DETAILED SOIL SURVEY AND LAND USE PLANNING

OF

THE OPERATIONAL RESEARCH PROJECT

FOR

INTEGRATED AREA DEVELOPMENT IN THE

UNION TERRITORY OF DELHI

REGIONAL CENTRE

DELHI

NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

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1. INTRODUCTION :

The Agricultural Extension Division of the Indian Agricultural Research Institute has been analysing the problems concerning agricultural development in the Delhi Territory which limit agricultural production. These problems mainly relate to salinity, waterlogging and poor quality of irrigation water, limited water supply for irrigation and other inputs, dense population in the villages resulting in large number of small and marginal farmers, high cattle population etc., leading to low average yield per hectare of land. The Institute took up the Operational Research Project to tackle the problems mentioned above. For this purpose, in the first instance four villages were selected in the Territory namely Sanoth for reclamation and management of saline soils and saline ground water, Holambi Kalan for development of marginal farms, Ghoga for improving limited supply of irrigation water and agricultural production and Bawana for maximising milk production.

Detailed soil survey of these villages was taken up to prepare a soil map and evolve suitable land use plans according to the productive potential of different soils.

2. DESCRIPTION OF THE AREA :

2.1 Location and Extent

Sanoth, Holambi Kalan, Ghoga and Bawana, situated between $28^{\circ}46'$ to $28^{\circ}50'$ N latitudes and $77^{\circ}2'$ to $77^{\circ}7'$ E longitudes in the Delhi Territory form contiguous villages in Alipur and Kanjhawala Blocks. The index map shows the location of the villages.

2.2 Climate :

The climate of the area is semi-arid with extreme summer and winter seasons. June is the hottest month and January, the coldest. The maximum temperature in summer months varies from 43.9° to 45.0°C. The mean maximum and mean minimum temperatures in summer are 38.8°C and 25.4°C respectively. The mean maximum and minimum temperatures in winter are 22.7°C and 8.4°C respectively. Mean summer temperature is 32.1°C and mean winter temperature is 15.5°C. Mean annual temperature is 25.2°C. The difference between mean summer and mean winter temperatures is more than 5°C, thus qualifying for hyperthermic regime.

Dust storms are common in May and June when the day temperature rises to 40.5°C. During this period the mean wind velocity is more than 10 Km per hour.

The mean annual rainfall recorded during the last 30 years (1931-60) is 714 mm. Paliwal and Yadav 1976, stated in the "Quality of Irrigation Water - Delhi Territory" that average rainfall for 45 years was 754 mm. A maximum rainfall of 1230 mm was recorded in 1964 and the lowest of 321.8 mm in 1938. The rainfall during June to September in 1975 was also reported as high when it was 1156 mm. Nearly 90% of the rainfall is received from the southwest monsoon during July-September and the rest in winter. Rainfall and temperature data are illustrated in the ombrothermic diagrams (Figures 1 & 2) and Table 1.

2.3 Geology :

The geology consists dominantly of the alluvium deposited by the river Jamuna and its tributaries. The alluvium is of mixed origin both from the Siwaliks and the Himalayas. Besides, the possibility of alluvial material brought by Aravillis is not ruled out. The

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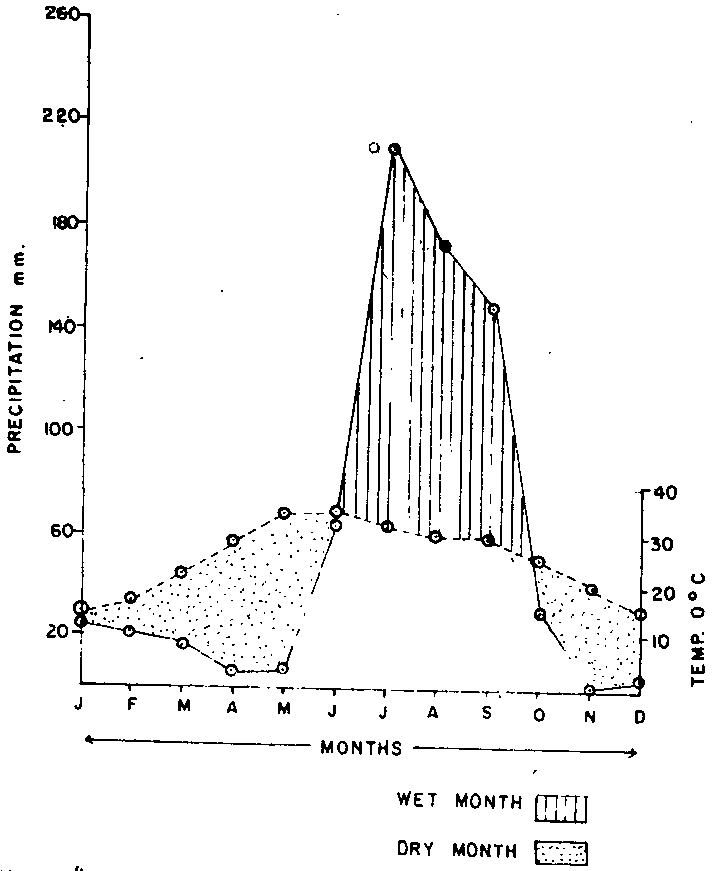
OMBROTHERMIC DIAGRAM

FIG. 1.



SOURCE:-"QUALITY OF IRRIGATION WATER-DELHI TERRITORY"
PALIWAL & YADAV 1976

MEAN MONTHLY MAXIMUM & MINIMUM TEMPERATURES

FIG. 2.

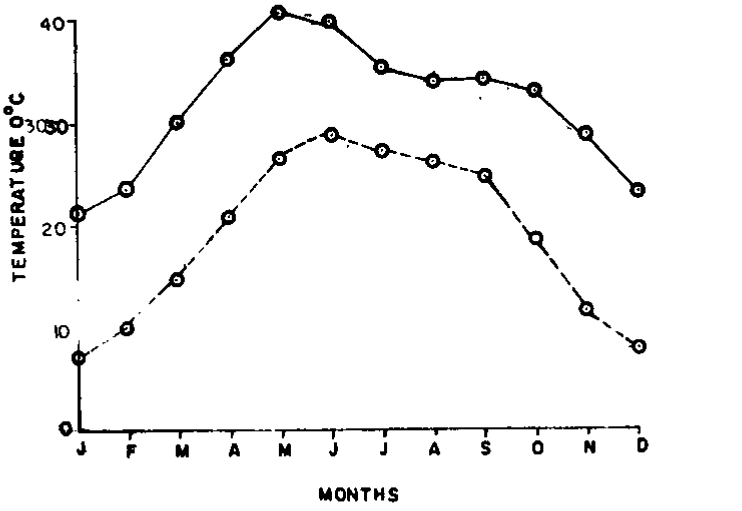


Table No. 1

Station : NEW DELHI (SAFDARJANG) 1931-60

Month	Temperature (°C)		Rainfall (mm)	Relative humidity %		Vapour pressure in mm (Hg)	
	Max.	Min.		Morning	Evening	Morning	Evening
1.	2.	3.	4.	5.	6.	7.	8.
January	21.3	7.3	24.9	48	62	3.5	5.5
February	23.6	10.1	21.8	45	59	3.7	5.8
March	30.2	15.1	16.5	37	48	4.0	6.1
April	36.2	21.0	6.8	32	37	5.4	6.5
May	40.5	26.6	7.9	34	35	7.6	8.2
June	39.9	28.7	65.0	53	53	12.1	13.3
July	35.3	27.2	211.1	86	88	17.2	19.0
August	33.7	26.1	172.9	89	92	17.4	18.9
September	34.1	24.6	149.7	75	82	13.9	16.0
October	33.1	18.7	31.2	47	59	7.2	9.6
November	28.7	11.8	1.2	31	48	3.6	6.0
December	23.4	8.0	5.2	36	55	3.3	5.5
Mean	32.1	15.5	-	51	59.8	8.2	10.0
Total			714.2				

analysis of sand fraction indicates uniformity in geological material up to about 200 cm depth. Quartz and feldsfars more or less occur in equal proportions. The soils also contain significant amount of mica, to the extent of 10 to 20%. The dominant heavy minerals in the sand fraction are chlorite and biotite mica. Garnet, pyroxyne , amphibole etc. are present in small amounts. Wind modification of the soil forming material is apparent.

2.4 Geomorphology :

The villages surveyed in the Delhi Territory form a part of the old alluvial plain of the Yamuna and its tributaries. The area can be divided into following geomorphic units.

(i) Levees - These are naturally undulating but modified by levelling operations. Ox-bow lakes and old channels along the levees are visible at some places in Sanoth village.

(ii) Terraces - Low level terraces are recognised in the area which form the upper-most land form unit in the villages. Terraces are nearly level and they can be divided into upper and lower parts. These stand over 3-4.5 mt. from the lowest point of the basin or meander plains.

(iii) Alluvial Plains - These are nearly level lands in between streams. They are divided into low level alluvial plains and upper level alluvial plains based on the general variation in relief.

(iv) Basin - This is the lowest part with concave relief and has high ground water being situated along the river.

(v) Old Meander Plains - These are recognised to occupy the lowest positions in the villages. They are built up by the flowing streams.

The geomorphic units are indicated in the physiographic map.

The slope of the levees ranges from 3-5%, whereas terraces are generally level lands with slopes up to 2%. Basins have less than 1% slope whereas meander plains are level lands with slopes up to 1%. The relief patterns can be distinguished on 1 : 30,000 aerial photographs. Contour maps of scale 1 : 20,000 show elevation differences in terraces up to 5 to 6 m from the lowest point to the highest point.

The area is drained by Bawana escape fed by different link drains. Even though the villages have a good net work of drainage lines to drain the water to Yamuna, the waterlogging problem still persists in localised farms due to construction of roads, rail embankments, etc. without providing for proper drainage ways.

In the basin and meander plains, water stagnation is common during rainy season due to lack of maintenance of existing drains or proper discharge in these drains.

2.5 Natural Vegetation :

The vegetation comprising common trees, shrubs, herbs and grasses are given below.

The only timber tree is Dalbergia sisoo (Sisam) and other trees are Ficus religiosa (Pipal), Ficus bengalensis (Barota), Accacia arabica (Babool), Azadirachta indica (Neam), Butea monosperma (Dhak), Zizyphus jujuba (Ber) and Tamarindus indica (Tamarind).

The fruit trees include Mangifera indica (Mango), Psidium guava (Guava), Morus alba (Saitoot), Eriobotrya japonica (Legut), Syzyguim cumini (Jamun), Punica granatum (Pomegranate), Aegle

marmelos (Bael fruit) and Mamlkara hexandra (Khirni).

A large number of herbaceous plants found in habitats like cultivated fields, fallow fields, road sides, waste land etc. contributing to the weeds in kharif crops are Cyprus rotendus (Deela), Euphorbia draeum culeidus (Dhudhi), Phyllanthus niruri (Hazardana), Cynodon dactylon (Doobgrass) and Sachrum sponteneum (Kans).

Those associated with rabi crops are Chinopodium album (Bathu), Chinopodium murale (Khatua), Asphodelus tenifolius (Paygi), and Lathyrus sativum (Matari) and others Euphorbia hirta (Dhudhi), Zizyphus numalaria (Jherberi) and Argemone maxicana (Satyanashi).

2.6 Present Land Use :

The present land use data pertaining to the villages are given in Table No. 2 and 3. It is seen that larger area is under rabi crops as compared to kharif. Jowar and bajra are major kharif crops. In addition, sugarcane and other crops are also grown. Bajra is generally taken under dry land farming conditions. Jowar gets some irrigation and is used for fodder. Among rabi crops, wheat and barley are the major crops. Wheat is grown quite extensively under irrigated conditions. Irrigation water is available partly through Jamuna canal and partly through tubewells. The ground water quality is variable. Majority of the tubewells in Sanoth village do not have good quality water. The quality of canal water, however, is good.

In Sanoth about 220 ha were under kharif crops. About 50% of the crop area under jowar in 1974-75, was under irrigation. Other crops were paddy, groundnut, guar and vegetables. In rabi an area of about 300 ha was sown and wheat accounted for about 90% of the cropped area. About 80% of the wheat area was under irrigation.

In Holambi Kalan, in kharif about 270ha were put to culti-

Table No. 2

PRESENT LAND USE IN HECTARES (KHARIF)

Crops	Vill. -Holambi Kalan 1974			Village - Sanoth 1973			Village - Ghoga 1974			Village - Bawana 1974		
	Irri-gated	Un-Irri-gated	Total	Irri-gated	Un-Irri-gated	Total	Irri-gated	Un-Irri-gated	Total	Irri-gated	Un-Irri-gated	Total
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13
Jowar (Fodder)	0.8	72.4	73.2	38.4	31.6	70.0	22.4	39.2	61.6	192.3	93.5	285.8
Bajra	0.4	36.0	36.4	4.0	70.6	74.6	2.8	38.0	40.8	30.3	66.7	97.0
Paddy	17.2	0.4	17.6	6.0	-	6.0	4.0	-	4.0	13.7	0.4	14.1
Maize	23.2	1.6	24.8	-	-	-	5.6	-	5.6	3.5	-	3.5
Cotton	2.8	1.6	4.4	-	-	-	1.2	0.4	1.6	11.7	1.2	12.9
Guar	-	6.4	6.4	0.8	4.8	5.6	0.8	-	0.8	-	-	-
Arhar	0.4	0.4	0.8	-	-	-	-	-	-	-	-	-
Sugarcane	0.8	-	0.8	-	-	-	7.6	-	7.6	47.3	0.4	47.7

(contd.....8/.....)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Vegetables	18.4	-	18.4	9.6	-	9.6	14.6	-	14.6	-	-	-
Flowers	10.4	-	10.4	-	-	-	-	-	-	-	-	-
Dhiancha	-	7.6	7.6	-	-	-	-	-	-	-	-	-
Chillies	3.2	-	3.2	-	-	-	-	-	-	-	-	-
Miscellaneous crops	-	-	-	-	-	-	-	-	0.4	19.8	-	19.8
Total :	77.6	126.4	212.00	58.8	107.0	165.8	59.0	77.6	136.6	318.6	162.2	480.8

(contd....9/.....)

Table No. 3

PRESENT LAND USE IN HECTARES (KHARIF)

Crops	Vill. - Holambi Kalan 1975			Village - Sanoth 1974			Village - Ghoga 1975			Village - Bawana 1975		
	Irri-gated	Un-Irri-gated	Total	Irri-gated	Un-Irri-gated	Total	Irri-gated	Un-Irri-gated	Total	Irri-gated	Un-Irri-gated	Total
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Wheat	323.2	-	323.2	188.8	28.0	216.8	128.7	-	128.7	725.8	6.8	732.6
Barley	77.2	6.4	83.6	42.0	30.4	72.4	0.4	0.8	1.2	100.0	17.8	117.8
Gram	0.8	2.0	2.8	-	-	-	-	4.4	4.4	-	-	-
Pea	3.6	-	3.6	-	-	-	-	-	-	21.0	0.4	21.4
Flowers	3.6	-	3.6	-	-	-	-	-	-	-	-	-
Vegetables (Tamato)	3.6	-	3.6	-	-	-	3.6	3.6	3.6	-	-	-
Mustard (Taramira)	0.4	-	0.4	0.8	1.60	2.4	0.4	-	0.4	-	-	-

(contd..... 10/.....)

1.	2.	3.	4.	5.	6.	7.		9.	10.	11.	12.	13.
Fodder (dr seem etc.)	9.2	-	9.2	6.4	-	6.4	5.6	-	5.6	11.2	0.4	11.6
Le.f.l	-	-	-	0.8	1.20	2.0	0.8	-	0.6	33.6	3.2	36.8
Chillies	-	-	-	-	-	-	0.8	-	0.8	-	-	-
Total :	361.60	8.4	370.0	238.8	61.2	300.0	140.3	5.2	145.5	891.6	28.6	920.2

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(contd....11/.....)

vation and about 80 ha were under irrigation. Jowar occupied nearly 75 ha. Other crops were bajra, maize, paddy, vegetables, dhaincha etc. In rabi out of 370 ha cultivated, more than 98% was put under irrigation. Wheat occupied 85% of the cropped area.

In Ghoga, in kharif about 130 ha were cultivated of which 80 ha received irrigation. Bajra and fodder jowar occupied 50% of the area. Other crops were paddy, maize, sugarcane, vegetables etc. Wheat occupied about 90% of the area in rabi and most of it was irrigated.

In Bawana, in kharif about 500 ha were cultivated, 60% of this was under irrigation. Jowar accounted for about 50% of the area. Bajra and sugarcane were other important crops. In rabi 920 ha were put to cultivation and more than 95% was irrigated. Wheat occupied more than 85% of the cropped area. The data on cropping shows that there is considerable variation in the cropping patterns followed in these villages. But dominance of wheat is apparent. Data regarding irrigation and their source are given in Table No. 4.

