols are:

- Low moisture storage capacity and the likelihood of moisture stress
- Greater runoff and loss of water
- Percolation, loss of water and nutrients
- Workability problems (Alfisols are easy to work when wet but harden on drying and require greater amounts of energy for tillage)

  Crusting
  Erosion
  Low soil fertility

- **Coarse textured surface horizons :-** (**Bisapur** series, Arandiya series, Massanbarra series and silghat series):- These soils have a tendency to harden upon drying, often making tillage difficult (less than 40 percent clay). To overcome, topsoil hardening, the techniques available are: - cover crops, mulches, organic matter incorporation, fertilizers, minimum tillage, deep ploughing, seed bed configuration or grass fallows.
- **Compaction: -** It is temporary condition that disappears when the soils are rewetted but becomes constraint when dry. This phenomenon reduces time for seed bed preparation and shortens length of growing period.
- **Fertility: -** These soils are deficient in available nitrogen, phosphorus, potassium and Zinc.

11.3. Inceptisols

The soil series classified in the subgroups of Inceptisols are Khamariya, Sagar, Chhui, Gorakhpur, Piparia and Lakhanadon in basaltic terrain and Khawasa, Bisapur and Silghat on granitic land forms. The mapping units include (i) Sa-Pd-Ky-Pc, (ii) At-Pc-Bg, (iii) Go-Sa-Pd, (iv) Sa-Bg-Dh- in basaltic lands and (v) Kw-Sk-Ta, (vi) Kw-Lu-Lk, (vii) Si-At-Cu in granitic land forms. The soil mapping units with subgroups on Inceptisols cover 16.89 percent of area in basaltic terrain and 13.68 percent in granitic land forms.

Processes

Virtually many pedogenic processes are active to some extent in Inceptisol profiles but none predominates. The genesis of Inceptisols includes multiple pathways depending on the processes occurring on a given landscape and geographic area. Environmental factors can slow down weathering and soil development to form other soil orders is retarded or even inhibited (Ciolkosz et al.1989). Soil erosion on steep slopes can alter the topsoil extremely. When erosion has levelled the slope erosion rates become lower and more distinct pedogenic features like argillie horizons are formed. Usually Inceptisols are formed in underlying volumes of parent material as erosion lowers the landscape by removing the volume of material that was soil. Long time periods and higherosion rates are necessary to develop an Inceptisol on a steep slope to a further developed soil (deep soil profile, ABC horizons).

Inceptisols form also in colluvium at the base of steep slopes. Processes to form colluvium are mass movement, soil creep (slow mass movement), and deposition. Due to the hillslope processes and weathering morphological features are being formed and destroyed continuously. In depression areas or valley bottoms poorly drained Inceptisols are found where gleization produces redoximorphic features. In those areas leaching may be more extensive than in other landscape positions, but the process of lessivage and thus argillic horizon formation is somewhat retarded, probably because the soils do not undergo frequent desiccation. In areas of acid rocks, soils formed in landscape depressions tend to be more leached and somewhat lower in base content than soils in surrounding areas. In landscapes of high base status soils, the associated poorly drained Inceptisols in depression areas usually have higher base status than the surrounding soils. This can be attributed to the enrichment of the low-lying parts of the landscape by lateral processes such as transport of bases attached to soil particles, in surface runoff, or lateral subsurface flow.

13.4. Entisols

The soil series include Parasia and Dhora in basaltic landscapes and Kanera, Jamuntola and Sukla series in granitic landscapes. The soil mapping units are (i) Pc-Pd-Ky, (ii) Pc-Pr-Ky, (iii) Pc-Ma-Ky-Roc and (iv) Dh-Sk-Pt in basalt and (v) Jm-Gl-Kh-Rk, (vi) Sk-Jm-Rk, (vii) Kn-Bs-Jm-Roc in granite.These mapping units cover 33 percent where in 22.3 percent of area is in basalt and the remaining 10.7 percent in granitic landscapes.

Processes

The characteristic of Entisols is that there is little or no evidence of soil development. They form a transition between the other soil orders of Soil Taxonomy and non-soil material such as bare rock, deep water or ice at the surface of the earth. For example, submerged or waterlogged soils exclude oxidation and retard weathering. Sparse vegetation results in low litter amounts which retards the accumulation of organic matter in the topsoii. The high compactness of rock may inhibit the penetration of roots and therefore inhibit plant growth.

The impact of most soil forming processes is not great enough to produce soil features recognized as diagnostic for other soil orders. Entisols may be 'climax soils' which are in equilibrium with the environment, they may form by soil degradation (e.g. soil erosion) from other soil orders, or they may develop from ’non-soil areas'.

12.
SOIL SURVEY INTERPRETATION

Soil survey interpretation involves the following steps:

(1) Assembling information on soil and landscape in which they occur.

(2) Deriving inferences, rules and guides for predicting soil behaviour for specific land uses and

(3) Integrating these prediction into generalization for the mapping units.

The most generally applied soil management group is land capability classification for common and recent group includes fertility classification system. The soil site information is also assessed for suitability of various crop combinations in the region. The details are given and described as

12.1. Land Capability Classification

The land capability classification is an interpretative grouping of soils mainly based on (i) the inherent soil characteristics, (ii) external land features and (iii) environmental factors that limit land use. The information on the first two items are provided by soil survey. The land capability is mainly based on inherent soil characteristics such as soil depth, cation exchange capacity, base saturation, organic carbon and electrical conductivity (iii) external land features such as stoniness, flooding, drainage and the environmental factors like climate, that limits the use of land (Klingebiel and Montgomery 1961). The classification of soil unit into the capability groupings will give vivid picture of hazards of soil to various factors which causes deterioration and decline in fertility. This classification systems has a class, subclass and capability units. The type of soil limitation in use become comparatively greater from class I to VIII. The classes are useful as means of introducing map user to the more detailed information on soil map. These classes show the location, amount and general suitability of soils for agricultural uses.

Sub-classes: Subclasses are groups of capability units which have a same conservation problems such as:

e - erosion and runoff,
w - excessively wet,
s - root zone limitation and
c - climatic limitations

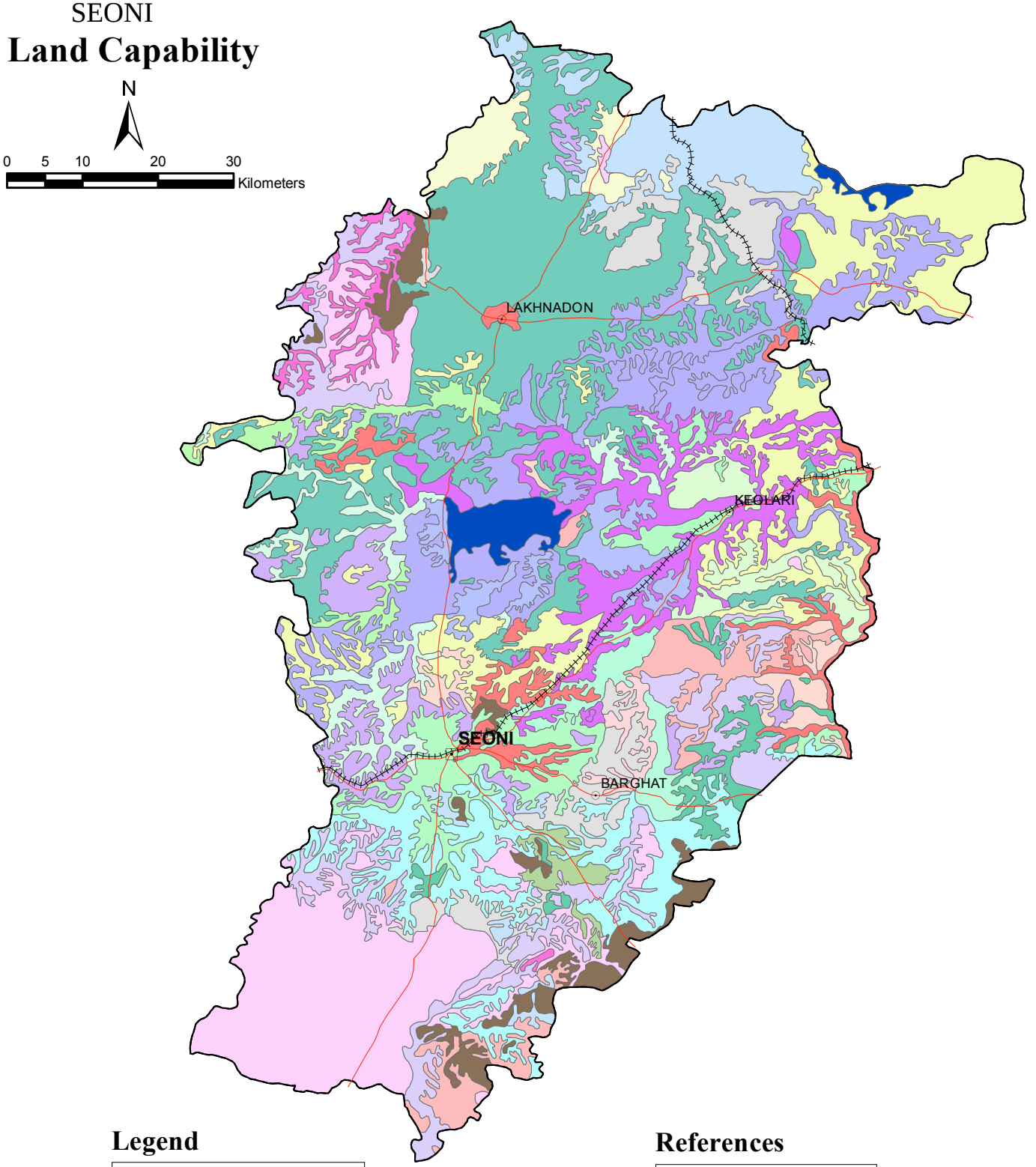
Capability unit is a grouping of one or more individual soil mapping units having a similar potential and continuing limitation on hazards. The soil capability units are sufficiently uniform to produce similar kind of cultivated crops and pasture land in the similar management practices, require similar conservation treatments and management requirements under the same kind and vegetative cover and have a comparable potential productivity. This unit condenses and simplifies soil information for planning individual tracts.

The soil mapping units provide a detailed information for all interpretative groupings. The soil mapping unit is portion of landscape having similar characteristic and qualities and whose limits are fixed by precise definition. These units were classified upto subclass level and its detailed description is given in the table 15, Fig.15.

The Land Irrigability map of the district is shown in the figure 16.

SEONI

Land Capability



Legend

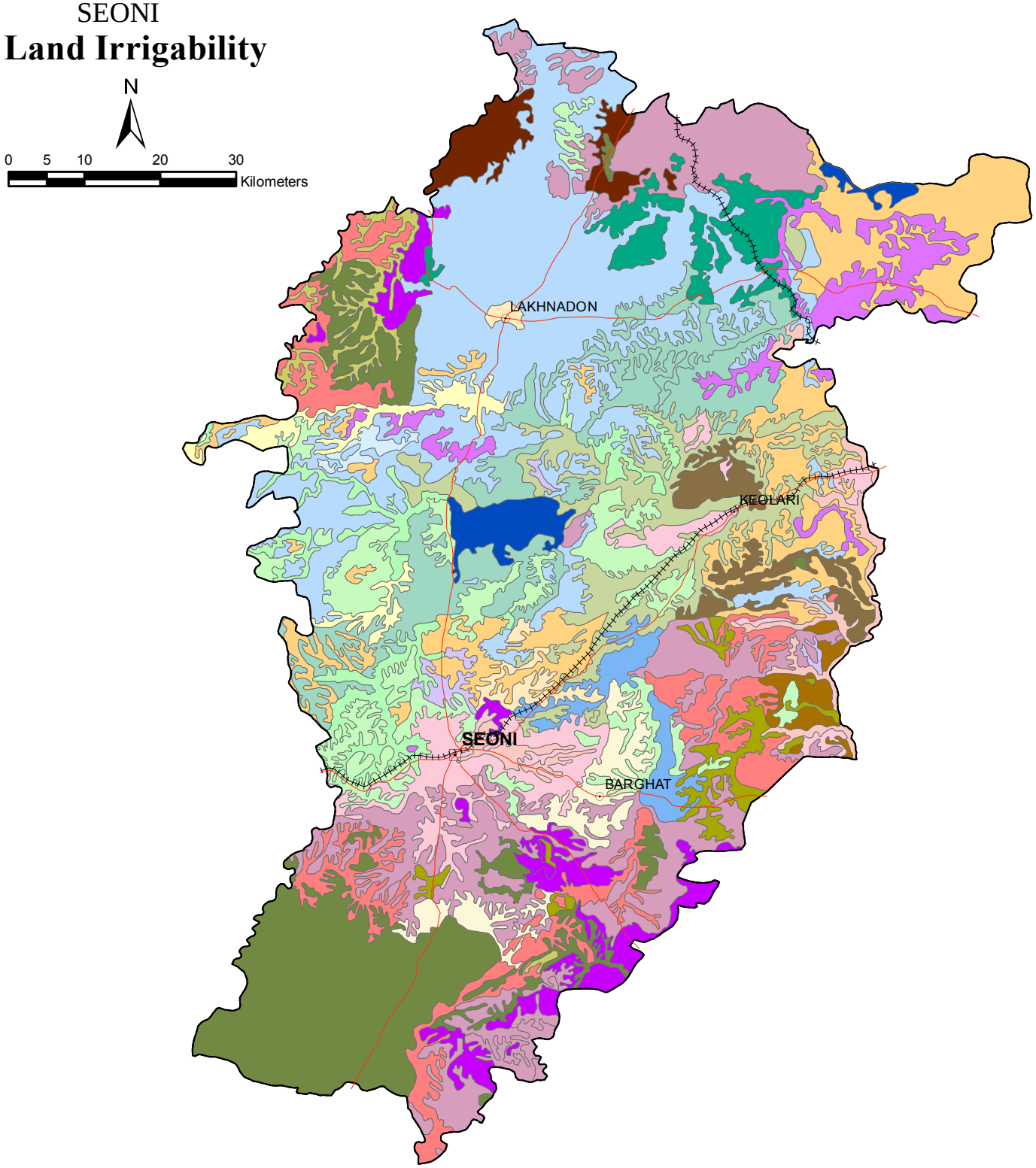
IIIe-IIIsw	IVes
IIIes-IVes	IVes-IIIes
IIIes-IVws	IVes-VIes
IIIs-IVsw	IVsw-IIIes
IIIsw-IIIes	IVsw-IIIsw
IIIw	V-VIIes
IIIw-IIw	VI-VIIes
IIIw-IVes	VIIIes
IIIws	VIIIes-VIIes
IIIws-IVw	VIIes-VIes
IIVsw-IIIw	Ves-VIIes
IIw-IIIes	NA
IIw-IIIsw	Reservoir

References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

SEONI

Land Irrigability



Legend

2s	3est	4st-4t-2st
2s-3est	3est-4t-RO	4st-4t-3st
2s-3est-4t	3st-2s	4t-2s
2st	3st-2st	4t-2st
2st-2s	3st	6est-3st-4st
2st-2s-3est	3st-6est	6est-4t-4st
2st-2s-6est	3st-6est-4st	6t-3est-RO
2st-4st	3st-6est-RO	Reservoir
2st-6est	4st	

References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

Fig. 16: Land Irrigability

Table 15. Evaluation of mapping units for land capability classification

Soil mappingunit	Class & subclass	Suitability	Management
Pc-Pd-Ky Pc-Pr-Ky Kt-At-Pc-Roc- Lk-Pr-Sa-Lu Pc-Ma-Ky Sk-Jm-Bs Dh-Sk-Kw-Nd Kn-Bs-Jm Dh-Sk-Pc	Ves-VIIes V-VIIes Ves-VIIes VI-VIIes VIIes-Ves VIIes-Vies VIIIes IVes- Vies VUIes-VIIes	AH steep land subject to erosion if cover is depleted. Suitable for grazing or forestry Very steep land, very shallow, stony limited to grazing only.	Manage grazing and logging to maintain sufficient residue and litter for soil and moisture conservation.
Sa-Pd-Ky -Roc At-Pc-Bg Nd-Sa-Dh Pr-Sa-Jp Go-Sa-Pd Ar-Kh-Bg-Nd At-Lu-Lk Si-At-Cu Dk-Pd-Kh Sa-Bg-Dh Kh-Jp-Ch-Pc Bg-Ky-At Kh-Go-Lk Sa-At-Lu Ko-Kw-Sk Jm-Gl-Kw Pt-Gl-Kh-Rk Sk-Jm-Rk Kw-Sk-Ta Ta-Ko-Jm Kw-Lu-Lk	IIIw-IIw IIIs-IVsw IIIw IIIw IIw-IIIes IIIws IVsw-IIIsw IVsw-IIIes IIw-IIIsw IIIw IIIws-IVw IVsw-IIIsw IIIsw-IIIes IV sw-IIIw IVes-IIIes IVes-IIIes IIIe-IIIsw IVes IIIes-IVes IIIw-Ives IIIes-IVws	Class III Gently to moderately sloping land having heavy textured soil of expanding type of clay mineral with gentle slope in black or mixed red and black soil region ,erosion and root zone limitation are common but drainage is difficult with intensive rains Class IV Strongly sloping to steep land, deep to shallow soils with intensive erosion and limitation of gravel, stone and strongly alkali soils.	The careful selection of crops in rotation with pastures

12.2. Fertility Capability Classification

Fertility capability classification is the first technical soil classification system(Sanchez et al. 1982) that group soils according to their fertility constraints in a quantitative manner. The term “top soil” refers to the plow layer or top 20 cm of soil whichever is shallower. The subsoil encompasses the depth interval between top soil and 60cm depth.

The system consists of three categorical levels:

(i) Type - Top soil textutre
(ii) Substrata type - Sub soil texture and
(iii) Modifers - 15 modifers including several changes from the original version (Boul et al 1975).

The FCC units is the combination of these three categorical level as defined below:

(i) Type: Texture of plow layer or surface 20 cm whichever is shallower.

(a) S - Sandy top soils: loamy sand and sands,
(b) L - loamh top soils <35% clay but not loamy sand or sand,
(c) C - Clayey top soils >35 percent clay and
(d) O - Organic soils >30% O.M. to a depth of 50 cm or more

(ii) Substrata type (texture of subsoils): If there is marked textural changes from the surface or if a hard root restricting layers is encountered within 50 cm.

S - Sandy subsoils texture as in type
L - Loamy subsoils texture as in type
C - Clayey subsoils texture as in type
R - Rock or other hard root restricting layer.

(iii) Modifiers: The criteria listed for each modifier for use in interpreting FCC units of Seoni district are as below:

(i) d-(dry) ustic, aridic or xeric, soil moisture regime (subsoil dry> 90 cumulative days per year within 20-60 cm depth.

(ii) i: - High P fixation) % free Fe_2O_3 percent clay >0.15 and more than 35% clay or hue of 7.5 YR or redder and granular structure. This modifier is used only in clay (C) types it applies only to plow layer or surface 20 cm of soil surface whichever is shallower.

(iii) v - (Vertisol): very sticky plastic clay >35 percent clay and 7.50 percent of 2:1 expanding clays or severe top soils shrinking and swelling

(iv) k - (low K reserves) <10% weatherable minerals in silt and sand fraction within 50 cm or the soil surface or exchangeable K <0.20 meq/100 g or K <2 percent of sum of bases if bases <10 meq/100 g.

(v) b - (basic reactions) Free CaCOs within 50 cm of soil surface (effervescence with HC1) or pH >7.3.

(vi) (gravel) a prime (‘) denotes 15-35% gravel or coarser (75 mm) particles by volume to any type or substrata type texture.

(vii) % - (Slope) where it is desirable to show slope with the FCC unit, the slope range percentage is shown in the unit.

The 30 soil series are grouped in the "FCC units. The soils in basaltic terrain were grouped in eight FCC units indicating clay top soils and hard root restricting substrata under ustic soil moisture regime (CRdv). Khamariya series has low K reserves, high P fixation where as 15-35 percent gravel by volume in Dhora series (CRbik) and severe top soil swelling and shrinkig in Gorakhpur series (CRdv) are the constraints for crop production. The Kharsaru and Lungsa series have clay top and substrata type with high P fixation capacity and are designated as CCdi. Kodajhiri and Chhui series have e potential deficiency of micronutrients such as zinc with FCC unit of CCdb. The low K reserves and 15-35 percent gravels are main modifiers used in defing FCC unit of Chunamati and Gondatola series (CCdk’).

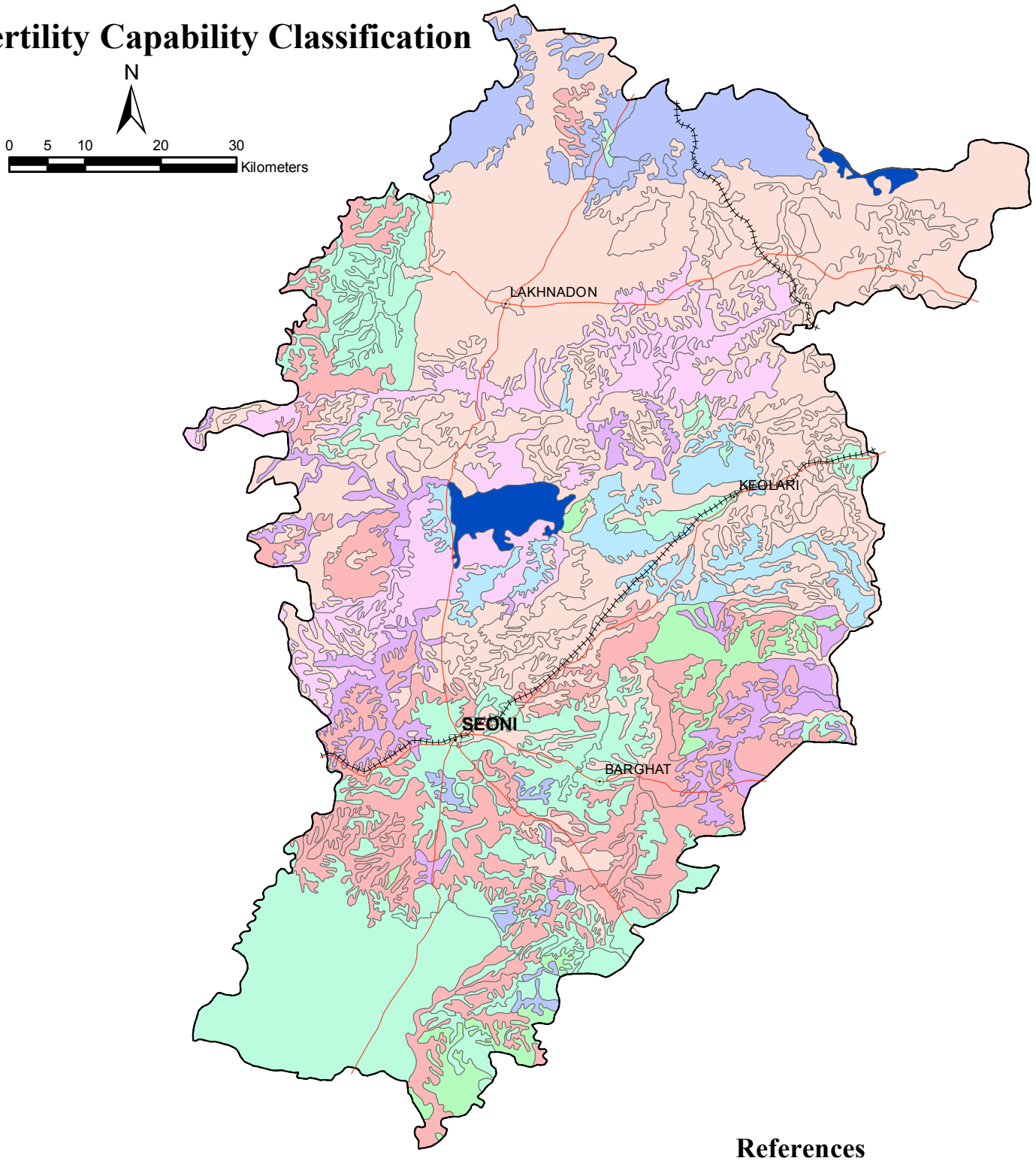
The Atari and Pratappur soils with vertic characteristic under ustic soil moisture regime have high P fixation and low K reserves (CCVdik) but in Nadora, Parasia, Tarali, Sagar, Paddikona, Jamunpani series have high. swell shrink potential and potential difficiencies of P, Fe and Zn (CCvdb).

The soils in granitic landforms have loamy top soil and hard root restricting substrata (LRd) in Kanera, Arandiya, Jamuntola and Pipariya with low ability to retain nutrients like K, Ca and Mg. The FCC unit of Silghat, Khawasa, Masanbarra and Lakhanadon series is designated Lbki. The Bisapur and Rukhad soils have sandy top, low waterholding capacity, low K supply and 15-35 percent gravels and were defined as SSbk. The soil mapping units were evaluated and detailed description of FCC unit is furnished in the table 16.

The extent each fertility capability units is in the order of CCvdb (38.71%) > CCvdik (18.7%) >LLdh (16.55%) >CCRdv (9.68%) and >CRidh (6.12%). The root restricting soils in the district cover 15.8 percent of total area and deep clay top and substrata type, with high shrink and swell capacity cover 38.7 percent of total area. The spatial pattern is depicted in Fig.17.

