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LAND RESOURCE INVENTORY FOR VILLAGE LEVEL LAND USE PLANNING

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ABSTRACT

A detailed soil survey of village Budhpur in Baraut block of Baghpat district (U.P.), on cadastral map (1:3960 scale) was carried out. Two major physiographic units viz. recent alluvial plain and active flood plain have been delineated. After detailed field investigation soils were studied for their morphology and physico-chemical characteristics. After correlation five soil series have been identified and mapped into ten mapping units. Soils of recent alluvial plain are moderately well developed Inceptisols (Typic/Udic Haplustepts). These soils suffer from the problems of low available water, deficiency of nutrients and slight to moderate erosion. They are intensively cultivated to sugarcane, wheat, sorghum, mustard etc., however at places problem of salinity/sodicity has been encountered which needs proper amelioration to enhance productivity. Whereas, soils of active flood plain are prone to seasonal flooding and have A-AC-C profiles and classified as Entisols (Ustipsamments). They are cultivated to sugarcane, wheat, mustard, sorghum, berseem, vegetable crops etc.

Key words: Physiography, classification, Ustipsamments, Haplustepts, amelioration

INTRODUCTION

In view of the present global crisis on food, rising food prices in the international market, progressive conversion of good lands to grow biofuel crops and/ or other non-agricultural uses, demand for urbanization and industrialization which may leads to increase anthropogenic activities in the post green revolution period on natural resources is leading to their degradation affecting the productivity of the land and upkeep of the environment. But sustainable crop production is not a viable proposition either through use of organic manures or chemical fertlizesrs alone (Singh *et al.* 2009) but sustained utilization of the soil resource, technologies for efficient management of our finite soil resources is of utmost important towards ensuring productivity, profitability and national food security (Sarkar 2011). It is imperative to know the nature, characteristics and extent of distribution of different soils along with their qualities, productive potentials and suitability for optimum land uses. Keeping this in view, a detailed soil survey of village Budhpur in Baraut block of Baghpat district (U.P.) was undertaken using cadastral map to characterize and classify the soils under different physiography and to know their limitations for evolving proper soil and water management strategies to optimize and sustain agriculture production.

MATERIALS AND METHODS

The study was undertaken in village Budhpur in Baraut block of Baghpat district (U.P.), situated at 29^0 13' N latitudes and 77^0 17.9 E' longitudes, covering an area of 567.8 ha with altitude ranging between 225-230 m above sea level (MSL). There is no natural drainage system in the area except the river Krishni on the eastern end. The soils of the area are developed on the alluvium of Yamuna river and its tributary Krishni. The climate of the area is semiarid, subtropical and monsoonic with annual precipitation of 915 mm of which nearly 80% is received during monsoon season. The mean maximum and minimum temperature are 40^oC and 23^oC in summer and 21^oC and 8^oC in winter, respectively. The temperature regime is hyperthermic and moisture regime is ustic. The natural vegetation in the area are vilayati babool (*Prosopis juliflora*), babool (*Acacia species*), ber (*Ziziphus jujuba*), neem (*Azadirichta indica*), shisham (*Dalbergia sissoo*), pipal (*Ficus religiosa)* and grasses like munj (*Saccharum Munja*), kans (*Saccharum spontaneum*) and dub (*Cynodon dactylon*). A detailed soil survey of village Budhpur in Baraut block of Baghpat district (U.P.) was carried out according to the procedures outlined in USDA Handbook No. 18 (Soil Survey Staff, 1951) & AIS &LUS, 1970). The cadastral map on 1:3960 scale was used as base map. The soils were mapped at phase level of the soil series. Geographically, the area can be divided into two major physiographic units viz. recent alluvial pain and active flood plain. The ground truth data in respect of soil and land use was collected during the field traverse through studies of mini pits and pedons. Soil profiles were studied for their morphological characteristics following the standard procedures. Typifying pedons were sampled horizon wise for laboratory characterization using standard analytical methods (Black, 1965; Sarma *et. al.* 1987; Jackson, 1973). Soils were classified as per Soil Taxonomy (Soil Survey Staff, 2010). In all, five

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soil series were identified and mapped into ten mapping units (phases of soils) on the basis of soil depth, surface texture, slope and erosion.

RESULTS AND DISCUSSION

Table 1 shows the site characteristics of five typifying pedons representing different soils. The soil series namely *Datnagar, Harchandpur, Daulcha* and *Jawaharnagar* were identified and mapped in the recent alluvial plain whereas only *Ghitaura* soil series was identified and mapped in the active flood plain.