3. SURVEY METHODS :

3.1 During the initial review of the area variability of the soils was established. During this review, aerial photographs of 1:30,000 were used to broadly identify land form variations of the alluvial plains. While traversing it was found that the difference between elevations was quite significant within the villages. The soils are mainly of alluvial origin from the river Jamuna and its tributaries. The soils occur on old levees, river terraces, old meander plains basins, and interfluves. The soils are believed to be of recent origin. The soil profiles vary in their textures from sandy to clayey. The most important differentiating characteristic is, therefore, soil texture. Within the textural variations, presence or absence of calcium carbonate in the soil profile is another important differentiating

Table No. 4

IRRIGATED AREA IN HECTARES

Particulars	Holambi Kalan		Sanoth		Choga		Bawana		Remarks
1.	2.		3.		4.		5.		6.
Total Area	550.0		400.0		257.00		1676.00		
Total Cultivated Area	619.2		Record not available in the Tehsil because of Consolidation work in progress		212.15		1535.60		From Tehsil Records
Total Irrigated Area	429.6				197.30		947.60		
Total Un-irrigated Area	189.6				14.50		588 .00		
Area Irrigated by Canals	242.4				28.00		644.40		
Irrigated by Tubewells	183.2				149.00		126.00		
Irrigated by Wells	4.0				-		10 . 00		
RABI : i) Irrigated	361.6	1974	238.8	1975	178.54	1975	713.80	1975	From Patwari's Records.
ii) Un-irrigated	8.4		61.2		16.59		232.00		
Total :	370.0		300.0		193.13		945.80		

(contd.....13/.....)

1.	2.		3.		4.		5.		6.
KHARIF : i) Irrigated.	77.6	1974	58.8	1973	59.09	1974	126.70	1974	From Patwari's Record
ii) Unirrigated	126.4		107.0		80.97		236.80		
Total :	204.0		165.8		140.06		363.50		
SOURCES OF IRRIGATION :									
a) Number of Wells	7		-		2		11		
b) Number of Tubewells	65		16		25		54		
i) Working	60		14		20		49		
ii) Non-working	5		2		5		5		

characteristic . Soil series are differentiated mainly on these two characteristics. Halomorphic soils occur as in the case of Sanoth village which are highly saline and sodic with accompanying high ground water. Saline and high ground water phases of some of the series are also recognised.

3.2 Base Maps :

Base maps used for soil survey were of 1 : 4000 (16" = 1 mile) cadestral maps. These maps contained the field boundaries. 100 metre grids were drawn on the base maps. Besides the cadestral maps, aerial photographs of 1 : 30,000 and topographic maps of 1 : 20,000 were also used during the survey to help in the separation of land form units and drawing of boundaries of various land forms on the cadestral maps through actual traversing.

3.3 Survey Technique :

After separating the land form units, auger bores were taken up to 125 cm depth and the soils were identified on the basis of texture and presence of calcium carbonate. Auger bores were also examined at regular intervals of 100 metre grids and phases of surface texture, slope, salinity and high ground water-table were mapped. The soil boundaries were drawn broadly on the basis of land forms and by interpolation within each land form the units separated during the traverse.

Representative soil profiles (pedons) were studied up to 150 cm depth in newly open dug pits. Morphological features were studied and samples drawn from different soil horizons for laboratory characterisation. The units of mapping comprise soil series, phases of surface texture, slope, salinity and high ground water-table.

3.4 Map Drafting :

The soil mapping unit boundaries were drawn on overlays of the

base maps of the villages. The scale of the soil map was same as that of field base maps to facilitate the use of the soil map for purposes of planning and execution by different agencies. However, the map of Bawana was reduced to half the scale of the cadestral map for convenience of handling and at the same time without loosing any details. The soil maps of the villages have been presented separately with an index map showing the location of the four villages in the Delhi Territory. The report is compiled for all four villages together. The idea of giving four village maps separately is with the view of keeping the size of the sheet within manageable limits as also for providing these maps to villagers independently.

For the purpose of comprehensive reading a consolidated soil map of 1 : 16,000 is given by photographic reduction of the original soil maps of 1 : 4,000.

From the soil map, different interpretive maps were prepared.

4. DESCRIPTION OF SOILS :(Series descriptions are given in the Appendix)

4.1 Coarse Textured Soils :

4.1.1 Razapur Series (R) - 43.54 ha i.e. 1.51%.

The soils of Razapur series occur on old levees. They are dominantly loamy sand to sandy loam in the series control section (15-100 cm). The soils are droughty with free internal drainage. Available moisture capacity of soils is low which is estimated at 4.1 cm for 60 cm profile depth and less than 7.0 cm up to 100 cm profile depth. The lands of Razapur unit which are on slopes up to 3% need to be levelled. These soils are susceptible to wind erosion. They can support short duration crops during rainy season but need frequent irrigation water during rabi due to high loss of irrigation water by percolation. The surface soils are in most of the cases loamy sand. Their potential fertility is low. Following phases of the series are mapped : -

RaA - Razapur loamy sand on 1% slope.
RaB - Razapur loamy sand on 1-3% slope.
RaC - Razapur loamy sand on 3-5% slope.

4.1.2 Kakra Series (Ka) - 126.16 ha i.e. 4.37%.

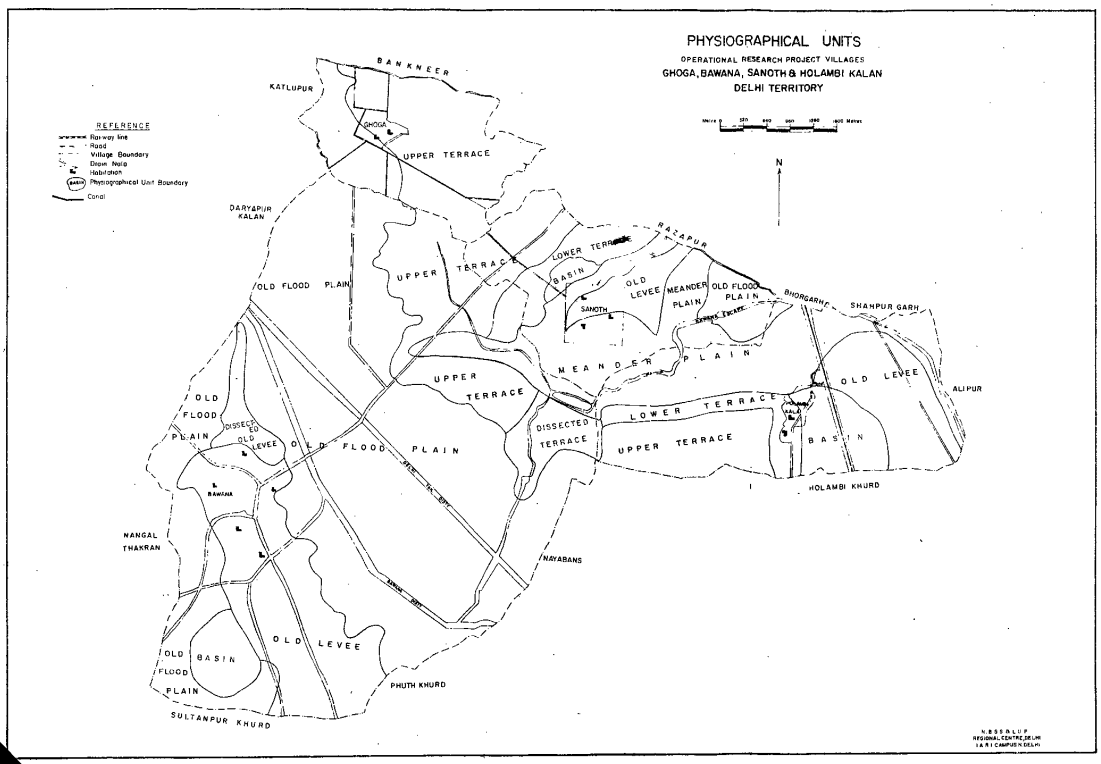
Kakra series occur on old levees with 1 to 3% slope but they are generally levelled. The soils are dominantly fine sandy loam (15-100 cm). They occur on the lower part of levees wherever they are associated with Razapur series. Available moisture capacity of the soils is 4.4 cm up to 60 cm profile depth and more than 8.4 cm up to 100 cm profile depth. Under rainfed conditions, they are suited for short duration deep rooted crops. In rabi they need frequent irrigation and percolation loss of irrigation water is expected. Their potential fertility is low.

The lands need levelling and are susceptible to wind erosion. Following phases of Kakra series are mapped :

KaaA - Kakra loamy sand on 0-1% slope.
KaaB - Kakra loamy sand on 1-3% slope. These are more droughty.
KabA - Kakra fine sandy loam on 1% slope.
KabA - Kakra fine sandy loam on 1% slope, with calcareous surface soil.
KabAs - Kakra fine sandy loam on less than 1% slope, saline.
KabB - Kakra fine sandy loam on 1-3% slope need levelling.
KabB - Kakra fine sandy loam on 1-3% slope with calcareous surface soil, require levelling.

4.1.3 Hamidpur Series (Hd) 99.89 ha i.e. 3.49%.

The soils of Hamidpur series occur on upper part of the


PHYSIOGRAPHICAL UNITS
OPERATIONAL RESEARCH PROJECT VILLAGES
GHOGA, BAWANA, SANOTH & HOLAMBI KALAN
DELHI TERRITORY
REFERENCE
Railway line
Road
Village Boundary
Dispur Nala
Habitation
Physiographical Unit Boundary
Canal
N
BANKNEER
KATLUPUR
GHOGA
UPPER TERRACE
DARYAPUR KALAN
OLD FLOOD PLAIN
UPPER TERRACE
LOWER TERRACE
BASIN
BAZAPUR
OLD LEVEE
MEANDER PLAIN
OLD FLOOD PLAIN
BHORGARH
SHAHPUR GARH
SANOTH
MEANDER PLAIN
OLD LEVEE
ALIPUR
UPPER TERRACE
DISSECTED TERRACE
LOWER TERRACE
UPPER TERRACE
BASIN
HOLAMBI KHURD
OLD FLOOD PLAIN
DISSECTED OLD LEVEE
OLD FLOOD PLAIN
BAWANA
NANGAL THAKRAN
NAYABANS
OLD BASIN
OLD FLOOD PLAIN
OLD LEVEE
PHUTH KHURD
SULTANPUR KHURD
N.B.S.S.&L.U.P.
REGIONAL CENTRE, DELHI
I.A.R.I. CAMPUS, N. DELHI

old meander plain on slopes of 1-3% adjoining the old levees. They are dominantly fine sandy loam to loam in the series control section (15-100 cm) and calcareous throughout the profile. Available moisture capacity of the soil is little above 7 cm up to 60 cm depth of the profile and 11.3 cm up to 100 cm. The soils are less droughty as compared to Razapur and Kakra series . They are better suited to crops despite limitations due to droughtiness. In rabi they respond well to irrigation. Their potential fertility is moderate due to low retention capacity of nutrients and presence of lime within 50 cm depth. They are susceptible to wind erosion. Following phases of Hamidpur series are mapped : -

HdaA - Hamidpur loamy sand on 1% slope.
HdbA - Hamidpur sandy loam on 1% slope.
HdbAs - Hamidpur sandy loam on 1% slope, saline.
HdbB - Hamidpur sandy loam on 1-3% slope.
HdbB2 - Hamidpur sandy loam on 1-3% slope, moderately eroded.
HdbBs - Hamidpur sandy loam on 1-3% slope, saline.
HdbB2s - Hamidpur sandy loam on 1-3% slope, moderately eroded, saline.
HdcA - Hamidpur loam on 1% slope.

4.2 Fine Loamy (Loam and Silt Loam) Soils :

4.2.1 Holambi Series (H) - 392.97 ha i.e. 13.65%.

Soils of Holambi series are mapped in the upper part of the alluvial terraces occupying a position higher than the meander plains. Holambi series are dominantly loam to silt loam in series control section (15-100 cm). They occupy the highest topographic positions. These soils are associated with Nabha series. Available moisture capacity of the soils is about 9.0 cm up to 60 cm depth and about 15.7 cm up to 100 cm profile depth.

During years of normal rainfall these soils can support

all the climatically adapted crops of the region. Phases with fine sandy loam texture on the surface may show droughty nature. The saline phases may require leaching and growing salt resistant crops. In rabi, the soils will respond well to irrigation and can support most of the crops. Their potential to retain nutrients is good. Following phases of Holambi series are mapped : -

HaB	-	Holambi loamy fine sand on 1-3% slope.
HbA	-	Holambi fine sandy loam on 1% slope.
HbB	-	Holambi fine sandy loam on 1-3% slope.
HbBs	-	Holambi fine sandy loam on 1-3% slope, saline.
HbB_2	-	Holambi fine sandy loam on 1-3% slope, moderately eroded.
HcAs	-	Holambi loam on 1% slope, saline.
HcAd	-	Holambi loam on 1% slope, high ground water.
HcB	-	Holambi loam on 1-3% slope.
HcB	-	Holambi loam on 1-3% slope, calcareous.
HcBd	-	Holambi loam on 1-3% slope, calcareous, high ground water.
HcBs	-	Holambi loam on 1-3% slope, high ground water, saline.
HcB2ds	-	Holambi loam on 1-3% slope, high ground water, saline.

4.2.2 Daryapur Series (D) - 377.41 ha i.e. 13.12%.

Soils of Daryapur series occur mostly on the lowest positions of the terrace and upper part of the meander plains. Daryapur series are dominantly loam to silt loam in series control section (15-100 cm). The soils are calcareous throughout the profile. Available moisture capacity of the soil is about 9.0 cm up to 60 cm and 15.6 cm up to 100 cm profile depth. They are suited to a variety of rabi crops but the surface texture phases of fine sandy loam may be droughty. They respond to irrigation and a variety of crops can be grown. These soils can also hold plant nutrients. Daryapur soil may present some problems

due to presence of free lime in the upper part of the profile. The saline phase units need leaching and phases of erosion need conservation measures to check erosion. Following phases are mapped : -

DbA - Daryapur fine sandy loam on 1% slope.
DbB - Daryapur fine sandy loam on 1-3% slope.
DbAs - Daryapur fine sandy loam on 1% slope, saline.
DbBs - Daryapur fine sandy loam on 1-3% slope, saline.
DbB2s - Daryapur fine sandy loam on 1-3% slope, moderately eroded, saline.
DcA - Daryapur loam on 1% slope.
DcAs - Daryapur loam on 1% slope, saline.
DcB - Daryapur loam on 1-3% slope.
DcBs - Daryapur loam on 1-3% slope, saline.
DcB2 - Daryapur loam on 1-3% slope, moderately eroded.
DcB2s - Daryapur loam on 1-3% slope, saline.
DcBds - Daryapur loam on 1-3% slope, high ground water, saline.

4.3 Fine Loamy (Loam to Silty Clay Loam) Soils :

4.3.1 Nabha Series (Na) 560 ha i.e. 19.46%.

Soils of Nabha series mostly occur on high elevations of the terraces. They are situated away from meander plains which occupy the lowest position of land forms. Nabha soils are dominantly loam to silty clay loam in series control section (15-100 cm). Available moisture capacity of the soils is about 12.4 cm at 60 cm profile depth and 21 cm up to 100 cm profile depth. They are suited to all the climatically adapted crops during years of normal rainfall. They will respond to normal level of management and general recommendations should result in optimum production in these soils. During rabi, they will respond to irrigation and can support all the rabi crops grown in the region. Under unirrigated conditions drought tolerant and deep-

rooted crops can be grown where irrigation facilities may not be available. The fertility potential of Nabha series is good. Saline phases need leaching to remove salts and phases of erosion need conservation measures to check soil erosion. Nabha soils show highest potential for producing wheat crop. Following phases are mapped : -

NabA - Nabha fine sandy loam on 1% slope.
NabB - Nabha fine sandy loam on 1-3% slope.
NacA - Nabha loam on 1% slope.
NaCA - Nabha loam on 1% slope, calcareous.
NacAs - Nabha loam on 1% slope, saline.
NacAd - Nabha loam on 1% slope, high ground water.
NacB - Nabha loam on 1-3% slope.
NaCB - Nabha loam on 1-3% slope, calcareous.
NacBs - Nabha loam on 1-3% slope, saline.
NadA - Nabha clay loam on 1% slope.
NadAd - Nabha clay loam on 1% slope, high ground water.
NadB - Nabha clay loam on 1-3% slope.
NadBs - Nabha clay loam on 1-3% slope, saline.
NadBd - Nabha clay loam on 1-3% slope, calcareous, high ground water.

4.3.2 Hissar Series (Hi) - 338.14 ha i.e. 11.77%.

Hissar series occur on lower terraces and along the meander plains. They are dominantly loam to silty clay loam in series control section (15-100 cm). Available moisture capacity of soil is 12.5 cm up to 60 cm profile depth and 22.0 cm up to 100 cm profile depth. These soils are suited to a variety of crops in years of normal rainfall. During rabi they will respond to irrigation to wheat and other crops. Under unirrigated conditions drought tolerant and deep-rooted crops can be grown where irrigation facilities may not be available. Fertility retention of Hissar soils is good. They may present problems due to lime in the upper part of the profile. The

following phases are mapped : -

HibB - Hissar fine sandy loam on 1-3% slope.
HibBs - Hissar fine sandy loam on 1-3% slope, saline.
HicA - Hissar loam on 1% slope.
HicAs - Hissar loam on 1% slope, saline.
HicB - Hissar loam on 1-3% slope.
HicBs - Hissar loam on 1-3% slope, saline.
HidA - Hissar clay loam on 1% slope.
HidB - Hissar clay loam on 1-3% slope.
HidBs - Hissar clay loam on 1-3% slope, saline.
HidB2ds- Hissar clay loam on 1-3% slope, moderately eroded with high ground water,saline.