SEONI

Fertility Capability Classification



Legend

- ccdb
- ccdi
- ccrdv
- ccvdb
- ccvdik
- cridk
- lldk
- lrd
- Reservoir

References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage

Fig. 17: Fertility Cpability classification

Table 16. Fertility capability classification and interpretation of soil mapping units

FCC Unit	Soil mapping units	Interpretation of FCC unit	Area (km^2)	(%)
CCVDB:-CLAYEY TYPE AND SUBSTRATA TYPEWITH LOE INFILTRATION, GOOD WATER HOLDING CAPACITY, HIGH SHRINK SWELL POTENTIAL, HIGHLY PRODUCTIVE. POTENTIAL DEFICIENCIES OF PHOSPHORUS, IRON AND ZINC			3384.79	38.71
CCRdv*	l.Pa-Pd-Ky*	Associated with Khamariya (Ky*) series with hard root restricting layers within 20 to 60 cm depth, severely eroded and dry more than 90 cumulative days per year.	422.83	4.84
LRd* CCRdv**	2.Pa-Pr*-Ky**-rockout crops	**Pipariya** series (Pr*) have loamy top, medium infiltration and good water holding capacity. Khamariya series (Ky**) with hard root restricting layers with in 20 to 60 cm depth and dry more than 90 cumulative days per year, severely eroded.	1014.69	11.62
CCRdv*	3.Sa-Pd-Ky*-Pa	Associated with Paddikona (Pd), **Sagar** (Sa) and **Parasia** (Pa) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Khamariya (Ky*) series with hard root restricting layers with in 20 to 60 cm depth, severely eroded and dry more than 90 cumulative days per year.	911.72	10.44
CRdik*	6.Nd-Sa-Dh*	**Nadora** (Nd) and **Sagar** (Sa) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Associated with **Dhora** (Dh*) series with clay top soil, hard root restricting layers, dry more than 90 cumulative days per year, high "P" fixation, low "K" reserves and have gravels more than 35 percent.	63.84	0.73
CRdik*	14.Sa-Bg-Dh*	**Sagar** (Sa) and Bhimgarh (Bg) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Associated with **Dhora** (Dh*) series with clay top soil, hard root restricting layers, dry more than 90 cumulative days per year, high "P" fixation, low "K" reserves and have gravels more than 35 percent.	128.66	1.47
CCRdv* CCVdik**	16.Bg-Ky*-At**	Bhimgarh (Bg) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Associated with Khamariya (Ky*) series with hard root restricting layers with in 20 to 60 cm depth, severely eroded and dry more than 90 cumulative days per year. **Atari** (At**) series have clayey top and substrata type, Vertic, Ustic soil moisture regime, high "P" fixation and low "K" reserves.	38.41	0.44

LLdk* CCRdv**	18.Pa-Ma*-Ky**- rockout crops	**Parasia** (Pa) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Masanbarra (Ma*) have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic. Khamariya (Ky**) series with hard root restricting layers with in 20 to 60 cm depth, severely eroded and dry more than 90 cumulative days per year.	211.98	2.43
Cedi	13.Dk-Pd-Kh*	**Dhenka** (Dk) and Paddikona (Pd) series have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Kharasu (Kh*) have clayey top soil and substrata type with ustic soil moisture regime and high "P" fixation capacity.	480.69	5.51
CCVdik* CCdi**	19.Sa-At*-Lu**	**Sagar** (Sa) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. **Atari** (At**) series have clayey top and substrata type, Vertic, Ustic soil moisture regime, high "P" fixation and low "K" reserves. **Lungsa** (Lu**) have clayey top soil and substrata type with Ustic soil moisture regime and high "P" fixation capacity.	58.52	0.67
CCdb* LRd**	28.Ta-Ko*-Jm**	**Tarali** (Ta) series have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. **Kodajhiri** (Ko) series have clayey top and sub soils with high shrink-swell potentials and dry more than 90 cumulative days per year and have hard root restricting layers. **Jamuntola** (Jm**) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season.	53.40	0.62
CCVdik;-CLAYEY TOP AND SUBSTRATA TYPE, VERTIC, USTIC SOIL MOISTURE REGIME, HIGH "P" FIXATION AND LOW K RESERVES			637.81	7.31
CCvdb*	4.At-Pa*-Bg*	**Atari** (At) series have clayey top and substrata type, Vertic, Ustic soil moisture regime, high "P" fixation and low "K" reserves. **Parasia** (Pa*) and Bhimgarh (Bg*) series have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc.	237.98	2.73
CCdi*	1l.At-Lu*-Kh*	**Atari** (At) series have clayey top and substrata type, Vertic, Ustic soil moisture regime, high "P" fixation and low "K" reserves. **Lungsa** (Lu*) and **Kharsaru** (Kh*) have clayey top soil and substrata type with Uustic soil moisture regime and high "P" fixation capacity.	65.62	0.75
CCdi:- CLAYEY TOP SOIL AND SUBSTRATA TYPE WITH USTIC SOIL MOISTURE REGIME AND HIGH "P"FIXATION CAPACITY			334.21	3.83
CRdv* LLdk*'*	17.Kh-Go*-Lk**	**Kharsaru** (Kh*) have clayey top soil and substrata type with ustic soil moisture regime and high "P" fixation capacity. Gorakhpur (Go*) series have clayey topsoil, hard root restricting substrata with Ustic soil moisture regime and severe top soil shrinking and swelling. **Lakhanadon** (Lk**)	171.05	1.96

		series have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic.		
CCVdb* CCdk'**	t5.Kh-Jp*- Ch**- Pa*	**Kharsaru** (Kh*) have clayey top soil and substrata type with ustic soil moisture regime and high "P" fixation capacity. Jamunpani (Jp*) and **Parasia** (Pa*) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. Chunamati (Ch**) series have clayey top and subsoil types with ustic moisture and low K reserves and have gravels more than 30 percent by volume in sub soils.	163.16	1.87
CCRdv:- CLAYEY TOPSOIL, HARD ROOT RESTRICTING SUBSTRATA WITH USTIC SOIL MOISTURE REGIME AND SEVERE TOP SOIL SHRINKING AND SWELLING			844.65	9.68
CRdv CCvdb*	9.Go-Sa*-Pd*	Gorakhpur (Go*) series have clayey topsoil, hard root restricting substrata with ustic soil moisture regime and severe top soil shrinking and swelling. **Sagar** (Sa*) and Paddikona (Pd*) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc.	108.98	1.25
CCvdik* CCvdb**	5.Ky-At*-Pa**- Rock outcrops	Khamariya (Ky**) with hard root restricting layers with in 20 to 60 cm depth and dry more than 90 cumulative days per year, severely eroded **Atari** (At*) series have clayey top and substrata type, Vertic, ustic soil moisture regime, high "P" fixation and low "K" reserves. **Parasia** (Pa**) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc.	735.67	8.43
CCdb:-CLAYEY TOP AND SUBSOIL TYPE WITH SEVERE SHRINK-SWELLPOTENTIALSAND DRY MORE THAN 90 CUMULATIVE DAYS PER YEARAND HARD ROOT RESTRICTING LAYERS BETWEEN 20 AND 60 CM			250.39	2.87
LLdk* LRd**	21.Ko-Kw*- Sk**	**Kodajhiri** (Ko) series have clayey top and subsoils with high shrink-swell potentials and dry more than 90 cumulative days per year and have hard root restricting layers. **Khawasa** (Kw*) series loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic. **Sukla** (Sk**) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season.	250.39	2.87
CRidk: - CLAY TOP SOIL, HARD ROOT RESTRICTING LAYERS, DRY MORE THAN 90 CUMULATIVE DAYS PER YEAR, HIGH "P"FIXATION, LOW "K" RESERVESAND HAVE GRAVELS MORE THAN 35 PERCENT.			534.59	6.12

LRd* LLdk**	22.Dh-Sk*-Kw* *-rock out crops	**Dhora** (Dh) series with clay top soil, hard root restricting layers, dry more than 90 cumulative days per year, high "P" fixation, low "K" reserves and have gravels more than 35 percent. **Sukla** (Sk*) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Khawasa** (Kw**) series loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dryseason, germination problems are often experienced if first rains are sporadic.	445.47 5.10	
LRd* CCvdb**	30.Dh*Sk*- Pa**	**Dhora** (Dh) series with clay top soil, hard root restricting layers, dry more than 90 cumulative days per year, high "P" fixation, low "K" reserves and have gravels more than 3 5 percent. **Sukla** (Sk*) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Parasia** (Pa**) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc.	89.12	1.02
CCvdik;- CLAYEY TOP AND SUBSTRATA TYPE, VERTIC, UST1C SOIL MOISTURE REGIME, HIGH "P" FIXATION AND LOW "K" RESERVES			1632.82	18.7
CCdki* CCdi** SSdki***	24.Pt-Gl*- Kh**- Rk***	**Pratappur** (Pt) have clayey top and substrata type, Vertic, Ustic soil moisture regime, high "P" fixation and low "K" reserves **Gondatola** (Gl*) and Chunamati (Ch**) series have clayey top and subsoil types with ustic moisture and low K reserves and have gravels more than 30 percent by volume in sub soils. **Kharsaru** (Kh**) have clayey top soil and substrata type with Ustic soil moisture regime and high *'P" fixation capacity. **Rukhad** (Rk***) series have sandy top and substrata type with high infiltration rate and low water holding capacity, moisture is limiting during dry season and low ability to supply K,	129.25	1.48
LRd:- LOAMY TOP SOIL, MEDIUM INFILTRATION, GOOD WATER HOLDING CAPACITY, HARD ROOT RESTRICTING SUBSOIL RESULTING FROM SEVERE EROSION, MOISTURE LIMITING DURING DRY SEASON			1493.43	17.23
CCvdb*	8,Pr-Sa*Jp*	**Pipariya** (Pr) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Sagar** (Sa*) and Jamunpani (Jp**) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc.	25.54	0.29
CCdi* CCvdb**	10.Ar-Kh*- Bg**- Nd**	Arandiya (Ar) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Kharsaru** (Kh**) have clayey top soil and substrata type with ustic soil moisture regime and high "P" fixation capacity. Bhimgarh (Bg**) and **Nadora** (Nd**) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet,	337.16	3.86

		potential deficiencies of iron and zinc.		
SSdki	20.Sk-Jm-Bs*-rockoutcrops	**Sukla** (Sk) and **Jamuntola** (Jm) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Bisapur** (Bs*)series have sandy top and substrata type with high infiltration rate and low water holding capacity, moisture is limiting during dry season and low ability to supply K,	206.76	2.37
CCdki* LLdk**	23.Jm-Gl*-Kw**- rockout crops	Jamunpani (Jm) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Gondatola** (GL*) and Chunamati(Ch**) series have clayey top and subsoil types with Ustic moisture and low K reserves and have gravels more than 30 percent by volume in sub soils. **Khawasa** (Kw**) series loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic.	169.07	1.94
CCvdb* SSdki**	25.Sk-Jp*-Rk**	**Sukla** (Sk) and **Jamuntola** (Jm) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dty season. Jamunpani (Jp*) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. **Rukhad** (Rk**) have sandy top and substrata type with high infiltration rate and low water holding capacity, moisture is limiting during dry season and low ability to supply K.	655.57	7.51
SSdki*	26.Kn-Bs*-Jm-rockoutcrops	**Kanera** (Kn) and Jamunpani (Jm) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Bisapur** (Bs*)series have sandy top and substrata type with high infiltration rate and low water holding capacity, moisture is limiting during dry season and low ability to supply K.	109.47	1.25
LLdk:-loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic			1445.06	16.55
LRd* CCvdb** CCdi***	7.Lk-Pr*-Sa**-Lu***	**Lakhanadon** (Lk) series have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K,Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic. **Pipariya** (Pr*) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Sukla** (Sk**) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. **Lungsa** (Lu***) have clayey top soil and substrata type with	250.53	2.87

		Ustic soil moisture regime and high “P” fixation capacity.		
CCvdki*	12.Si-At* Cu**	Silghat (Si) series have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic. **Atari** (At*) series have clayey top and substrain type, vertic, ustic soil moisture regime, high “P” fixation and low “K” reserves.Chhui (Cu**) series have clayey top and subsoils with high shrink-swell potentials and dry more than 90 cumulative days per year and have hard root restricting layers.	110.87	1.27
	27.Kw-Sk-Ta	**Khawasa** (Kw)and **Sukla** (Sk) series have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic. **Tarali** (Ta*) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season.	546.51	6.26
CCdi*	29.Kw-Lu*-Lk	**Khawasa** (Kw)and **Lakhanadon** (Lk) series have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic. **Lungsa** (Lu*) have clayey top soil and substrata type with Ustic soil moisture regime and high “P” fixation capacity.	537.15	6.15

13.
FERTILITY STATUS

A. Soils with A horizon

The soils on basaltic terrain (**Dhora**, **Parasia**) are low in N, P, K and Zn status where as the soils on granitic terrain (**Jamuntola**, **Sukla**&**Kanera**) are low in N, P , Zn and medium in K.

B. Soils with Ap and Bw horizons

The basaltic soils are low in N, P and Zn (Atari, Khamariya, Pipariya and Chhui series) and high P and K, medium in Zn levels and medium Zn and K (Gorakpur and Sagar series). The N, P and Zn decreases with depth in all the soils. The nitrogen content varies from 57 to 124 mg/kg, P from 1.23 to 9.3 mg/kg and Zn from 0.35 to 1.13 mg/kg. The soils on granitic land forms have low status of N, P, K and Zn (Khawasa, Bisapur, Silghat) and high P and medium Zn in Rukhad series. These nutrients show decreasing trend with depth.

C. Soils with cambic B and Slickensided zones

The fine textured Tarali, Kodajhiri series have low P and Zn and medium to high K status. The Fe is marginal in Kodajhiri series with its value of 4.09 mg/kg in surface Ap horizon to 2.46 mg/kg in slickensided zone. The very fine textured basaltic soils (Dohra, Paddikona, Lungsa and Khawasa series) are low in N, P and Zn status and medium to high in K status. The Jamunpani and Bhimgarh series have high to medium Fe and low in N, P and Zn. The Nadora series have high K status, low N, P, Fe and Zn status .

D. Soils with Ap and argillic B horizon

These soils were grouped in three fertility classes based on level of acceptance of critical limits (Benton Jones, 2001). The group 1 includes Gondatola having low N, P, K and Zn status. Group 2 soils (Pratappur, Chunamati series) have medium K status and low N, P, Fe and Zn. The Group 3 Aradiya series have high K and low in N, P and Zn status.

The thematic map on NPK status in soils (Fig.18 and Table 17) showed that 40.26 percent of soils in northern Lakhanadon plateau have low available nitrogen, phosphorus and medium in available potassium content, where as soils in southern lowlands have low nitrogen, low or high phosphorus and medium to high available potassium contents and the soils in upper Wainganga valley have low nitrogen, phosphorus and medium to high available potassium contents (Table 18).

SEONI

NKP Status of Soils

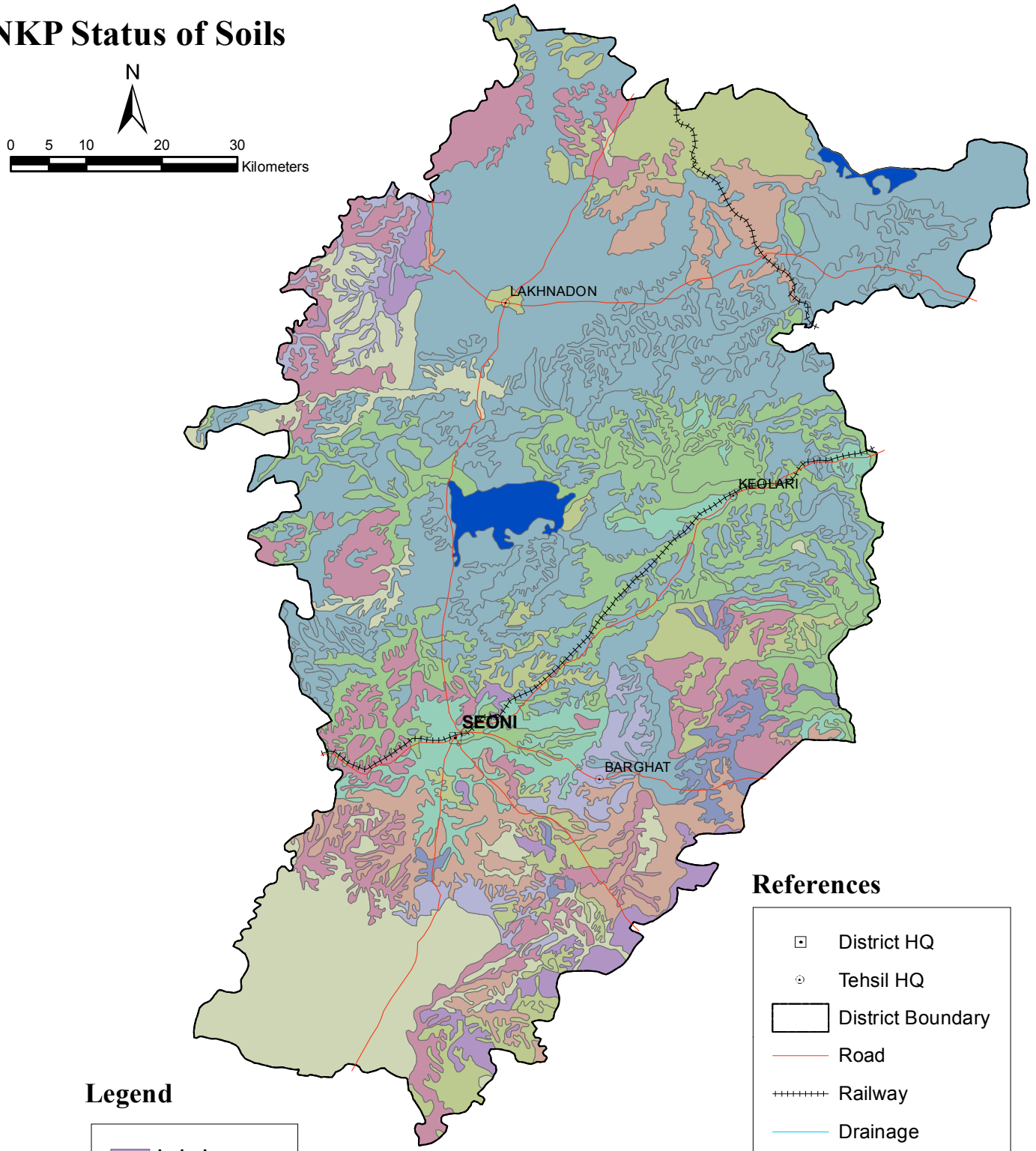


Fig. 18: NKP Status of Soils

Table 17. Fertility status of soils in Seoni district

SI. No.	Soil Series	Depth (cm)	Available (mg kg^{-1})			DTPA Extractable ((mg kg^{-1})			
			N	P	K	Fe	Mn	Cu	Zn
1.	**Nadora**	0-19	61.6	4.1	375	2.3	6.77	3.51	0.64
		19-26	60.2	2.8	340	1.94	5.83	2.68	0.44
		26-62	57.4	1.74	330	1.66	6.10	1.51	0.29
		62-90	54.6	1.42	315	1.57	6.16	2.27	0.31
		90-105	74.2	1.50	270	2.07	4.65	1.70	0.18
2.	Khamariya	0-11	106.4	2.3	375	11.12	87.43	9.4	0.57
		11-23	96.6	1.7	270	9.37	53.07	7.02	0.34
		23-35	82.6	1.60	245	5.54	22.47	4.54	0.38
3.	Dhora	0-9	156.2	1.8	165.0	10.6	75.9	3.4	0.52
4.	Parasia	0-12	126	2.3	215	24.4	82.52	8.81	1.02
5.	Chunamati	0-18	72.8	2.3	340	2.93	25.71	2.44	0.24
		18-39	70.0	1.3	250	3.02	17.39	2.17	0.26
		39-60	64.4	0.9	275	2.98	16.22	2.07	0.36
		60-90	71.4	1.2	190	1.44	3.29	0.97	0.42
6.	Gorakhpur	0-9	93.8	27.2	630	23.2	84.24	10.61	1.13
		9-23	81.2	25.4	520	20.1	54.64	10.00	0.55
		23-39	57.4	8.4	760	7.9	9.69	2.75	0.08
7.	Arandiya	0-9	88.2	21.56	170	51.07	40.47	1.24	1.31
		9-35	86.8	7.53	155	19.93	19.52	1.67	0.46
		35-58	93.8	20.04	200	22.05	8.56	0.86	0.35
		58-97	105.0	14.04	215	15.25	11.12	0.64	0.36
8	Bhimgarh	0-14	78.4	1.71	465	3.44	13.77	3.03	0.56
		14-33	75.6	1.56	420	3.54	13.88	3.32	0.47
		33-53	74.2	1.30	385	3.31	13.01	2.45	0.43
		53-85	79.8	0.87	345	3.23	10.57	2.32	0.45
		85-140	68.6	1.12	335	3.18	9.05	2.12	0.57
9	Jamunpani	0-24	88.2	1.69	435	12.61	58.61	2.59	0.97
		24-62	67.2	1.80	360	9.19	23.42	2.19	0.57
		62-113	70.0	1.82	390	5.83	11.52	1.35	0.47
		113-127	64.4	1.48	235	2.61	3.65	2.68	0.40
		127-150	61.6	1.57	170	3.09	2.20	0.14	0.46
10.	Dhenka	0-11	82.6	1.67	465	2.81	9.74	1.66	0.52
		11-34	70.0	1.10	390	2.30	7.65	1.30	0.44
		34-65	71.4	1.58	400	1.79	6.32	1.17	0.51
		65-103	63.0	1.52	415	1.55	4.26	1.05	0.48
		103-150	60.2	1.28	405	1.53	3.28	0.85	0.37
11.	Chuui	0-15	82.6	2.96	355	8.91	24.63	2.49	0.23
		15-63	71.4	1.13	280	3.07	7.78	1.64	0.45
		63-104	47.6	2.29	245	2.21	3.21	1.36	0.39
		104-150	40.6	2.00	195	2.07	3.39	0.93	0.40
12.	Kharsaru	0-25	71.4	1.90	435	7.15	34.38	11.47	0.54
		25-53	75.6	1.34	425	5.48	19.36	10.39	0.48
		53-81	71.4	1.55	465	2.89	5.57	4.29	0.34
13.	Atari	0-14	80.0	1.95	350	16.59	45.95	3.01	0.60
		14-45	79.8	1.33	295	1.85	7.15	0.90	0.38
		45-90	68.6	0.96	310	1.22	3.46	0.58	0.35
		90-150	60.2	0.88	335	1.14	2.89	0.56	0.41
14.	Masanbarra	0-7	85.4	19.5	145.0	108.8	42.92	0.76	0.36
		7-25	91.0	3.66	70.0	70.02	31.79	0.66	0.36
		25-52	74.2	5.70	95.0	33.26	31.54	0.51	0.32
		52-68	74.2	6.68	95.0	23.84	41.72	0.38	0.28
		68-90	85.4	6.45	105.0	19.98	38.93	0.47	0.30
15.	Paddikona	0-10	72.8	4.21	360	6.85	28.61	7.38	0.69
		10-30	71.4	4.92	355	5.34	16.09	7.36	0.58
		30-50	64.4	4.96	350	3.80	6.76	6.53	0.39
		50-90	49.0	7.03	360	3.70	4.24	6.74	0.44
		90-150	64.4	7.17.	380	3.77	4.88	8.00	0.44

16.	Lungsa	0-8	58.8	1.70	275	8.83	38.62	1.91	0.57
		8-59	64.4	0.98	280	4.82	11.72	1.47	0.46
		59-93	70.0	0.63	280	3.97	11.60	1 31	0.44
		93-140	68.6	1.14	290	1.43	3.41	0.49	0.36
17.	Sagar	0-12	93.8	1.86	370	14.05	87.0	6.28	0.95
		12-32	86.8	2.42	350	10.21	47.70	5.53	0.74
		32-46	78.4	1.32	345	8.37	31.33	4.96	0.80
		46-60	77.0	1.30	195	5.06	5.84	1.56	0.11
18.	Lakhandon	0-3	124.6	9.33	350	26.33	50.26	8.43	1.26
		3-13	114.8	5.26	250	18.51	74.89	9.13	0.29
		13-30	110.6	4.21	255	13.57	68.76	6.78	0.32
		30-54	81.2	2.41	310	10.07	23.33	1.94	0.45
19.	Pipariya	0-5	113.4	1.64	340	18.56	46.91	5.73	0.23
		5-16	102.2	4.87	245	6.45	16.73	1.74	0.08
		16-35	71.4	2.10	260	3.60	13.81	0.24	0.13
20.	Kanera	0-12	110.6	2.72	245	10.63	75.96	3.38	0.52
21.	Kodhjhiri	0-19	131.6	2.82	430	4.09	4.92	1.45	0.55
		19-42	141.4	1.10	255	2.49	2.98	0.75	0.30
		42-76	91.6	1.18	265	2.77	3.10	0.68	0.16
		76-123	82.6	1.44	295	2.83	3.14	0.87	0.32
		123-150	78.4	1.29	370	2.46	2.84	0.53	0.31
22.	Silghat	0-11	96.6	7.07	105.0	126.90	48.80	2.32	0.32
		11-21	93.8	2.42	120.0	35.70	66.96	1.79	0.34
		21-42	85.4	1.80	95.0	18.78	23.11	131	0.39
		42-80	72.8	1.35	115.0	7.91	16.37	0.83	0.35
		80-110	74.2	1.56	130.0	5.74	16.50	0.70	0.37
23.	Jamuntola	0-13	121.8	6.0	225.0	21.53	74.38	3.15	0.21
24.	Tarali	0-22	71.4	2.03	325.0	11.42	35.85	3.51	0.70
		22-56	67.2	1.74	325.0	2.89	7.03	2.16	0.52
		56-82	60.2	1.55	345.0	2.42	4.21	2.10	0.50
		82-110	53.2	1.39	345.0	1.90	2.55	1.95	0.42
		110-161	45.0	1.36	340.0	1.91	2.92	1.53	0.47
25.	Khawasa	0-13	95.2	2.10	120.0	26.53	27.79	0.71	0.60
		13-31	84.0	1.79	105.0	14.75	13.31	1.05	0.46
		31-60	79.8	2.25	95.0	13.47.	12.07	1.37	0.39
		60-96	61.6	3.76	105.0	9.64	13.07	1.62	0.39
		96-140	57.4	3.56	115.0	9.79	16.49	1.99	0.37
26.	Pratappur	0-19	74.2	0.63	385.0	18.02	51.51	3.49	0.66
		19-44	81.2	2.59	375.0	7.23	1281	2.60	0.43
		44-75	70.0	1.51	365.0	3.77	4.98	2.39	0.30
		75-111	60.2	1.36	305.0	2.78	2.49	1.69	0.29
		111-159	63.0	1.21	315.0	3.29	0.38	1.85	0.38
27.	Rukhad	0-16	68.6	9.17	185.0	55.30	1.34	0.53	1.34
		16-49	71.0	4.97	135.0	40.36	0.68	0.53	0.68
		49-78	74.0	5.25	135.0	35.32	0.57	0.48	0.57
		78-108	67.0	3.74	150.0	50.29	0.69	1.48	0.69
28.	Sukla	0-18	94.2	1.8	170.0	25.17	40.17	2.67	0.67
		18-34	98.0	1.58	140.5	17.21	29.53	1.89	0.47
29.	Bisapur	0-17	74.2	3.84	190.0	36.0	35.36	1.92	1.04
		17-46	85.4	0.72	115.0	37.43	26.31	1.98	0.62
		46-78	81.2	4.33	100.0	33.84	19.74	1.41	0.46
		78-120	75.6	8.50	115.0	36.36	17.49	1.36	0.44
30.	Gondatola	0-14	120.0	3.68	155	58.32	153.0	5.53	0.68
		14-43	110.	0.76	140	23.75	82.62	5.47	0.35
		43-78	100	1.40	145	14.76	47.41	3.26	0.35
		78-122	95.2	1.66	115	13.77	29.40	2.08	0.16