Table 1: Soil site characteristics of soils

Soils Series	Slope (%)	Drainage	Erosion	Flooding	Land Use
Recent alluvial plain					
1. Datnagar	0-3	Well drained	Slight	Nil	Sugarcane, wheat, mustard, sorghum, berseem
2. Harchandpur	0-1	Well drained	Slight	Nil	Sugarcane, wheat, mustard, sorghum, berseem
3. Daulcha	0-3	Well drained	Slight	Nil	Sugarcane, wheat, mustard, sorghum
4. Jawahar-nagar	0-5	Well drained	Slight to moderate	Nil	Wheat, sugarcane, sorghum, potato
Active flood plain					
5. Ghitaura	1-5	Somewhat excessively drained	Moderate	Occasional flooding-Moderate flooding	Wheat, vegetables, cucurbits

Morphological Characteristics

Soils of recent alluvial plain occur on nearly level to gently sloping landscape (0-5% slope) are very deep, well drained, yellowish brown to dark yellowish brown (10YR 5/4 to 4/4M) and sandy loam to loam in texture. The eluvial and illuvial horizon varies in thickness considerably (Table 2). The structure of subsurface horizons of all the soils is medium weak subangular blocky, whereas, it is medium moderate subangular blocky in Datnagar soils.They are medium productive soils and are cultivated to sugarcane, wheat, mustard, sorghum, berseem, vegetable crops etc. Ghitaura soils occurring on flood prone areas of the river Krishni on very gently to gently sloping (1-5% slope) active flood plain are in single grained, exhibit Ap-AC-C profile and do not show any diagnostic sub surface horizons except ochric epipedon. The soils are formed on fluvial sediments deposited during frequent and seasonal overflows. They are very deep, excessively drained, brownish yellow to yellowish brown (10YR 6/6 to 5/4M), calcareous sand to loamy sand in texture. They are mainly cultivated to wheat, vegetable crops and cucurbits in flood free season.

The data (Table3) revealed that sand and silt constitute major portion in mechanical composition. The downward increasing pattern of sand in *Ghitaura* soils could be due to sandy parent material whereas the presence of higher sand in surface soils of other soils might have been caused by translocation or removal of finer soil fractions by illuviation (Singh *et al.* 1991). The clay fraction in general, is more in subsurface horizons of the soils of recent alluvial plain which may be due to mass movement of the fine clay (Pal *et al.* 1999). The *Daulcha* and *Ghitaura* soils are calcareous and moderately to strongly alkaline in nature whereas *Datnagar, Harchandpur*, and *Jawaharnagar* soils are non calcareous. The higher pH values of *Daulcha* and *Ghitaura* soils might be due to the presence of lime rich parent material (Gawande and Tamhane, 1971). These soils are low in organic carbon content ranging from 0.02-0.56 per cent may be due to prevalence of tropical conditions, where the degradation of organic matter occurs at faster rate coupled with low vegetation cover, thereby leaving less organic carbon in all the pedons (Nayak *et al.* 2002). The organic carbon and EC values are higher in surface horizons and decreases with the depth of the soils(Verma *et al.*2014). The organic carbon content is higher in surface horizon may be due to addition of plant residues and farm yard manures (Leelawathi *et al.* 2009 and Verma *et al.* 2012). The CEC of *Ghitaura* soils is very low varying from 1.02 to 3.72 cmol (p^+) kg^{-1} which may be due to the sandy parent material and presence of low CEC bearing minerals, whereas CEC of other soils varied from 5.71 to 11.56 cmol (p^+) kg^{-1} because of higher clay content. The CEC values in general increased in sub surface horizons as compared to surface horizons except in Ghitaura soils as a consequence of variation in clay content. Since, soils are low in organic carbon content, the clay fraction is the dominant factor for CEC values of the soils in this area.

Soil Classification

Based on morphological and physico-chemical characteristics, the soils have been classified (Table 2) into different taxa as per Soil Taxonomy