4.4 Fine Clayey Soils :

4.4.1 Ghoga Series (G) - 161.75 ha i.e. 5.62%.

Ghoga series occur on the old flood plains which are subject to flooding during monsoon. Ghoga soils occur mostly on 1% slope. They are deminantly heavy silty clay loam to clayey in series control section (15-100 cm). Available moisture capacity of the soil is about 14.4 cm up to 60 cm profile depth and more than 24.4 cm up to 100 cm profile depth. During rainy season these soils become wet on flooding and hence they are problematic to grow normally adapted crops of the region like bajra, jowar and kharif legumes. They are suited only for paddy. During rabi they will respond to irrigation. They may be put under unirrigated crops to utilise the stored moisture in rabi. Their fertility retention capacity is good. They need proper surface drainage to avoid stagnation and flooding.

Ghoga calcareous variant is mapped in the area. These soils occupy lower positions than Ghoga soils in the landscape. The soils are subject to flooding and stagnation. They are similar to Ghoga series in other respects and limitations to management.Following

phases are mapped : -

GcA - Ghoga loam on 1% slope.
GcAd - Ghoga loam on 1% slope, high ground water.
GdA - Ghoga clay loam on 1% slope.
GdAs - Ghoga clay loam on 1% slope, saline.
GdAd - Ghoga clay loam on 1% slope, high ground water.

4.4.2 Khampur series (Kh) - 3,454 ha i.e. 1.10%.

Khampur series occur on old meander plains and basins. These soils are clay loam to clayey in the series control section and are calcareous. They have characteristic grayish colour and mottles due to poor drainage conditions. Available soil moisture capacity is 14.1 cm in 60 cm profile and 24.0 cm in 100 cm profile. The soils are both saline and sodic in nature. Ground water-table remains high during monsoon and winter seasons. Khampur soils have been mapped in Sanoth village. They are typical from classification point of view hence they have been described as a separate series. They are likely to be mapped in similar areas in the Delhi Territory and adjoining States like Haryana and U.P.

Khampur series need to be reclaimed for growing crops. Drainage has to be provided to keep the ground water level low. After initial reclamation paddy and wheat can be grown. Following phases have been mapped : -

KcAd - Khampur loam on 1% slope, high ground water.
KdAs - Khampur loam on 1% slope, saline.

4.5 Fine Loamy Over Coarse Loamy or Sandy Soils :

4.5.1 Santosh Series (Sn) - 19.56 ha i.e. 0.63%.

Santosh series occur mostly on old meander plains. The

soils are characterised by the occurrence of coarse loamy or sandy material below 50 to 60 cm depth from the surface. They are calcareous. They may also have high ground water due to their location in the meander plain. Available moisture capacity of soil is 9.0 cm up to 60 cm depth and 13.0 cm up to 100 cm depth. The soils can grow all the climatically adapted crops during normal rainfall years. Their fertility retention capacity is good.

During rabi season they respond to irrigation and support a variety of crops. Saline phases need to be leached to remove salts. Following phases are mapped : -

SnbA	-	Santosh sandy loam on 1% slope.
SncB	-	Santosh loam on 1-3% slope.
SncAd	-	Santosh loam on 1% slope, high ground water.
SncBds	-	Santosh loam on 1-3% slope, high ground water, saline.
SndA	-	Santosh clay loam on 1% slope.

4.3.2 Senoth Series (S) - 35.40 ha i.e. 1.24%

Senoth series are mapped in meander plains. The soils are fine loamy over coarse loamy or sandy. The sandy loam or sandy material may be present below 40 cm depth in the profile. Unlike Santosh series, these soils exhibit characteristic colour and mottles due to poor drainage conditions. Senoth soils have high groundwater and they are highly saline though the area under these soils is not enough to give series status, they are likely to occur in large areas. Further, they are typical for classifying.

These soils need drainage and leeching of salts to make them fit to grow crops. Quite a large area of the soils is mapped in Senoth village. After reclamation, a variety of crops can be grown. Following phases are mapped : -

ScA - Sanoth loam on 1% slope.
ScAd - Sanoth loam on 1% slope, high ground water.

4.6 Coarse Loamy Over Fine Loamy Soils :

4.6.1 Nagar Series (N) - 4.44 ha i.e. 0.14%.

Soils of Nagar series are mapped in meander plains. They have coarse loamy (sandy loam or loam) over fine loamy (silty clay loam) textures. The silty clay loam may be present below 60 cm depth in the profile. Available moisture capacity of the soil is 6.7 cm up to 60 cm and 14.8 cm up to 100 cm depth profile. They have saline and high ground water phases and are moderately well drained to imperfectly drained.

These phases need drainage and leaching or scrapping of salts to make them fit to grow crops. Growing Dhaincha as green manure may improve the physical condition of the soil. After reclamation a variety of crops can be grown on these soils. Following phases are mapped : -

NbAs - Nagar sandy loam on 1% slope, saline.
NcAds - Nagar loam on 1% slope, high ground water, saline.

4.7 Highly Variable Stratified Soils :

4.7.1 Wazirabad Series (W) - 9.00 ha i.e. 0.31%.

Wazirabad series occur mostly on old meander plains. The soils are characterised by the occurrence of highly variable strata of textures in the series control section (15-100 cm). They are calcareous. Available moisture capacity of soil is 7.6 cm up to 60 cm profile depth and 14.7 cm up to 100 cm profile depth. Under rainfed conditions, they are suited for short duration deep-rooted crops.

These soils will present problems for moisture management due to stratified layers of soil. Their potential fertility is low.

The lands are subject to occasional seasonal flooding.

Following phases of Wazirabad Series are mapped : -

WbA - Wazirabad sandy loam on 0-1% slope.

4.8 Undifferentiated Complexes :

4.8.1 Hamidpur-Santosh Complex - 5.28 ha i.e. 0.18%.

Hamidpur Santosh complex occurs on meander plains in Holambi village.

Hamidpur soils are fine sandy loamy to loam (coarse texture) in series control section. They are calcareous.

Santosh soils are fine loamy over coarse loamy or sandy with coarse material occurring below 50 cm depth in the control section. They are calcareous. They may have high ground water.

The soils are suited to climatically adapted crops in normal rainy season. They will respond to irrigated crops during rabi season.

4.8.2 Hamidpur-Daryapur-Razapur Complex - 7.36 ha i.e. 0.25%.

The soils of the complex occur in meander plains in Bawana village.

Hamidpur soils are sandy loam to loam (coarse textured) calcareous soils. Daryapur soils are loam to silt loam soils (fine loamy) calcareous. Razapur soils are sandy (coarse textured). They

vary in their moisture and fertility status. They will respond to mixed cropping and growing deep-rooted legume crops.

4.6.3. Nabha-Kakra Complex - 5.26 ha i.e. 0.18%.

Nabha-Kakra complex occur on old flood plains in Bawana village.

Nabha soils are loam to silt loam (fine loamy) whereas Kakra soils are fine sandy loam (coarse textured). They vary in moisture capacity and fertility status and are suited to a variety of climatically adapted crops.

5. SOIL SURVEY INTERPRETATION :

5.1 Principles of Interpretation :

The soil maps of the villages consist of different phases of soil series and it is assumed that the delineations on the map are accurate up to 80%. Interpretations take into consideration the fact that any kind of soil has many interacting properties. The purpose of survey and mapping the soils of the villages is mainly for making recommendations to grow crops both under rainfed and irrigated conditions. The delineations on the soil map will help to ascertain the qualities and properties which are important in the use of a particular soil or intended use of the land. Soil survey interpretations are based on variations in soil properties and qualities that become important as they affect response to management for growing plants or other uses that require significant investment. Such planning needs to take into account the artificial embankments like road, canals or drainage ways and the like.

The interpretation groupings for the four villages are made for land capability classification as well as irrigability classification.

5.2 Land Capability Classification :

Capability classification is an interpretive grouping made primarily for agricultural purposes. Cultivable soi re grouped according to their potentialities and limitations for . stained production of the commonly cultivated crops. The crops considered are the ones listed under presently cultivated crops.

Land capability classes are grouped as sub-classes that are groups of soils that have the same kinds of dominant limitations for agricultural use. Four kinds of limitations at the sub-class level are 'e' for wind or water erosion hazard, 'w' for drainage difficulties, wetness or over-flow, 's' for soil limitations affecting plant growth and 'c' for limitations due to climate.

Influence of climate in land use classification has to be considered when the soil conditions are considered favourable. It is generally regarded to classify the soils from class III and to IV level under semi-arid climate. But in the present case rainfall during main growing season i.e. from July-September, is considered where crops mature in 120 days period. In the surveyed area during this period, average rainfall received is 68 cm. Though this is considered enough to grow climatically adapted crops, rainfall is erratic and its distribution cannot be predicted as a result of deviation from normal through the growing season of the crops. Hence, best soils of the area are classified as II C. Class II C soils will not be having any other limitations. Other major limitations are due to soil and due to wetness problems. The other soils are grouped under sub-classes of Class II and III lands. Class IV lands are not mapped. Once the capability class and sub-class are determined for any mapping unit, then a capability unit designation is made. The characteristics of the soil profile play a dominant role in assigning capability unit. Following characteristics of soils are considered for assigning land capability units which are appended to respective land capability sub-classes to specify the limitation.

(0) Stony or rocky, (1) Erosion hazard-slope, erosion or both, (2) Coarse textures (Sandy to sandy loams), (3) Fine features (Heavy clays and silty clay), (4) Slowly permeable sub-soils, (5) Coarse underlying material, (6) Salinity or alkali, (7) Stagnation, overflow, high ground water, (8) Depth and (9) Fertility problems.

Capability units are groups of soils within capability subclasses that are nearly alike in plant growth, and response to management. The dominant influences in identifying the capability units in the area are due to slope or erosion, salinity, overflow or stagnation and coarse textures. These limitations are described by appropriate symbols.

The assumptions made in classifying the soils are : -

That within a capability sub-class or unit soils have similar limitations or hazards. Response that can be expected from applying a given set of alternatives is approximately uniform for the soils in a capability unit.

A favourable ratio of output to input exists based on economic trends.

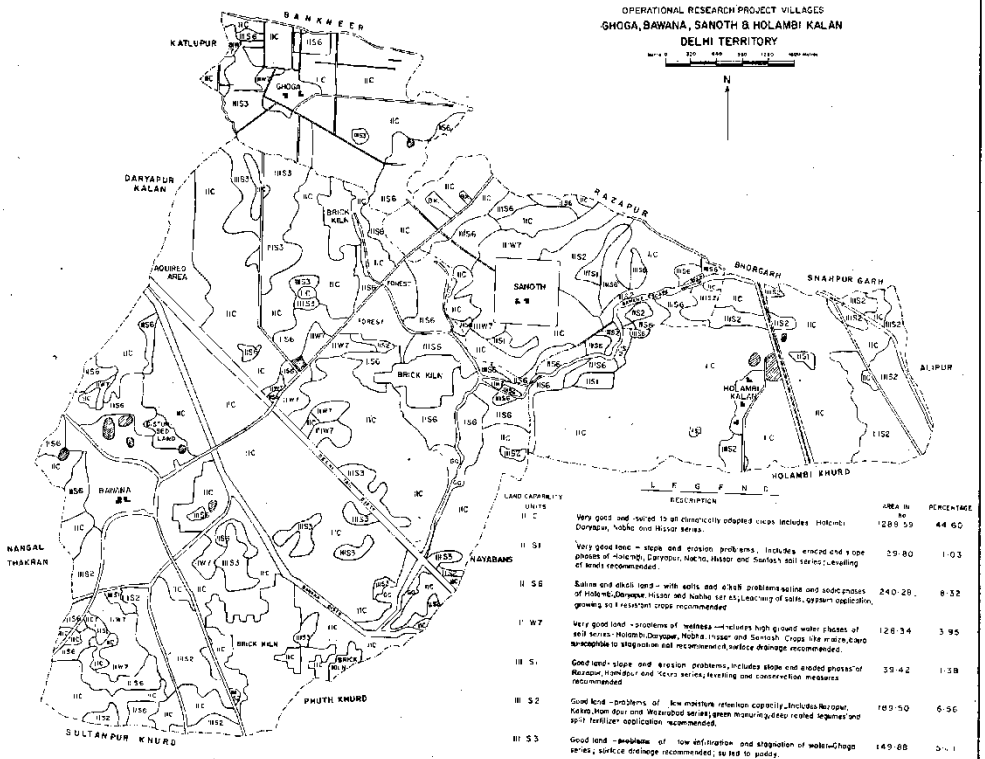
5.2.1 Land Capability Units :

Capability Sub-Class II C :

Soils of this unit are very deep, well drained fine loamy with loam to clay loam surface textures. The soils occur on nearly level lands. Available moisture capacity ranges from 9.0 cm to 12.5 cm up to 60 cm depth and from 13.0 cm to 22.0 cm up to 100 cm soil profile depth. Nutrient retention capacity of the soils is good. The soils can grow all climatically adapted crops of the region like jowar, bajra, maize and kharif legumes. Their response to alternative management is expected to be best as they are by far the most productive soils.

LAND CAPABILITY MAP

OPERATIONAL RESEARCH PROJECT VILLAGES
GHOGA, BAWANA, SANOTH & HOLAMBI KALAN
DELHI TERRITORY



REFERENCE

- Railway line
- Road
- Village Boundary
- State, Rural Habitation
- Land Capability class Boundary
- Pond
- GG Severely Gullied Land
- Canal

LAND CAPABILITY UNITS	DESCRIPTION	AREA IN ha	PERCENTAGE
II C	Very good and suited to all climatically adapted crops includes Holambi, Daryapur, Nabha and Hissar series.	1288.59	44.60
II S1	Very good land – slope and erosion problems, includes eroded and slope phases of Holambi, Daryapur, Nabha, Hissar and Santosh soil series; Levelling of lands recommended.	29.80	1.03
II S6	Saline and alkali land – with salts and alkali problems saline and sodic phases of Holambi, Daryapur, Hissar and Nabha series; Leaching of salts, gypsum application, growing salt resistant crops recommended	240.28	8.32
II W7	Very good land – problems of wetness – includes high ground water phases of soil series – Holambi, Daryapur, Nabha, Hissar and Santosh. Crops like maize, bajra susceptible to stagnation soil recommended, surface drainage recommended.	128.34	3.95
III S1	Good land – slope and erosion problems, includes slope and eroded phases of Razapur, Nangalpur and Kewra series; levelling and conservation measures recommended	39.42	1.38
III S2	Good land – problems of low moisture retention capacity – includes Razapur, Kalka, Mandpur and Mazraabad series; green Manuring, deep rooted legumes and split fertilizer application recommended.	189.50	6.56
III S3	Good land – problems of low infiltration and stagnation of water – Ghoga series; surface drainage recommended; suited to paddy.	149.88	5.11
III S6	Saline and alkali land – soils of Sonsah series and saline and sodic phases of Alamdpur, Nagar and Ghoga series; leaching and other reclamation measures; growing salt resistant crops including dhaincha recommended.	60.80	2.13
III W7	Good land – problems of excessive wetness – includes high ground water phases of Ghoga, Nagar, Khampur series; surface drainage recommended; suited for paddy, crops like maize, bajra not recommended.	56.57	2.49

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(Mapping Units : HbA, HbB, HcA, HaB, HcB, HcB, DbA, DbB, DcA, DcB, NabA, NabB, NacA, NadA, NacB, HibB, HicA & HicB; HidA, HidB, SnbA).

Capability Unit II S1 :

Soils of this unit are similar to II C sub-class but for erosion and slope. They have good available moisture and nutrient retention capacity. Levelling as a normal conservation practice is necessary.

(Mapping Units : HbB2, DcB2, HdcA, NadB, SncB).

Capability Unit II S6 :

The soils of this unit include phases of soil series separated due to salinity or alkali or soil series which are characteri tically saline-alkali. Conservation recommendations are removal of salinity through leaching of the land preceeded by levelling. The problem is expected to persist due to overall land form features of the area. Growing salt resistant crops is recommended.

(Mapping Units : HbBs, HcAs, HcBs, DbAs, DbBs, DbB2s, DcBs, DcAs, DcB2s, NadAs, NacAs, NadBs. NacBs, HicBs, HidBs, HibBs, HicAs).

Capability Unit II W7 :

The soils of the unit are grouped under the sub-class of wetness. Wetness is due to high ground water-table or due to low relief in which these soils are located. Wetness may be also due to overflow and stagnation caused during rainy season. The unit includes lands that suffer from high ground water due to close proximity to the irrigation distributaries and minors, artificial embankments created due to roads and such other constructions.

Conservation measures recommended are for putting up engineering structures to remove excess water and provide for surface drainage.

Crops that are susceptible to water stagnation are not recommended. Cultural practices like shifting the date of sowing, provision of surface drainage are important. If the soils suffer due to salinity, lowering of water-table should receive due attention.

(Mapping Units : HcAd, HcBd, HcBds, DcBds, NacAd, NadAd, NadBd, HicAd, HidB2ds, SncBds, SncAd).

Class III Lands :

Soils of this class have severe limitations that reduce the choice of crops or require special practices of management or both. Limitations of Class III lands in the area are limited available moisture capacity due to coarse textures (III S) or wetness of the soils during the growing season due to low relief and or textures of soil that cause stagnation on account of limited infiltration and permeability (III W).

Capability Unit III S1 :

The soils of this land capability unit have problems due to slope and or erosion. They are also susceptible to wind erosion. They include soils that have low available moisture capacity.

Lands need to be levelled. They are suited to bajra and kharif legumes under years of normal rainfall. If the July rains fail these soils should be preferred to legumes.