Table 18. Extent of Soil mapping units as per NPK status

S. No.	Rating			Soil Mapping Units (SMU)	Area	
	N	P	K		(ha)	(%)
1.	Low	Low	Low	**Sukla-Jamuntola-Bisapur** (20)	50487.800	5.760
2.	Low	Low	Medium	**Parasia**-Paddikona-Khamariya(l), **Parasia-Pipariya**- Khamariya(2), **Sagar**-Paddikona-Khamariya (3), Khamariya-**Atari** - **Parasia** (5), Silghat -**Atari** - Chhui (12), **Kharsaru** - Gorakhpur-**Lakhanadon** (17) and **Sagar** -**Atari** - **Lungsa** (19)	352620.38	40.26
3. 1	Low	Low	Low-Medium	**Parasia**-Masanbarra-Khamariya (18), **Khawasa-Sukla-Tarali** (27)	78110.3	8.92
4.	Low	Low	Medium-High	**Atari-Parasia**-Bhimgarh (4), **Pipariya-Sagar**-Jamunpani (8), **Atari-Lungsa-Kharsaru** (11), **Dhenka**-Paddikona -**Kharsaru** (13), **Sagar**-Bhimgarh-**Dhenka**(14), **Kharsaru**-Jamunpani-Chunamat-**Parasia** (15), Bhimgarh- Khamariya-**Atari** (16)	110707.99	12.64
5.	Low	Low-Medium	Low-Medium	**Lakhanadon-Pipariya-Sagar** (7), **Khawasa-Lungsa-Lakhanadon**(29), **Dhora-Sukla**-Prattappur(30)	90160.25	10.29
6.	Low	Low-High	Medium-High	Gorakhpur-**Sagar**-Paddikona (9), **Sukla-Jamuntola-Rukhad** (25)	67506.26	7.71
7.	Low-Medium	Low-Medium	Low-High	**Pratappur-Gondatola-Khawasa** -**Rukhad**(24)	13303.17	1.52
8.	Low-Medium	Low	Low-High	**Nadora-Sagar-Dhora**(6), **Kodajhiri-Khawasa-Sukla** (21), **Dhenka-Sukla-Khawasa-Nadora**(22), **Tarali** - **Kodajhiri-Jamuntola** (28)	83772.47	9.57
9. -	Low	Medium	Medium	**Jamuntola-Gondatola-Kharsaru-Rukhad** (23), **Kanera-Bisapur-Jamuntola**(26)	28674.4	3.27
10.	Low	Low-High	Low-High	Arandiya-**Kharsaru**-Bhimgarh -**Nadora**(10)	346.96	0.04

14.
LAND USE PLAN

The Land use plan of Seoni District was generated using soil resource information and land capability classification. The methods employed includes separation of arable and non arable soil mapping units and evaluation of each arable unit for locally grown crops (Sys et al 1991). This kind of exercise was carried out as per (Vadivelu, et al, 2003). The soil-site suitability with land capability analysis showed that 55.4 percent of area is arable in the Seoni district. Within the arable units, Rice - Wheat cropping system is suitable in 2.17 percent of total area covering four soil mapping units (Sa-Pd-Kh, Go-Sa-Pd, Sa-At-Lu, Bh-Kh-At). The suitability analysis further revealed that 24 percent of land is suitable for sorghum - soybean, 15.29 percent for sorghum-cotton and 24 percent of total arable land for citrus in the district. The non-arable portion (44.7 percent) of total land is evaluated for forestry and wild life. Thirty seven percent of land is suitable for forestry and grazing, and remaining 6. 8 percent is suitable for wild life. The spatial distribution of 11 land suitable units is depicted in Fig. 19 and details of land units is given as table 19. The non arable portion is mostly concentrated in upper ridges of **Lakhanadon** plateau and the cultivated area in gently sloping and lower pediment surfaces in North-Eastern and South- Eastern/Central parts of the district.

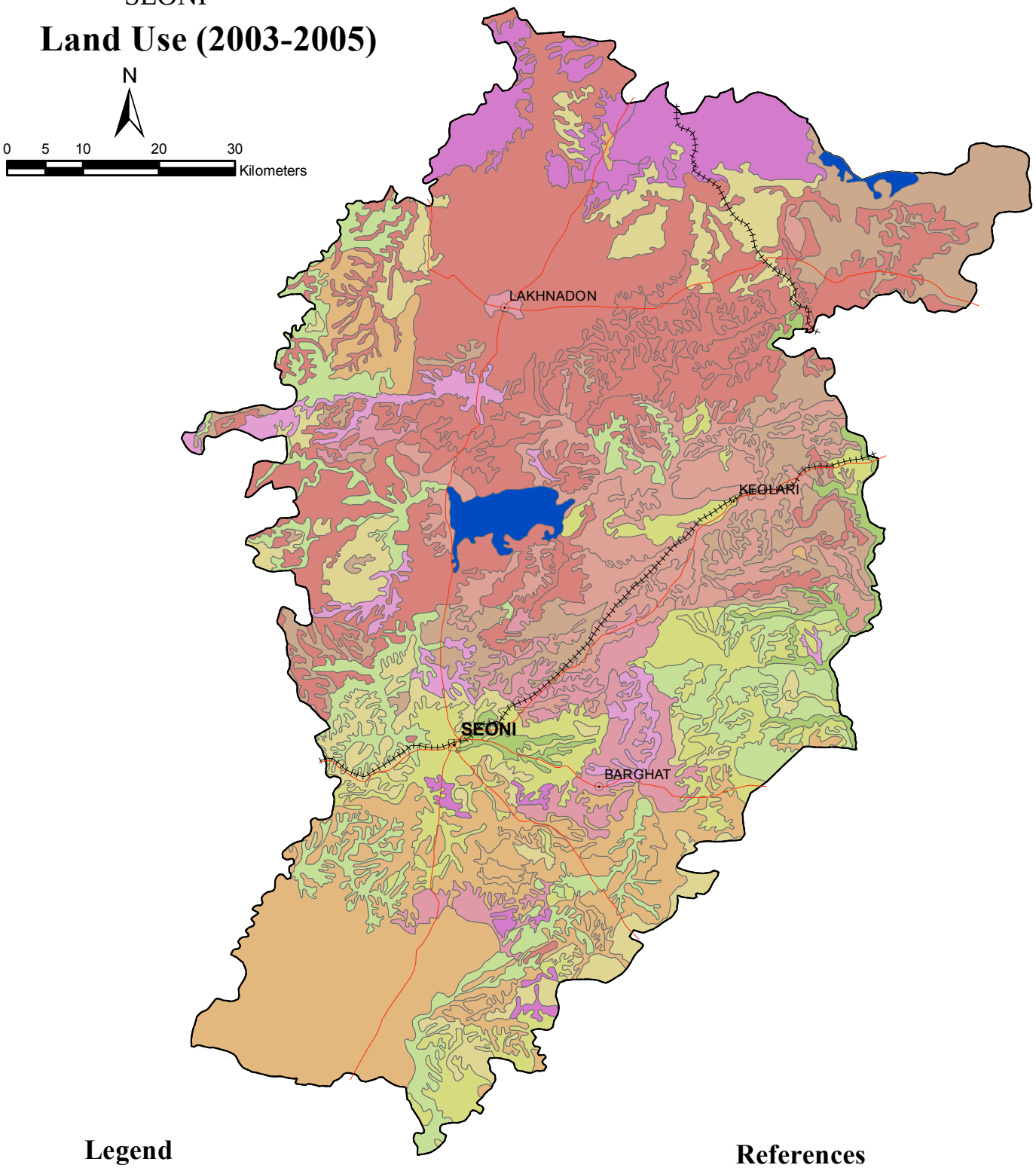
Table 19. Land use plan of Seoni district based on geo-pedological approach

SI. No.	Land suitable units	Soil Mapping units	Area	
			(ha)	(%)
1.	Soybean-sorghum-cotton- maize-vegetables	Sk-Jm-Rk(25),Kw-Sk-Ta(27), Ta - Ko-Jm(28)	129347.26	14.77
2.	Rice-wheat-soybean- sunflower-sorghum	Sa-Pd-Ky-Pc(3)	93840.66	10 71
3.	Rice-wheat-soybean-citrus- maize-sunflower	Go-Sa-Pd{9), Bg-Ky-At (16), Sa-At-Lu(19)	10090.3	1.15
4.	Sorghum-cotton	Dk-Pd-Kh(13),Kh-Jp-Ch-Pc (15), Kh-Go-Lk(17)	83953.12	9.59
5.	Sorghum-cotton-citrus-maize	At-Pc-Bg(4), At-Lu-Kh(ll), Kw-Lu-Lk(29)	79885.43	9.12
6.	Wheat-soybean-sorghum- cotton-maize	Na-Sa-Dh(6),Pr-Sa-Jb (8), Si-At-Cu(12), Jm-Gl-Kh-Rk(23)	38012.86	4.34
7.	Soybean-sorghum-citrus	Sa-Bg-Dh(14)	13212.86	1.51
8.	Soybean-sorghum-cotton- citrus-maize	Ar-Kh-Bg-Nd(l 0),Ko-Kw-Sk (21) - Pt-GI-Kw-Rk(24)	39446.73	4.50
9.	Forestry and grazing	Pc-Pd-Ky(l), Pc-Pr-Ky(2), Ky-At-Pc-Roc(5),Kn-Bs-Jm - Roc (26)	234960.86	26.83
10.	Fairly well suited for forestry and grazing	Lk-Pr-Sa-Lu(7), Pc-Ma-Ky-Roc (18), Sk-Jm-Bs-(20)	98042.42	11.19
11.	Suitable for wild life	Dh-Sk-Kw-Nd(20),Dh-Sk-Pt (30)	59655.93	6.81

Land use/land cover map of the distirct derived from analysis of ETM+ 2002 data is shown in figure 20.

SEONI

Land Use (2003-2005)

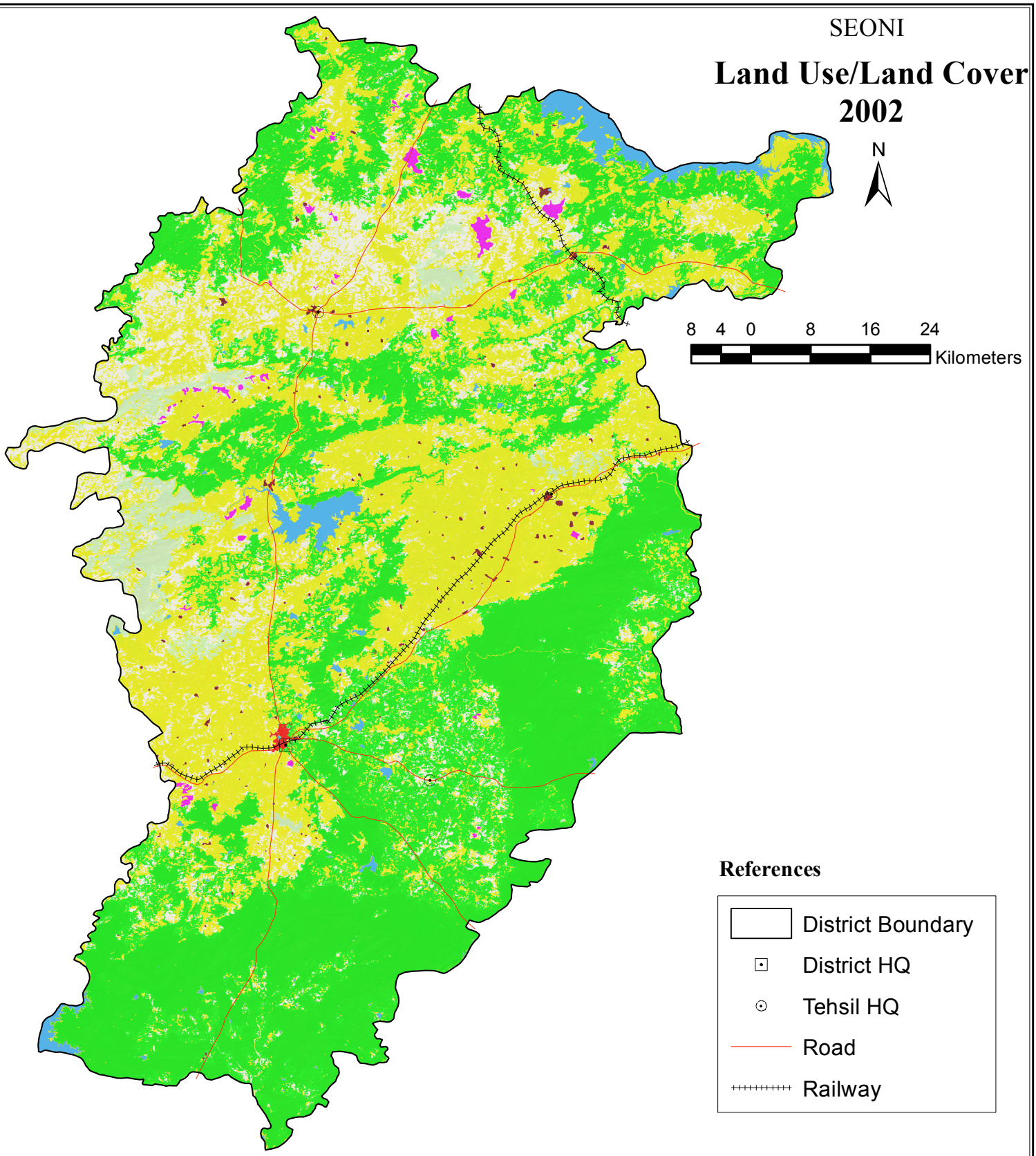


Legend

- Fairly well suited for forestry and grazing
- Forestry and grazing
- Rice-wheat-soybean- sunflower-sorghum
- Rice-wheat-soybean-citrus- maize-sunflower
- Sorghum-cotton
- Sorghum-cotton-citrus-maize
- Soybean-sorghum-citrus
- Soybean-sorghum-cotton- citrus-maize
- Soybean-sorghum-cotton- maize-vegetables
- Suitable for wild life
- Wheat-soybean-sorghum- cotton-maize
- Reservoir

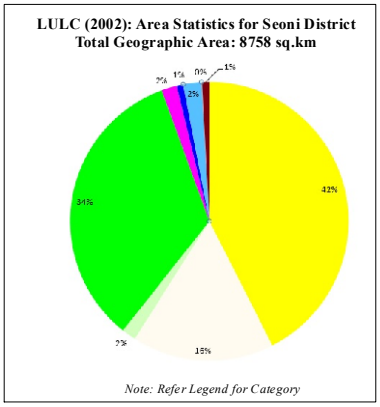
References

- District HQ
- Tehsil HQ
- District Boundary
- Road
- Railway
- Drainage



Legend

Classes	Area [sq.km]
Agriculture	
Agriculture, Cropland	3725
Agriculture, Single Crop, Fallow	1443
Builtup	
Built-up, Rural	75
Built-up, Urban	5
Forest	
Forest, ScrubForest	145
Forest, Deciduous	2959
Uncultivable	
Barren/Uncultivable/Wastelands, Scrub Land	156
Water	
Wetlands/Water Bodies, Reservoir/Lakes/Ponds	148
Wetlands/Water Bodies, River/Stream/Canals	66



Data Source: Landsat ETM+ Satellite data of Kharif (2002) and Rabi (2002), SRTM DEM, Existing Soil Maps & Reports (NBSS & LUP), and other Statistical Data

Fig. 20: Land Use/Land Cover 2002

15.
CONCLUSION

The reconnaissance soil survey on l: 50000scale in Seoni district, Madhya Pradesh was carried out during 2003 to 2005 with an objective of mapping soil bodies for designing land use plan. The methodological tools and approaches used to define complex landscapes involve identification of lithology codification of relief, land cover, land forms, field survey of soils, correlation and classification, deriving soil mapping unit composition for interpretation and mapping, and cartographic work for generalizations of maps . The following conclusions were drawn:

1.Delineated and estimated area under fourteen landforms in basaltic and granitic landforms as (i)structural plateaus (3.08 percent) (2) middle level plateaus (8.17 percent), (3) Narrow interhill basins (9.3 percent), (4) Structural hills and ridges (17.43 percent), (5) undulating plateaus (6.85 percent), (6) rolling pediplains (6.68 percent), (7) upper denudational plateaus (19.46 percent), (8) lower denudational plateaus (17.76 percent), (9) steeply sloping denudational escarpments (2.06 percent), (10) valleys (1.67 percent), (ll) Broad interhill basins (0.29 percent), (12) isolated hillocks (1.23 percent), (13) Gently sloping flood plains (6.95 percent) and (14) ridges (0.17 percent).

2. A total of 962 profiles were dug for study. Thirty soil series identified after correlation. Out of thirty soil series, eighteen series occur on basalt and remaining 12 in granite/laterite land forms. These series associations were made to derive thirty soil mapping units for generation of soil map.

3. The soil mapping units were evaluated for land capability, fertility capability and suitability for crops. The land capability analysis showed that the suitable land for wild life and forestry is 44.5 percent and remaining land is arable. Out of total arable land, 24 percent is suitable for citrus and soybean cropping system.

4. As per fertility capability classification, the soil mapping units were grouped into eight FCC units in the order of extent as CCvdb (38.71 percent) >Ccvdik (18.7 percent)> LLdh (16.55 percent) > CCRdv (9.68 percent) and Cridh (6.12 percent). Most of the soils are deficient in available nitrogen, phosphorus and zinc, clay top soils usually experience water deficit due to hard root restricting layers.

5. The map of NPK status showed that fine textured basaltic clay soils are low in nitrogen and phosphorus and medium to high in exchangeable potassium where as argillic red soils on granite in southern lands have medium in K status and low N and P status. The district is divided into ten zones where in more than sixty percent of soils are deficient in N,P and medium to high K status.

6. The appraisal of soil resources and utility of map for agro-management indicated that land evaluation programmes are to be taken up on the basis of suitable zones for land utilization types and include management requirements for sustainable crop production.

REFERENCES

Ahmad, N. and Mermut, A. (1996) Vertisols and Technologies for their management. Developments in soil science 24. Elsevier Science B.V., Netherlands.

Benton Jones, J.Jr. (2001).Laboratory Guide for Conducting soil tests and plant analysis.CRC press, London.

Bolkhuis, w.a. (1982) Morphology and genesis of Vertisols. In: Vertisols and Rice soils in the Tropics.Trans.12th lmrer. Congr. Of Soil Sci. New Delhi, Vol.3 , pp.23-47.

Boulet, R.(1978) Toposequences de sols trpicaux en Haute -Volta, equilibre et desequilibre pedobioclimatique.Mem. ORSTOM. 85,272pp.

Bourgeon, G. ((1992) Les sols rouges de l'inde peninsularie meridionale pedogenese fersiallitique sur socle cristallin en milieu tropical.Inst.fr.Pondichery, publications du department d ecologie No.31, 271, pp.

Bourgeon, G. and Sehgal, J. (1998) a comparative study of red soils of India and West Africa and their management for sustainable agriculture. Red and Lateritic soils (Eds. By Sehgal, J., Blum, W.E. and Gajbhiye, K.S.).pp.77-91.

Boul, S.W., Sanchez, P.A., Cate, R.B.,Jr. and Granger, M.A.(1975). Soil fertility capability classification, A technical soil classification system for fertility management. In: Bomemisza, E. and Alvarado, A.(editors), soil management in tropical America.N.C. state university, Raleigh, NC PP126-14.

Bridges, E.M. and Davidson, D.A.(1982) Principles and applications of soil geography. Longman, London and New York.

Ciolkosz, E.J., Waltman, W.J., Simpson, T.W. and Dobos, R.R. (1989). Distribution and genesis of soils of the northeastern United States.Geomorphology.2:285-302.

District Statistical Report. (2003/ District Seoni. District Statistical Office. Seoni.

Dudal, R.(1965) Dark clay soils of tropical and subtropical regions. FAO Agricultural development Paper N0.83, Rome.

Eswaran, H., Kimble, J. and Cook, T. (1988).Properties, genesis and classification of vertisols. In: L.R.Hirekur, J.L.Seghal, D.K.Pal and S.B.Deshpande (Editors). Classification, Management and Use Potential of Swell- Shrink soils. Trans. Int.Ltd. New Delhi.Bombay, Calcutta.pp.1-22.

Geological survey of India (2002). District Resource Map Seoni District Madhya Pradesh

Guru, S.D. (1989). Seoni. Madhya Pradesh District Gazetteers. Directorate of Gazetteers, Department of culture, Madhya Pradesh, Bhopal.

Hesse, P.R.(1971). A text book of Soil chemical analysis. John Murray Publishers Ltd. London.

Hubble, G.D. (1984).The cracking clay soils: definition, distribution, nature, genesis and use. In J.W. Mcgarity, E.H.Hoult and H.B.So (Editors), The properties andutilization of cracking clay soils. Reviews in Rural Sciences 5, University of New England, Armidale, Australia, pp 3-13.

Hudson, B.D. (1992).The soil survey as paradigm based science. Soil Science Society of America Journal. 56:836-841.

Jackson, M.L.(1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi.

Jenny, H.(1961). E.W.Hilgard and the birth of modem soil science (Berkely, CA. Farallo publication).

Kaloga, B. (1966). Pedological study of the slopes of white- red volta basins in Upper Volta. II. The Vertisols. Cah. Pedoi ORSTROM, 4:29-61.

Klingebiel, A.A. and Montgomery, P.H. (1961) Land capability classification. Agri. handb.210.USD/l, Soil conserve. Serv. Washington, DC.

Komomik, G.W. and Zeitlin, J.G. (1970) Laboratory determination of lateral and vertical stress in compacted swelling clay. J. Materials, 5:108-128.

Lindsay, W.L. and Norvell, W.A.(1978). Development of a DTPA micronutrient soil test for zinc, iron, manganese and copper. Soil Science Society of America Journal .42:421 -428.

Little, I.P., Ringrose - Voase, A.J.,and Ward, W.T.(1992) Surface structure in grey clays of North western New South Wales in relation to micromorphology, cation suite and particle size attributes. A us. J. soil Res. 30:1-16.

Lotse, E.G., Datta, N.P., Tomar, K.P. and Motsara, M.R. (1975). Minerological composition of some red and black soils of India. Bull. Indian nat. Sci.Acad. 50: 216-226.

Murthy.R.S., Bhattacharjee, J.C., Landey, R.J. and Pofali, R.M.(1982). Distribution, Characteristics and Classification of Vertisols. In Vertisols and Rice Soils of the Tropics. Symposia Paper \\J2ih International Congress of Soil Science, Vol. 3, pp3-22(Indian Society of Soil Science New Delhi.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A.(1954).Estimation of available phosphorus in soils by extraction with sodium bicarbonate, U.S.D.A.Circular Number 939, U.S.Government Printing Office,Washington, D C.

Piper, C,S. (1942). Soil and Plant Analysis. The University of Adelaide, Adelaide, Australia.

Reddy R.S.(2006). Methodlogy for Correlation of Soil Series in Soil Survey and • Mapping. Agropedology, 16,1-11.

Sanchez, P.A., Couto, W. and Boul, S.W. (1982). The fertility capability soil classification: interpretation, applicability and modification. Geoderma. 27:283-309.

Sarma, V.A.K., Krishnan, P. and Budihal, S.L. (1987).Laboratory methods. Bulletin No. 14. NBSS Publ.

Schollenberger, C.J. and Simon,R.H. (1954).Determination of exchange capacity and Exchangeable bases in soil-ammonium acetate method. Soil Science.59:13-24.

Shankaranarayana, H.S., Sarma, V.A.K., Deshpande, S.B. and Pandey, S. (1984). Memorandum on Soil Correlation. Bull no 10. NBSS& LUP, Nagpur.