Table 2: Morphological characteristics of soils

Horizon	Depth (cm)	Boundary*	Colour (M)	Texture*	Structure*	Efferves-cence* (with dil. HCl)
1. *Datnagar* Soils: Fine loamy, Udic Haplustepts						
Ap	0-15	cs	10YR 5/4	sl	f 1 sbk	nil
AB	15-37	gs	7.5YR4/4	sl	m 1 sbk	-
Bw1	37-64	gs	7.5YR4/4	l	m 2 sbk	-
Bw2	64-92	gs	7.5YR4/4	l	m 2 sbk	-
Bw3	92-122	gs	7.5YR5/4	l	m 2 sbk	-
Bw4	122-150		7.5YR5/4	l	m 2 sbk	-
2. *Harchandpur* Soils: Coarse loamy, Udic Haplustepts						
Ap	0-14	cs	10YR 5/4	sl	m 1 sbk	-
AB	14-32	cs	10YR 5/4	sl	m 1 sbk	-
Bw1	32-60	gs	10YR 4/4	sl	m 1 sbk	-
Bw2	60-90	gs	10YR 4/4	sl	m 1 sbk	-
Bw3	90-120	gs	10YR 4/4	sl	m 1 sbk	-
Bw4	120148	gs	10YR 5/4	sl	m 1 sbk	-
Bw5	148-172		10YR 5/5	sl	m 1 sbk	-
3. *Daulcha* Soils: Coarse loamy (Calc.), Typic Haplustepts						
Ap	0-14	cs	10YR 5/4	sl	f 1 sbk	e
AB	14-30	cs	10YR 4/4	sl	m 1 sbk	e
Bw1	30-56	gs	10YR 4/4	sl	m 1 sbk	e
Bw2	56-85	gs	10YR 5/4	sl	m 1 sbk	es
Bw3	85-115	gs	10YR 5/4	sl	m 1 sbk	e
Bw4	115-138	gs	10YR 5/6	sl	m 1 sbk	e
Bw5	138-156		10YR 5/6	sl	m 1 sbk	e
4. *Jawaharnagar* Soils: *Coarse loamy, Udic Haplustepts*						
Ap	0-16	cs	10YR 5/4	sl	f 1 sbk	nil
AB	16-41	cs	7.5YR4/4	sl	m 1 sbk	-
Bw1	41-72	gs	7.5YR4/4	sl	m 1 sbk	-
Bw2	72-102	gs	7.5YR4/4	sl	m 1 sbk	-
Bw3	102-130	gs	7.5YR4/5	sl	m 1 sbk	-
Bw4	130-154		7.5YR4/6	sl	m 1 sbk	-
5. *Ghitaura* Soils: Calc. Typic Ustipsamments						
Ap	0-16	cs	10YR 5/4	ls	sg	es
AC	16-34	cs	10YR 5/4	ls	sg	es
C1	34-60	gw	10YR 6/4	s	sg	es
C2	60-92	gw	10YR 6/3	s	sg	es
C3	92-122	gw	10YR 6/3	s	sg	es
C4	122-150		10YR 6/3	s	sg	es

** Boundary-cs= clear smooth; gs= gradual smooth; gw= gradual wavy; Texture- s= sand; sl= sandy loam; l= loam; Structure-sg= single grain; f 1 sbk = fine, weak, subangular blocky; m 1 sbk=medium, weak, subangular blocky; m 2 sbk= medium, moderate subangular blocky; Effervescence-e= slight effervescent; es= strong effervescent; ev= violent effervescent*

Physico-chemical characteristics

(Soil Survey Staff, 2010). The soils of recent alluvial plain are classified as Inceptisols, since these meet the requirement of a cambic horizon, the presence of structural peds, which have sufficient aggregations and formed as a result of biological activity, accumulation of clay enough to meet the requirements of cambic horizon but not other diagnostic horizons (i.e argillic or calcic/petrocalcic). As these soils having ustic moisture regime, hence classified as Haplustepts at great group level. At sub group level, they key ut as Typic Haplustepts as these soils qualifies the central concept of Haplustepts. Further, based on particle size distribution and mineralogical makeup of the series control section and calcareousness, these soils at family level could be classified as coarse lomy,Typic Haplustepts (*Harchandpur* and *Jawaharnagar* soils), fine loamy, Typic Haplustepts (*Datnagar* soil) and coarse loamy (calc.), Typic Haplustepts (*Daulcha* soil). In contrast, soils of active flood plain are placed in order Entisols due to the absence of any diagnostic sub surface horizon. The presence of ochric epipedon, ustic moisture regime and texture corser than loamy fine sand in the series control section qualify for Ustipsamments greatgroup and as calcareous, Typic Ustipsamments at family level.