(Mapping Units : Rac, HdbB2, KabB, KabB)

Capability Unit III S 2 :

Soils of this land capability unit have problems arising due to coarse textures and consequently have low available moisture capacity. The available moisture capacity ranges from 4.1 cm to 7.6 cm/60 cm and 6.8 cm to 14.7 cm/100 cm depth. Hence the soils are likely to become droughty. They can support crops like bajra and kharif legumes. Mixed cropping is recommended for complementary utilisation of moisture. The soils are low in nutrient retention capacity and hence split application of N fertilisers will be necessary. Phosphatic fertilisers may, however, be applied in one doze.

(Mapping Units : RaA, RaB, KaaB, KabA, KabA, HdaA, HdbA, HdbB, WbA).

Capability Unit III S3 :

Soils grouped in this unit have problems of heavier textures, low infiltration and temporary stagnation restricting the choice of crops. These soils are not suited to crops like bajra and maize. Even a crop like jowar needs efficient management providing for adequate surface drainage and early planting. With good rains in September and high available moisture capacity the soils can support rabi crops. They may respond to zinc under high levels of management.

(Mapping Units : GcA, GdA).

Capability Unit III S6 :

The main problems in the soils of this unit relate to salinity and or alkali. Leaching of salts and growing salt resistant crops are among recommended practices. Gypsum application on soil test basis is also considered essential.

(Mapping Units : KabAs, HdbAs, HdbBs, HdbB2s, GdAs, ScA, NbAs, KdAs).

Capability Unit III W7 :

Soils of this unit have the problems of excessive wetness. It is due to low relief position coupled with high ground water. The soils may also be saline-sodic. Where the ground water is also saline the problem of salinity is more severe. The soils are heavier in nature. This restricts the choice of crops due to excessive moisture during the growing season.

Provision of drainage and selection of crops that are not sensitive to wetness are appropriate practices. Rabi crops can be grown with stored moisture on soil units that are not saline.

(Mapping Units : GcAd, GdAd,ScAd, NcAds, KcAd).

5.3 Irrigability Classification :

The present land use data shows that a greater part of the area is used for rainfed agriculture during kharif whereas a very large percentage of land is put to irrigated agriculture during rabi season.

Irrigability classification is made taking note of the fact that temperature and sunshine conditions are favourable throughout the growing period for climatically adapted crops. Soil irrigability classification is made on the basis of important soil characteristics namely depth, soil texture, available moisture holding capacity, inherent infiltration and permeability and saline-sodic conditions. 4 Land Irrigability Classes (Class 1 to 4) are recognised. Sub-classes are defined as limiting factors namely soil problems (s), drainage (d), topography (t) and climate (c). Class 1, 2 and 3 lands are mapped in the area. Land irrigability units in a subclass are also identified. Lands have been classified into irrigability units based on the intensity of major limitations. Irrigability class 1 lands do not have any limitations and hence they are not grouped into sub-classes and units. These include soil mapping units that have good available moisture

capacity and which do not pose problems of drainage and salinity.

Assumption made in classifying the lands are that within an irrigability sub-class or unit, soils have similar limitations or hazards.

Response to practices taken in a irrigability unit will be generally uniform for the soils. Availability of irrigation water is assumed to be adequate.

Quality of irrigation water where ground water is used is not taken into account. Such ground waters are to be considered on the basis of individual situations with respect to soil-water relationships, crop selection and management. Canal waters are of good quality.

Major factors considered in classifying lands into irrigability units are soil textures, available moisture capacity, salinity and or sodic condition, overflow, stagnation and high ground water. These limitations are described with appropriate symbols under 2s, 2d and 3s and 3d sub-classes.

5.3.1 Land Irrigability Units :

Irrigability Class I :

These include soils which are deep with available moisture capacity of about 15 to 22 cm/100 cm depth and with no hazards of drainage or salinity. Under irrigation these lands can support all the crops and orchard plants climatically adapted to the region. They will respond to the recommended average irrigation schedule. Some lands under this class may need initial levelling which is not going to pose difficulties. The soils are expected to have the most favourable interaction to management.

(Mapping Units are HbA, HaB, HbB, HbB2, HcA, HcB, HcB, DbA, DbB, DcA, DcB, NabA, NacA, NabB, NadA, NacB, HibB, HicA, HicB, HidA, HidB, HbB2, DbB2, DcB2, HdcA, NadB, SncB, SndA).

Irrigability Unit 2 S3 :

These include soils that are clayey in nature with restricted permeability and susceptible to stagnation especially during monsoons. These variations restrict the choice of crops and the lands need proper surface drainage. The soils are well suited to forage crops like berseem and paddy under irrigation.

(Mapping Units are GcA, GdA,).

Irrigability Unit 2 S6 :

These include soils that are saline and/or sodic. Therefore, leaching of salts and other reclamation measures based on gypsum requirement test are necessary. Salt resistant crops are recommended.

(Mapping Units are HbBs, HcAs, HcBs, DbAs, DbBs, DbB2s, DcBs, DcB2s, NacAs, NadAs, NacBs, HicBs, HibBs, HicAs, HidBs, SncB).

Irrigability Unit 2 d7 :

This includes soils having drainage problems due to stagnation, over flow, high ground water or both. This also includes some soil units that are saline. Surface drainage can mitigate the bad effects. During kharif these lands restrict the choice of crops. Crops sensitive to excess moisture are not recommended on these lands. These soils also pose problems with regard to fertiliser use due to wetness.

(Mapping Units are HcAd, HcBd, HcBds, DcBds, NacAd, NadAd, NadBd, HicAd, HidB2ds, SncAd, SncBds).

Irrigability Unit 3 s2 :

This includes soil units that are droughty due to low available moisture capacity. Available moisture capacity ranges from 4.1 cm to 15 cm/100 cm depth. These soils present problems due to heavy percolation losses and frequent irrigation needs. They also present problems due to shorter furrow length, ratio of field area to flow for border strip or basin and flow rate of irrigation water due to coarse textures. Low fertility retention capacity and percolation losses of nitrogenous fertilisers is obvious. Choice of crops are restricted and selecting crops to use moisture and fertiliser at deeper depths of soil profile is necessary.

(Mapping Units are RaA, RaB, RaC, KaaB, KaaA, KabA, KabA, HdaA, HdbA, HdbB, NbAs, HdbB2, KabB, KabB, SnbA, WbA).

Irrigability Unit 3 s6 :

This includes soil mapping units that are highly saline and sodic and that require leaching of salts and addition of gypsum. Growing of salt resistant crops is recommended. The problem may persist to some extent even after initial reclamation.

(Mapping Units included are KabAs, HdbAs, HdbBs, HdbB2s, GdAs, ScA, KdAs, NbAs).

Irrigability Unit 3 d7 :

This includes soil mapping units that have problems due to low relief, high ground water, stagnation and overflow hazards. The soils are also clayey in nature that affects infiltration and permeability. These lands need surface drainage to check overflow and high ground water. Crops susceptible to stagnation should be avoided.

They can support crops like paddy. Berseem is best suited in rabi on soils which are not saline. Wetness of these soils pose problems in the use of fertilisers.

(Mapping Units included are GcAd, GdAd, ScAd, KcAd, NaAds).

The table (No. 8 & 9 at page No 46) gives the recommended crops for the soils mapped in the villages.

5.4 Productivity and Yield Prediction :

Soil productivity is the capacity of a soil in its normal environment, to produce a specified plant or sequence of plants under a specified system of management. Productivity hence specifies the capacity of soil to produce crops and should be expressed in terms of yields.

The interpretation of soils with respect to productivity is best accomplished by gathering yield data and preparation of a table of yield estimates under alternative systems of management.

In land capability and irrigability classification, soil and land characteristics were taken into account to classify them under different categories. Productivity and yield prediction estimates may be considered as a further step for developing interpretation of soils for land use planning. In the villages surveyed wheat is the most important crop. It is grown on most of the soils mapped. There is more awareness to use the improved technology for better management of the crop. Hence, a study was made to estimate productivity of different soils in respect of wheat crop under defined management levels.

The data was collected through observation of crops during mapping and making inquiries from the farmers on the performance and management.

Different units at soil series level were chosen as soil variables.

Management as input was an important variable to estimate productivity under specific combination of treatments. As the study was made on the basis of individual farmer's management efforts there were several variations. Nevertheless it was possible to classify management levels into three identifiable levels. Following are the three levels of management defined on the basis of information collected during survey from individual farmers.

a) Low level of management
Use of local variety of seeds, less than 20 Kg N, 4 to 5 ploughings and limited source of irrigation, no plant protection measures.

b) Medium level of management
Use of improved varieties of seeds, 20to 40 Kg Nitrogen, 5 to 6 ploughings, adequate irrigation, no plant protection measures.

c) High level of management
Use of improved variety of seeds, 40 to 60 Kg N, 30 to 40 Kg. phosphorus, 6 to 7 ploughings and adequate irrigation and plant protection measures.

Generally the farmers over-irrigate when the water is available.

Limited number of soil series were selected at the initial stages of the study. The Table No. 5 shows the soil series selected with other particulars.

Table No. 5

Soil Series	Levels of Management (No. of farmers interviewed)			Total No. of Farmers interviewed.
	Low	Medium	High	
Holambi (F.loamy)	3	3	3	9

Daryapur (F. loamy)	2	2	2	6
Hissar (F. loamy)	0	4	3	7
Hamidpur (C. loamy)	2	3	2	7
Total :				29

The yield prediction and management information are generated from the interviews with the farmers. The indications according to observations made are that sandy soils have low yield levels than coarse loamy soils and clayey soils may equal coarse loamy soils in yield levels. For these soils (Razapur and Ghoga Series) similar information was not collected in order to give firm range in yield based on different management levels. Following table No. 6 gives the information on predicted yield of wheat on coarse loamy and fine loamy soils.

Table No. 6

Level of management	Management definition	Wheat yields quintals/ha	
		Coarse loamy	Fine loamy
Low	Local variety 0-20 Kg, N, 4-5 ploughings, irrigation not adequate.	10-15	20-25
Medium	S 308, 1553, N 20 to 40 Kg. P 15-20 Kg. Ploughings 5-6 irrigation average.	20-25	25-30
High	S 308, 1552, N 40-60, P 30-40, Irrigation adequate.	25-30	35-40

Following table No. 7 gives the distribution of soils of different textural families in the four villages.

Table No. 7

Soil textural family	Area in ha.	Per cent
Sandy	44.04	1.54
Coarse loamy	195.48	6.76
Fine loamy	1313.57	48.95
Clayey	175.92	6.11
Soils of variable textures & complex.	36.78	1.65
Salt affected soils	407.43	12.17
Gullied & Misc. lands	642.22	22.66

Broadly speaking the differential response to management may be attributed to differences in soil moisture relationship and aeration of soils. On fine-loamy soils highest yield is obtained under irrigation (under assumed moisture supply). Lower yields on sandy soils is obviously due to low available moisture holding capacity. The performance of coarse-loamy soils compared with fine-loamy soils can be explained for similar reasons.

Productivity information on the soils may be used to project and programme area under wheat which is the most important crop of the area. This should also help in choosing more favourable input - output package to produce this crop.

Limitations due to use of saline ground-waters was also observed during the survey. Ground water quality has to be assessed on individual well basis to plan the management of soils.

5.5 Soil Fertility Management :

Soil fertility variations are broadly distinguished on soil textures which affect the fertility holding capacity, clay mineralogy and proportions of unweathered minerals being the same. Sandy soils are less retentive whereas loams and clay loams have better capacity to hold nutrients with good base saturation ratio in all the soils. Some soils pose the problem of free calcium carbonate, within the 50 cm depth profile that might affect phosphate fixation and hinder the availability of zinc which is recognised as a limiting factor. Similarly soils that are wet are expected to pose the problems of zinc availability and loss of nitrogen.

Still low fertility levels and infiltration problems are common temporary conditions irrespective of inherent characteristics. This is caused due to past use and management. These are to be corrected through proper application of fertilisers and cultural practices. For example response to zinc may be expected in a paddy-wheat rotation even in irrigability Class 1 land whereas it may not be so in a maize-wheat or bajra-wheat rotation. In the case of 2d7 soils application of zinc may be necessary irrespective of the rotation followed. Fertility management of soils should be made on the basis of inherent soil characteristics. It is assumed that soil testing is done to apply fertilisers to meet the requirement of different crops.

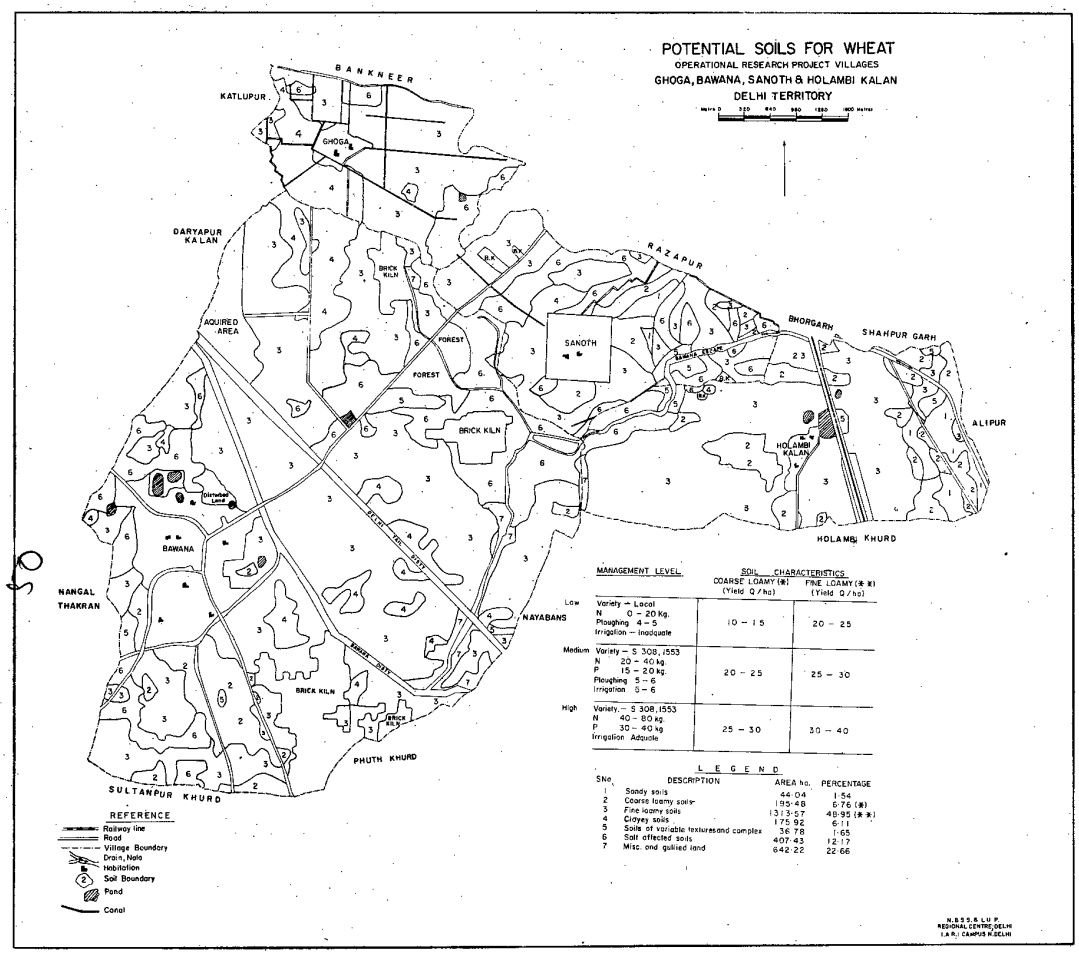
5.5.1 Soils with no problem of fertility management :

These are soils with favourable fertility retention capacity and will respond to generally recommended fertiliser application.

(Mapping Units included are HaB, HbA, HbB, HcA, HcB NabA, NabB, NacA, NadA, NacB, NadB).

5.5.2 Soils with problem of fertility management due to free lime :

These include the soils of the units that have free lime within 50 cm profile depth that might affect phosphate nutrition and


POTENTIAL SOILS FOR WHEAT
OPERATIONAL RESEARCH PROJECT VILLAGES
GHOGA, BAWANA, SANOTH & HOLAMBI KALAN
DELHI TERRITORY
BANKNEER
KATLUPUR
GHOGA
DARYAPUR KALAN
AQUIRED AREA
BRICK KILN
FOREST
SANOTH
RAZAPUR
BHORGARH
SHAHPUR GARH
ALIPUR
HOLAMBI KALAN
HOLAMBI KHURD
BAWANA
NANGAL THAKRAN
NAYABANS
PHUTH KHURD
SULTANPUR KHURD
REFERENCE
Railway line
Road
Village Boundary
Drain, Nala
Habitation
Soil Boundary
Pond
Canal
MANAGEMENT LEVEL
SOIL CHARACTERISTICS
COARSE LOAMY (*) (Yield Q/ha)
FINE LOAMY (**) (Yield Q/ha)
Low
Variety – Local
N 0 – 20 Kg.
Ploughing 4 – 5
Irrigation – Inadquate
10 – 15
20 – 25
Medium
Variety – S 308, 1553
N 20 – 40 kg.
P 15 – 20 kg.
Ploughing 5 – 6
Irrigation 5 – 6
20 – 25
25 – 30
High
Variety – S 308, 1553
N 40 – 80 kg.
P 30 – 40 kg
Irrigation Adquate
25 – 30
30 – 40
L E G E N D
SNo. DESCRIPTION AREA ha. PERCENTAGE
1 Sandy soils 44·04 1·54
2 Coarse loamy soils 195·48 6·76 (*)
3 Fine loamy soils 1313·57 48·95 (**)
4 Clayey soils 175·92 6·11
5 Soils of variable textures and complex 36·78 1·65
6 Salt affected soils 407·43 12·17
7 Misc. and gulkied land 642·22 22·66
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availability of zinc. Free lime will be generally more than 1% in 50 cm depth.