Sohan Lal ,Deshpande, S B. and Sehgal, J. (1994). Soil Series of India. Soils Bulletin 40, NBSS &LUP, Nagpur, India 684p.

Soil Survey Staff. (1951). Soil Survey Manual, USDA, HB.18, Washington DC, USA

Soil Survey Staff. (1975). Soil Taxonomy. Agril.Hb. 436,754pp.
Soil Survey Staff. (1995). Soil Survey Manual, USDA, Hb18, Washington DC, USA

Soil Survey Staff (1998). Keys to Soil Taxonomy, 9th Edition, United State Department of Agriculture, Natural Resource Conservation Service, Washington DC,USA.

Subbaiah, B.V. and Asija, G.L.(1956). A rapid procedure for estimation of available nitrogen in soils. Current Science. 25,259-260.

Sys, Ir.C., Van Ranst, E. and Debaveye, Ir.J. (1991) Land Evaluation (Part-J to III), Agricultural Publications No.7, Central Administration of Development Cooperation, Brussels, Belgium.

Tamgadge, D.B., Gajbhiye, K.S., Velayutham, M. and Kaushal, G.S. (1999).Soils Series of Madhya Pradesh. NBSS Publ. No. 78, NBSS&LUP, Nagpur, 523p.

Thompson, C.H., Beckmann,G.G.(1982) Gilgai in Australian Black Earth and some of its effects on plants. Trop. Agri, (Trin),59:149-156.

Vadivelu, S., Baruah, U., Bhaskar, B.P., Thampi, J., Sarkar, D., Walia, C.S., Nayak, D.C. and Maji, A.K. (2003). A land use plan for Jorhat district of Assam. Agropedology. 13, 1-10.

Vadivelu, S. and Challa, O. (1985) Depth of slickensides occurrence in Vertisols. Journal of the Indian Society of Soil Science. 33, 452-454.

Pedon data **Annexure**-1

1. ARANDIYA SERIES (Ar)

Classification : Fine-loamy, mixed, hyperthermic family of Udic Haplustalfs
Type location : Village: Arandiya, Tehsil: Keolari, Dist: Seoni, M.P. 22°12'11" N lat. and 80°01'37" E long
Profile No : 64B/4 - P/5
Physiographic position : Rolling pediplains, structural plateaus, upper denuded plateau
Elevation : 340 m above MSL
Ground water table :2-5 m
Rainfall : 1155 mm
Slope & erosion : Moderately sloping (8-15%), moderate
Drainage & permeability : Moderately well drained, moderate permeability
Use & vegetation : Palas, Mahua
Geology & parent material : Basalt/ weathered basaltic material
Soil association :Khawasa, Bhimgarh, Nadora,
Soil correlation :
Distribution and extent : Extensive in Arandiya, Sakri and Sarekha kalan area of Keolari Tehsil, Seoni District, M.P.
Typifying pedon : Arandiya - sandy loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-9	Yellowish brown (10YR 5/4 M) to pale brown (10YR 6/3 D) sandy loam; medium, weak, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; pH 5.72; clear smooth boundary.
Btl	9-35	Dark yellowish brown (10YR 4/4 M) sandy clay loam; granular structure; loose, friable, slightly sticky and slightly plastic; very fine few roots with more than 15 percent coarse fragments; pH 6.25; gradual smooth boundary.
Bt2	35-58	Brown (10YR 4/3 M) sandy clay loam; granular structure; loose, friable, non-sticky and non-plastic; pH 6.60; gradual smooth boundary.
Bt3	58-97	Yellowish brown (10YR 5/6 M) sandy clay loam; granular structure; loose, friable, non-sticky and non-plastic with more than 30percent coarse fragments; pH 6.5.
R	97+	----------Hard murrum.....

Range in characteristics:

This soil is moderately deep and contains 15 to 32 percent clay. The thickness of the solum is 71 to 90 cm. The thickness of A horizon is 6 to 12 cm. Its colour is in hue of 10YR, value 5 and chroma 3 to 4. The texture is sandy loam and the structure is medium, weak subangular blocky. The thickness of B horizon is upto 88 cm. It is in hue of 10YR, value 4 to 5 and chroma 3 to 6. The texture is sandy clay loam and the structure is moderate, strong subangular blocky. It has 15 to 30 percent coarse fragments and slightly acid to neutral.

Competing series and their differentiae: Not identified.

Interpretation

This soil is moderately deep, moderately eroded and moderately well drained. This soil is arable with surface to sandy loam texture and low organic carbon. This soil is moderately to slightly acid with low in N, K and

medium in Zn and high in P. Arandiya (Ar) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season

a) Interpretative groupings: **Agril. Uses** **Non.Aeril.Uses (Patches)**

Land capability sub-class : IIIs
Soil site suitability : Suitable for sorghum
Moderately suitable Wheat, soybean, sunflower, citrus, potato, cottonMarginally suitable for rice, maize

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-9	77.7	6.9	15.4	4
Bwl	9-35	68.1	7.3	24.6	4
Cl	35-58	62.8	5.5	31.7	16.7
C2	58-97	65.3	5.9	28.8	16.7

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-9	0.67	nil	0.06	5.7	10.9	3.6
9-35	0.52	nil	0.08	6.2	14.1	5.7
35-58	0.52	nil	0.04	6.6	15.2	7.3
58-97	0.30	nil	0.02	6.5	11.8	7.1

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-9	4.5	0.4	0.1	0.1	5.1	6.0	85
9-35	8.7	0.8	0.1	0.1	9.7	108	89.8
35-58	10.0	4.4	0.1	0.2	14.78	14.6	100.7
58-97	8.0	5.6	0.1	0.1	13.86	14.6	94.5

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-9	1.2	51.1	40.5	1.3	88.2	21.6	170.0
9-35	1.7	19.9	19.5	0.5	86.8	7.5	155.0
35-58	0.9	22.0	8.6	0.3	93.8	20.0	200.0
58-97	0.6	15.2	11.1	0.4	105.0	14.0	215.0

2. ATARI SERIES (At)

Classification : Fine, mixed, hyperthermic family of Vertic Haplustepts
Type location :Village: Atari, Tehsil: Barghat, Dist: Seoni, M.P. 22°04‘45" N lat. and 79°49'52" E long.
Profile No :55N/16 - P/9
Physiographic position :Steeply sloping dedunational escarpments, structural plateau, middle level plateaus, structural hill and ridges
Elevation :500 m above MSL
Ground water table :>10 m
Rainfall 1200 mm
Slope & erosion :Moderately steeply sloping (15-30%), moderate
Drainage & permeability : Somewhat poorly drained, slow
Use & vegetation :Palas, Mango, Mahua, Ber, Sindhi
Geology & parent material :Basalt/Weathered basalt
Soil association :Parasia, Bhimgarh, Khamariya, Lugsa, Khawasa, Silghat, Chunamati
Soil correlation :
Distribution and extent : Extensive in Atari, Takhla Khurd and Chhapara area of Barghat Tehsil, Seoni District, M.P
Typifying pedon : Atari - clay, cultivated

Horizon	Depth (cm)	Description
Ap	0-14	Light olive brown (2.5Y 5/3 D), olive brown (2.5Y 4/3 M) clay; medium, moderate, subangular blocky, hard, firm, sticky and plastic; fine few roots; fine pores; pH 6.4; clear smooth boundary.
Bwl	14-45	Olive brown (2.5Y 4/3 M) clay; medium, moderate, angular blocky; hard, firm, sticky and plastic; very fine few roots; very fine few pores; very fine few calcium nodules; pH 7.7; clear smooth boundary.
Bw2	45-90	Very dark greyish brown (2.5Y 3/2 M) clay; medium, moderate, subangular blocky; hard, firm, sticky and plastic; very fine few pores; very fine few calcium nodules; pH 7.9; gradual smooth boundary.
Bw3	90-150	Very dark greyish brown (2.5Y 3/2 M) clay; medium, moderate, subangular blocky; hard, firm, sticky and plastic; very fine few pores; very fine few calcium nodules; pH 8.0; gradual smooth boundary.

Range in characteristics:

These soils are very deep with Ap-Bw horizon sequence. The thickness of the solum is more than 150 cm. The thickness of A horizon is 14 to 17 cm. It is in hue 2.5Y with value 4 to 5 and chroma 3. The texture is clay. The thickness of B horizon ranges from 125 to 130 cm. It has hue of 2.5Y with value 3 to 4 and chroma 2 to 3. Its texture is clay and averages 45 to50 percent clay. Cracks of 1 to 2 cm wide extend upto 20 cm depth. It is slightly to moderately alkaline. This horizon has moderate, medium, subangular blocky structure.

Competing series and their differentiae: Not identified.

a) Interpretation:
This soil is very deep, moderately eroded and somewhat poorly drained. They have medium water holding capacity, slightly acid to slightly alkaline and low in N, P and Zn but medium in Potassium. Atari (At*) series have clayey top and substrata type, vertic, ustic soil moisture regime, high “P” fixation and low “K” reserves.

This soil is arable but classified under land capability of IV, It is fairly good land suited for limited cultivation. Conserve rainfall and develop water storage structures for irrigation or convert to grazing or pasture lands.

a) Interpretative groupings:

Land capability sub-class	Asril. Uses : IVc
Irrigability	: 4t
Productivity potential	: good
Soil site suitability	Suitable for sorghum, cotton Moderately suitable for citrus, potato Marginally suitable for rice, wheat, soybean, sunflower, cotton, maize, potato

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-14	31.8	22.7	45.5	4
Bwl	14-45	32.7	22.5	44.8	6
Bw2	45-90	28.2	23.1	48.7	2
Bw3	90-150	26.5	23.3	50.2	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-14	0.61	--	0.28	6.4	18.9	7.8
14-45	0.41	--	0.14	7.7	18.3	9.4
45-90	0.34	--	0.10	7.9	19.3	9.8
90-150	0.34	--	0.14	8.0	22.5	11.1

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-14	20.9	3.8	0.4	0.8	25.9	36.5	71
14-45	17.6	2.5	0.4	0.2	20.7	34.8	59
45-90	22.0	2.9	0.5	0.4	25.8	42.6	61
90-150	24.7	3.5	0.5	0.3	29.0	43.4	67

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-14	3.0	16.6	45.9	0.6	80.0	1.95	350.0
14-45	0.9	1.8	7.1	0.4	79.8	1.33	295.0
45-90	0.6	1.2	3.5	0.3	68.6	0.96	310.0
90-150	0.6	1.1	2.9	0.4	60.2	0.88	335.0

3. BHIMGARH SERIES (Bg)

Classification : Very fine, montmorillonitic, hyperthermic family of calcareous Ustic Endoaquerts
Type location :Village: Bhimgarh, Tehsil: Lakhanadon, Dist: Seoni, M.P. 22°24'18" N lat. and 79°40'17" E long.
Profile No :55N/11 - P/16
Physiographic position :Upper denudational plateaus, lower denudational plateaus interhill basins and rolling Pedi plain
Elevation :500 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Moderately sloping (8-15% slope), moderate
Drainage & permeability : Moderately well drained, very slow permeability
Use & vegetation :Wheat, Gram, Masur, Coriander, Pigeonpea; Mango, Custard apple
Geology & parent material :Basalt/weathered basalt
Soil association :Atari, Parasia, Khamariya, Khawasa, Arindiya, Nadora, Sagar, Dhenka,
Soil correlation :
Distribution and extent : Extensive in Lakhandon plateau of Seoni District, M.P
Typifying pedon : Bhimgarh - clay, cultivated

Horizon	Depth (cm)	Description
Ap	0-14	Very dark greyish brown (2.5Y 3/2 M) clay; medium, moderate, angular blocky; very hard, friable, sticky and plastic; very fine many roots; pH 8.0; clear smooth boundary.
Bwl	14-33	Very dark greyish brown (2.5Y 3/2 M) clay; medium, moderate, angular blocky with pressure faces; very hard, friable, sticky and plastic; very fine many roots; pH 8.0; clear smooth boundary.
Bw2	33-53	Very dark greyish brown (2.5Y 3/2 M) clay; coarse, strong, angular blocky with pressure faces; very hard, friable, sticky and plastic; fine many roots; pH 8.01; diffused smooth boundary.
Bssl	53-85	Very dark greyish brown (2.5Y 3/2 M) clay; coarse, strong, angular blocky; very hard, friable, very sticky and very plastic; fine few roots; intersecting slickensides tilted at an angle of 40° to the horizontal axis; pH 8.04; diffused smooth boundary.
Bss2	85-140	Very dark greyish brown (2.5Y 3/2 M) clay; coarse, strong, angular blocky; very hard, friable, very sticky and very plastic; intersecting slickensides tilted at an angle of 45° to the horizontal axis; pH 8.03.

Range in characteristics:

This soil has Ap-Bw-Bss horizon sequence. The Ap horizon is very dark greyish brown with 2.5Y hue, value 3 to 4 and chroma of 2. Its thickness is 12 to 14 cm with clay content more
Horizon Depth (cm) than 60 percent. It is moderately alkaline with moderate angular blocky structure. The thickness of solum ranges from 100 to 150 cm. The B horizon is very dark grey brown with hue 2.5Y with value 3 to 4 and chroma 3 with clay content of 69 to 75 percent. The cambic B horizon is 25-40 cm thick with wedge shape aggregates and moderately alkaline. The slickensided B horizon appears below 50 cm to a depth of 100 cm with strong angular blocky aggregates.

Competing series and their differentiae:

Lungsa series. It has light olive brown Ap horizon with 58 percent clay and 0.7 percent organic carbon. The slickensided B horizon is very dark grey with 60 percent or more clay. This soil is slightly alkaline.

Interpretation:

This soil is very deep and moderately well drained with moderate erosion. They have high available water holding capacity with low NP and Zn status and high K, medium and adequate amounts of Cu and Mn. Bhimgarh (Bg) have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. This soil is arable with limitations of flooding for few days in the year, slope and drainage. This soil is moderately alkaline in reaction.

a) Interpretative groupings:

	Agril. Uses
Land capability sub-class	: IIIws
Irrigability	: 2s
Productivity potential	: Medium
Soil site suitability	: Moderately suitable for rice, soybean, citrus, maize,potato Marginally suitable for sunflower, sorghum, cotton

b) Yield: Based on data from farmer's field:

Crops/Forest	**Farmer's practices**	**Improved practices**
	<----------(yield q/ha^{-1})----------->	
1. Gram	10-15	15-20
2. Wheat	10-15	15-20

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-14	4.7	25.5	69.8	4
Bwl	14-33	4.2	25.9	69.9	2
Bw2	33-53	2.5	24.8	72.7	2
Bssl	53-85	2.3	22.0	75.7	4
Bss2	85-140	2.6	21.0	76.4	4

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-14	0.81	5.2	0.17	8.0	41.4	19.0
14-33	0.67	4.5	0.17	8.0	38.6	18.8
33-53	0.52	4.4	0.16	8.0	41.2	18.3
53-85	0.45	3.6	0.14	8.0	41.7	18.8
85-140	0.44	3.8	0.14	8.0	42.2	17.8

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-14	39.2	4.0	0.1	0.9	44.20	48.9	90.4
14-33	40.6	3.5	0.2	0.8	45.1	48.2	94.0
33-53	40.9	6.1	0.3	0.7	48.1	52.2	92.0
53-85	38.7	7.2	0.3	0.7	46.9	48.9	96.0
85-140	40.8	8.2	0.3	0.7	50.0	53.1	94.0

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-14	3.0	3.4	13.8	0.6	78.4	1.7	465.0
14-33	3.3	3.5	13.9	0.5	75.6	1.6	420.0
33-53	2.4	3.3	13,0	0.4	74.2	1.3	385.0
53-85	2.3	3.2	10.6	0.4	79.8	0.9	345.0
85-140	2.1	3.2	9.0	0.6	68.6	1.1	335.0

4. BISAPUR SERIES (Bs)

Classification : Fine-loamy, mixed, hyperthermic family of Typic Haplustepts
Type location :Village: Bisapur, Tehsil: Lakhanadon, Dist: Seoni, M.P. 22°2V49" N lat. and 79°27'09" E long.
Profile No :550/9 0- P/27
Physiographic position :Flood plains, interhill basins, lower denudational plateaus
Elevation :600 m above MSL
Ground water table :>10 m
Rainfall : 1150 mm
Slope & erosion :Very gently sloping (1-3%), moderate
Drainage & permeability : Well drained, moderate permeability
Use & vegetation :Forest
Geology & parent material :Granite/Weathered granitic material
Soil association :Sukla, Jamuntola, Parasia, Khawasa,
Soil correlation :
Distribution and extent : Extensive in Bisapur, Gorakhpur, Rampur and Fatopur area of Kurai tehsil Tehsil, Seoni District, M.P.
Typifying pedon : Bisapur - loamy - forest

Horizon	Depth (cm)	Description
A	0-17	Dark brown (7.5YR 3/2 M), loamy sand; fine, weak, subangular blocky structure, loose, friable, non-sticky and non-plastic; fine many roots; pH 6.5; clear smooth boundary.
Bwl	17-46	Dark brown (7.5YR 3/4 M), loamy sand; fine, weak, subangular blocky structure, loose, friable, non-sticky and non-plastic; medium many roots; pH 5.9; gradual smooth boundary.
Bw2	46-78	Dark brown (7.5YR 3/4 M), loamy sand; fine, weak, subangular blocky structure, loose, friable, non-sticky and non-plastic; medium many roots; pH 6.0; gradual smooth boundary.
Bw3	78-120	Dark brown (7. SYR 3/4 M), loamy sand; fine, weak, subangular blocky structure with 8-10% coarse fragments; loose, friable, non-sticky and nonplastic; pH 5.9.
Cr	120+	----------Hard rock----------

Range in characteristics:

This soil is deep with A and Bw horizon sequence. The thickness of the solum is 100 to 120 cm. The thickness of A horizon isl7-25 cm. It is dark brown in hue 7.5YR, value 3 to 5 and chroma 4 to 6. The texture is loamy sand and contains 18-20 percent clay. This horizon has fine, weak, subangular blocky structure. It is neutral. The dark brown cambic B horizons have 7.5YR hue, value of 3 or 4 and chroma of 4 or more. The deeper layers of B horizons have 8 to 10 percent coarse fragments. This horizon is moderately acid to slightly acid.

Competing series and their differentiae: Not identified.

Interpretation:

This soil is deep, very gently sloping, moderately eroded and well drained with moderate permeability. Bisapur (Bs) series have sandy top and substrata type with high infiltration rate and low water holding capacity, moisture is limiting during dry season and low ability to supply K. This soil is slightly acid to moderately acid with NPK and Zn. They are suitable for non-arable uses.

a) Interpretative groupings **Non.AgriI.Uses (Patches)**

Land capability sub-class:	:	VIIes
Irrigability	:	3st
Productivity potential	:	
Soil-site Suitability	:	Suitable for sorghum, soybean Moderately suitable for sunflower cotton,maize, potato Marginally suitable for rice, citrus

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
A	0-17	75.6	8.0	16.4	2
Bwl	17-46	75.0	5.4	19.6	2
Bw2	46-78	75.9	5.6	18.5	2
Bw3	78-120	75.6	4.6	19.8	3

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-17	1.11	--	0.07	6.5	11.2	5.4
17-46	0.56	--	0.02	5.9	6.9	3.6
46-78	0.35	--	0.01	6.0	7.6	3.5
78-120	0.34	--	0.01	5.9	6.6	3.4

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-17	6.9	1.2	Tr	0.2	8.3	9.5	87.4
17-46	3.9	1.0	Tr	0.1	5.0	7.6	65.8
46-78	3.3	0.9	Tr	0.1	4.3	6.5	66.1
78-120	3.7	0.9	Tr	0.1	4.7	8.0	60.3

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-17	1.9	36.0	35.4	1.0	74.2	3.8	190.0
17-46	2.0	37.4	26.3	0.6	85.4	0.7	115.0
46-78	1.4	33.8	19.7	0.5	81.2	4.3	100.0
78-120	1.4	36.4	17.5	0.4	75.6	8.5	115.0

5. CHHUI SERIES (Cu)

Classification : Fine, mixed, hyperthermic, calcareous, family of Typic Epiaquepts
Type location : Village: Chhui, Tehsil: Barghat, Dist: Seoni, M.P. 22°14'06" N lat. and 79°47'31" E long.
Profile No : 55N/16-P/46
Physiographic position :Gently to very gently sloping lands
Elevation :480 m above MSL
Ground water table :1-2 m
Rainfall : 1109 mm
Slope & erosion :Gently sloping (3-8%), slight,
Drainage & permeability : Poor drainage, slow permeability
Use & vegetation :Mango, Palas, Babul, Ritha, Sindi
Geology & parent material :Basalt and basaltic material
Soil association :Silghat, Bhimgarh, Atari
Soil correlation :
Distribution and extent : Extensive in Chhui and adjoining area of Keolari and Barghat Tehsil, Seoni District, M.P.
Typifying pedon : Chhui - clay - pasture

Horizon	Depth (cm)	Description
Ap	0-15	Greyish brown (2.5Y 5/2 M) and dark greyish brown (2.5Y 4/2 M) clay; medium, weak, subangular blocky structure, very hard, friable, very sticky and very plastic; fine few roots; pH 7.0; gradual smooth boundary.
Bwl	15-63	Very dark grey (2.5Y 3/1 M) clay; medium, moderate, subangular blocky structure, hard, friable, very sticky and very plastic; very fine few roots; pH 8.0; gradual smooth boundary.
Bw2	63-104	Very dark grey (2.5Y 3/1 M) clay; medium, moderate, subangular blocky structure, slightly hard, friable, very sticky and very plastic; pH 8.7; gradual smooth boundary,
Bw3	104-150	Dark greyish brown (2.5Y 4/2 M) sandy clay; medium, weak, subangular blocky structure, slightly hard, friable, very sticky and very plastic with fine few lime concretions, slight effervescence; pH 8.7.

Range in characteristics:

This soil has greyish brown to very dark grey Ap and Bw horizon sequence with chroma of 2 or 1 throughout depth. This soil shows gradual increase in alkalinity and exchangeable sodium with depth. The thickness of the solum is 150 cm. The thickness of A horizon is 15 cm. Its colour is in hue 2.5Y with value 4 or 5 and chroma 1 or 2. Its texture is clay and structure is medium, weak, subangular blocky. The thickness of B horizon is 135 cm. Its colour is in hue 2.5Y with value 3 or 4 and chroma 1 or 2. The texture is sandy clay to clay and structure is medium, weak to moderate, subangular blocky.

Competing series and their differentiae: Not identified.

Interpretation:
This soil is very deep, poorly drained and slightly eroded. This soil is slightly to moderately alkaline with low amounts of N, P and Zn but medium in potassium contents. This series have clayey top and sub soils with high shrink-swell potentials and dry more than 90 cumulative days per year and have hard root restricting layers.

a)	**Interpretative groupings**	:	Agril.Uses
	Land capability sub-class	:	IVw
	Irrigability	:	2st
	Productivity potential	:	Low in times of flooding but medium under normal rainfall
	Soil site suitability	:	Moderately suitable for sorghum Marginally suitable for rice, soybean, sunflower, cotton, maize, potato

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-15	14.3	32.2	53.5	2
Bwl	15-63	13.5	29.2	57.3	2
Bw2	63-104	25.7	21.9	52.4	4
Bw3	104-150	44.4	14.7	40.9	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-15	0.96	1.8	0.10	7.0	29.4	13.1
15-63	0.89	1.9	0.12	8.0	29.9	14.1
63-104	0.74	2.0	0.32	8.7	30.1	13.2
104-150	0.27	-	0.27	8.7	26.5	10.1

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-15	22.1	7.7	1.2	0.4	31.4	33.0	95.1
15-63	21.0	9.9	3.1	0.3	34.3	31.2	109.9
63-104	13.5	13.4	4.8	0.2	31.9	23.4	136.3
104-150	11.5	13.8	3.0	0.2	28.5	38.2	74.6

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-15	2.5	8.9	24.6	0.2	82.6	3.0	355.0
15-63	1.6	3.1	7.8	0.4	71.4	1.1	280.0
63-104	1.4	2.2	3.2	0.4	47.6	2.3	245.0
104-150	0.9	2.1	3.4	0.4	40.6	2.0	195.0

6. CHUNAMATI SERIES (Ch)

Classification : Fine, mixed, hyperthermic family of Typic Haplustalfs
Type location : Village: Nager warn, Tehsil: Barghat, Dist: Seoni, M.P. 22 08’36” N lat And79°38’54" E long
Profile No : 55N/12-P/57
Physiographic position :Undulating pediplains/hill slopes, ridge tops, structural hills and ridges and lower denuded plateau
Elevation :560m above MSL
Ground water table :>10 m
Rainfall : 1506 mm
Slope & erosion :Gently sloping (3-8%), moderate
Drainage & permeability : Well drained, slow permeability
Use & vegetation :Mahua, Mango
Geology & parent material :Basalt/ weathered basalt
Soil association :Khawasa, Jamunpani,Parasia
Soil correlation :
Distribution and extent : Extensive in Nagerwara and Barelipar area of Barghat Tehsil, Seoni district, M.P.
Typifying pedon : Chunamati - clay - cultivated

Horizon	Depth (cm)	Description
Ap	0-18	Dark brown (7.5YR 3/2 M) and brown (7.5YR 4/2 D) clay; medium, weak, sub angular blocky structure; hard, firm, sticky and plastic; coarse many roots; pH 6.8; clear smooth boundary.
Btl	18-39	Dark brown (7.SYR 3/2 M) clay; medium, moderate, angular blocky structure; slightly hard, firm, sticky and plastic; coarse many roots; pH 7.1; gradual smooth boundary.
Bt2	39-60	Dark brown (7.5YR 3/2 M) sandy clay; medium, strong, angular blocky structure; very hard, very firm, very sticky and very plastic with fine many lime concretions with slight effervescence; pH 7.1; gradual smooth boundaiy.
Bt3	60-90	Brown (7.5YR 4/2 M) sandy clay; medium, weak, sub angular blocky structure; hard, firm, sticky and plastic, coarse few roots, medium many lime concretions with violent effervescence; pH 8.2.
Cr	90+	Weathered basaltic material

Range in characteristics:

This soil has 60 cm thick dark brown clay textured Ap and Bt horizons with slight to violent effervescence and increase of alkalinity with depth. The thickness of the solum is 75 to 110 cm. The thickness of Ap horizon is 16 to 18 cm. Its colour is in hue 7.5YR ,value 2 to 4 and chroma 2 to 4. Its texture is clay loam or clay with sub angular blocky structure. The thickness of B horizon is 17 to 110 cm. Its colour is in hue 7.5YR ,value 2 or 4 and chroma 2 or 4. The texture is clay loam to clay and structure is sub angular blocky to angular blocky

Competing series and their differentiae: Not identified.