Table 3: Physico-chemical Properties of Soils

Horizon	Depth (cm)	Sand	Silt	Clay	pH (1:2.5)	EC (1:2.5) (dSm^{-1})	Org. Carbon ($g\ kg^{-1}$)	$CaCO_3$ ($g\ kg^{-1}$)	CEC [c mol (p+) kg^{-1}]
		----------%--------							
1. *Datnagar* Soils									
AP	0-15	65.25	20.50	14.25	8.12	1.40	5.6	Nil	7.90
AB	15-37	61.75	21.75	16.50	8.24	0.48	3.2	-	8.24
Bw1	37-64	56.00	24.25	19.75	8.30	0.32	2.4	-	9.84
Bw2	64-92	48.25	30.25	21.50	8.32	0.24	2.1	-	10.71
Bw3	92-122	46.50	31.25	22.25	8.35	0.24	1.6	-	11.56
Bw4	122-150	47.50	31.00	21.50	8.37	0.20	1.4	-	11.25
2. *Harchandpur* Soils									
AP	0-14	71.60	13.20	15.20	8.01	0.72	5.2	Nil	8.20
AB	14-32	67.10	16.60	16.30	8.24	0.69	2.9	-	8.52
Bw1	32-60	63.50	18.10	18.40	8.28	0.56	2.7	-	9.15
Bw2	60-90	62.80	18.50	18.70	8.41	0.51	1.9	-	9.20
Bw3	90-120	67.30	16.80	15.90	8.50	0.50	1.4	-	7.90
Bw4	120148	71.00	15.20	13.80	8.62	0.40	1.3	-	6.72
Bw5	148-172	73.50	15.00	11.50	8.64	0.35	0.9	-	5.71
3. *Daulcha* Soils									
AP	0-14	76.50	10.65	12.85	8.41	0.76	5.4	9.8	7.45
AB	14-30	75.50	10.85	13.65	8.72	0.29	2.4	7.6	6.35
Bw1	30-56	70.10	12.75	17.15	8.80	0.24	1.6	9.2	8.40
Bw2	56-85	68.60	13.40	18.00	8.86	0.23	1.4	14.2	8.50
Bw3	85-115	68.10	13.78	18.12	8.92	0.23	1.0	07.2	8.60
Bw4	115-138	69.20	15.20	15.60	9.24	0.25	0.9	6.8	8.25
BW5	138-156	73.90	14.35	11.75	9.41	0.25	0.8	9.1	6.50
4. *Jawaharnagar* Soils									
AP	0-16	73.55	16.25	10.20	8.01	0.98	3.9	Nil	6.10
AB	16-41	70.15	17.20	12.65	8.27	0.63	2.1	-	6.72
Bw1	41-72	69.20	15.45	15.35	8.31	0.56	1.9	-	7.66
Bw2	72-102	68.00	14.50	17.50	8.35	0.49	1.8	-	7.98
Bw3	102-130	69.25	14.00	16.75	8.44	0.45	1.4	-	7.82
Bw4	130-154	73.25	12.75	14.00	8.51	0.42	0.8	-	6.96
5. *Ghitaura* Soils									
AP	0-16	79.85	13.85	6.30	8.22	1.40	2.4	18.0	3.72
AC	16-34	85.75	9.70	4.55	8.84	0.98	1.0	36.2	2.60
C1	34-60	91.50	6.00	2.50	9.02	0.70	0.5	32.2	1.75
C2	60-92	93.00	4.40	2.60	9.15	0.56	0.3	26.4	1.42
C3	92-122	97.00	2.25	0.75	9.20	0.48	0.1	27.2	1.02
C4	122-150	97.25	2.25	0.50	9.27	0.42	0.2	26.8	1.02

Constraints, management needs and land use

Ghitaura soils occurring along the river are marginally suitable for agriculturally important crops. The major constraints of the soils of active flood plain (Ghitaura soils) are inundation during monsoon season reducing their length of growing period substantially, sandy texture, low water and nutrient retentivity, weed infestation, low organic carbon content, poor fertility and droughtiness during pre and post flood periods. Due to combined and location specific effects of these problems, yields are not only low but also quite unstable. Therefore, to enhance the productivity of these poor quality soils, it is desirable that sufficient organic manures and green manuring is practiced for improving physical conditions and to maintain nutrient supply. It is suggested that frequent and light irrigation must be applied to increase water use efficiency and to avoid loss of nutrients through leaching. However, nitrogenous fertilizers must be applied in splits to check nitrate pollution in of ground water (Gasser *et. al.* 2002 and Antil *et al.* 2002). These soils are mostly suited to short duration crops maize, potato, toria, wheat and vegetable etc. To make the system more remunerative tree plantation along the field boundaries may be adopted in a big way.

Datnagar, Harchandpur and *Daulcha* soils are quite productive; however slight problems due to depletion of ground water, slow surface drainage owing to constructing roads and nutrient deficiencies

are encountered. These soils are ideal for growing all climatically adopted crops and may be intensively cultivated to sugarcane-wheat, sorghum-wheat, sorghum-mustard under assured irrigation and balanced fertilization. However, inclusion of legumes in the crop rotations must be adopted for sustaining productivity. *Jawaharnagar* soils suffer from somewhat high permeability, poor physical condition, leaching of nutrients, depletion of groundwater and nutrient deficiencies. Incorporation of residual biomass in large quantity as a result of better harvest on balanced application of nutrients is responsible for sustaining the crop productivity and soil health (Singh and Wanjari, 2013).The sustainable cropping system suitable for these soils are maize-wheat and potato-wheat. Field bunding, addition of organic manures, balanced fertilization, using N-fertilizers in splits and light and frequent irrigations must be adopted to sustain production.

Thus, it may be concluded that using the soils as per their land capabilities will prove to be an efficient and ecofriendly strategy for management of finite land resources which will not only maximize the productivity but also simultaneously protect and conserve resource potential.

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