(Mapping Units include the following series - Hardpur, Daryapur, Hissar, Khampur, Nagar, Santosh, Wazirabad).

5.5.3 Soils with problems of fertility management due to coarse textures :

These include mapping units that are sandy and sandy loams (coarse loamy) throughout the profile depth of 125 cm.

(Mapping Units included are RaA, RaB, Rac, KaaA, KaaB, KabA, KabA, HdaA, HdbA, HdbB, HdbB2, KabB, KabB).

5.5.4 Soils with problem of fertility management due to salinity :

These include soil mapping units that are saline and/or sodic.

(Mapping Units included are HbBs, HcBs, HcAs, DbAs, DbBs, DbB2s, DcAs, DcBs, DcB2s, NacAs, NadBs, NacBs, HicBs, HibBs, HicAs, HidBs, ScA, KdAs, NbAs, KabAs, HdbAs, ---- , HdbBs, HdbB2s).

5.5.5 Soils with problem of fertility management due to wetness:

These include soils that are subject to stagnation, overflow or with high ground water table problems.

(Mapping Units included are HcAd, HcBd, HcBds, DcBds, NacAd, NadAd, NadBd, HicAd, HidB2ds, NcAds, SncAd, SncBds, KcAd, GcAd, ScAd, GdAd, GcA, GdA).

6. CROP AND MANAGEMENT RECOMMENDATIONS :

The area is already put to intensive agricultural use as indicated by information collected during the survey. Soil survey has provided information on the distribution of different soils in the area and their inherent characteristics and qualities. Based on these land evaluation has been made for rainfed and irrigation farming. Information on productivity and yield prediction should make it possible to choose package of practices for projected yields or to make contingency plans.

Management requirements and adapted crops are listed for various land classes. The recommendations given furnish general guideline for cropping and management practices. However, these do not take the place of detailed recommendations made by Extension Agronomists. The recommendations refer to the identified and mapped soil units.

6.1 Soils of High Ground Water :

Proper drainage of affected lands is essential. The group of villages are drained through Bawana escape and its attendant laterals. Proper surface drainage will mitigate the problem of high ground water and/or overflow and stagnation. Paddy may be grown with supplemental irrigation followed by barley, mustard, gram and lentil. The mapping units indicate such soils that are affected due to poor drainage. On site problems will have to be tackled for individual fields.

6.2 Salt Affected Soils :

Leaching of salts and reducing sodicity is necessary. Drainage will be necessary where ground water is high. The salt affected soils generally do not pose problems to reclaim them. Leaching may be followed by dhaincha for green manuring or paddy based on removal of salts and alkali in the upper part of the profile. With partial reclamation, mustard, barley, wheat and berseem can be grown.

6.3 Dry Land Farming :

During rabi mustard and gram may be grown on fine loamy and clayey soils. On sandy soils castor is a good choice.

6.4 Soils of Sloping Land :

Land having 1-3% slope should be levelled up to 0.05 to 0.5% based on soil textures for irrigation.

6.5 Bed Length :

Length of seed bed should not be more than 90-120 m in case of Razapur, Kakra, and Hamidpur series for better distribution of irrigation water.

6.6 Small Holdings :

On holdings of less than half hectare vegetable crops can be selected for coarse loamy and fine loamy soils.

6.7 Fertiliser and Manure :

Recommended doses of fertilisers need to be used on different soils. Recommended dose, economic dose and half the recommended dose that have been worked out are expected to give good results on fine-loamy soils which are grouped under IIC and Clas I irrigable lands. In respect of coarse textured soils, wet soils, soils with free lime within the first 50 cm soil profile and saline-sodic soils appropriate modifications are necessary. Recommendations for marginal land holders should be modified to apply fertilisers for maximum return per unit of applied fertiliser to keep down the input need.

6.8 Soils of High Productivity Potential for Wheat :

Mapping units of Nabha, Hissar, Daryapur and Holambi series are

delineated as soils of high productive potential for wheat crop. The soils will respond well under different levels of management. Wheat crop was chosen to know the productive potential of soils because this crop is the most preferred crop in the area. Secondly this crop is systematically replacing other crops like legumes and oil seeds which are also important to fulfil pulses and oil seeds. About 49 per cent of the area in the group of four villages come under these soils. Gullied and miscellaneous lands contribute to about 23%. The remaining 28% of the lands belong to sandy, coarse loamy, clayey and salt affected soils. The distribution of the lands in the area should be helpful to project crops, develop the concept of area planning to meet the requirements of the villages based on land evaluation for crop needs and to maintain ecological balance. The distribution of soils in the group of villages also shows that for any given level of planing, distribution of soils becomes important as they differ in their specific crop adaptability, other things being equal.

6.9 Alternate Crops :

Recommending alternate crops was discussed during one of the meetings with Extension Scientists. The major problem identified was failure of bajra and/or jowar and even maize due to excess rain, causing wetness.

Observation in the field revealed that such failures may be either due to excess rainfall or due to nature of the soils and site characteristics that encourage stagnation of water.

Following suggestions are made for alternate cropping strategy:-

a) Under irrigation where bajra crop fails due to heavy showers in July-August alternate crops may be vegetables and potato. September sown vegetables (carrot) or potato may be followed by wheat sown up to mid-December.

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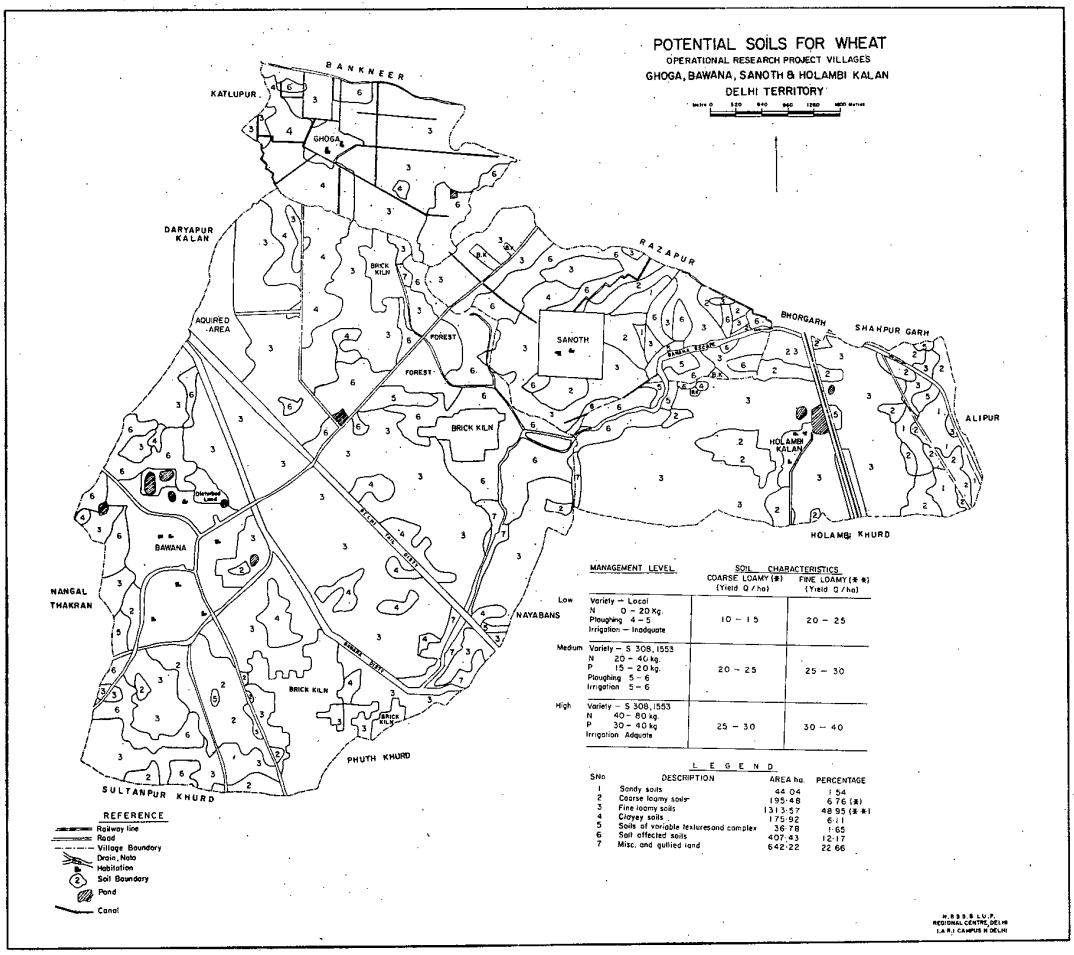
POTENTIAL SOILS FOR WHEAT
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GHOGA, BAWANA, SANOTH & HOLAMBI KALAN
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SHAHPUR GARH
ALIPUR
HOLAMBI KALAN
HOLAMBI KHURD
BRICK KILN
BAWANA
NANGAL THAKRAN
NAYABANS
BRICK KILN
PHUTH KHURD
SULTANPUR KHURD
REFERENCE
Railway line
Road
Village Boundary
Drain, Nala
Habitation
Soil Boundary
Pond
Canal
MANAGEMENT LEVEL
SOIL CHARACTERISTICS
COARSE LOAMY (#) (Yield Q/ha)
FINE LOAMY (# #) (Yield Q/ha)
Low
Variety — Local
N 0 – 20 Kg.
Ploughing 4 – 5
Irrigation — Inadquate
10 – 15
20 – 25
Medum
Variety – S 308, 1553
N 20 – 40 kg.
P 15 – 20 kg.
Ploughing 5 – 6
Irrigation 5 – 6
20 – 25
25 – 30
High
Variety – S 308, 1553
N 40 – 80 kg.
P 30 – 40 kg.
Irrigation Adquate
25 – 30
30 – 40
L E G E N D
SNo DESCRIPTION AREA ha. PERCENTAGE
1 Sandy soils 44·04 1·54
2 Coarse loamy soils 195·48 6·76 (#)
3 Fine loamy soils 1313·57 48·95 (# #)
4 Clayey soils 175·92 6·11
5 Soils of variable textures and complex 36·78 1·65
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b) In similar condition alternate crop to rainfed bajra could be toria followed by wheat with irrigation.

c) Peas should become an important alternative crop for wheat especially on those soils that are identified as less productive for wheat. Peas, gram and/or mustard should be alternative crops for wheat under rainfed or limited irrigation.

d) On salt affected lands mustard may be an alternative crop to wheat.

e) Mixed cropping should be encouraged for complementing the utilisation of moisture and applied fertiliser from lower depths of soil profile. Mixed cropping should be encouraged on marginal farm holdings besides encouraging vegetables.

6.10 On Site Problems :

On site problems of stagnation due to construction of roads and embankments are to be tackled on individual field basis. Provision of surface drainage may become on site requirement and also for specific crops.

(contd.....p.-46/....)

Table No. 8

SUGGESTED CROPPING PLAN FOR OPERATIONAL RESEARCH PROJECT VILLAGES (TENTATIVE SUBJECT TO CHANGE)

****

KHARIF CROPS

Soil series and textural family	Available moisture capacity 60 cm depth.	Unirrigated	Irrigated	
			Cereals & oil seeds	Vegetables & Flowers
1.	2.	3.	4.	5.
1. Razapur series sandy.	4.10	Guar, moong, til, castor.	Bajra, guar, moong, groundnut.	-
2. Kakra series coarse loamy.	4.40	Bajra, arhar, guar, moong, til, castor (mixed cropping)	Bajra, guar, moong, groundnut, maize.	Tomato, brinjal, chillies, cucurbits, potatoes, bhindi.
3. Hamidpur series coarse loamy.	7.00	Bajra, guar, moong.	Bajra, guar, moong, maize.	Turnips, palak, sonf, cucurbits, rose.
4. Holambi series fine loamy.	9.00	Bajra, guar, moong.	Maize (cobs), jowar, bajra, cotton, moong, urd.	Tomato, brinjals, beans, palak, chillies, cucurbits, sonf, bhindi.
5. Daryapur series fine loamy.	9.00	Chari, jowar, dhaincha.	Jowar, bajra, guar, chari.	-

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(contd.....47/....)

1.	2.	4.	5.
6. Nabha series fine loamy.	12.50	Chari, jowar, dhaincha.	Chari, jowar, maize, paddy, sugarcane, cotton, moong, urd.	Tomato, brinjal, beans, palak, chillies, cucurbits, sonf, bhindi.
7. Hissar series fine loamy.	12.50	Chari, jowar, dhaincha, for green manure or for sticks.	Paddy, jowar, sugarcane.	-
8. Ghoga series clayey.	14.40	Chari, jowar, dhaincha.	Paddy	-
9. Khampur series clayey.	14.00	Dhaincha for green manure or sticks.	Paddy-dhaincha.	-
10. Santosh series fine loamy over coarse loamy.	9.00	Bajra, guar, moong.	Jowar, bajra, guar, moong.	-
11. Sanoth series fine loamy over coarse loamy.	9.00	Dhaincha for green manure.	Dhaincha for green manure, paddy.	-
12. Nagar series (S & SW)	6.70	Dhaincha	Dhaincha	-
13. Wazirabad (Stratified)	7.60	Fallow	Fallow	Summer chari and cucurbits.

(contd.....48/....)

Table No. 9

RABI CROPS

Soil series and textural family	Available moisture capacity 60 cm depth.	Unirrigated	Irrigated	
			Cereals & oil seeds	Vegetables & Flowers.
1.	2.	3.	4.	5.
1. Razapur series sandy.	4.1	Fallow, gram, taramira, barley.	Barley, gram, sunflower.	-
2. Kakra series coarse loamy.	4.4	Fallow - barley, gram, mustard, taramira.	Barley, mustard, sunflower.	Potatoes, pea, carrot, raddish, turnip, onion, marygold, cucurbits, melons, sugarbeet.
3. Hamidpur series coarse loamy.	7.0	Fallow-barley, mustard, gram.	Barley, mustard, toria, sunflower.	- do -
4. Holambi series fine loamy.	9.0	Mustard, barley.	Wheat	Potatoes, pea, carrot, onion, marygold, garlic, coriander, cauliflower, cabbage.
5. Daryapur series fine loamy.	9.0	Mustard, barley, gram.	Wheat	Onion, cauliflower, peas.
6. Nabha series fine loamy.	12.5	Gram, mustard, wheat, barley.	Wheat-berseem.	Peas & cauliflower.
7. Hissar series fine loamy.	12.5	Gram-lentil	- do -	Peas & cauliflower.

(contd....49/....)

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1.	2.	3.	4.	5.
8. Ghoga series clayey.	14.4	Gram-lentil	Wheat-berseem-lentil.	-
9. Khampur series clayey.	14.0	Barley	Barley	-
10. Santosh series fine loamy over coarse loamy.	9.0	Mustard, barley.	Wheat, barley, mustard.	Vegetables & peas.
11. Sanoth series fine loamy over coarse loamy.	9.0	Barley	Barley, mustard, (after reclamation wheat).	Tomato.
12. Nagar series (S & SW) coarse loamy over fine loamy.	6.7	Barley	Barley, mustard.	-
13. Wazirabad (Stratified).	7.6	Barley	Barley	Summer cucurbits, melons, tomato.

: APPENDIX :

Tentative

RAZAPUR SERIES

****

Razapur series comprises well drained to excessively drained, very deep, loamy sand to sandy loam soils of dark yellowish brown to yellowish brown colour. They occur on gently undulating relief (upto 5% slope). The climate is semi-arid with mean annual temperature of more than 22°C and mean annual rainfall of 714 mm.

Razapur series is a member of sandy, non-acid, mixed, hyperthermic family of Typic Ustipsamments.

Typifying Pedon : Razapur sand-cultivated.

Horizon	Depth	Description
Ap	0-20 cm	Pale brown (10YR 6/3D), yellowish brown (10YR 5/4M), sand; single grain, loose; many fine to medium roots; clear smooth boundary.
A12	20-89 cm	Yellowish brown (10YR 5/6 D), yellowish brown to dark yellowish brown (10YR 5/4, 4/4), loamy sand; weak, fine granular; soft, very friable; many fine to medium roots; few fine to medium pores; gradual smooth boundary.
C2	89-140 cm	Yellowish brown (10YR 5/6 D), yellowish brown to dark yellowish brown (10YR 5/4, 4/4) sandy loam; weak, fine granular, friable; common fine to medium roots; few fine medium pores; clear smooth boundary.
C3	140-170 cm	Light grey (10YR 7/2 D), pale brown (10YR 6/3 M), loamy sand; single grain, loose; common fine medium pores.

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PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-20	40.74	43.00	1.15	9.25	6.50
20-89	38.85	34.00	14.25	6.00	8.00
89-140	30.63	35.66	20.00	6.50	7.75
140-170	54.24	28.55	9.00	1.25	7.50

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-20	1.60	8.00	0.20	0.50	0.10	3.45
20-89	1.58	8.30	0.20	-	0.15	4.27
89-140	1.56	8.65	0.20	3.47	0.15	4.09
140-170	1.60	8.70	0.20	2.52	0.15	3.27

Available Moisture in 60 cm profile is 4.1 cm and
in 100 cm profile is 6.8 cm. :

RANGE IN CHARACTERISTICS :

The colour of the surface soil ranges from brown to light yellowish brown and texture from sand to loamy sand. Sub-soil colour varies from yellowish brown to dark yellowish brown and texture loamy sand to sandy loam. The structure varies from crumb to sub-angular blocky.