Interpretation:

These soils are moderately deep soils and well drained. This soil is arable with limitations of slope (3-8 percent), clay surface texture and soil depth. These soils have clayey top and subsoil types with Ustic moisture and low K reserves and have gravels more than 30 percent by volume in sub soils. This soil is slightly acid to slightly alkaline with low N,P Fe and Zn and medium in potassium status.

a)	**Interpretative groupings**	**:**	**Agril. Use**
	Land capability sub-class	**:**	IIIw
	Irrigability	**:**	
	Productivity potential	**:**	
	Soil-site suitability	**:**	Marginally suitable for rice, sunflower, soybean, citrusModerately suitable for wheat, cotton, potato Highly suitable for sorghum and maize

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
A	0-18	19.4	15.8	64.8	Nil
Btl	18-39	17.6	16.6	65.8	Nil
Bt2	39-60	49.4	11.1	39.5	Nil
Bt3	60-90	43.4	18.7	37.9	20

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-18	0.93	2.7	0.06	6.8	30.3	15.9
18-39	0.74	2.9	0.03	7.1	31.8	16.7
39-60	0.67	3.0	0.04	7.1	34.3	19.1
60-90	0.34	10.6	0.11	8.2	21.5	11.0

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-18	37.0	2.2	0.2	0.5	39.97	41.9	95.2
18-39	38.1	1.6	0.2	0.4	40.32	42.7	94.4
39-60	37.3	1.4	0.2	0.4	39.38	33.4	117.7
60-90	26.4	0.9	0.2	0.3	27.8	28.0	99.3

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-18	2.4	2.9	25.7	0.2	72.8	2.3	340.0
18-39	2.2	3.0	17.4	0.3	70.0	1.3	250.0
39-60	2.1	2.8	16.2	0.4	64.4	0.9	275.0
60-90	1.0	1.4	3.3	0.4	71.4	1.2	190.0

7. DHENKA SERIES (Dk)

Classification : Very-fine, montmorillonitic, hyperthermic family of Ustic Epiaquerts.
Type location : Village: Dhenka, Tehsil: Barghat, Dist: Seoni, M.P. 22°14'56" N lat. And 79°47'38" E long.
Profile No : 55N/16 - P/50
Physiographic position :Upper and Lower pediments
Elevation :480 m above
Ground water table :MSL 1-2 m
Rainfall : 1109 mm
Slope & erosion :Gently sloping (3-8%), slight.
Drainage & permeability : Somewhat poorly drained, slow permeability
Use & vegetation :Ber, Babul, Mango, Guava, Neem, Pipal, Kathal,
Geology & parent material :Basalt/Weathered basaltic material
Soil association :Paddikona, Khawasa
Soil correlation :
Distribution and extent : Extensive in Dhenka, North east side of Barghat Tehsil, Seoni District,M.P.
Typifying pedon : Dhenka - clay - cultivated

Horizon	Depth (cm)	Description
Ap	0-11	Greyish brown (2.5Y 5/2 D) to dark greyish brown (2.5Y 4/2 M) clay; medium, moderate, subangular blocky structure, slightly hard, friable, veiy sticky and very plastic; fine few lime nodules; fine few roots; pH 7.5; clear smooth boundary.
Bwl	11-34	Very dark grey (2.5Y 3/1 M) clay; medium, weak, subangular blocky structure, slightly hard, friable, very sticky and very plastic; fine few lime nodules; very fine few roots; pH 7.9; clear smooth boundary.
Bssl	34-65	Very dark grey (2.5Y 3/1 M) clayey; medium, weak, subangular blocky structure, slightly hard, friable, very sticky and very plastic; fine few lime concretions with slight pressure faces and intersecting slickensides; pH 7.9; gradual smooth boundary.
Bss2	65-103	Dark greyish brown (2.5Y 4/2 M) clayey; medium, weak, subangular blocky structure with intersecting slickensides; hard, friable, very sticky and very plastic; pH 8.0; gradual smooth boundary.
Bss3	103-150	Very dark greyish brown (2.5Y 3/2 M) clayey; medium, weak, subangular blocky structure with intersecting slickensides; slightly hard, friable, very sticky and very plastic; pH 8.0.

Range in characteristics:

The soil has greyish brown Ap horizon to very dark grey cambic B horizon and very dark greyish brown slickensided B horizons below 35 to 150 cm. The thickness of the solum is 149cm. The thickness of Ap horizon is 19 cm. Its colour is in hue of 2.5Y with value 3 and chroma 2 or 1. Its texture is clay and structure is medium, weak, subangular blocky. The thickness of B horizon is 140 cm. Its colour is in hue 2.5Y with value 3 or 4 and chroma 1 to 4. The texture is clay and structure is medium, moderate or strong angular blocky with pressure faces and intersecting slickensides. This horizon is slightly to moderately alkaline in reaction with depth.

Competing series and their differentiae:
Jamunpani series: It has light olive brown Ap horizon having 68 percent clay and very dark greyish brown to brown slickensided B horizons with 71 to 85 percent clay. The surface horizons are slightly acid but gradually changed to moderately alkaline.

Interpretation:

This soil is very deep, somewhat poorly drained and slightly eroded. Dhenka (Dk) series have clayey top and substrate type with high shrink swell potential and tillage too difficult when dry or wet. This soil is arable with drainage and clayey surface texture. This soil is slightly alkaline with low amounts of N, P and Zinc

a) Interpretative groupings	**:**	**Agril. Uses**
Land capability sub-class	**:**	IIIW
Irrigability	**:**	3st
Productivity potential	**:**	Medium
Soil-site suitability	**:**	Suitable for sorghum,Moderately suitable for wheat, cotton, potato Marginally suitable for rice, soybean, sunflower,maize

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-11	14.9	26.6	58.5	4
Bwl	11-34	10.2	23.8	66.0	4
Bssl	34-65	8.9	29.3	61.8	4
Bss2	65-103	8.9	27.8	63.3	4
Bss3	103-150	8.2	26.1	65.7	4

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-11	0.75	—	0.18	7.5	29.1	13.2
11-34	0.61	—	0.10	7.9	31.1	16.5
34-65	0.54	—	0.12	7.9	34.3	16.7
65-103	0.47		0.14	8.0	36.6	17.4
103-150	0.47	—	0.14	8.0	35.3	18.3

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-11	34.4	5.6	0.5	0.4	40.9	42.6	96.0
11-34	32.8	9.2	0.5	0.4	42.9	46.9	91.5
34-65	37.6	9.2	0.6	0.4	47.8	48.7	98.1
65-103	34.4	16.0	0.6	0.5	51.4	55.6	92.6
103-150	39.2	10.8	0.7	0.5	51.2	54.8	93.4

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-11	1.7	2.8	9.7	0.5	82.6	1.7	465.0
11-34	1.3	2.3	7.6	0.4	70.0	1.1	390.0
34-65	1.2	1.8	6.3	0.5	71.4	1.6	400.0
65-103	1.0	1.5	4.3	0.5	63.0	1.5	415.0
103-150	0.8	1.5	3.3	0.4	60.2	1.3	405.0

8. DHORA SERIES (Dh)

Classification : Loamy, mixed, hyperthermic family of Lithic Ustorthents
Type location : Village: Dhora, Tehsil: Lakhandon, Dist: Seoni, M.P. 22°50'24" N lat. And 79°45'56" E long.
Profile No : 55N/13 - P/23
Physiographic position :Narrow interhill basins and broad interhill basins
Elevation :540 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Gently sloping (3-8% slope) and severe erosion
Drainage & permeability : Moderately well drained,moderately slow
Land Use & vegetation :Teak, Palas, Khair, Neem
Geology & parent material :Basalt
Soil association :Nadora, Sagar, Bhimgarh, Sukla, Khawasa, Pratappur, Bisapur
Soil correlation :Chichband series
Distribution and extent : Extensive in Dhora and Lakhanadon plateaus of northern parts of Seoni Distict, M.P.
Typifying pedon : Dhora, clay, forest

Horizon	Depth (cm)	Description
A	0-9	Dark brown (7.5YR 3/3 M) clay; medium, weak, subangular blocky; hard, friable, slightly sticky and slightly plastic; very fine medium roots; pH 6.1 and clear smooth boundary.
R	9+	**----------Hard basalt----------**

Range in characteristics:

The thickness of A horizon is 5 to 10 cm. The dark brown A horizon has hue of 7.5YR value and chroma of 3 with clay content of 47 to 50 percent. This horizon is slightly acid with base saturation of 85 percent and organic carbon of 2.93 percent.

Competing series and their differentiae:

Parasia series. This soil is reddish brown with hue 5YR and clay content of 33 percent, slightly acid and organic carbon of 1.29 percent.

Interpretation:

This soil is very shallow, non-arable with surface texture of clay and stoniness. They have low water holding and retentive capacity, low fertility status and low responsive to soil and crop management practices. They are mostly under non-arable uses and planted for teak, bamboo and grasses. Dhora(Dh*) series with clay top soil, hard root restricting layers, dry more than 90 cumulative days per year, high "P" fixation, low "K" reserves and have gravels more than 35 percent. This soil is slightly acid, medium in available nitrogen, potassium, zinc and low in available phosphorus.

a) Interpretative groupings : Agril. Uses

Land capability sub-class : VIIIes
Irrigability : 6est
Productivity potential : Low

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
A	0-9	26.4	25.8	47.8	12

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-9	2.93		0.10	6.1	33.2	18.8

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-9	15.5	7.6	0.2	0.2	23.5	27.7	84.8

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-11	11.7	27.6	93.8	2.1	158.2	1.8	165

9. GONDATOLA SERIES (Gl)

Classification : Fine, mixed, hyperthermic family of Typic Rhodustalfs
Type location : Village: Gondatola, Tehsil: Kurai, Dist: Seoni, M.P. 21°56'24"N lat. and 79°35'36" E long.
Profile No : 550/9-P/35
Physiographic position :Rolling pediplains, upper and lower denuded plateaus
Elevation :620 m above MSL
Ground water table :>10 m
Rainfall : 1171 mm
Slope & erosion :Moderately sloping (8-15%), moderate
Drainage & permeability : Well drained, moderate permeability
Use & vegetation :Teak, Bamboo, Palas
Geology & parent material :Basalt
Soil association :Jamuntoia, Khawasa, Pratappur, Rukhad
Soil correlation :Chichband series
Distribution and extent : Extensive in lateritic terrain of Mohgaon, Gopalganj and adjoining areas of Kurai Tehsil, Seoni district, M.P.
Typifying pedon : Gondatola - clay - cultivated

Horizon	Depth (cm)	Description
Ap	0-14	Dark reddish brown (2.5YR 3/4 M) clay; medium, weak, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; fine few roots; pH 4.92; clear smooth boundary.
Btl	14-43	Dark red (2.5YR 3/4 M) clay; medium, weak, subangular blocky structure; slightly hard, friable, sticky and plastic; pH 5.13; clear smooth boundary.
Bt2	43-78	Dark red (2.5YR 3/6 M) clay; medium, moderate, subangular blocky structure; slightly hard, friable, sticky and plastic; pH 5.5; clear smooth boundary.
Bt3	78-122	Dark red (2.SYR 3/6 M) sandy clay loam; medium, weak, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; pH 5.7; clear smooth boundary.
Cr	122+	----------Weathered parent material----------

Range in characteristics:

This soil has Ap and Bt horizons sequence with gradual increase in redness, clay and CEC contents with base saturation more than 50 percent throughout depth. The thickness of the solum is 66 to 122 cm. The thickness of A horizon is 14 cm. Its colour is in hue of 2.5YR, value 3 and chroma 6. The texture is clay loam and the structure is medium, weak subangular blocky. The thickness of B horizon is 108 cm. Its colour is in hue of 2.5YR, value 3 and chroma 6. The texture is sandy clay loam to clay and the structure is medium, weak subangular blocky. The soil has very strongly acid A horizons and strongly to moderately acid, dark red B horizons.

Competing series and their differentiae: Not identified.

Interpretation:

This soil is deep, moderately eroded on moderately sloping lands, well drained and moderate permeability. This soil series have clayey top and subsoil types with ustic moisture and low K reserves and have gravels more than

30 percent by volume Ln sub soils. These soils are moderately good cultivable lands, very strongly to moderately acid, low in NPK and Zn.

a)	**Interpretative groupings**	**:**	**Agril, Uses**
	Land capabilitysub-class	**:**	IIIe
	Irrigability	**:**	4t
	Productivity potential	**:**	
	Soil-site Suitability	**:**	Suitable for sorghum,Moderately suitable for wheat, cotton, rice, maize, potato soybean citrus, sunflower Marginally suitable for rice, sunflower

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-14	25.2	33.8	41.0	2
Bwl	14-43	15.7	25.9	58.4	2
Bw2	43-78	25.8	16.0	58.2	2
Bw3	78-122	41.1	10.8	48.1	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-14	1.11	Nil	0.01	4.9	21.4	11.0
14-43	0.91	Nil	0.01	5.1	25.6	11.8
43-78	0.62	Nil	0.02	5.5	18.6	11.5
78-122	0.49	Nil	0.01	5.7	17.9	10.8

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-14	5.0	2.0	Tr.	0.1	7.1	13.6	52.2
14-43	7.8	2.9	Tr.	0.1	10.9	18.0	60.0
43-78	7.9	2.9	0.1	0.2	10.9	16.7	66.5
78-122	6.8	2.3	0.1	0.1	9.3	13.8	67.4

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-14	5.5	58.3	153.0	0.7	120	3.7	155.0
14-43	5.5	23.7	82.6 1	0.3	110	0.	140.0
43-78	3.3	14.8	47.4	0.3	100	1.4	145.0
78-122	2.1	13.8	29.4	0.2	95	1.7	115.0

10. GORAKHPUR SERIES (Go)

Classification : Fine, mixed, hyperthermic family of Lithic Haplustepts
Type location : Village: Gorakhpur, **Tehsil: Lakhanadon, Dist: Seoni, M.P. 22°28'19" N** and 79°20'29" E long.
Profile No : 55N/7 - P/45
Physiographic position :Undulating plateaus, rolling to very gently sloping
Elevation :720 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion : Moderately sloping (8-15%)
Drainage & permeability : Well drained, moderate permeability
Use & vegetation :Mango, Ber, Mahua, Babul,
Geology & parent material :Basalt/weathered basalt
Soil association :Paddikona, Sagar, Khawasa, Lakhanadon
Soil correlation :
Distribution and extent : Extensive in western part of Gorakhpur and adjoining area in Lakhanadon Tehsil, Seoni District, M.P.
Typifying pedon : Gorakhpur - clay - cultivated

Horizon	Depth (cm)	Description
Ap	0-9	Very dark grey (2.5Y 3/1 D&M) clay; medium, moderate, subangular blocky structure; very hard, firm, very sticky and very plastic; few fine roots; pH 6.4; clear smooth boundary.
Bwl	9-23	Very dark grey (2.5Y 2.5/1 M) clay; medium, moderate, subangular blocky structure; very hard, firm, very sticky and very plastic; very few fine roots; pH 6.7; gradual smooth boundary.
Bw2	23-39	Very dark grey (2.5Y 2.5/1 M) sandy clay loam; medium, moderate, subangular blocky structure with 1-2 percent coarse fragments; slightly hard, firm, sticky and plastic; pH 7.2.
R	39+	----------Weathered basaltic material----------

Range in characteristics:

This soil has Ap-Bw horizon sequence with lithic contact below 50 cm. The thickness of the solum is 39 cm. The thickness of A horizon is 9 cm is very dark grey hue 2.5Y with value 3 and chroma 1. Its texture is clay and structure is medium moderate subangular blocky. The thickness of B horizon is 30 cm and is very dark grey hue 2.5Y with value 2 to 3 and chroma 1. The texture is clay to sandy clay loam (clay content of 29 to 69 percent) and structure is medium moderate subangular blocky.This soil is slightly acid to neutral with CEC of 51 to 58 cmol kg^{-1}

Competing series and their differentiae:

Khamariya series: This soil has dark brown Ap horizon with 60 percent clay and 1.23 percent organic carbon. The cambic B horizon is very dark brown with 50 to 54 percent clay and 0.8 to 1 percent organic carbon.
Pipariya series: This soil has greyish brown. Clay loam textured A horizon in forest areas. The cambic B horizons are grey to dark grayish brown. Clay loam textured and neutral in reaction. The CEC varies from 43 to 54 cmol (+) kg'1.

Interpretation:

These soils are shallow, moderately well drained and moderately eroded. This soil is arable with severe depth, surface texture and stoniness. Go rakpur (Go*) series have clayey topsoil, hard root restricting substrata with ustic soil moisture regime and severe top soil shrinking and swelling. This soil is slightly acid to slightly alkaline with low N, medium in Zn, high in P, K and adequate in Fe, Mn and Cu contents.

a) Interpretative groupings : Agril, Uses

Soil-site Suitability : Moderately suitable for soybean, citrus, maizeMarginally suitable for rice, wheat, sorghum, cotton

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand(2.0-0.05)	Silt(0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-9	9.5	25.8	64.7	Nil
Bwl	9-23	12.7	17.5	69.8	Nil
Bw2	23-39	55.6	15.6	28.8	14.3

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-9	0.82	Nil	0.12	6.4	36.2	17.8
9-23	0.51	Nil	0.05	6.7	36.4	18.3
23-39	0.12	Nil	0.05	7.2	37.2	15.5

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-9	28.3	11.8	0.7	7.0	41.8	51.3	81.5
9-23	31.0	12.2	0.7	1.0	44.9	54.0	83.1
23-39	37.4	13.6	0.7	0.8	52.5	58.2	90.2

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-9	10.6	23.2	84.2	1.1	93.8	27.2	630.0
9-23	10.0	20.1	54.6	0.5	81.2	25.4	520.0
23-39	2.7	7.9	9.7	0.1	57.4	8.3	760.0

11. JAMUNPANI SERIES (Jp)

Classification : Very-fine, montmorillonitic, hyperthermic family of Ustic Epiaquerts
Type location : Village: Jamunpani, Tehsil: Keolari, Dist: Seoni, M.P. 22°19'15"N lat. and 79°56'03" E long.
Profile No : 55N/I5 - P/57
Physiographic position :Upper denudational plateaus, lower denudational plateaus and top of the structural hills and ridges
Elevation :460 m above MSL
Ground water table :>10 m
Rainfall : 1150 mm
Slope & erosion :Gently sloping (3-8% slope), moderate
Drainage & permeability : Well drained, moderate
Use & vegetation :Palas, Neem, Ber, Mango, Sesum, Soybean, Tur
Geology & parent material :Basalt / weathered basaltic material
Soil association :Parasia, Khawasa, Chunamati, Sagar,
Soil correlation :
Distribution and extent : Extensive in Jamunpani, Balgai and adjoining areas of Keolari tehsil, Seoni District, M.P.
Typifying pedon : Jamunpani - clay, cultivated

Horizon	Depth (cm)	Description
Ap	0-24	Light olive brown (2.5Y 5/4 D) to olive brown (2.5Y 4/3 M) clay; medium, moderate, subangular blocky structure; hard, firm, very sticky and very plastic; fine few roots; pH 6.32; clear smooth boundary.
Bwl	24-62	Very dark greyish brown (2.5Y 3/2 M) clay; coarse, weak, angular blocky structure with intersecting slickensides; hard, firm, very sticky and very plastic; very fine few roots; pH 6.65; gradual smooth boundary.
Bss1	62-113	Very dark greyish brown (2.5Y 3/2 M) clay; coarse, medium, angular blocky structure with intersecting slickensides; hard, firm, very sticky and very plastic; pH 6.96; gradual smooth boundary.
Bss2	113-127	Dark brown (10YR 4/3 M) clay; medium, moderate, subangular blocky structure; slightly hard; friable, slightly sticky and slightly plastic; slightly effervescence with 10-12 percent coarse fragments; pH 8.4; gradual smooth boundary.
Bss3	127-150	Dark yellowish brown (10YR 4/6 M) sandy clay loam; medium, weak, subangular blocky structure; slightly hard; friable, slightly sticky and slightly plastic with 10-15 percent coarse fragments; slightly effervescence; pH 8.33.'

Range in characteristics:

The thickness of the solum is 150 cm. The thickness of A horizon is 24 cm. The A horizon is light olive brown with hue 2.5Y, value 4 or 5 and chroma 4. Its texture is clay (68 percent clay) and structure is medium, moderate, subangular blocky. The thickness of B horizon is 101 cm. The B horizon are very dark greyish brown to dark brown with 2.5 or 10YR hue, value 3 or 4 and chroma 2 or 6. The texture is sandy clay loam to clay and structure is medium, weak, subangular blocky to coarse moderate angular blocky with intersecting slickensides. These horizons are slightly acid to moderately alkaline; 10 to 12 percent coarse fragments and slight effervescence.

Competing series and their differentiae:Dhenka series: This soil has greyish brown Ap horizon with 59 percent clay and very dark grey to dark grayish brown slickensides B horizons. This soil is moderately alkaline with increase in exchangeable Ca (32 to 39 cmol (+) kg^{-1}) and exchangeable Mg (5.6 to 16 cmol (+) kg^{-1}

Interpretation:

This soil is very deep, moderately eroded and well drained. It is moderately acid to moderately alkaline.They have high available water holding and low in N,P and Zn and high in K.It will respond to management practices. It is arable with slope and surface texture (clay) limitations. It has clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet.

a)	**Interpretative groupings**	**:**	**Agril, Uses**
	Land capabilitysub-class	**:**	IIIw
	Irrigability	**:**	4st
	Productivity potential	**:**	Medium
	Soil-site Suitability	**:**	Suitable for wheat sorghum, cotton Moderately suitable for soybean, citrus, potato Marginally suitable for rice, sunflower, maize

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-24	7.4	24.8	67.8	2
Bwl	24-62	5.7	22.4	71.9	2
Bssl	62-113	4.3	20.2	75.5	2
Bss2	113-127	22.5	23.7	53.8	6
Bss3	127-150	48.3	27.3	24.4	6

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-24	0.08	--	0.05	6.3	34.0	20.2
24-62	0.53	--	0.02	6.6	41.1	23.4
62-113	0.52	--	0.03	7.0	46.2	24.3
113-127	0.15	--	0.12	8.2	42.2	23.1
127-150	0.07	--	0.13	8.3	31.4	21.5

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-24	30.2	8.8	0.4	0.8	40.2	44.4	90.5
24-62	33.2	8.3	0.4	0.8	42.7	45.8	93.2
62-113	42.4	10.8	0.5	0.6	54.3	58.0	93.6
113-127	56.0	9.4	0.4	0.4	66.2	66.8	99.1
127-150	41.5	6.5	0.4	0.3	48.7 1	50.5	96.4

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-24	2.6	12.6	58.6	1.0.	88.2	1.7	435.0
24-62	2.2	9.2	23.4	0.6	67.2	1.8	360.0
62-113	1.3	5.8	11.5	0.5	70.0	1.8	390.0
113-127	2.7	2.6	3.6	0.4	64.4	1.5	235.0
127-150	0.1	3.1	2.2	0.5	61.6	1.6	170.0

12. JAMUNTOLA SERIES (Jm)

Classification : Loamy, mixed, hyperthermic family of Lithic Ustorthents
Type location : Village: **Jamuntola**, Tehsil: Kurai, Dist: Seoni, M.P. 21°42’30" N lat. and 79°24'17" E long.
Profile No : 55O/6 - P/3
Physiographic position :Upper denudational plateaus, convex hill slopes and ridge tops
Elevation :428 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Gently sloping (3-8% slope), moderate
Drainage & permeability : Somewhat excessively drained, rapid permeability
Use & vegetation :Teak, Tendu, Palas, Garadi, Lendia, Saj, Char, Awala
Geology & parent material :Granite/Weathered granitic material
Soil association :Bisapur, Kanera, Gondatola, Khawasa, Tarali, Kodajhiri
Soil correlation :
Distribution and extent : Extensive in Jamultola of Kurai Tehsil of Seoni District, M.P
Typifying pedon : Jamuntola - Sandy loam, Forest

Horizon	Depth (cm)	Description
A	0-13	Dark brown (10YR 3/3 M) sandy loam; medium, weak, sub angular blocky; slightly hard, friable, slightly sticky and slightly plastic; fine medium roots; pH 6.9 and clear smooth boundary.
Cr	13+	…….Weathered parent material…….

Range in characteristics:

The thickness of the A horizon 13 to 16 cm. This horizon has 10YR hue, value and chroma of 3 with sandy loam texture. This structure is medium weak, subangular blocky and neutral.

Competing series and their differentiae:
Kanera series: This soil has sandy clay loam texture (clay of 30%), slightly acid (pH 6.3) and CEC of 55.3 cmol (+) kg'1. This soil is deficient in N, P and Zn.

Interpretation:

They have low water holding and retentive capacity, low fertility status and low responsive to soil, and crop management practices. They are mostly under non-arable uses and planted for teak, bamboo, grasses, etc.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class : IVest
Irrigability : 6est
Productivity potential : Low

ANALYTICAL DATA

Horizon	Depth (cm)	Partice size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
A	0-13	75.2	5.0	19.8	

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-17	0.99		0.14	6.9		
13+	…….Weathered parent material …….					

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-13	6.9	1.4	0.3	0.4	9.0	10.2	88.2
13+	……..Weathered parent material…….						

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-13	3.1	21.5	74.4	0.2	121.8	6.0	225.0
13+	……..Weathered parent material…….						

13. KANERA SERIES (Kn)

Classification : Loamy, mixed, hyperthermic family of Lithic Ustorthents
Type location : Village: Kanera, Tehsil: Lakhanadon, Dist: Seoni, M.P 22°32'30" N lat. and 79°26'00" E long
Profile No : 55N/6-P/12
Physiographic position :Structural plateau, denudational pediplains and ridge tops
Elevation :620 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Moderatlely steeply sloping (15-30 percent) and severe
Drainage & permeability : Somewhat excessively drained, rapid permeability
Use & vegetation :Ber, Jam, Mango, Mahua
Geology & parent material :Granite/Weathered granitic
Soil association :Bispur, Jamunpani,
Soil correlation :
Distribution and extent : Extensive in western parts of Lakhanadon plateau and Southern lowlands of Seoni district, MP
Typifying pedon : Kanera, sandy clay-loam, cultivated

Horizon	Depth (cm)	Description
A	0-13	Dark brown (7.5YR 3/4 M) sandy clay loam; medium, weak, sub angular blocky; slightly hard, friable, slightly sticky and slightly plastic; very fine few roots; pH 6.3; clear smooth boundary.
Cr	13+	----------Weathered granite----------

Range in characteristics:

The thickness of A horizon is 8 to 12 cm. The colour of A horizon is dark brown with7.5YR hue, value 3 and chroma 4 and clay loam texture with clay content of 31 percent. This soil has sandy loam texture with clay of 20% and neutral reaction with CEC of 10.18 cmol (p+) kg1. This soil is slightly acid with low electrical conductivity.

Competing series and their differentiae:

Jamuntola series: This soil is extremely shallow with dark brown Ap horizon having 10YR hue, value 3 and chroma of4 with sandy loam texture. This structure is medium weak, sub angular blocky and neutral with CEC of 10.2 cmol (+) kg^{-1}.

Interpretation:

This soil is very shallow, somewhat excessively drained and severely eroded. They have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season low responsive to soil, and crop management practices. They are mostly under non-arable uses and planted for teak, bamboo, grasses.

a)	**Interpretative groupings**	**:**	**Agril, Uses**
	Land capabilitysub-class	**:**	VIes
	Irrigability	**:**	
	Productivity potential	**:**	

Soil site suitability :

b) Yield: Based on data from farmer's field

Crops	Farmer's practices	Improved practices
	<----------(yield q/ha^{-1})------->	
Wheat	2	5
Soybean	3	6

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-12	49.2	19.9	30.9	

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-12	1.0	--	0.09	6.3	34.3	(17.7)

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-12	28.5	13.9	0.3	0.4	43.2	55.3	77.9

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-12	3.4	10.6	76.0	0.5	110.6	2.7	245.0

14. KHAMARIYA SERIES (Ky)

Classification : Fine, mixed, hyperthermic family of Lithic Haplustepts
Type location : Village: Khamariya, Tehsil;Lakhanadon, Dist: Seoni, M.P., 22°25'46" N lat. and 79°29'41" E long.
Profile No : 55N/7 - P/28
Physiographic position :Structural plateau, structural hill tops
Elevation :640 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Very gently sloping (1-3% slope), moderate
Drainage & permeability : Well drained, medium
Use & vegetation :Mango, Palas, Char, Mahua
Geology & parent material :Basalt, weathered basalt
Soil association :Parasia, Pipariya, Paddikona, Sagar, Atari,
Soil correlation :
Distribution and extent : Extensive in Khamariya and Lakhanadonplateau of Seoni District, M.P.
Typifying pedon : Khamariya - clay, cultivated

Horizon	Depth (cm)	Description
Ap	0-9	Dark brown (7.5YR 3/4 M) clay; fine, weak, subangular blocky, slightly hard, friable, slightly sticky and slightly plastic; fine few roots; pH 6.4; clear smooth boundary.
Bwl	9-25	Very dark brown (7.5YR 2.5/3 M) clay; medium, weak, subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; very fine few roots; pH 6.8; gradual smooth boundary.
Bw2	25-50	Dark reddish brown (5YR 3/3 M) clay; granular loose, friable, non-sticky and non-plastic; 15-20% coarse fragments; pH 6.9.
Cr	50+	------Weathered basalt-----

Range in characteristics:

The soil is shallow and contains 15 to 20 percent rock fragments. The Ap horizon is 9-12 cm thick, dark brown and clay textured with fine weak subangular blocky structure. These soils are slightly acid to neutral with more than 15 percent and >28 percent of sand. The B horizon is 15 to 30 cm thick. Its colour is in hue of 7.5YR with value and chroma 3. The texture is sandy clay loam. The thickness of the solum is 20 to 50 cm.

Competing series and their differentiae:

Pipariya series: This soil has grayish brown, clay loam textured A horizons in forest areas. The cambic B horizons are grey to dark grayish brown, clay textured and neutral in reaction. The CEC varies from 43 to 54 cmol (+) kg^{-1}.

Interpretation:

Khamariya series is non-arable subclass of Ves, because of high amount of stoniness, soil depth and slope. Khamariya series (Ky) with hard root restricting layers with in 20 to 60 cm depth and dry more than 90 cumulative days per year and severely eroded. They are shallow with high clay (>60% in B horizon), organic carbon (>1.1 in A horizon), CEC of 55 to 60 cmol (+) kg^{-1} and deficient in available, zinc (<0.6 mg kg'1) low water holding and retentive capacity and suitable for non-arable uses.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class : Vest
Irrigability : 3est
Productivity potential : Very low

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-9	18.9	21.5	59.6	--
Bwl	9-25	16.5	19.9	63.6	--
Bw2	25-50	28.8	21.3	49.9	40

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-9	1.23	--	0.10	6.4	33.67	17.8
9-25	0.95	--	0.22	6.8	36.22	20.0
25-50	0.75	--	0.08	6.9	36.60	19.9

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-9	34.3	15.5	0.5	0.5	50.9	58.2	87.3
9-25	35.7	13.9	0.5	0.3	50.4	60.8	82.9
25-50	38.4	13.7	0.6	0.3	53.0	57.2	92.6

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-9	7.4	11.1	87.4	0.6	106.4	2.3	375.0
9-25	7.0	9.4	53.0	0.3	96.6	1.7	270.0
25-50	4.5	5.5	22.5	0.4	82.6	1.5	245.0

15. KHARSARU SERIES (Kh)

Classification : Fine, montmorllonitic, hyperthermic family of Ustic Epiaquerts
Type location : Village: Kharsaru, Tehsil: Keolari, Dist: Seoni, M.P. $22^0$24'13" N lat. and 79°51'49" E long.
Profile No : 55N/15 - P/7
Physiographic position :Lower denudational plateaus, undulating/rolling plateaus
Elevation :460 m above MSL
Ground water table :>10 m
Rainfall : 1155 mm
Slope & erosion :Moderately sloping (8-15%), moderate
Drainage & permeability : Well drained, moderate permeability
Use & vegetation :Neem, Mango, Palas, Mahua
Geology & parent material :Basalt and weathered basaltic material
Soil association :Arandiya, Bhimgarh, Nadora, Dhenka, Paddikona
Soil correlation :
Distribution and extent : Extensive in Kharsaru, Deor, Malara, Keolari and adjoining area of Wainganga river in Keolari Tehsil, Seoni District, M.P.
Typifying pedon : Khamariya - clay, cultivated

Horizon	Depth (cm)	Description
Ap	0-25	Very dark greyish brown (2.5Y 3/2 M) and dark greyish brown (2.5Y 4/2 M) clay; medium, angular blocky structure, very hard, firm, very sticky and very plastic; fine few roots; pH 6.9; clear smooth boundary.
Bwl	25-53	Very dark greyish brown (2.5Y 3/2 M) clay; medium, moderate, angular blocky structure with intersecting slickensides, very hard, firm, very sticky and very plastic; fine few roots; pH 7.2; gradual smooth boundary.
Bssl	53-81	Very dark greyish brown (2.5Y 3/2 M) clay; medium, weak, angular blocky structure with intersecting slickensides, hard, firm, very sticky and very plastic; pH 7.8.

Range in characteristics:

This soil has very dark greyish brown Ap and Bss horizon sequence with neutral to moderately alkaline reaction and presence of intersecting slickensides below 25 to 100 cm. The thickness of the solum is 81 cm. The thickness of A horizon is 25 cm. Its colour is in hue of 2.5 Y with value 3 to 4 and chroma 1 to 2. Its texture is clay and structure is subangular blocky. The thickness of B horizon is 56 cm. Its colour is in hue of 2.5Y with value 3 and chroma 1 to 2. The texture is clayey and structure is angular blocky. The clay content ranges from 56 to 70 percent. This soil is neutral to slightly alkaline in reaction with depth.

Competing series and their differentiae: Not identified

Interpretation:

This soil is moderately deep, well drained and moderately eroded. This soil has slightly acid surface horizon and slightly alkaline subsoils with low in N,P and Zn but medium in Potassium. Kharsaru (Kh**)have clayey top soil and substrata type with ustic soil moisture regime and high “P” fixation capacity. This soil is arable with clayey surface texture and moderately sloping.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class	:	IIIsw
Irrigability	:	
Productivity potential	:	
Soil site suitability	:	Marginally suitable for rice, sorghum, cotton

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-25	9.8	22.7	67.5	2
Bwl	25-53	7.4	22.2	70.4	1
Bssl	53-81	30.1	14.3	55.6	1

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-25	0.80	--	0.04	6.9	40.4	19.6
25-53	0.78	--	0.03	7.2	41.9	19.7
53-81	0.50	--	0.09	7.8	38.9	17.8

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-25	30.8	10.8	0.4	0.8	42.8	43.8	97
25-53	31.6	10.4	0.4	0.8	43.2	45.4	95
53-81	34.8	14.8	0.5	0.8	50.9	52.00	97.9

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-25	11.5	7.1	34.4	0.5	71.4	1.9	435.0
25-53	10.4	5.5	19.4	0.5	75.6	1.3	425.0
53-81	4.3	2.9	5.6	0.3	71.4	1.5	465.0

16. KHAWASA SERIES (Kw)

Classification : Coarse-loamy, mixed, hyperthermic family of Typic Haplustepts
Type location : Village: Khawasa, Tehsil: Kurai, Dist: Seoni, M.P. $21^0$41'28" N lat. and 79°26'30'' E long.
Profile No : 550/6-P/1
Physiographic position :Lower denudational plateaus, undulating and rolling plains
Elevation :400 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Moderately sloping (8-15%), moderate
Drainage & permeability : Moderately well drained, very slow permeability
Use & vegetation :Teak, Palas, Custard apple, Mango, Lendia, Bamboo, Tendu
Geology & parent material :Granite/weathered granitic material
Soil association :Kodojhiri, Sukla, Dhenka, Nadora, Jamuntola, Gondatola, Rukhad, Pratappur, Tarali, Lungsa, Lakhanadon
Soil correlation :
Distribution and extent : Extensive in Khawasaand adjoining areas of Kurai Tehsil of Seoni district, M.P.
Typifying pedon : Khawasa - sandy loam, forest

Horizon	Depth (cm)	Description
A	0-13	Dark yellowish brown (10YR 4/4 M) sandy loam; medium, weak, sub angular blocky; very hard, friable, slightly sticky and slightly plastic; very fine many roots; pH 5.8; clear smooth boundary.
Bwl	13-31	Dark yellowish brown (10YR 4/4 M) sandy loam; medium, weak, sub angular blocky; hard, friable, slightly sticky and slightly plastic; very fine few roots; pH 6.4; clear smooth boundary.
Bw2	31-60	Brown (10YR 4/3 M) sandy loam; medium, weak, sub angular blocky; hard, friable, slightly sticky and slightly plastic; very fine few roots; pH 6.6; clear smooth boundary.
Bw3	60-96	Dark yellowish brown (10YR 4/4 M) sandy loam; medium, weak, sub angular blocky; hard, friable, slightly sticky and slightly plastic; very fine few roots; pH 6.9; gradual smooth boundary.
Bw4	96-140+	Dark yellowish brown (10YR 4/4 M) sandy loam; medium, weak, sub angular blocky; hard, friable, sticky and plastic; very fine few roots; pH 7.0.

Range in characteristics:
The thickness of the solum ranges from 60 to 140 cm. The A horizon is 13 to 16 cm thick, 10YR, dark yellowish brown with value 4 and chroma of 3 or 4, sandy clay texture and medium subangular blocky structure. The clay content is 13 to 16 percent with moderately acid and CEC of 5.4 cmol (+) kg^{-1}. The B horizon is brown to dark yellowish brown with 10YR hue value 4 and chroma 3 to 4 with sandy loam texture.

Competing series and their differentiae:
Rukhad series: The A horizon is 16 cm thick, light yellowish brown, loamy sand textured (clay 14%) and strongly acid with CEC of 9.7 cmol (+) kg^{-1}. The cambic B horizon are yellowish brown to dark yellowish brown, loamy sand or sandy textured and strongly to moderately acid.

Interpretation: This soil series have loamy top soil and subsoil type, good water holding capacity and low ability to retain nutrients for plants mainly K, Ca, Mg, Moisture is limiting during dry season. Germination problems are often experiencedif first rains are sporadic. This soil is moderately to slightly acid with low amounts of NPK and Zn. This soil is moderately good cultivable land on moderate slopes.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class : IIIes
Irrigability : 3st
Productivity potential :
Soil site suitability : Suitable for Sorghum Moderately suitable for wheat, soyabean, cotton, citrus, maize Marginally suitable for rice, potato and sunflower

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
A	0-13	79.7	4.9	15.4	4
Bwl	13-31	80.3	4.8	14.9	4
Bw2	31-60	80.3	3.8	15.9	2
Bw3	60-96	81.3	3.4	15.3	2
Bw4	96-140+	79.3	4.3	16.4	1

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-13	0.49	--	0.03	5.8	13.8	6.8
13-31	0.43	--	0.03	6.4	13.2	6.4
31-60	0.35	--	0.03	6.6	14.0	6.8
60-96	0.21	--	0.04	6.9	14.1	6.9
96-140+	0.21	--	0.05	7.0	14.3	7.0

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-13	3.3	0.9	0.1	0.1	4.4	5.4	81.4
13-31	5.2	0.8	0.1	0.1	6.2	6.7	92.5
31-60	5.3	0.9	0.1	0.1	6.4	7.0	91.4
60-96	5.7	0.9	0.1	0.1	6.7	7.1	95.7
96-140+	5.4	1.1	Tr.	0.1	6.6	6.7	98.5

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-13	0.7	26.5	27.8	0.6	95.2	2.1	120.0
13-31	1.0	14.7	13.3	0.5	84.0	1.8	105.0
31-60	1.3	13.5	12.1	0.4	79.8	2.2	95.0
60-96	1.6	9.6	13.1	0.4	61.6	2.8	105.0
96-140+	2.0	9.8	16.5	0.4	57.4	2.6	115.0

17. KODAJHIRI SERIES (Ko)

Classification : Fine, montmorillonitic hyperthermic family ofUstic Endoaquerts
Type location : Village: Kodajhiri, Tehsil: Kurai, Dist: Seoni, M.P. 21°47‘36" N lat. and 79°29'36" E long.
Profile No : 55/5 -P/309
Physiographic position :Middle level plateaus, undulating/rolling plains, pediplains
Elevation :420 m above MSL
Ground water table :>10 m
Rainfall : 1271 mm
Slope & erosion :Moderately sloping (8-15%), moderate
Drainage & permeability : Well drained, moderate permeability
Use & vegetation :Teak, Palas, Sal;
Geology & parent material :Granite/weathered granitic material
Soil association :Tarali, Jamuntola
Soil correlation :
Distribution and extent : Extensive in Kodajhiri and adjoining areas of Pench reserved forest, Kurai Tehsil of Seoni district, M.P.
Typifying pedon : Kodajhiri - clayey - cultivated

Horizon	Depth (cm)	Description
Ap	0-19	Dark greyish brown (2.5Y 4/2 M) clay; medium, weak, subangular blocky, slightly hard, firm, sticky and plastic; fine, few roots; pH 8.0; clear smooth boundary.
Bwl	19-42	Very dark greyish brown (2.5Y 3/2 M) clay; medium, moderate, subangular blocky structure, slightly hard, firm, sticky and plastic with pressure faces; pH 8.4; gradual smooth boundary.
Bssl	42-76	Very dark greyish brown (2.5Y 3/2 M) clay; medium, strong, angular blocky structure, hard, firm, sticky and plastic; fine few iron concretions with intersecting slickensides; pH 8.5; gradual smooth boundary.
Bss2	76-123	Very dark greyish brown (2.5Y 3/2 M) clay; medium, strong, angular blocky structure with intersecting slickensides; very hard, firm, very sticky and very plastic; few fine iron concretions; pH 8.7; gradual smooth boundary.
Bss3	123-150	Very dark greyish brown (2.5Y 3/2 M) clay; medium, strong, angular blocky structure with intersecting slickensides; very hard, very firm, very sticky and very plastic with few fine iron concretions followed by weathered parent material; pH 8.8.

Range in characteristics:
The thickness of the solum is 125 to 150 cm. The thickness of A horizon is 15 to 19 cm. Its colour is in hue 2.5Y with value 4 and chroma 2. The texture is clay (55 percent clay) and structure is medium, moderate subangular blocky. The B horizon has very dark greyish brown with cambic and slickensided zone and the thickness of B horizon is 131 cm. Its colour is in hue 2.5Y with value 3 and chroma 2. The texture is clay with strong subangular to angular blocky with intersecting slickensides below 60 cm to 150 cm. These horizon are strongly alkaline with increasing in exchangeable sodium with depth. The cambic B horizon is 23 to 30 cm thick with slightly hard consistency and wedge shaped aggregate with shiny pressure faces. This horizon has clay content of 55 to 60 percent and moderately alkaline.

Competing series and their differentiae: Not identified.
Interpretation:
There are very deep soils, well drained and moderately eroded. This series have clayey top and subsoils with high shrink-swell potentials and dry more than 90 cumulative days per year and have hard root restricting layers.

This soil is moderately to strongly alkaline and medium in N, high in K and low in P and Zn status. This soil is fairly good land, cultivation to special summer crops, hazard of crop failure is always present.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class : IVw
Irrigability :
Productivity potential :
Soil site suitability : Marginally suitable for rice, wheat, soybean, sunflower, sorghum, cotton, citrus and maize

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-19	23.4	21.1	55.5	4
Bwl	19-42	24.2	18.4	57.4	2
Bssl	42-76	22.4	23.1	54.5	4
Bss2	76-123	21.5	21.7	56.8	4
Bss3	123-150	18.9	24.6	56.5	4

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-19	0.98	--	0.22	8.0	36.5	19.3
19-42	0.61	--	0.18	8.4	37.2	20.1
42-76	0.48	--	0.18	8.5	37.0	19.8
76-123	0.48	--	0.29	8.7	37.3	20.3
123-150	0.47	--	0.41	8.8	38.1	20.9

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-19	19.4	10.1	1.3	0.6	31.4	32.2	97.5
19-42	19.3	11.5	2.6	0.4	33.8	34.1	99.1
42-76	15.4	12.6	3.5	0.4	31.9	31.2	102.2
76-123	15.5	14.3	5.1	0.4	35.2	34.4	102.3
123-150	16.3	16.7	7.1	0.6	40.7	35.0	116.3

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-19	1.4	4.1	4.9	0.5	131.6	2.8	430.0
19-42	0.7	2.5	3.0	0.3	141.4	1.1	255.0
42-76	0.7	2.8	3.1	0.2	91.6	1.2	265.0
76-123	0.9	2.8	3.1	0.3	82.6	1.4	295.0
123-150	0.5	2.5	2.8	0.3	78.4	1.3	370.0

18. LAKHANADON SERIES (Lk)

Classification : Fine, mixed, hyperthermic family of Typic Haplustepts
Type location : Village: Nandora, Tehsil: Lakhanadon, Dist: Seoni, M.P. 22°20'49" N lat. and79°27' 09" E long
Profile No : 55N/7 - P/39
Physiographic position :Isolated hillocks, plateau tops, pediplains
Elevation :520 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Moderately sloping (8-15 percent) and severely
Drainage & permeability : Somewhat excessively drained, rapid permeability
Use & vegetation :Pasture land; Lendia, Bharati,Neem, Palas, Tendu, Custardapple
Geology & parent material :Basalt
Soil association :Parasia, Sagar, Lungsa, Khawasa
Soil correlation :
Distribution and extent : Extensive in Nadora, Barsa, Ramgrahtola area of Lakhanadon Tehsil, Seoni district, MP.
Typifying pedon : Lakhanadon - sandy clay loam, pasture land

Horizon	Depth (cm)	Description
Ap	0-3	Dark brown (7.5YR 3/3 D), very dark brown (7.5YR 3/2 M) sandy clay loam;, medium ,weak, sub angular blocky, , slightly sticky and slightly plastic; fine many roots; pH 6.4; clear smooth boundary.
Bwl	3-13	Very dark brown (7.5YR 2.5/2 M) sandy clay loam;, medium ,weak, sub angular blocky, slightly sticky and slightly plastic; 5-10% coarse fragments of 3-5 mm size; fine common roots; pH 6.6; gradual smooth boundary.
Bw2	13-30	Dark reddish brown (5YR 3/3 M) sandy loam, medium ,weak, sub angular blocky non- sticky and non-plastic; 15-20% coarse fragments of 3-5 mm size; fine common roots; pH 6.8; gradual smooth boundary.
Bw3	30-54	Dark reddish brown (5YR 3/3 M) sandy loam; fine weak sub angular blocky non-sticky and non-plastic; 5-10% coarse fragments of 3-5 mm size; fine many roots; pH 7.0; gradual smooth boundary.
R	54+	----------Hard rock----------

Range in characteristics:

This soil has Ap-Bw horizon sequence. The Ap horizon is 3 to 5 cm thick dark brown in hue 7.5 YR with value and chroma 3. The texture is sandy clay loam (>38% clay). The cambic B horizon is very dark brown with 7.5 YR hue, value of 2.5 or 3 and chroma 2 or 3, sandy clay loam or sandy loam texture and 15 to 20 percent coarse fragments. These horizons are slightly acid with CEC of 38 to 46 cmol (+) kg^{-1}.

Competing series and their differentiae: Not identified.

Interpretation:
This soil is moderately shallow, severely eroded and somewhat excessively drained with rapid permeability. This soil is slightly acid with low N, medium in P. K and Zn. This have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during

dry season, germination problems are often experienced if first rains are sporadic, This soil is well suited for grazing or forestry.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class : VIes
Irrigability : 2st
Productivity potential :
Soil site suitability : Grazing and forestry

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-3	39.1	22.8	38.1	6.0
Bwl	3-13	38.1	21.0	40.9	4.0
Bw2	13-30	35.8	23.2	41.0	4.0
Bw3	30-54	72.4	14.4	13.2	16.7

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-3	1.84	--	0.16	6.4	22.2	9.4
3-13	0.56	--	0.08	6.6	18.3	10.6
13-30	0.55	--	0.06	6.8	23.6	8.8
30-54	0.42	--	0.07	7.0	15.6	7.5

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-3	18.6	11.7	0.6	1.0	31.9	33.8	94.4
3-13	20.1	12.4	0.4	0.2	33.1	46.0	71.9
13-30	24.1	14.7	0.5	0.3	39.6	41.6	95.2
30-54	19.6	10.2	0.6	0.3	30.7	38.2	80.4

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-3	8.4	26.3	50.3	1.3	124.6	9.3	350.0
3-13	9.1	18.5	74.9	0.3	114.8	5.3	250.0
13-30	6.8	13.6	68.8	0.3	110.6	4.2	255.0
30-54	1.9	10.1	23.3	0.4	81.2	2.4	310.0

19. LUNGSA SERIES (Lu)

Classification : Very-fine, montmorillonitic, hyperthermic calcareous family of Ustic Endoaquerts
Type location : Village: Lungsa, Tehsil: Barghat, Dist: Seoni, M.P. 22°07'28" N lat. and 79°46'07" E long.
Profile No : 55N/16-P/41
Physiographic position :Valley bottom, interhill basins and lower pediments
Elevation :500 m above MSL
Ground water table :1-2 m
Rainfall : 1506 mm
Slope & erosion :Very gently sloping (1-3% slope), slight
Drainage & permeability : Somewhat poorly drained, slow permeability
Use & vegetation :Palas, Babul, Bija, Seasum, Ber, Tur, Linseed, Lakhori
Geology & parent material :Basalt/ weathered basaltic material
Soil association :Sagar, Atari, Lakhanadon, Parasia, Khamariya
Soil correlation :
Distribution and extent : Extensive in Lungsa and adjoining area of Barghat tehsil, Seoni District, M.P.
Typifying pedon : Lungsa - clay - cultivated Description

Horizon	Depth (cm)	Description
Ap	0-8	Light olive brown (2.5Y 5/4 D) to dark greyish brown (2.5Y 4/2 M) clay; medium, moderate, subangular blocky structure; very hard, friable, very sticky and very plastic; few fine roots; pH 6.1; clear smooth boundary.
Bwl	8-59	Very dark grey (2.5Y 3/1 M) clay; medium, moderate, subangular blocky structure; hard, friable, very sticky and very plastic; very few fine roots; pH 6.7; gradual smooth boundary.
Bssl	59-93	Very dark grey (2.5Y 3/1 M) clay; medium, moderate, subangular blocky structure; hard, friable, very sticky and very plastic; pH 7.0; gradual smooth boundary.
Bss2	93-140	Very dark greyish brown (2.5Y 3/2 M) clay; medium, moderate, subangular blocky structure; slightly hard, friable, very sticky and very plastic; few fine calcium carbonate nodules with slight effervescence; pH 7.8.