Available moisture capacity of the soil is 4.1 cm for 60 cm and 6.8 cm for 100 cm profile depth from the surface.

Surface texture and slope phases are mapped.

DRAINAGE AND PERMEABILITY :

Excessively to well drained with rapid permeability.

USE AND VEGETATION :

Mainly used for cultivation of bajra, cowpea, wheat and barley. Natural vegetation consists of sacharum spontenium as grass as well as weeds and sacharum as shrubs; Delbergia s.[illegible], Accacia arabica as trees.

DISTRIBUTION & EXTENT :

Series extent is 44.04 ha. Not extensive and found in small scattered patches in the North-west part of the Delhi Territory on old levees.

TYPE LOCATION :

The profile is located about 300 meters on Alipur-Narela road towards east near Holambi link road crossing (approximately latitude 28° 49' N and longitude 77° 7' E).

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Tentative

KAKRA SERIES

****

Kakra series comprises well drained to excessively drained, very deep sandy loam to loam soils of dark yellowish brown to strong brown colours. The soil occurs on nearly level to gently sloping levees on alluvium.

Kakra series is a member of coarse loamy non-acid mixed, hyperthermic family of Typic Ustochrepts.

Typifying pedon : Kakra loamy sand-cultivated.

Horizon	Depth	Description
Ap	0-16 cm	Light yellowish brown (10YR 6/4 D), dark yellowish brown (10YR 4/4 M), loamy sand; single grain, loose when dry and moist, few fine roots; few coarse pores; very rapid permeability; gradual wavy boundary.
B_1	16-39 cm	Reddish yellow (7.5YR 6/6 D) sandy loam; strong brown (7.5YR 5/6 M); weak fine granular; loose when moist, slightly sticky when wet; few fine and very few medium roots; common medium pores; rapid permeability, gradual wavy boundary.
B2	39-81 cm	Strong brown (7.5YR 5/6 M), sandy loam; weak coarse angular blocky breaking into sub-angular blocky structure; firm when moist, slightly sticky when wet; few fine and very few medium pores; moderately rapid permeability; thin patchy clay film bridging the sand grains; diffuse wavy boundary.

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B3 81-132 cm Strong brown (7.5YR 5/6) sandy loam; weak medium sub-angular blocky structure; firm when moist, slightly sticky when wet; few fine roots; few medium pores; moderately rapid permeability; diffuse, smooth boundary.

C1 132-182 cm Strong brown (10YR 5/6) sandy loam; weak medium subangular blocky; firm when moist, slightly sticky when wet; few very fine roots; few coarse pores; moderate permeability; krotovinas present.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-16	0.36	79.52	11.17	4.00	4.50
16-39	-	72.25	10.82	4.25	12.25
39-81	-	69.40	8.50	6.50	14.25
81-132	-	63.04	13.51	9.25	13.25
132-182	-	67.25	14.10	10.25	18.75

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-16	1.58	8.00	0.20	0.06	0.13	3.00
16-39	1.55	7.65	0.20	0.17	0.12	5.70
39-81	1.55	7.45	0.40	0.11	0.12	5.16
81-132	1.52	7.65	0.20	0.11	0.12	6.52
132-182	1.55	7.65	0.40	0.06	0.12	5.80

Available Moisture in 60 cm profile is 4.4 cm and
in 100 cm profile is 8.4 cm :

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RANGE IN CHARACTERISTICS :

The colour of the surface soil varies from strong brown (7.5YR 5/6) brown (10YR 5/3) to dark yellowish brown (10YR 4/4); texture varies from loamy sand to sandy loam. Colour of the sub-soil ranges from strong brown (7.5YR 5/6) brownish yellow (10YR 6/6) to dark yellowish brown (10YR 4/4); texture of the sub-soil ranges from sandy loam to loam. Clay is less than 18% in the texture control section. Soil structure is moderately developed. The soils are non-calcareous. Mineralogy is mixed. CEC is somewhat low.

Available moisture capacity of the soil is 4.4 cm for 60 cm and 8.4 cm for 100 cm profile depth from the surface.

Surface texture, slope and calcareous phases are mapped.

DRAINAGE AND PERMEABILITY :

Excessively well drained with rapid permeability.

USE & VEGETATION :

The soil is used for wheat cultivation and dry land crops like guar etc.

Natural vegetation consists of sacharum spontenium, cyprus rotendus as grasses and weeds, sacharum munja, calatropis procera as herbs and shrubs, Accacia arabica, Zizyphus jujuba, Dalbergia sissoo, Azadirachta indica as trees.

DISTRIBUTION AND EXTENT :

The extent of series is 126.12 ha and occur in other parts of Delhi Territory and Haryana State extensively.

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TYPE LOCATION :

The profile is located on nearly level cultivated tract of levee 1 Km from Bawana on Bawana - Delhi (via Putc' Khurd) road and on field No. 155/21 (approximately N latitude 28° 47' 30" and E longitude 77° 2' 20").

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HAMIDPUR SERIES

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Hamidpur series comprises well drained, very deep, calcareous, sandy loam soils of yellowish brown colour. They occur on nearly level to gently sloping lands with slopes of 1-3%. The climate is semi-arid with mean annual temperature of more than 22°C and mean annual rainfall of 714 mm.

Hamidpur series is a member of coarse loamy, calcareous, mixed hyperthermic family of Typic Ustochrepts.

Typifying pedon : Hamidpur sandy loam-cultivated.

Horizon	Depth	Description
Ap	0-19 cm	Pale brown (10YR 6/3 D) yellowish brown (10YR 5/4 M) sandy loam; weak, fine, crumb; loose when dry and moist, slightly sticky; strong effervescence with dil. HCl; many fine roots; many fine and medium pores; clear smooth boundary.
A3	19-90 cm	Pale brown (10YR 6/3 D) yellowish brown (10YR 5/4 M) sandy loam; weak fine crumb; loose when dry and moist, slightly sticky; violent effervescence with dil. HCl; many fine roots; many fine and medium pores; gradual smooth boundary.
B2	90-11[illegible] cm	Pale brown (10YR 6/3 D) light yellowish brown to yellowish brown (10YR 5.5/4 M) sandy loam; strong, fine to medium, sub-angular blocky; slightly hard when dry, friable when moist, slightly sticky; violent effervescence with dil. HCl; few fine roots; many fine pores; clear smooth boundary.

C 119-165 cm Pale brown (10YR 6/3 D) yellowish brown (10YR 5/3 M) sandy loam; single grain; few fine roots; many fine pores.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-19	33.38	36.64	3.75	19.00	6.25
19-90	15.07	30.50	27.50	16.25	10.25
90-119	20.94	32.03	28.00	10.25	8.75
119-165	39.05	25.86	19.03	7.25	8.50

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-19	1.58	8.40	0.50	0.78	0.30	4.62
19-90	1.50	8.60	0.80	6.72	0.15	5.44
90-119	1.55	8.90	0.80	4.09	0.13	4.89
119-165	1.55	9.10	0.40	2.63	0.16	4.27

Available Moisture in 60 cm profile is 7.0 cm and
in 100 cm profile is 11.3 cm :

RANGE IN CHARACTERISTICS :

The colour of the surface soil varies from light yellowish brown to yellowish brown and texture from loamy sand to sandy loam. The structure of the surface soil varies from crumb to sub-angular blocky. The colours of the sub-soil vary from yellowish brown to dark yellowish brown and texture varies from sandy loam to loam. Clay per cent is less than 18 in texture control section, CEC is somewhat low.

Available moisture capacity of the soil is 7.0 cm for 60 cm and 11.3 cm for 100 cm profile depth from the surface.

Surface texture, slope& saline phases are mapped.

DRAINAGE & PERMEABILITY :

Well drained with rapid to moderate permeability.

VEGETATION :

The soils of this series are mostly cultivated to bajra, gwar, wheat and barley. Natural vegetation comprises sacharum spontenium, cyprus rotandus as grasses and weeds, sacharum munja, calatropis procera as herbs and shrubs, Accacia arabica, Zizyphus jujuba, Delbergia sisoo, Azadiracheta indica as trees.

DISTRIBUTION AND EXTENT :

Series extent is 99.89 ha. It is extensive in the surveyed area but not very extensive in other parts of Delhi Territory.

TYPE LOCATION :

Along Alipur-Narela road near Arbind Garden. Field No. 9 of Mustateel No. 57 (approximately N latitude 28° 49' and E longitude 77° 7').

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Tentative

HOLAMBI SERIES

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Holambi series comprises well drained, very deep, loam to silt loam soils of yellowish brown to dark yellowish brown colour. They occur on level to nearly level lands with slopes of less than 1 per cent. The climate is semi-arid with mean annual temperature of more than 22°C and mean annual rainfall of 714 mm.

Holambi series is a member of fine loamy, non-acid mixed hyperthermic family of Typic Ustochrepts.

Typifying pedon : Holambi sandy loam-cultivated.

Horizon	Depth	Description
Ap	0-12 cm	Light yellowish brown (10YR 6/4 D) light yellowish brown to yellowish brown (10YR 5.5/4 M), sandy loam; moderate, medium crumb; slightly hard when dry, friable when moist, slightly sticky; many fine to medium roots; clear smooth boundary.
B1	12-46 cm	Light yellowish brown (10YR 6/4 D) yellowish brown (10YR 5/6 M) loam; strong, medium to coarse, sub-angular blocky, hard when dry and firm when moist, sticky and slightly plastic; many fine and medium roots; many fine and medium pores; gradual smooth boundary.
B3	46-108 cm	Yellowish brown (10YR 5/6 D & M) loam; strong, medium to coarse, sub-angular blocky; hard when dry and firm when moist, sticky and slightly plastic; slight effervescence with dil. HCl; common fine roots; many fine and medium pores; gradual smooth boundary.

C1 108-148 cm Yellowish brown (10YR 5/6 D & M) loam; moderate, medium, subangular blocky; hard when dry, friable when moist, slightly sticky and slightly plastic; slight effervescence; few fine roots, many pores; clear smooth boundary.

C2 148-168 cm Yellowish brown (10YR 5/8 D) yellowish brown (10YR 5/6 M) loam; moderate, fine to medium, granular; slightly hard when dry, friable when moist, slightly sticky and slightly plastic; slight effervescence with dil. HCl, few fine roots, few fine pores.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-12	11.11	44.20	20.00	9.25	15.00
12-46	0.40	32.20	31.00	12.50	24.25
46-108	0.36	43.04	18.00	12.00	26.00
108-148	0.26	44.04	24.00	10.25	21.50
148-168	0.19	44.51	28.00	8.50	18.75

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-12	1.58	8.00	0.25	0.32	0.26	5.16
12-46	1.50	8.00	0.55	0.32	0.22	9.24
46-108	1.52	8.00	0.55	0.28	0.09	9.24
108-148	1.52	8.00	0.55	0.34	0.06	9.43
148-168	1.55	8.00	1.00	0.28	0.47	8.15

Available Moisture in 60 cm profile is 9.0 cm and in 100 cm profile is 15.7 cm :

RANGE IN CHARACTERISTICS :

The colour of the surface soil varies from light yellowish brown to yellowish brown and texture sandy loam to fine sandy loam. The colours of sub-surface soil vary from light yellowish brown to dark yellowish brown and texture loam to silt loam; sometimes below 80 cm depth soil is clay loam. Clay per cent is more than 18 in the texture control section. The structure is subangular blocky to angular blocky. The CEC is moderate with good fertility retention capacity.

Available moisture capacity of the soils is 9.0 cm for 60 cm and 15.7 cm for 100 cm profile depth from surface.

Surface texture, slope, calcareous and saline phases are mapped.

DRAINAGE & PERMEABILITY :

Well drained with moderate permeability.

USE & VEGETATION :

The soils of this series are mostly cultivated to jowar, maize, bajra, cotton, tomato, wheat, pea and mustard. The vegetation consists of trees, Accacia-species, Dalbergia sisoo and Morus alba; shrubs like Zizyphus numelaria, Tribulus-teristris and cyprus rotendus, phyllanthus neruri and some grasses.

DISTRIBUTION & EXTENT :

Extent of this series is 329.97 ha and it is very extensive.

TYPE LOCATION :

The profile is located near village Holambi Kalan, about 1/2 Km south-west, in the 25th plot of 47 block (approximately latitude N 28° 49' and E longitude 77° 7').

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Tentative

DARYAPUR SERIES

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Daryapur series comprises moderately well drained to imperfectly drained, very deep, calcareous, loam to clay loam soils of yellowish brown to dark yellowish brown colours. They occur on nearly level to gently sloping lands of 1-3% on the alluvial plains. Ferromanganese concretions and calcium carbonate coated nodules are occasionally present.

Daryapur series is a member of fine loamy calcareous, mixed, hyperthermic family of Typic Ustifluvents.

Typifying pedon : Daryapur silt loam - cultivated.

Horizon	Depth	Description
Ap	0-14 cm	Pale brown (10YR 6/3 D) and brown (10YR 5/3M) silt loam; weak medium subangular blocky structure; slightly hard when dry, firm when moist, slightly sticky, when wet; strong effervescence with dil. HCl; common coarse and medium pores; gradual wavy boundary.
C1	14-45 cm	Yellowish brown (10YR 5/4) silt loam; weak medium angular blocky breaking into sub-angular blocky structure; firm when moist, slightly sticky and non-plastic when wet; strong effervescence with dil. HCl; common fine roots; common fine and few medium pores; moderate permeability; diffuse, smooth boundary.
C2	45-76 cm	Yellowish brown (10YR 5/4) loam; weak medium angular blocky breaking into sub-angular blocky structure; firm when moist, slightly

sticky; strong effervescence with dil. HCl; few (1-2 mm) soft ferromanganese concretions; few fine roots, few medium and fine pores; moderately slow permeability; diffuse smooth boundary.

C3 76-101 cm Yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; firm when moist, slightly sticky and slightly plastic when wet; slight effervescence with dil. HCl; few (1-2 mm) soft ferromanganese nodules; very few fine roots; few coarse pores; moderately slow permeability; gradual wavy boundary.

C4 101-156 cm Dark yellowish brown (10YR 4/4) silt loam; massive when wet; weak medium subangular blocky structure; hard when dry; firm when moist, slightly sticky and plastic when wet; slight effervescence with dil. HCl; few (1-3 mm) soft ferro-manganese concretions; very few fine pores; slow permeability.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-14	1.37	32.37	28.40	25.50	12.25
14-45	0.30	27.80	32.10	25.50	14.25
45-76	0.65	36.00	42.10	2.50	18.50
76-101	0.50	15.50	33.00	25.25	25.00
101-156	1.10	18.25	29.80	27.75	23.50

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PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-14	1.50	8.60	0.50	1.18	0.52	7.60
14-45	1.50	8.65	0.50	1.23	0.22	5.98
45-76	1.52	8.30	1.10	1.40	0.12	8.80
76-101	1.50	8.45	1.10	0.90	0.16	9.52
101-156	1.50	8.60	1.10	0.90	0.16	N.D.

Available Moisture in 60 cm profile is 9.0 cm and
in 100 cm profile is 15.6 cm :

RANGE IN CHARACTERISTICS :

The colour of the surface soil ranges from pale brown (10YR 6/3) to dark yellowish brown (10YR 6/4); texture ranges from sandy loam to silt loam; sub-soil colour ranges from dark brown,brown (10YR 4/3) to yellowish brown (10YR 5/6); texture ranges from loam to clay loam. The soils have moderately developed structure. C.E.C. is moderate. The soils are slightly calcareous. Associated relief is sub-normal.

Available moisture capacity of the soil is 9.0 cm for 60 cm and 15.6 cm for 100 cm profile depth from surface. Surface texture, slope, calcareous and saline phases are mapped.

DRAINAGE & PERMEABILITY :

Imperfectly drained with moderate permeability.

USE & VEGETATION :

Used for wheat cultivation. Natural vegetation consists of Cyprus rotendus, Cynodon dectylon as grasses; Chinopodium, sp, Asphodelus tunifolious, Lathyrous, sativus as weeds; Accacia arabica,

Zizyphus jujuba, date palm as trees.

DISTRIBUTION & EXTENT :

The extent of this series is 377.41 ha and found to occur in other parts of Delhi Territory.

TYPE LOCATION :

On nearly level cultivated land, 1/2 Km from Bawana on Bawana-Narela Road (approximately N latitude 77° 47' 20" and E longitude 28° 2' 40").

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Tentative

NABHA SERIES

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Nabha series comprises well drained, very deep, loam to silty clay loam soils of brown to dark yellowish brown colours. The soil occurs on nearly level to gently sloping lands and are derived from old alluvium. They have well developed horizons and strongly developed structure.

Nabha series is a member of fine loamy, mixed hyperthermic family of Typic Ustochrepts.

Typifying pedon : Nabha silt loam - cultivated.

Horizon	Depth	Description
Ap	0-11 cm	Pale brown (10YR 6/3 D), brown (10YR 4/3 M), silt loam; moderate coarse sub-angular blocky structure; slightly hard when dry, firm when moist, sticky when wet; few fine roots; few coarse pores; moderate permeability; gradual-wavy boundary.
B21	11-25 cm	Pale brown (10YR 6/3 D), brown (10YR 4/3 M) silt loam; moderate coarse angular blocky structure; firm when moist, sticky when wet; few fine and medium roots; few coarse and medium pores; moderate permeability; strong biological activity; gradual wavy boundary.
B22	25-52 cm	Brown (10YR 5/3 M) silt loam; moderate medium and coarse angular blocky breaking into subangular blocky structure; common fine faint yellowish brown (10YR 5/6) mottlings; firm when moist, sticky and slightly plastic when wet; few fine roots; few coarse and common medium pores; moderately slow permeability; diffuse wavy boundary.