Range in characteristics:

This soil is very deep with Ap-Bw horizon sequence and clay texture throughout depth. The thickness of the solum is more than 140 cm. The thickness of Ap horizon is 18 cm. It is light olive brown with 2.5Y hue, value 4 or 5 and chroma 2 or 4. The texture is clay and structure is medium, moderate, subangular blocky. The thickness of B horizon is 122 cm. It is very dark grey with 2.5Y hue, value 3 or 4 and chroma 1 or 2. Texture is clay and structure is medium, moderate subangular blocky. The clay content in control section ranges from 65 to 69 percent. The deeper parts of B horizons have carbonate nodules and slightly alkaline.

Competing series and their differentiae:

Bhimgarh series: This has very dark greyish brown Ap horizons with clay 72 percent and an organic carbon of 0.81 percent. The cambic and slickensided B horizons are very dark greyish brown with clay content of 69 to 76 percent and an organic carbon of 0.67 percent to 0.44 percent. This soil is moderately alkaline with exchangeable Ca of 40 cmol(+)kg^{-1}, Mg of 3.4 to 8 cmol(+) kg^{-1} and K of 0.74 to 0.81 cmol(+)kg^{-1}

Interpretation:
This soil is very deep, slightly eroded and somewhat poorly drained. This soil have clayey top soil and substrata type with ustic soil moisture regime and high "P"fixation capacity. This soil is arable under the subclass of IVws indicating bottom lands that is very wet or subject to severe overflow and suitable for special summer crops. The soil limitation is slightly acid to slightly alkaline. Special attention to seeding and harvest dates to minimize crop failures. These soils are low in N,P and Zn and medium in K status.

a)	**Interpretative groupings**	**:**	**Agril, Uses**
	Land capabilitysub-class	**:**	IVws
	Irrigability	**:**	2st
	Productivity potential	**:**	
	Soil site suitability	**:**	Moderately suitable for cotton and maize
			Marginally suitable for rice, wheat, soybean, sorghum, citrus, potato

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-8	22.0	20.0	58.0	2
Bwl	8-59	h 15.2	20.2	64.6	2
Bssl	59-93	13.7	18.8	67.5	2
Bss2	93-140	9.3	20.8	69.9	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-8	0.67	1.8	0.05	6.1	24.9	9.7
8-59	0.48	2.0	0.04	6.7	29.8	14.5
59-93	0.46	3.0	0.05	7.0	32.6	15.1
93-140	0.47	4.2	0.15	7.8	34.9	16.1

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-8	21.9	8.7	0.6	0.6	31.8	37.2	85.5
8-59	28.1	9.3	0.7	0.6	38.7	37.2	104.0
59-93	33.1	10.4	0.7	0.6	44.8	43.4	103.2
93-140	38.9	9.8	0.8	0.6	50.1	58.2	86.1

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-8	1.9	8.8	38.6	0.6	58.8	1.7	275.0
8-59	1.5	4.8	11.7	0.5	64.4	1.0	280.0
59-93	1.3	4.0	11.6	0.4	70.0	0.6	280.0
93-140	0.5	1.4	3.41	0.4	68.6	1.1	290.0

20. MASANBARRA SERIES (Ma)

Classification : Fine-loamy, mixed, hyperthermic family of Typic Haplustepts
Type location : Village: Masanberra, Tehsil: Keolari, Dist: Seoni, M.P. 22°21'13" N lat and80°04’16" E long
Profile No : 64B/3 - P/22
Physiographic position :Steeply sloping dedunational escarpments, structural plateau, structural hills and ridges
Elevation :420 m above MSL
Ground water table : 5-10 m
Rainfall : 1200 mm
Slope & erosion : Steeply sloping (15-30%), severe
Drainage & permeability : Well drained, moderate permeability
Use & vegetation : Teak, Saja, Palas, Tendu, Mahua
Geology & parent material : Basalt
Soil association : Parasia, Khamariya
Soil correlation :
Distribution and extent :Extensive in Masanbarra and adjoining forest area of Keolari Tehsil, Seoni. District, M.P.
Typifying pedon : Masanberra - clay, forest

Horizon	Depth (cm)	Description
Ap	0-7	Very dark greyish brown (10YR 3/2 M) sandy loam; granular structure; slightly hard, friable, slightly sticky and slightly plastic; fine few roots; pH 5.08; clear smooth boundary.
Bw1	7-25	Dark grey (10YR 4/1 M) sandy clay loam; granular structure; loose, friable, slightly sticky and slightly plastic; very fine few roots; pH 5.30; gradual smooth boundary.
Bw2	25-52	Light olive brown (2.5Y5/3M) sandy clay loam; granular structure; loose, friable, non-sticky and non-plastic; very fine few roots; pH 5.09; gradual smooth boundary.
Bw3	52-68	Light olive brown (2.5Y5/3M) sandy clay loam; granular structure; loose, friable, slightly sticky and slightly plastic; pH 5.26; gradual smooth boundary.
C	68-90	Light yellowish brown (2.5Y6/3M) sandy clay loam; granular structure; loose, friable, slightly sticky and slightly plastic; pH 5.27.

Range in characteristics:

This soil is moderately deep with very dark greyish brown Ap horizon and grey to light grey Cambic B horizons. This soil is strongly acid throughout depth. The thickness of the solum is more than 90 cm. The thickness of A horizon is 25 cm. Its colour is in hue of 10YR, value 3 and chroma 2. The texture is sandy loam and structure is granular. The thickness of B horizon is 65 cm. Its colour is in hue of 10YR with value 5 to 8 and chroma 1 to 2. Its texture is sandy clay loam and structure is medium, moderate and subangular block.

Competing series and their differentiae: Not identified.
Interpretation:

This soil is moderately deep, severely eroded and well drained. This soil has loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic. This soil is non-arable and fit to subclass of Vis because of steep lands subject to erosion and well suited to forestry or grazing. Cover it with grasses and trees to maintain litter on the soil and conserve moisture.

a) Interpretative groupings : **Non.Agril.Use (Patches)**

Land capability sub-class : VIs
Irrigability : 6t
Productivity potential :

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-7	74.5	5.9	19.6	—
Bwl	7-25	69.5	6.5	24.0	4
Bw2	25-52	61.5	9.0	29.5	12
Bw3	52-68	59.3	13.2	27.5	8
Bw4	68-90	63.2	13.1	23.7	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-7	2.10	-	0.26	5.1	7.9	2.9
7-25	0.77	-	0.09	5.3	9.9	4.6
25-52	0.28	-	0.02	5.1	11.1	4.8
52-68	0.37	-	0.01	5.3	11.3	4.7
68-90	0.56	-	0.01	5.3	16.3	7.3

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-7	6.0	2.4	0.1	0.1	8.56	10.8	79
7-25	8.4	2.4	0.1	Tr.	10.89	11.8	92
25-52	5.2	0.8	0.1	0.1	6.13	7.6	82
52-68	7.6	2.4	0.1	0.1	10.12	10.8	93
68-90	8.8	2.0	0.1	0.1	10.95	12.0	83

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-7	0.8	108.8	42.9	0.4	85.4	19.5	145.0
7-25	0.7	70.0	31.8	0.4	91.0	3.7	70.0
25-52	0.5	33.3	31.5	0.3	74.2	5.7	95.0
52-68	0.4	23.9	41.7	0.3	74.2	6.7	95.0
68-90	0.57	20.0	38.9	0.3	85.4	6.4	105.0

21. NADORA SERIES (Nd)

Classification : Very fine, mixed, hyperthermic, montmorillonitic, family of (calcareous), Typic Haplusterts
Type location : Village: Nadora, Tehsil: Seoni, Dist: Seoni, M.P 22°01'06" N lat. And 79°32'18" E long
Profile No : 55N/12 - P/2
Physiographic position :Structural plateaus, lower denuded plateaus and upper denuded plateaus
Elevation :600 m above MSL
Ground water table :>10 m
Rainfall : 1506 mm
Slope & erosion :Gently sloping (3-8%), moderate
Drainage & permeability : Moderately well drained, slow permeability
Use & vegetation :Palas, Mahua, Neem, Anjan, Sal, Teak
Geology & parent material :Basalt, weathered basalt
Soil association :Dhora, Sukla, Khawasa, Arandiya, Bhimgarh
Soil correlation :Dunda Seoni, Savali series
Distribution and extent : Extensive in Nadora and Amakola area of Seoni District, M.P.
Typifying pedon : Nadora - clay - cultivated

Horizon	Depth (cm)	Description
Ap	0-19	Dark yellowish brown (10YR 4/4 D) and dark greyish brown (10YR 4/2 M) clay; medium, weak, subangular blocky, slightly hard, friable, slightly sticky and slightly plastic; very fine few lime concretions; very fine many roots; pH 8.2; clear smooth boundary.
Bwl	6-26	Dark greyish brown (10YR 4/4 M) clay; medium, weak, angular blocky with pressure faces; slightly hard, friable, slightly sticky and slightly plastic; very fine few lime concretions; fine few roots; pH 8.3; gradual smooth boundary
Bw2	26-62	Brown (10YR 4/3 M) clay; medium, moderate, angular blocky with pressure faces; hard, firm, sticky and plastic; very fine few lime concretions; pH 8.2; gradual smooth boundary.
Bssl	62-90	Dark yellowish brown (10YR 4/4 M) clay; medium, moderate, angular blocky with pressure faces; hard, firm, sticky and plastic; fine few lime concretions; pH 8.1; gradual smooth boundary
Bss2	90-105	Dark yellowish brown (10YR 4/4 M) clay loam; medium, weak, subangular blocky with pressure faces; hard, friable, slightly sticky and slightly plastic; fine few lime concretions; pH 8.1; gradual smooth boundary
Cr	105+	.....Weathered basalt.....

Range in characteristics:
The thickness of the solum is 105-110 cm. The thickness of Ap horizon is 18-19 cm. Its colour is in hue of 10YR with value 3 to 4 and chroma 2 to 4. Its texture is clay loam to clay and structure is subangular blocky to angular blocky. The thickness of B horizon is 86-92 cm. Its colour is in hue of 10YR with value 4 to 5 and chroma 2 to 4. The texture is clay loam to clay and structure is subangular blocky to angular blocky with pressure faces. The Cr horizon is mixture of soil with weathered basalt.

Competing series and their differentiae:
Paddikonda series is very deep (>150 cm), very dark brown to black matrix with value 2 and chroma of 1 or 2. This soil has very fine particle size throughout depth with slightly alkaline and organic carbon of 0.8 to 1.0 percent. This soil is deficient in P and Zn with Ex. Ca of 33 to 35 cmol (+) kg'1.

Interpretation:

Nadora series is arable with limitations of surface clayey texture, slope of 3 to 8 percent on structural plateaus, denuded plateaus and lower plateaus where in possibility of surface irrigation is difficult and are presently under dry land crops.Nadora (Nd) series have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc. This soil is moderately alkaline, high in potassium, low in nitrogen and phosphorus, adequate in Cu and Mn but low in Fe and Zn. This series is suitable for raising wheat, soybean, sorghum, moderately suitable for rice, cotton, sunflower, citrus and potato due to alkaline reaction and low organic carbon.

a)	**Interpretative groupings**	**:**	**Agril, Uses**	**Non.Agril.Uses (Patches)**
	Land capabilitysub-class	**:**		
	Irrigability	**:**		
	Productivity potential	**:**		
	Fertility capability class	**:**	CCvdb	
	Soil site suitability	**:**	S3f for rice, S2ft for wheat, S3ft for soyabeanS3f for sunflower, S2f for sorghum, S3f for cotton	

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
A	0-19	6.2	28.8	65.0	—
Bwl	19-26	6.0	29.5	64.5	—
Bw2	26-62	5.0	28.5	66.5	—
Bssl	62-90	5.6	28.9	65.5	—
Bss2	90-105	24.3	24.2	51.5	—

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-19	0.62	3.7	0.09	8.2	36.1	16.3
19-26	0.62	3.8	0.09	8.3	34.9	17.3
26-62	0.62	4.0	0.09	8.2	36.4	18.3
62-90	0.48	4.4	0.10	8.2	35.5	18.0
90-105	0.48	4.0	0.10	8.1	34.4	15.4

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-19	47.2	1.6	0.3	0.7	49.8	51.5	96.7
19-26	47.0	1.6	0.3	0.6	49.5	50.8	97.4
26-62	47.3	1.8	0.3	0.6	50.0	51.5	97.1
62-90	45.9	2.1	0.3	0.6	48.9	49.3	99.2
90-105	47,0	2.7	0.3	0.4	50.4	50.8	99.2

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-19	3.5	2.3	6.8	0.6	61.6	4.0	375.0
19-26	2.7	1.9	5.8	0.4	60.2	2.8	340.0
26-62	1.9	1.7	6.1	0.3	57.4	1.7	330.0
62-90	2.3	1.6	6.2	0.3	54.6	1.4	315.0
90-105	1.7	2.1	4.6	0.2	74.2	1.5	270.0
105 +	---------- Weathered basalt----------						

22. PADDIKONA SERIES (Pd)

Classification : Very fine, montmorillonitic, hyperthermic, calcareous family of Typic Haplusterts
Type location : Village: Paddikona, Tehsil: Ghansor, Dist: Seoni, M.P. 22°44'26" N lat. And
80°11'30" E long.
Profile No : 64B/2 - P/5
Physiographic position :Valley bottom, broad and narrow interhill basin
Elevation :640 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Very gently sloping (1-3% slope), slight Moderately
Drainage & permeability : well drained, slow permeability
Use & vegetation :Pigeonpea; Mahua, Palas, Anjan, Teak
Geology & parent material :Basalt/weathered basalt
Soil association :Parasia, Khamariya, Sagar, Gorakhpur, Dhenka,
Soil correlation :
Distribution and extent .Extensive in Seoni District, M.P.
Typifying pedon : Paddikona - clay, cultivated

Horizon	Depth (cm)	Description
Ap	0-10	Very dark brown (10YR 2/2 M) clay; medium, moderate, sub angular blocky; very hard, friable, sticky and plastic; very fine many roots; pH 7.0; clear smooth boundary.
Bwl	10-30	Very dark brown (10YR 2/2 M) clay; medium, moderate, subangular blocky with pressure faces; very hard, friable, very sticky and very plastic; medium few roots; pH 7.3; clear smooth boundary.
Bw2	30-50	Black (10YR 2/1 M) clay; coarse, strong, angular blocky with pressure faces; very hard, friable, very sticky and very plastic; very fine few roots; pH 7.6; gradual smooth boundary.
Bssl	50-90	Black (10YR 2/1 M) clay; coarse, strong, angular blocky; very hard, friable, very sticky and very plastic; very fine few roots; intersecting slickensides tilted at an angle of 45° to the horizontal axis; pH 7.7; gradual smooth boundary.
Bss2	90-150+	Black (10YR 2/1 M) clay; coarse, strong, angular blocky; very hard, friable, very sticky and very plastic; intersecting slickensides tilted at an angle of 50° to the horizontal axis; pH 7.6

Range in characteristics:

These soils are very deep with Ap-Bw and Bss horizon sequence. The thickness of the solum is more than 150 cm. The organic matter decrease with depth and is less than 1 percent. The A horizon is very dark brown with 10YR hue, value of 2 and chroma 2. It is neutral. The B horizon is very dark brown to black with chroma of less than 1 between 30 to 150 cm. It has 64 to 69 percent clay and less than 15 percent sand. This horizon has strong angular aggregates inslickensided zones. It is neutral to slightly alkaline. The B horizon is in hue of 10YR with value 2 and chroma 2 to 1. Cracks 2 cm wide extend up to 60 cm depth.

Competing series and their differentiae:
Nadora series: This soil is deep with dark yellowish brown Ap horizons, dark greyish brown or brown cambic B horizons and dark yellowish brown slickensided B horizons. The clay distribution is irregular but have 65 percent or more upto 90 cm. The organic carbon is 0.62 percent upto 62 cm and decreases to 0.48 percent with

depth. The exchangeable calcium is more than 45 cmol (+)kg^{-1} throughout depth but has low exchangeable magnesium of 2.7 cmol (+)kg^{-1} to 1.56 cmol(+)kg^{-1}. This soil is moderately alkaline with low electrical conductivity.

Interpretation:

This soil is arable and good cultivate lands with problems of alkalinity. They have high available water holding capacity, low in N, P and Zn but medium in K status. This series have clayey top and substrate type with high shrink swell potential, tillage too difficult when dry or wet, potential deficiencies of iron and zinc

a)	**Interpretative groupings**	**:**	**Agril, Uses**
	Land capabilitysub-class	:	IIes
	Irrigability	:	2s
	Productivity potential	:	Medium
	Soil site suitability	:	Moderately suitable for rice, wheat Marginally suitable for sunflower, cotton, maize

b) Yield: Based on data from farmer's field

Crops/Forest	Farmer's practices	Improved practices
	<----------(yield q/ha^{-1})---------->	
1. Gram	10-15	15-20
2. Wheat	10-15	15-20

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-10	13.9	22.7	63.4	2
Bwl	10-30	14.7	20.7	64.6	2
Bw2	30-50	12.8	20.0	67.2	2
Bssl	50-90	15.3	23.9	60.8	4
Bss2	90-150	9.8	21.4	68.8	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-10	1.1	4.5	0.16	7.0	18.0	9.1
10-30	0.9	4.7	0.22	7.3	18.6	9.2
30-50	0.9	6.1	0.24	7.6	19.8	8.0
50-90	0.8	5.3	0.21	7.7	18.6	9.0
90-150	0.8	5.9	0.29	7.6	17.8	8.7

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-10	33.2	8.8	0.1	0.6	42.7	47.2	90.5
10-30	34.9	9.4	0.1	0.5	45.03	48.4	92.8
30-50	35.2	9.9	0.1	0.5	45.74	47.4	96.4
50-90	34.3	10.4	0.2	0.5	45.43	50.0	90.8
90-150	33.9	10.8	0.3	0.5	45.45	47.8	95.2

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-10	7.4	6.8	28.6	0.7	72.8	4.2	360.0
10-30	7.4	5.3	16.1	0.6	71.4	4.9	355.0
30-50	6.5	3.8	6.8	0.4	64.4	5.0	350.0
50-90	6.7	3.7	4.2	0.4	49.0	7.0	360.0
90-150	8.0	3.8	4.9	0.4	64.4	7.2	380.0

23. PARASIA

Classification : Loamy, mixed, hyperthermic family of Lithic Ustorthents
Type location : Village: Parasia, Tehsil: Lakhanadon, Dist: Seoni, M.P. 22°42'31" N lat. and 79°30'45" E long.
Profile No : 55N/10-P/1
Physiographic position :Structural hills and ridges, steeply sloping denuded escarpments, structural plateau tops
Elevation :500 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Steeply sloping (30-50%), severe erosion
Drainage & permeability : Well drained, moderate
Use & vegetation :Palas, Mahua, Teak, Neem, Lendia
Geology & parent material :Basalt/ weathered basalt
Soil association :Paddikona, Khamariya, Sagar, Atari, Bhimgarh, Sukla, Jamunpani
Soil correlation :Chichband series, Dhora series
Distribution and extent : Extensive in Parasia and Lakhanadon plateau in northern and eastern parts of Seoni District, M.P.
Typifying pedon : Parasia, sandy clay loam, cultivated

Horizon	Depth (cm)	Description
Ap	0-13	Reddish brown (5YR 4/3 M) sandy clay loam; medium, weak, sub angular blocky; hard, friable, sticky and plastic; very fine medium roots; pH 6.1 and clear smooth boundary.
Cr	13+	----------Weathered basalt----------—

Range in characteristics:

The thickness of A horizon is 8 to 15 cm. The reddish brown A horizon has hue 5YR value 4 and chroma 3 with clay loam texture (>34 percent clay) and fine to medium, weak, subangular blocky aggregates. This horizon is moderately acid with base saturation more than 60percent.

Competing series and their differentiae:

Dhora series: This soil has 7 to 10 cm thick Ap horizon with dark brown, organic carbon of 2.49 percent, clay of 45 percent and slightly acid in reaction.

Interpretation:

This series is very shallow, non-arable with steep slopes on escarpments and not suitable for surface irrigation. **Parasia** (Pc) have hard root restricting layers within 20 to 60 cm depth and dry more than 90 cumulative days per year, severely eroded. They are mostly under non-arable uses and planted for teak, bamboo and grasses.

a) Interpretative groupings : Non.Agril.Uses (Patches')

Land capability sub-class : VIIes

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
AP	0-12	46.4	20.1	33.5	

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-12	1.29	-	0.06	6.1	27.5	13.1

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-12	9.4	2.5	0.8	0.5	13.2	19.6	67.3

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-12	8.8	24.1	82.5	1.0	126.0	2.3	215.0
12+	----------Weathered basalt----------						

24. PIPARIYA SERIES (Pr)

Classification : Fine, mixed, hyperthermic family of Lithic Haplustepts
Type location : Village: Pipariya, Tehsil: Seoni, Dist: Seoni, M.P. 22° 18'06" N lat. and 79°24'47" E long.
Profile No : 55N/7 - P/32
Physiographic position :Ridges, Undulating plains, pediment surfaces, convex hill slopes
Elevation :620 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Moderately sloping (8-15%) severe
Drainage & permeability : Somewhat excessively drained, rapid permeability
Use & vegetation :Forest, Teak, Tendu, Saja, Lendia, Mahua, Char, etc.
Geology & parent material :Basalt
Soil association :Parasia, Khamariya, Lakhanadon, Sagar, Lungsa, Jamunpani
Soil correlation :
Distribution and extent : Extensive in Pipariya, Nakatiya reserve forest of the area of Seoni Tehsil, Seoni district, M.P.
Typifying pedon : Pipariya - sandy clay loam, Forest

Horizon	Depth (cm)	Description
A	0-5	Greyish brown (2.5Y 5/2 D); dark greyish brown (2.5Y 4/2 M); clay loam; fine, weak, subangular blocky, slightly hard, friable, slightly sticky and slightly plastic; fine few roots; pH 6.6; clear smooth boundary.
Bwl	5-16	Dark greyish brown (2.5Y 4/2 D); clay loam; medium, weak, subangular blocky, slightly hard, friable, slightly sticky and slightly plastic; fine many roots; pH 6.9; gradual smooth boundary.
Bw2	16-35	Grey (2.5Y 6/1 D); clay loam; medium, weak, subangular blocky, slightly hard, friable, slightly sticky and slightly plastic; fine common roots; pH 7.0; gradual smooth boundary.
R	35+	------Hard basaltic parent material-----

Range in characteristics:

The thickness of the solum is 20 to 35 cm. The A horizon is 5 to 10 cm thick, greyish brown with 2.5Y hue, value 4 to 6 and chroma 1 to 2. The texture is sandy clay loam. The B horizon is dark greyish brown with sandy clay loam texture (29 to 37 percent clay) and neutral in reaction.

Competing series and their differentiae:

Khamariya series: They have dark brown Ap horizon with 60 percent clay and 23 percent organic carbon. The cambic B horizons are dark brown with 50 to 54 percent clay and 08 to 1 percent organic carbon.

Gorakhpur series: They are shallow with dark grey matrix of hue 2.5Y, value of 2.5 or 3 and chroma of 1. The clay content is more than 60 percent in A and cambic B horizons with slightly acid to slightly alkaline reaction and CEC of 51 to 58 cmol(+) kg'1. These soils are cultivated.

Interpretation:
These are shallow soils with poor water holding and retentive capacity and suitable for non-arable uses. This series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil

resulting from severe erosion, moisture limiting during dry season. This soil is fairly suitable for grazing or forestry.This soil is slightly acid with low amounts of N,P and Zn and medium in K status.

a) Interpretative groupings : Non.Agril, Uses (patches)

Land capabilitysub-class : VIIes
Irrigability :
Productivity potential :
Soil site suitability :

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
A	0-5	42.2	28.6	29.2	1
Bwl	5-16	35.9	27.5	36.6	1
Bw2	16-35	33.8	29.1	37.1	1

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-5	1.05	--	0.11	6.6		22.3
5-16	0.98	--	0.07	6.9		20.2
16-35	0.42	--	0.08	7.0		24.7

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-5	25.8	10.2	0.4	0.4	36.8	43.4	84.6
5-16	26.8	10.7	0.4	0.2	38.1	49.4	77.1
16-35	30.5	11.9	0.3	0.3	43.0	53.8	79.9

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-5	5.7	18.6	46.9	0.2	113.4	1.6	340.0
5-16	1.7	6.4	16.7	0.1	102.2	4.9	245.0
16-35	0.2	3.6	13.8	0.1	71.4	2.1	260.0

25. PRATAPPUR SERIES (Pt)

Classification : Very-fine, mixed, hyperthermic family of Udic Haplustalfs
Type location : Village: Pratappur, Tehsil: Kurai, Dist.: Seoni, M.P. 21°57'00" N lat. and 9°32'0"E long.
Profile No : 550/9-P/36
Physiographic position :Lower denudational plateaus, undulating and rolling plains
Elevation :620 m above MSL
Ground water table :>10 m
Rainfall : 1271mm
Slope & erosion :Moderately sloping (8-15 percent) and moderate
Drainage & permeability : Moderately well drained, moderate permeability
Use & vegetation :Teak, Palas
Geology & parent material :Granite/Weathered granitic material
Soil association :Parasia, Khamariya, Lakhanadon, Sagar, Lungsa, Jamunpani
Soil correlation :
Distribution and extent : Extensive in Pratappur, Mundra temple area of Kurai Tehsil, Seoni district, M.P.
Typifying pedon : Pratappur - clay - cultivated

Horizon	Depth (cm)	Description
Ap	0-19	Very dark greyish brown (10YR 3/2 M) clay; medium, weak, subangular blocky structure, hard, friable, sticky and plastic; very fine very few roots; pH 6 .25; clear smooth boundary.
Btl	19-44	Very dark gray (1QYR 3/1 M) clay; medium, strong, subangular blocky structure with pressure faces; very hard, very firm, very sticky and very plastic; very fine and very few roots; pH 6.93; gradual smooth boundary.
Bt2	44-75	Olive brown (2.5Y 4/4 M) clay; medium, strong, angular blocky structure with pressure faces; very hard, very firm, very sticky and very plastic; fine few iron nodules; pH 7.45; gradual smooth boundary.
Bt3	75-111	Olive brown (2.5Y 4/4 M) clay; medium, strong, angular blocky structure with pressure faces; very hard, very firm, very sticky and very plastic; very fine very few iron nodules; pH 7.22; gradual smooth boundary.
Bt4	111-159	Olive brown (2.5Y 4/4 M) clay; medium, strong, angular blocky structure with pressure faces; very hard, veiy firm, very sticky and very plastic; very fine very few iron nodules; pH 7.25.