C1 52-91 cm Brown (10YR 4/3 M) loam; moderate medium and coarse angular blocky structure; firm when moist, sticky and slightly plastic when wet; slight effervescence with dil. HCl; few fine roots; few coarse and common medium pores; moderately slow permeability; diffuse-smooth boundary.

C2 91 - 126 cm Yellowish brown (10YR 5/4 M) and dark yellowish brown (10YR 4/4 M) clay loam; massive; firm when moist, sticky and slightly plastic when wet; slight effervescence with dil. HCl; very few fine roots; few medium pores; slow permeability.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-11	0.40	33.40	26.55	24.75	16.00
11-25	0.30	22.80	26.25	27.75	21.75
25-52	0.15	21.10	25.24	27.50	26.00
52-91	1.45	30.20	15.35	26.50	26.50
91-126	1.10	17.90	26.10	24.50	29.75

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-11	1.45	8.25	0.40	0.17	0.52	6.52
11-25	1.45	8.00	0.35	0.17	0.27	8.69
25-52	-	8.00	0.50	0.17	0.22	9.79
52-91	-	7.85	1.30	0.28	0.19	10.60
91-126	-	8.20	1.35	1.12	0.18	11.96

Available Moisture in 60 cm profile is 12.4 cm and in 100 cm profile is 21.0 cm :

RANGE IN CHARACTERISTICS :

Colour of the surface soil ranges from pale brown (10YR 6/3) to yellowish brown (10YR 5/6) and texture from sandy loam to silt loam. Colour of the subsoil is brown (10YR 4/4) and texture is loam to silty clay loam or clay loam with clay per cent more than 18 in textural control section.

Available moisture capacity is 12.4 cm for 60 cm and 21.0 cm for 100 cm profile depth from the surface.

Surface texture, slope, calcareous and saline phases are mapped.

DRAINAGE & PERMEABILITY :

Moderately well drained with moderate permeability.

USE & VEGETATION :

Mostly cultivated to wheat. Natural vegetation consists of cynodon dectylon as grasses; Chinopodium sp., Asphodehus tunifolius, Lathyrous sativus as weeds; Accacia arabica, Delbergia sisoo, Azadirachta indica as trees.

DISTRIBUTION AND EXTENT :

It occupies 560 ha of land and is very extensive series; it is also found in Delhi Territory and Haryana State.

TYPE LOCATION :

The profile is located on nearly level cultivated land. (Approximately N latitude 28° 47' and E longitude 77° 2').

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Tentative

HISSAR SERIES

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Hissar series comprises well drained very deep, calcareous, brown to yellowish brown soils with silty clay loam texture. They occur on nearly level to gently sloping lands and are derived from old alluvium. Nodular lime and ferromanganese concretions are occasionally present. Hissar series is a member of fine loamy calcareous mixed, hyperthermic family of Typic Ustochrepts.

Typifying pedon : Silt loam - cultivated.

Horizon	Depth	Description
Ap	0-11 cm	Very pale brown (10YR 7/3 D), yellowish brown (10YR 5/4 M) silt loam; weak coarse subangular blocky structure; slightly hard; firm when moist, slightly sticky when wet; slight effervescence with dil. HCl; common fine, few medium roots; few medium tubular pores; moderately slow permeability; gradual wavy boundary.
B1	11-49 cm	Yellowish brown (10YR 5/4) silty clay loam; moderate coarse and very coarse angular blocky structure; firm moist, sticky and slightly plastic when wet; few fine faint yellowish brown (10YR 5/6) mottles; slight effervescence with dil. HCl; very few coarse, few medium and common fine roots; common medium tubular pores; slow permeability; few weak (2.5-3.5 cm) rodent holes present; diffuse, smooth boundary.
B2	49-82 cm	Yellowish brown (10YR 5/4) silty clay loam; moderate coarse subangular blocky; firm when moist, sticky and slightly plastic when wet; common fine faint yellowish brown

(10YR 5/6) mottles; strong effervescence with dil. HCl; very few (1-2 mm) soft ferro-manganese concretions; thin patchy clay film; few fine roots; common tubular pores; slow permeability; few rodent holes; diffuse-smooth boundary.

B22 82-123 cm Yellowish brown (10YR 5/4) clay loam, moderate, very coarse, angular blocky structure; firm, sticky and plastic when wet; common fine faint (10YR 5/6) mottles; strong effervescence with dil. HCl; few very fine roots; few medium and common coarse tubular pores; slow permeability; few about 3% by volume small calcium carbonate nodules; diffuse smooth boundary.

Cca 123-147 cm Yellowish brown (10YR 5/4) clay loam; massive when wet; weak coarse angular blocky structure; firm when moist sticky and slightly plastic when wet; few fine faint yellowish brown (10YR 5/6) mottles; violent effervescence with dil. HCl; few medium and coarse pores; very slow permeability; small calcium carbonate coated nodules (5% by volume) present.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-11	0.44	22.98	36.00	25.00	16.25
11-49	0.44	16.99	32.35	22.75	28.00
49-82	1.16	20.11	0.50	48.00	31.00
82-123	0.99	21.61	23.00	22.75	32.00
123-147	0.50	19.25	25.00	22.50	33.50

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-11	1.45	8.40	0.70	0.84	0.37	8.43
11-49	1.43	8.60	0.40	0.85	0.27	9.24
49-82	1.40	8.50	0.30	1.29	0.27	10.60
82-123	-	8.40	0.60	1.57	0.18	11.42
123-147	-	8.20	0.90	1.18	0.16	11.69

Available Moisture in 60 cm profile is 12.5 cm and
in 100 cm profile is 22.0 cm :

RANGE IN CHARACTERISTICS :

The colour of the surface soil ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/4) and texture from sandy loam to loam; surface structure is coarse subangular blocky. Colour in the sub-soil ranges from dark brown (10YR 4/3) to dark yellowish brown (10YR 4/4) and texture loam or silty clay loam. Clay is more than 18 per cent in the texture control section. Structure is subangular blocky to angular blocky; mottles are present mostly below 50 cm depth. The soils are calcareous, $CaCO_3$ is more than 1% in the first 50 cm profile. Nodular lime is present within 1 meter depth of the profile. C.E.C. is good.

Available moisture capacity is 12.5 cm for 60 cm and 22.0 cm for 100 cm, profile depth from the surface.

Surface texture, slope, calcareous and saline phases have been mapped.

DRAINAGE & PERMEABILITY :

Moderately well drained with moderate permeability.

USE & VEGETATION :

Intensively cultivated; one of the best soils of the area. Natural vegetation consists of Cyprus rotendus, Cynodon-dectylon as grasses; Chinopodium sp. Asphodelus tunifolius, Lathyrous sativus as weeds; Accacia arabica, Zizyphus jujuba, Date palm as trees.

DISTRIBUTION & EXTENT :

It occupies an area of 338.14 ha and is extensive. It also occurs in other parts of Delhi Territory and Haryana State.

TYPE LOCATION :

About 2 Km from the Bawana-Narela road and Delhi-Tail distributory crossing, 400 m east of Bawana escape (approximately N. latitude $^{\circ}$ 47' 40" and E. longitude 77° 2' 4").

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GHOGA SERIES

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Ghoga series comprises moderately well drained, very deep brown to dark yellowish brown clayey soils, on nearly level to low relief lands of upper alluvial plain, developed on old alluvium.

Ghoga series is a member of clayey, mixed, hyperthermic family of Udic Ustochrepts.

Typifying pedon : Ghoga silty clay loam - cultivated.

Horizon	Depth	Description
Ap	0-15 cm	Very pale brown (10YR 7/3 D) yellowish brown (10YR 5/4 M); silty clay loam; moderate coarse subangular blocky structure; hard when dry, firm when moist, sticky and slightly plastic when wet; few fine roots; common medium few coarse tubular pores; moderately slow permeability; clear wavy boundary.
B11	15-37 cm	Brownish yellow (10YR 6/6) and yellowish brown (10YR 5/4) clay loam; strong very coarse angular blocky tending to be prismatic; firm, sticky and slightly plastic; few fine roots; few medium tubular pores; slow permeability; diffuse smooth boundary.
B12	37-69 cm	Dark yellowish brown (10YR 4/4) silty clay loam; moderate coarse angular blocky tending to prismatic; firm when moist, very sticky and slightly plastic when wet; very few (2-3 mm) soft-ferromanganese nodules; thin patchy clay film along the pores; few fine roots; common medium tubular pores; slow permeability; diffuse smooth boundary.

B2 69-107 cm Dark brown (10YR 4/3) silty clay loam; moderate very coarse angular blocky tending to prismatic; firm when moist, very sticky and slightly plastic when wet; few (2-3 mm) soft ferromanganese nodules; thin clay films along the pores; few fine roots; common medium tubular pores; gradual wavy boundary.

C1 107-157 cm Dark yellowish brown (10YR 4/4) clay loam massive when wet; moderate coarse angular blocky structure; firm when moist, very sticky and slightly plastic when wet; common (05 mm) soft and hard ferromanganese nodules; few coarse and common medium tubular pores; slow permeability.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-15	0.15	17.61	32.62	29.75	20.75
15-37	-	13.90	23.00	31.60	32.50
37-69	0.50	16.24	16.25	31.50	35.50
69-107	0.31	13.06	20.48	28.00	38.00
107-157	0.52	17.57	19.71	28.00	33.75

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-15	1.45	8.10	0.20	0.45	0.45	12.51
15-37	1.45	8.15	0.20	0.11	0.28	12.51
37-69	1.43	8.10	0.20	0.39	0.27	13.68
69-107	-	7.70	0.20	0.22	0.22	13.85
107-157	-	7.85	0.50	0.11	0.18	13.68

Available Moisture in 60 cm profile is 14.4 cm and in 100 cm profile is 24.4 cm :

RANGE IN CHARACTERISTICS :

Colour of the surface soil ranges from grayish brown (10YR 5/3) to yellowish brown (10YR 5/4); texture varies from silt loam to silty clay loam. Subsoil colour varies from dark brown (10YR 3/3) to dark yellowish brown (10YR 4/4). Texture is silty clay loam to clay and clay per cent is more than 35 in texture control section. Structure is coarse angular blocky to prismatic and it is massive in C horizon. C.E.C. is good; clay mineralogy is mixed.

Available moisture capacity is 14.4 cm for 60 cm and 24.4 cm for 100 cm profile depth from the surface.

Surface texture and slope phases are mapped.

Ghoga series occupies an area of 164.75 ha.

DRAINAGE & PERMEABILITY :

Moderately well drained with slow permeability. Susceptible to stagnation.

USE & VEGETATION :

Used for wheat cultivation; natural vegetation consists of cynodon dectylon as grass; Lathyrous sativus, Chinopodium sp., orebanche aegyptiaca as weeds and Accacia arabica, Dalbergia sisoo as trees.

DISTRIBUTION & EXTENT :

Series occupies an area of 164.75 ha and is not much extensive. It is found to occur to a smaller extent in Delhi Territory.

TYPE LOCATION :

Located on flat (nearly level) plain, 2.5 km from Delhi Tail distributory and Bawana-Narela Road crossing and about 100 m east of unmettalled road (approximately N latitude 28° 49' 25" and E longitude 77° 2' 40").

Tentative

KHAMPUR SERIES

Khampur series comprises very deep, moderately well drained to poorly drained fine textured soils of pale brown to dark grayish alluvium. They are found to occur on nearly level lands on concave reliefs in depressions. Mottles are present in series control section.

Khampur series is a member of clayey, calcareous mixed hyperthermic family of Typic Halaquepts.

Typifying pedon : Khampur clay loam - cultivated.

Horizon	Depth	Description
A	0-12 cm	Grayish brown (2.5Y 5/2 D) dark grayish brown (2.5Y 4/2 M) clay loam; medium weak subangular blocky structure; hard firm, sticky and plastic; few fine roots; strong effervescence; clear and wavy boundary.
A3	12-29 cm	Dark grayish brown (2.5Y 4/2 M) clay loam; medium moderate subangular blocky structure; fine roots; common medium pores; strong effervescence with dil. HCl ; clear and wavy boundary.
B21	29-60 cm	Dark grayish brown (2.5Y 4/2 M) clay; moderate coarse angular blocky structure; firm sticky and plastic; common fine distinct iron mottles of strong brown (7.5YR 5/6) colour; slight effervescence with dil. HCl; few fine roots; common medium pores; gradual and wavy boundary.

B22	60-84 cm	Dark grayish brown (10YR 4/2 M) clay; coarse strong angular blocky structure; firm sticky and plastic; slight effervescence with dilute acid; few medium roots; few coarse pores; few fine faint iron mottles; diffuse and wavy boundary.
C1	84-104 cm	Dark grayish brown to grayish brown (10YR 4.5 M) clay; medium to coarse angular blocky structure; firm, sticky and plastic; strong effervescence; few medium roots; common pores; soft ferro-manganese concretions; 15-20% small acid soft calcium carbonate coated nodules; few fine faint iron mottles; diffuse and wavy boundary.
C2	104-113 cm	Dark grayish brown (10YR 4/2 M) clay; medium moderate angular blocky structure; firm, sticky and plastic; strong effervescence with dil. HCl; common fine faint iron mottles; 10% lime concretions by volume; few medium roots; common coarse pores; clear and wavy boundary.
C3	113-135 cm	Dark grayish brown (10YR 4/2 M) clay; massive; firm very sticky and very plastic; strong effervescence with dil. HCl; many medium distinct iron mottles; 5 to 40% small to medium concretions in pockets.

(contd.....30/.....)

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-12	24.1	22.8	1.8	26.5	28.0
12-29	16.8	25.3	1.3	24.5	33.5
29-60	17.5	27.3	2.0	18.2	36.5
60-84	9.7	14.4	1.9	33.2	43.0
84-104	5.9	8.6	2.0	35.0	45.0
104-113	9.0	4.1	2.0	36.3	51.2
113-155	4.3	8.3	1.3	46.0	40.0

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-12	1.45	7.9	9.0	2.35	0.54	10.34
12-29	1.45	7.9	6.0	0.56	0.27	8.16
29-60	-	7.5	6.0	0.25	0.18	16.32
60-84	-	7.6	3.3	0.25	0.27	12.51
84-104	-	7.5	4.5	0.25	0.21	27.2
104-113	-	7.7	5.0	1.94	0.22	25.02
113-135	-	7.7	5.0	2.56	0.27	19.58

Available Moisture in 60 cm profile is 14.1 cm and
in 100 cm profile is 24.0 cm :

RANGE IN CHARACTERISTICS :

The colour of the surface soil ranges from grayish brown to brown and texture from silt loam to silty clay. Sub-soil colour ranges from dark grayish brown to grayish brown and texture from loam to silty clay. Mottles are present in the soil profile. Texture control section

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is clayey with clay per cent more than 35.

Available Moisture Capacity is 14.1 cm for 60 cm and 24.0 cm for 100 cm profile depth from the surface.

DRAINAGE & PERMEABILITY :

Imperfectly drained with slow permeability.

USE & VEGETATION :

Cultivated to paddy, wheat, and berseem. Natural vegetation consists of trees like Accacia arabica, Zizyphus jujuba, Butea monosperma and grasses i.e. Cynodon dactylon, Orebanche aegyptiaca.

DISTRIBUTION & EXTENT :

It occupies an area of 31.84 ha and of limited extent.

TYPE LOCATION :

About 3/4 Km from the Sanoth village to the east (approximately N latitude 28° 49' and E longitude 77° 6').

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SANTOSH SERIES

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Santosh series comprises well drained to moderately well drained, very deep, calcareous, fine loamy over coarse loamy soils of pale brown to yellowish brown colours. The soils occur on nearly level lands. They have weakly developed 'B' horizon.

Santosh series is a member of fine loamy over coarse loamy calcareous, mixed, hyperthermic family of Typic Ustochrepts.

Typifying pedon : Santosh loam - cultivated.

Horizon	Depth	Description
Ap	0-13 cm	Very pale brown (10YR 7/3 D) and pale brown (10YR 6/3 D) and yellowish brown (10YR 5/4 M) loam; weak medium subangular blocky; firm when moist, slightly sticky when wet; strong effervescence with dil. acid; few fine and few medium roots; few medium tubular pores; moderate permeability.
B21	13-29 cm	Yellowish brown (10YR 5/4) loam; weak coarse subangular blocky structure; hard when dry, firm when moist, slightly sticky when wet; strong effervescence with dil. acid; few fine roots; common medium and few coarse tubular pores; moderate slow permeability; diffuse, wavy boundary.
B22	29-49 cm	Yellowish brown (10YR 5/4 M) loam; moderate coarse subangular blocky structure; firm when moist, sticky and plastic when wet, strong effervescence with dil. acid; few fine roots; common medium and few coarse pores; moderately slow permeability; gradual, wavy boundary.

C1	49-108 cm	Brownish yellow (10YR 6/6) sandy loam; massive, friable to firm when moist, slightly sticky when wet; violent effervescence with dil. acid; common (3-5 m)few fine roots; few medium and few coarse pores; moderate permeability.
C2	108+ cm	Water-table

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-13	0.89	37.70	31.00	15.25	15.00
13-29	0.71	35.79	23.00	21.75	19.50
29-49	1.06	35.79	22.00	22.50	20.75
49-108	1.01	66.81	12.00	7.30	13.25

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-13	1.50	8.30	0.60	1.57	0.45	8.26
13-29	1.50	8.50	0.55	0.62	0.45	9.10
29-49	-	8.60	0.60	1.12	0.22	8.43
49-108	-	8.55	0.50	0.28	0.15	6.10

Available Moisture in 60 cm profile is 9.0 cm and
in 100 cm profile is 13.0 cm :

RANGE IN CHARACTERISTICS :

Colour of the surface soil ranges from brown (10YR 5/4) to dark yellowish brown (10YR 4/4); texture is sandy loam or loam. Colour

CB

in the sub-soil varies from dark brown (10YR 3/3) to yellowish brown (10YR 5/4). Texture is variable between clay loam and loam or sandy loam.