Range in characteristics:

The thickness of the solum is 149 cm. The thickness of Ap horizon is 19 cm, is very dark greyish brown with hue 10YR , value 3 and chroma 2. Its texture is clay with medium, weak, subangular blocky structure. The clay content in A horizon is 60 to 70 percent and slightly acid. The thickness of B horizon is 140 cm, very dark grey to olive brown 10YR to 2.5 Y hue, value 3to 4 and chroma I to 4. The texture is clay with medium, moderate, subangular blocky structure to medium strong angular blocky with pressure faces on red surfaces. The clay content in B horizon ranges from 73 to 87 percent and neutral to slightly alkaline in the most part.

Competing series and their differentiae: Not identified.

Interpretation:
This soil is very deep, moderately well drained and moderately eroded. **Pratappur** (Pt) have clayey top and substrata type, vertic, ustic soil moisture regime, high "P" fixation and low "K" reserves. This soil is slightly

acid to slightly alkaline with low in N, P and Zn and medium in K status. This soil is bottom land but moderately good cultivable land subject to water erosion.

a) Interpretative groupings : Non.Agril, Uses (patches)

Land capabilitysub-class : IIIw
Irrigability : 4st
Productivity potential :
Soil site suitability : Suitable for sorghum, wheat moderately suitable for soyabean, cotton, citrus, maize, potato Marginally suitable for rice, sunflower

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-19	5.0	26.7	68.3	4
Btl	19-44	4.6	18.5	76.9	2
Bt2	44-75	4.4	9.2	86.4	1
Bt3	75-111	4.2	8.4	87.4	--
Bt4	111-159	17.9	8.6	73.5	1

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-19	0.90	--	0.1	6.2	37.3	19.2
19-44	0.97	--	0.1	6.9	40.6	19.9
44-75	0.49	--	0.1	7.4	49.8	23.7
75-111	0.34	--	0.1	7.2	46.9	24.5
111-159	0.34	--	0.1	7.2	55.9	27.0

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-19	35.4	9.2	0.1	0.5	45.2	37.5	120.3
19-44	33.1	7.3	0.2	0.5	41.1	42.0	97.9
44-75	39.5	8.5	0.2	0.5	48.7	42.6	114.3
75-111	38.7	7.0	0.3	0.4	46.1	40.3	114.4
111-159	40.6	7.8	0.3	0.5	49.2	46.7	105.3

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-19	3.5	18.0	51.5	0.7	74.2	0.6	385.0
19-44	2.6	7.2	12.8	0.4	81.2	2.6	375.0
44-75	2.4	3.8	5.0	0.3	70.0	1.5	365.0
75-111	1.7	2.9	2.5	0.3	60.2	1.4	305.0
111-159	1.8	3.3	0.4	0.4	63.0	1.2	315.0

26. RUKHAD SERIES (Rk)

Classification : Coarse-loamy, mixed, hyperthermic Typic Haplustepts
Type location : Village: Rukhad, Tehsil: Kurai, Dist: Seoni, M.P. 21°53'42" N lat. and 79°38’42" E long.
Profile No : 55O/9 - P/81
Physiographic position :Broad interhill basins, rolling pediplains, lower denuded plateaus
Elevation :530 m above MSL
Ground water table :>10 m
Rainfall : 1150 mm
Slope & erosion :Gently sloping (3-8%) to moderately sloping (8-15%), moderate
Drainage & permeability : Moderately well drained, moderate permeability
Use & vegetation :Teak forest
Geology & parent material :Granite/Weathered granitic material
Soil association :Sukla, Jamuntola, Pratappur, Gondatola, Khawasa
Soil correlation :
Distribution and extent : Extensive in Rukhad forest and Masur nala of Kurai Tehsil, Seoni district, M.P.
Typifying pedon : Rukhad - loamy - forest

Horizon	Depth (cm)	Description
A11	0-16	Light yellowish brown (10YR 6/4 M) loamy sand; fine, weak subangular blocky; loose, friable, non-sticky and non-plastic; medium many roots; pH 5.18; clear smooth boundary.
Bwl	16-49	Yellowish brown (10YR 5/4 M) loamy sand; fine, weak subangular blocky; loose, friable, non-sticky and non-plastic; medium many roots; pH 5.17; clear smooth boundary.
Bw2	49-78	Dark yellowish brown (10YR 4/4 M) loamy sand; fine, weak subangular blocky; loose, friable, non-sticky and non-plastic; fine many roots; pH 5.6; gradual smooth boundary.
Bw3	78-108	Dark yellowish brown (10YR 4/4 M) sandy loam; fine, weak subangular blocky structure; loose, friable, non-sticky and non-plastic; fine few roots; pH 5.7.
Cr	108+	----------Weathered parent material----------

Range in characteristics:

The thickness of the A horizon is 16 to 20 cm. Its colour is light yellowish brown with hue 10YR, value 5 to 6 and chroma of 4. The texture is loamy sand to sandy loam with clay content of 14 to 16 percent and have fine, weak to sub angular blocky aggregates. This horizon is strongly acid. The B horizon is 60-90 cm thick with yellowish brown matrix, loamy sand or sandy loam texture and weak, sub angular blocky structure. This horizon is moderately acid with 0.8 to 0.9 percent of organic carbon with depth. The Cr horizon is below 1 m with weathered granitic material mixed up with little amount (<5 percent) of soil.

Competing series and their differentiae:

Khawasa series: This soil is 13 cm thick. A horizon of dark yellowish brown, sandy loam textured and moderately aid. The cambic B horizon are brown to dark yellowish brown sandy loam textured and slightly acid to neutral reaction. Deficient in P and Zn.

Interpretation:

This soil is deep, moderately sloping and moderately eroded , moderately well drained and moderate permeability. **Rukhad** (Rk) series have sandy top and substrata type with high infiltration rate and low water holding capacity, moisture is limiting during dry season and low ability to supply K. This soil is strongly to moderately acid with low in N,K, high in P and medium in Cu and Zn. Thi soil fairly good land suited for limited cultivation.

a)	**Interpretative groupings**	**:**	**Non.Agril, Uses (patches)**
	Land capabilitysub-class	**:**	IVes
	Irrigability	**:**	4st
	Productivity potential	**:**	low
			rice, sunflower

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
All	0-16	84.1	1.6	14.3	1
Bwl	16-49	83.6	1.5	14.9	2
Bw2	49-78	83.3	2.1	14.6	1
Bw3	78-108	77.3	5.9	16.8	1

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-16	0.99	--	0.03	5.8	9.2	4.0
16-49	0.83	--	0.01	5.7	9.7	4.1
49-78	0.63	--	0.01	5.6	9.4	4.0
78-108	0.90	--	0.01	5.7	11.3	4.6

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-16	4.1	1.3	0.2	0.2	5.8	9.7	59.8
16-49	4.4	1.3	0.2	0.2	6.1	9.5	64.2
49-78	4.4	1.2	0.2	0.2	6.0	9.7	61.8
78-108	6.7	1.2	0.2	0.2	8.3	11.6	71.5

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-16	0.4	55.3	1.3	1.3	68.6	9.2	185.0
16-49	0.5	40.4	0.7	0.7	71.0	5.0	135.0
49-78	0.5	35.3	0.6	0.6	74.0	5.2	135.0
78-108	1.5	50.3	0.7	0.7	67.0	3.7	150.0

27. SAGAR SERIES (Sa)

Classification : Fine, mixed, hyperthermic family of Typic Haplustepts
Type location : Village: Sagar, Tehsil: Seoni, Dist: Seoni, M.P
22° 17'18" N lat. and 79^0 26'05" E long
Profile No : 55N/7 - P/10
Physiographic position :Broad interhill basin, valley bottom
Elevation :580 m above MSL
Ground water table :>10 m
Rainfall : 1200 mm
Slope & erosion :Gently sloping (3-8%), moderate
Drainage & permeability : Moderately well drained & slow
Use & vegetation :Babul, Mahua, Jamun
Geology & parent material :Basalt/weathered basaltic material
Soil association :Atari, Paddikona, Parasia, Nadora, Dhenka, Lakhanadon Lungsa, Pipriya, Jamunpani, Gondaola, Bhimgarh
Soil correlation :
Distribution and extent : Extensive inSagar, Chargaon, Bakhari area of Seoni Tehsil, Seoni district, M.P.
Typifying pedon : Sagar - sandy clay loam, cultivated

Horizon	Depth (cm)	Description
Ap	0-12	Very dark greyish brown (10YR 3/2 M) clay; medium, moderate, subangular blocky; hard, firm, very sticky and very plastic; fine few roots; pH 6,4; clear smooth boundary.
Bwl	12-32	Very dark greyish brown (10YR 3/2 M) clay; moderate, subangular blocky; hard, firm, very sticky and very plastic; fine few roots; pH 6.7; gradual smooth boundary.
Bw2	32-46	Very dark gray (10YR 3/1 M) clay; moderate, sub angular blocky; hard, firm, very sticky and very plastic; pH 7.0; gradual smooth boundary.
Bw3	46-60	Very dark gray (10YR 3/1 M) sandy clay; moderate, subangular blocky; slightly hard, firm, sticky and plastic; pH 7.4; gradual smooth boundary.
R	60+	---------Weathered parent material----------

Range in characteristics:

The thickness of the solum ranges from 50 to 60 cm. The A horizon is very dark greyish brown to very dark grey with 10 YR hue, value 3 and chroma 2. Its texture is clay more than 56 percent The B horizons in hue of I0YR with value 3 and chroma 1 to 2 with sandy clay to clay texture. The clay content ranges from 28 to 63 percent. This horizon is slightly alkaline with CEC of 44 to 46 cmol(p+) kg'1.

Competing series and their differentiae: Not identified.

Interpretation:

This soil is moderately shallow, Moderately well drained and moderately eroded. This soil is slightly acid to slightly alkaline, low in N,P and medium in K and Zn. This soil is under moderately good cultivable land that needs careful management of excess water and selection of crops adapted to wet conditions, a) Interpretative groupings: Agril. Uses Land capability sub-class IIIW

a)	**Interpretative groupings**	**:**	**Agril. Uses**
	Land capabilitysub-class	**:**	IIIw
	Irrigability	**:**	2st
	Productivity potential	**:**	
	Soil site suitability	**:**	Suitable for cotton, sorghum, Moderately suitable for potato, maize, citrus, sunflower, soyabean, wheat, rice

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-12	18.6	25.4	56.0	1
Bwl	12-32	16.9	19.9	63.2	6
Bw2	32-46	19.7	22.1	58.2	4
Bw3	46-60	58.8	13.0	28.2	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-12	1.07	--	0.09	6.4	23.8	12.3
12-32	0.68	--	0.06	6.7	29.4	11.2
32-46	0.54	--	0.06	7.0	32.8	16.6
46-60	0.20	--	0.07	7.4	24.2	11.2

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-12	22.4	17.4	0.5	0.3	40.6	40.0	101.5
12-32	25.0	17.5	0.5	0.4	43.4	46.8	92.7
32-46	25.0	16.3	0.5	0.3	42.1	45.2	93.1
46-60	34.7	20.4	0.6	0.2	55.9	44.2	103

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-12	6.3	14.0	87.0	0.9	93.8	1.9	370.0
12-32	5.5	10.2	47.7	0.7	86.8	2.4	350.0
32-46	5.0	8.4	31.3	0.8	78.4	1.3	345.0
46-60	1.6	5.1	5.8	0.1	77.0	1.3	195.0

28. SILGHAT SERIES (Si)

Classification : Fine-loamy, mixed, hyperthermic family of Dystric Haplutepts
Type location : Village: Silghat, Tehsil: Barghat, Dist: Seoni, M.P
22°09'07" N lat. and 79°41'32" E long
Profile No : 55N/16- P/59
Physiographic position :Middle level plateau, undulating and rolling plains
Elevation :500 m above MSL
Ground water table :2-5 m
Rainfall : 1508 mm
Slope & erosion :Moderatly sloping (8-15 percent), moderate
Drainage & permeability : Well drained, moderate permeability
Use & vegetation :Palas, Mahua, Mango, Tendu, Bija, Teak, Char
Geology & parent material :Granite/Weathered granitic material
Soil association :Atari, Chhui
Soil correlation :
Distribution and extent : Extensive in Silghat and adjoining area of Barghat Tehsil, Seoni district, M.P.
Typifying pedon : Silghat - sandy clay loam - cultivated

Horizon	Depth (cm)	Description
Ap	0-11	Pale brown (10YR 6/3 D) to brown (10YR 5/3 M) sandy clay laom; medium, angular blocky structure, slightly hard, firm, slightly sticky and slightly plastic; fine few roots; pH 5.5; clear smooth boundary.
Bwl	11-21	Dark brown (7.5 YR 3/2 M) sandy clay loam; medium, angular blocky structure, slightly hard, firm, slightly sticky and slightly plastic; very fine few roots; pH 5.9; gradual smooth boundary.
Bw2	21-42	Dark brown (7.5 YR 3/2 M) sandy clay loam; granular structure, loose, friable, non-sticky and non-plastic with more than 15% coarse fragments, pH 5.9; gradual smooth boundary.
Bw3	42-80	Dark brown (7.5 YR 3/2 M) sandy clay loam; granular structure, loose, friable, non-sticky and non-plastic with more than 15% coarse fragments, pH 6.3; gradual smooth boundary.
Bw4	80-110	Dark brown (7.5 YR 3/2 M) sandy clay loam; granular structure, loose, friable, non-sticky and non-plastic with more than 15% coarse fragments, pH 6.4 gradual smooth boundary.

Range in characteristics:

This soil has Ap-Bw horizon sequence with base saturation less than 50% throughout depth and have coarse fragment of 15 percent or more. The thickness of the solum is 110 cm. The thickness of A horizon is 11cm, pale brown with 10YR hue, value 5 to 6 and chroma 3. The texture is sandy clay loam and structure is medium, angular blocky. The thickness of B horizon is 99 cm, 7.SYR hue, value 2 or 3 and chroma 2 or 3. The texture is sandy clay loam and structure is granular to angular blocky. The soil has strongly acid Ap horizons to slightly acid cambic B horizons.

Competing series and their differentiae: Not identified

Interpretation: There are very deep soils, well drained and moderately eroded. This soil series have loamy top soil and subsoil type, good water holding capacity, low ability to retain nutrients for plants mainly K, Ca, Mg, moisture is limiting during dry season, germination problems are often experienced if first rains are sporadic.

This soil is moderately to slightly acid with low contents of N, K and Zn but medium in phosphorus. This soil is good on moderate slopes subject to erosion.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class : IIIe
Irrigability : 4st
Productivity potential :
Soil site suitability : Moderately suitable for maize, sunflower, soybeanwheat, Cotton, sorghumMarginally suitable for rice, potato, citrus

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-11	57.7	13.6	28.7	6
Bwl	11-21	59.8	7.7	32.5	8
Bw2	21-42	68.8	4.7	26.5	28.6
Bw3	42-80	70.9	4.8	24.3	16
Bw4	80-110	69.0	5.4	25.6	6

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-11	1.27	—	0.05	5.5	18.3	7.4
11-21	0.88	—	0.02	5.9	13.4	7.2
21-42	0.69	--	0.01	5.9	10.8	5.4
42-80	0.44	—	0.02	6.3	9.3	4.3
80-110	0.18	--	0.02	6.4	9.0	5.4

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-11	4.7	0.4	0.3	0.1	5.5	10.4	52.9
11-21	5.5	0.7	0.3	0.1	6.6	16.5	40.0
21-42	6.7	1.7	0.3	0.1	8.8	25.2	34.9
42-80	3.0	0.4	0.3	0.1	3.8	26.0	14.6
80-110	3.2	0.5	0.3	0.2	4.2	28.6	14.7

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-11	2.3	126.9	48.8	0.3	96.6	7.1	105.0
11-21	1.8	35.7	67.0	0.3	93.8	2.4	120.0
21-42	1.3	18.8	23.1	0.4	85.4	1.8	95.0
42-80	0.8	7.9	16.4	0.3	72.8	1.3	115.0
80-110	0.7	5.7	16.5	0.4	74.2	1.6	130.0

29. SUKLA SERIES (Sk)

Classification : Clayey, mixed, hyperthermic family of Typic Ustorthents
Type location : Village: Sukla, Tehsil: Kurai, Dist: Seoni, M.P
$21^0$54'48" N lat. and 79°41'06, E long
Profile No : 550/9 - P/42
Physiographic position :Isolated hillocks, ridge tops, hill slopes, upper and middle level plateau
Elevation :570 m above MSL
Ground water table :>10 m
Rainfall : 1171 mm
Slope & erosion :Moderately sloping (8-15%), severe
Drainage & permeability : Somewhat excessively drained, moderate permeability
Use & vegetation :Teak forest
Geology & parent material :Granite/Weathered granitic material
Soil association :Dhenka, Jamuntola, Bhimgarh, Parasia.Khawasa,Nadora,Rukhad, Tarali
Soil correlation :
Distribution and extent : Extensive in Aran and Sukla talab area of Kurai Tehsil, Seoni district, M.P,
Typifying pedon : Sukla - loamy, forest

Horizon	Depth (cm)	Description
A	0-18	Dark yellowish brown (10YR 4/4 M) clay loam; fine, weak, subangular blocky structure; loose, friable, slightly sticky and slightly plastic; fine many roots; pH 5.65; clear smooth boundary.
A1	18-34	Dark yellowish brown (10YR 4/4 M) clay loam; fine, weak, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; fine many roots; pH 5.76.
Cr	34+	----------Weathered parent material----------

Range ill characteristics:

The thickness of the A horizon is 15 to 34 cm. Its colour is in hue 10YR, value 3 to 4 and chroma 3 to 4. The texture is sandy clay (40% clay) with fine, weak, subangular blocky aggregates. This horizon is moderately acid.

Competing series and their differentiae: Not identified.

Interpretation:

This soil is shallow, somewhat excessively drained and severely eroded. This soil have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. This soil is moderately acid with low amounts of NPK and Zn. This soil is fairly good for limited cultivation.

Typifying pedon Horizon Depth (cm)

a)	**Interpretative groupings**	**:**	**Agril, Uses**
	Land capabilitysub-class	**:**	IVes
	Irrigability	**:**	3st
	Productivity potential	**:**	
	Soil site suitability	**:**	Suitable for sorghum, soybean moderately suitable for sunflower cotton, maize, potato Marginally suitable for rice, citrus

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
All	0-18	45.3	14.7	40.0	1
A12	18-34	44.3	15.7	40.0	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-18	1.10		0.03	5.6	15.2	8.8
18-34	0.75		0.02	5.8	17.5	9.8

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-18	6.0	2.0	Tr.	0.2	8.2	13.6	60.3
18-34	7.3	2.0	Tr.	0.1	9.4	14.2	66.2

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-18	2.7	25.2	40.2	0.7	95.2	1.8	170.0
18-34	1.9	17.2	29.5	0.5	98.0	1.6	140.0

30. TARALI SERIES (Ta)

Classification : Fine, montmorillonitic, hyperthermic family of Typic Haplusterts
Type location : Village: Tarali, Tehsil: Kurai, Dist: Seoni, M.P
79°37'24" N lat. and 21°55'12" E long.
Profile No : 55O/9-P/39
Physiographic position :Upper denudational plateaus/Pediplain
Elevation :540 m above MSL
Ground water table :>10 m
Rainfall : 1271 mm
Slope & erosion :Moderately sloping (8-15 percent), moderate
Drainage & permeability : Moderately welt drained, moderate permeability
Use & vegetation :Cultivated (Single cropped)
Geology & parent material :Granite and weathered granitic material
Soil association :Kodhjhiri, Jamuntola, Khawasa, Sukla
Soil correlation :
Distribution and extent : Partly extensive in eastern parts of Taraliand adjoining area of Hirri river in
Kurai Tehsil, Seoni district, M.P
Typifying pedon : Tarali - fine - cultivated

Horizon	Depth (cm)	Description
Ap	0-22	Dark brown (10YR 3/3 M); clay; medium, weak, subangular blocky structure, hard, friable, sticky and plastic; few fine roots; pH 6.65; clear smooth boundary.
Bwl	22-56	Dark brown (10YR 3/3 M); clay; medium, strong, subangular blocky structure; hard, firm, sticky and plastic; very fine few roots with pressure faces; pH 7.65; gradual smooth boundary.
Bssl	56-82	Very dark greyish brown (10YR 3/2 M); clay; medium, strong, angular blocky structure with intersecting slickensides; very hard, very firm, very sticky and very plastic; pH 7.98; gradual smooth boundary.
Bss2	82-110	Very dark greyish brown (10YR 3/2 M); clay; medium, strong, angular blocky structure with intersecting slickensides; very hard, very firm, very sticky and very plastic; fine few iron and manganese nodules, pH 8.00.
Bss3	110-161	Very dark greyish brown (10YR 3/2 M); clay; medium, strong, angular blocky structure with intersecting slickensides; very hard, very firm, very sticky and very plastic; fine few iron and manganese nodules, pH 8.00.

Range in characteristics:

The thickness of the solum is 45 to 161 cm. The thickness of Ap horizon is 22 to 28 cm, with 10YR hue, value 3 to 4 and chroma 3. Its texture is clay with medium, weak, subangular blocky. The clay content in Ap horizon is 50 percent and slightly acid. The thickness of B horizon is 123 to 149 cm. Its colour is in hue 10YR with value 2 to 3 and chroma 2 to 3. This horizon is clay with more than 55 percent clay. The clay content of the B horizon is 56 to 67 percent and slightly to moderately alkaline.

Competing series and their differentiae: Not identified.

Interpretation:

These are very deep soils commonly used for growing rice as major crop with wheat, gram and vegetables. **Tarali**(Ta*) series have loamy top soil, medium infiltration, good water holding capacity, hard root restricting subsoil resulting from severe erosion, moisture limiting during dry season. This soil is slightly acid to slightly

alkaline with low N,P and Zn and medium K contents. This is a good soil on moderate slopes with careful management of excess water.

a) Interpretative groupings : Agril, Uses

Land capabilitysub-class : IIIw
Irrigability : 3st
Productivity potential :
Soil site suitability : Moderately suitable for Rice, Potato, Citrus, Maize, Soybean, Wheat, Cotton, Sorghum Marginally suitable for Sunflower

ANALYTICAL DATA

Horizon	Depth (cm)	Particle size diameter (mm)			Coarse fragments >2mm % of whole soil
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	
		<----------(%)---------->			
Ap	0-22	30.8	18.7	50.5	2
B1	22-56	23.4	18.6	58.0	4
Bssl	56-82	24.5	18.9	56.6	4
Bss2	82-110	22.4	10.2	67.4	4
Bss3	110-161	26.4	15.9	57.7	2

Depth (cm)	O.C. (%)	CaC03 (%)	E.C.(1:2.5) (soil: water) dS m^{-1})	pH soil: water (1:2.5)	Water retention (%)	
					33 kPa	1500 kPa
0-22	0.62	--	0.06	6.6	23.4	12.6
22-56	0.34	--	0.07	7.6	27.3	12.3
56-82	0.34	--	0.11	8.0	30.4	16.2
82-110	0.27	--	0.11	8.0	28.5	15.9
110-161	0.27	--	0.13	8.0	30.8	17.7

Depth (cm)	Exchangeable cations					C.E.C.	Base saturation
	Ca	Mg	Na	K	Sum		
	<----------cmol(+)kg^{-1}---------->						
0-22	15.9	4.2	0.10	0.4	20.6	22.4	91.9
22-56	20.2	4.5	0.10	0.5	25.3	31.5	80.3
56-82	25.9	5.6	0.10	0.5	32.1	32.9	97.5
82-110	I 25.1	5.8	0.10	0.4	31.4	32.4	96.9
110-161	25.1	7.5	0.10	0.5	33.2	34.1	97.4

Depth (cm)	DTPA Extractable (mg kg^{-1})				Available(mg kg^{-1})		
	Cu	Fe	Mn	Zn	N	P	K
0-22	3.5	11.4	35.8	0.7	71.4	2.0	325.0
22-56	2.2	2.9	7.0	0.5	67.2	1.7	325.0
56-82	2.1	2.4	4.2	0.5	60.2	1.5	345.0
82-110	1.9	1.9	2.5	0.4	53.2	1.4	345.0
110-161	1.5	1.9	2.9	0.5	45.0	1.4	340.0