A high fluctuating ground water-table and seasonal inundation during monsoon keeps the soil saturated for a significant part of the year. External drainage is poor at places.

Available moisture capacity of the soil is 09.0 cm for 60 cm and 13.0 cm for 100 cm profile.

DRAINAGE & PERMEABILITY :

Imperfectly drained with moderately slow permeability.

USE & VEGETATION :

Cultivated to wheat. Natural vegetation comprises Zizyphus jujuba, Butea monospoma, Accacia arabica as trees; Nelitotus sp. vicia sp. Euphorbia draum as weeds.

DISTRIBUTION & EXTENT :

It occupies an area of 31.84 ha and is limited in extent.

TYPE LOCATION :

The profile is located on gently sloping low lying cultivated land about 1/2 Km from the Delhi Tail distributory and Bawana-Narela Road (oroximately N latitude 28° 48' 25" and E longitude 77° 48' 30")

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Tentative

SANOTH SERIES

Sanoth series comprises very deep, moderately well drained fine loamy over coarse loamy or sandy calcareous soils of dark brown to yellowish brown colours. They have developed over Yamuna alluvium. They occur on nearly level lands of slope of 0-2 per cent in old meander plains.

Sanoth series is tentatively classified as a member of fine loamy over coarse loamy, calcareous, mixed hyperthermic family of Aeric Halaquepts.

Typifying pedon : Sanoth clay loam - Cultivated.

Horizon	Depth	Description
Ap	0-18 cm	Very dark grayish brown to dark grayish brown (2.5Y 3.5/2) clay loam; coarse moderate angular blocky structure; slightly firm, slightly sticky and slightly plastic; strong effervescence with dilute HCl; few coarse and medium roots; clear and smooth boundary.
B11	18-38 cm	Dark brown (10YR 3/3 M) loam; medium moderate angular blocky; slightly hard, friable, slightly sticky and plastic; strong effervescence with dil. acid; common fine distinct iron mottles of dark brown to brown (7.5YR 4/4) colour; few medium and coarse roots; few coarse and medium pores; gradual and smooth boundary.
B12	38-74 cm	Dark brown (10YR 3/3 M)sandy loam; weak medium angular blocky structure; friable, slight effervescence with dil. acid; soft ferromanganese concretions 2 mm in diameter; common fine

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distinct iron mottles of dark brown (7.5YR 3/2) colour; diffused and smooth boundary.

C1 74-96 cm Dark brown to brown (10YR 4/3 M) sandy loam; massive; friable; slight effervescence with dil. HCl; few fine and medium roots; many distinct iron mottles of dark brown (7.5YR 3/2) colour.

C2 96-127+ cm Not examined.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand %	Fine Sand %	Coarse Silt %	Fine Silt %	Clay %
0-18	16.08	21.78	20.09	30.77	11.75
18-38	30.42	24.88	9.38	19.17	17.12
38-74	39.98	20.88	6.46	11.25	17.00
74-96	42.15	27.45	3.58	8.65	16.75
96-127+	39.67	23.48	3.58	10.02	18.30

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity m mho/cm	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-18	1.50	7.40	12.00	1.37	0.48	13.06
18-38	1.55	7.80	5.00	0.31	0.16	10.61
38-74	-	7.85	5.50	0.15	0.01	9.25
74-96	-	8.00	3.60	0.10	0.12	8.16
96-127+	-	8.00	2.50	nil	0.07	9.79

Available Moisture in 60 cm profile is 9.0 cm and
in 100 cm profile is 13.0 cm :

RANGE IN CHARACTERISTICS :

The colour of the surface soil ranges from grayish brown to brown in 2.5Y and 10YR hue and texture varies from clay loam to loam.

Sub-soil colour varies from very dark grayish brown to brown in 10YR hue and texture ranges from sandy loam to loamy sand. The structure is weak to medium angular blocky; water-table may be presen within series control section. Iron mottles and ferro-manganese concretions are present within 50 cm from surface.

Available moisture capacity is 9.0 cm for 60 cm and 13 cm for 100 cm profile depth from the surface.

DRAINAGE & PERMEABILITY :

Imperfectly to poorly drained with moderately slow permeability.

USE AND VEGETATION :

Uncultivated lands and saline lands; natural vegetation consists of salt weeds of Halozylon sp.

DISTRIBUTION & EXTENT :

Limited in extent, about 35.40 ha.

TYPE LOCATION :

About 1/2 Km from the Sanoth village to the north-west (approximately N latitude 28° 49' and E longitude 77° 6').

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Tentative

NAGAR SERIES

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Nagar series comprises, moderately well drained to imperfectly drained, very deep, sandy loam over clay loam or silty clay loam (coarse loamy over fine loamy) soils of brown to dark yellowish brown colour. Clay is more than 18 per cent below 50 cm depth from the surface. These soils are found to occur on nearly level to almost flat lands of O-1% slope.

Nagar series is a member of coarse loamy over fine loamy, mixed hyperthermic family of Typic Ustifluents.

Typifying pedon : Nagar loam-cultivated.

Horizon	Depth	Description
Ap	0-26 cm	Yellowish brown (10YR 5/4 M) loam; moderate, medium subangular blocky; hard when dry friable when moist, slightly sticky; strong effervescence with dil. HCl; clear and smooth boundary; common fine to medium continuous roots; common fine exped pores.
A3	26-63 cm	Yellowish brown (10YR 5/4 M) sandy loam; moderate fine to medium, subangular blocky; slightly hard when dry friable when moist and slightly sticky when wet; slight effervescence with dil. HCl; abrupt wavy boundary; fine to medium continuous roots; many fine to medium exped pores.
C1	63-83 cm	Dark yellowish brown (10YR 4/4 M) silty clay loam; strong coarse angular blocky ; very hard when dry, firm when moist sticky and plastic; strong effervescence; clear wavy boundary; common fine to medium continuous roots; few inped pores.

C2 83-150 cm Brown (10YR 5/3) silty clay loam; strong coarse, angular blocky; very hard when dry, firm when moist, sticky and plastic; strong effervescence with dil. HCl; many medium faint mottles; few fine continuous roots; plentiful fine to medium inped and exped pores.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-26	1.70	45.30	24.00	14.00	15.00
26-63	0.42	57.90	20.85	11.75	12.00
63-83	1.60	7.15	25.25	29.80	35.25
83-150	1.80	15.47	41.07	8.75	32.00

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mmho/cm	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-26	1.58	8.5	2.15	3.30	0.17	10.34
26-63	1.50	8.5	0.95	1.68	0.08	8.16
63-83	1.45	8.60	1.60	2.86	0.16	16.32
83-150	1.45	8.35	1.10	0.34	0.08	12.51

RANGE IN CHARACTERISTICS : Available Moisture in 60 cm profile is 6.7 cm and in 100 cm profile is 14.8 cm.

The colour of the surface soil ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6, 5/4). Texture ranges from sandy loam to loam. Subsoil colour ranges from brown (10YR 5/3) to dark yellowish brown (10YR 4/4) and texture from loam to silty clay loam and fine loam. Structure is subangular blocky to angular blocky. Mineralogy is mixed. High ground water may be present during winter.

Available moisture capacity is 06.7 cm for 60 cm depth and 14.8 cm for 100 cm profile depth.

DRAINAGE AND PERMEABILITY :

Moderately well drained with moderate permeability.

USE AND VEGETATION :

Mainly cultivated to barley. Natural vegetation consists of salt weeds and Accacia trees.

DISTRIBUTION AND EXTENT :

It occupies an area of 4.44 ha. Not extensive in occurrence and found in small scattered patches in the village of Holambi Kalan.

TYPE LOCATION :

The profile is located in field No. 20 Block No. 20 in between N latitude 28° 49' and E longitude 77° 6'.

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 Tentative

WAZIRABAD SERIES

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Wazirabad series consists of very deep, imperfectly drained, highly stratified soils of light brownish gray to yellowish brown colours. They occur on meander plains as well as recent flood plain of Jamuna river. They remain under flood water every year for a few days.

Wazirabad series is a member of coarse loamy, calcareous, mixed hyperthermic family of Typic Ustifluvents.

Typifying pedon : Wazirabad fine sandy loam-cultivated.

Horizon	Depth	Description
Ap	0-15 cm	Light brownish grey (10YR 6/2D) yellowish brown (10YR 5/4 M) fine sandy loam; weak; fine to medium, granular; slightly hard when dry, friable when moist, slightly sticky; strong effervescence with dilute acid; common fine roots; many fine pores; clear smooth boundary.
A3	15-40 cm	Light brownish grey (10YR 6/2 D) yellowish brown (10YR 5/4 M)fine sandy loam; weak, fine to medium, crumb; slightly hard, friable, slightly sticky; strong effervescence with dil. HCl; few fine roots; many fine pores; gradual smooth boundary.
C1	40-70 cm	Light brownish grey (10YR 6/2 D) yellowish brown (10YR 5/4 M) loamy sand; weak, fine, crumb; loose; few fine roots; many fine pores; abrupt wavy boundary.

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C2 70-99 cm Light grey (10YR 7/2 D) light brownish grey (10YR 6/2 M) sand; single grain, sometimes effervescence due to lime pocket; few fine roots; abrupt wavy boundary.

IIC3 990-165 cm Dark yellowish brown (10YR 4/4 M) silt loam; moderate, fine, subangular blocky; hard, firm, sticky and plastic; strong effervescence; few fine roots; many fine to medium pores; few medium size roots throughout the profile.

PARTICLE SIZE DISTRIBUTION

Depth (cm)	Coarse Sand%	Fine Sand%	Coarse Silt%	Fine Silt%	Clay %
0-15	2.03	31.41	37.45	18.45	12.85
15-40	0.33	27.28	44.05	22.17	8.70
40-70	0.28	25.46	48.67	21.67	7.23
70-99	1.29	67.62	22.30	5.70	6.50
99-165	3.21	7.63	21.98	51.00	19.00

PHYSICO-CHEMICAL PROPERTIES

Depth (cm)	Bulk Density (g/cc)	pH (1:2.5)	Electrical conductivity mho/cm.	$CaCO_3$ %	Organic Carbon %	CEC M.eq/ 100 g
0-15	1.45	8.2	1.05	1.37	0.33	7.07
15-40	1.45	8.2	0.70	1.65	0.22	7.62
40-70	-	8.1	0.60	1.48	0.19	7.34
70-99	-	8.2	0.35	1.04	0.09	6.26
99-165	-	7.5	0.85	3.74	0.35	13.60

Available Moisture in 60 cm profile is 7.6 cm and in 100 cm profile is 14.7 cm.

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RANGE IN CHARACTERISTICS :

The surface soil colour varies from light yellowish brown to yellowish brown. The textures are variable and have sand, loamy sand, fine sandy loam or sandy loam. They are calcareous except coarse sand.

The colours of sub-soil range from light brownish gray to dark yellowish brown (10YR 6/2 to 10YR 4/4). The strata of sand, fine sand, loamy sand, sandy loam, fine sandy loam and silt loam are found without any sequence. All variable textured strata are calcareous and stratified within the horizon.

Available moisture capacity is 7.6 cm for 60 cm and 14.7 cm for 100 cm profile depth from the surface.

DRAINAGE & PERMEABILITY :

Moderately well drained to imperfectly drained with moderate permeability.

USE AND VEGETATION :

Mainly cultivated to jowar, sugarcane, wheat and vegetables.

DISTRIBUTION & EXTENT :

These are not extensive and have hardly 9 ha of land.

TYPE LOCATION :

About 1½ Km from village Hiranki towards South-east near Bawana escape end.

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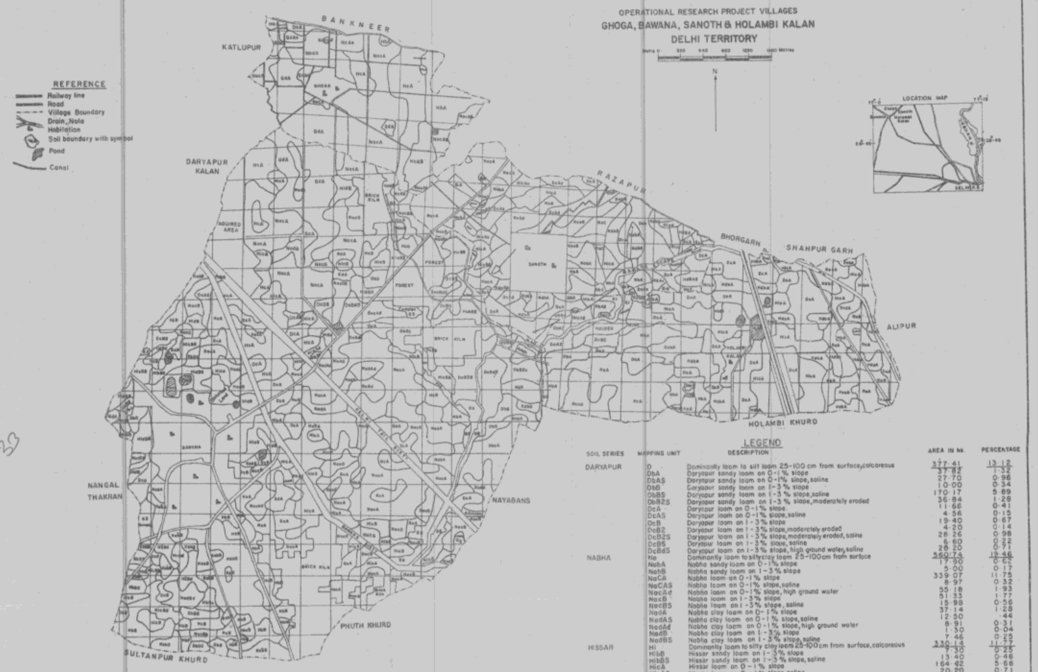
SOIL MAP

OPERATIONAL RESEARCH PROJECT VILLAGES
GHOGA, BAWANA, SANOTH & HOLAMBI KALAN
DELHI TERRITORY



LEGEND

SOIL SERIES	MAPPING UNIT	DESCRIPTION	AREA IN ha.	PERCENTAGE
RAZAPUR	R	Dominantly loamy sand to sandy loam 25-100 cm from surface	44·04	1·54
	RaA	Razapur loamy sand on 0-1 % slope	30·04	1·04
	RaB	Razapur loamy sand on 3 % slope	5·00	0·18
	RaC	Razapur loamy sand on 3-5 % slope.	9·00	0·32
KAKRA	Ka	Dominantly sandy loam 25-100 cm from surface	126·12	4·37
	KaaA	Kakra loamy sand on 0-1% slope	10·08	0·34
	KabA	Kakra sandy loam on 0-1 % slope	31·60	1·09
	KaбA	Kakra sandy loam on 0-1% slope, calcareous surface	4·02	0·14
	KabAS	Kakra sandy loam on 0-1% slope, saline	0·60	0·02
	KaaB	Kakra loamy sand on 1-3 % slope	56·84	1·97
	KabB	Kakra sandy loam on 1-3 % slope	12·60	0·44
	KaбB	Kakra sandy loam on 1-3 % slope, calcareous surface	10·38	0·36
HAMIDPUR	Hd	Dominantly sandy loam to loam 25-100 cm from surface, calcareous	99·89	3·48
	HdaA	Hamidpur loamy sand on 0-1% slope	4·56	0·16
	HdbA	Hamidpur sandy loam on 0-1% slope	42·84	1·48
	HdbA	Hamidpur sandy loam on 0-1 % slope, saline	9·87	0·35
	HdbB	Hamidpur sandy loam on 1-3 % slope	5·60	0·19
	HdbB2	Hamidpur sandy loam on 1-3 % slope, moderately eroded	15·30	0·54
	HdbBS	Hamidpur sandy loam on 1-3 % slope, saline	7·44	0·26
	HdbB2S	Hamidpur sandy loam on 1-3 % slope, moderately eroded, saline	4·80	0·18
	HdcA	Hamidpur loam on 0-1 % slope	9·48	0·33
HOLAMBI	H	Dominantly loam to silt loam 25-100 cm from surface	392·97	13·65
	HaB	Holambi loamy sand on 1-3 % slope	13·92	0·48
	HbA	Holambi sandy loam on 0-1 % slope	79·86	2·76
	HbB	Holambi sandy loam on 1-3 % slope	0·80	0·02
	HbB2	Holambi sandy loam on 1-3 % slope, moderately eroded	187·99	6·51
	HbBS	Holambi loam on 1-3 % slope, saline	7·15	0·25
	HcA	Holambi loam on 0-1 % slope	5·16	0·16
	HcAS	Holambi loam on 0-1% slope, saline	3·50	0·12
	HcAd	Holambi loam on 0-1% slope, high groundwater	55·11	1·92
	HcB	Holambi loam on 1-3 % slope	7·00	0·24
	HčB	Holambi loam on 1-3 % slope, calcareous surface	14·46	0·51
	HcBS	Holambi loam on 1-3 % slope, saline	2·80	0·09
	HcBd	Holambi loam on 1-3 % slope, high ground water	10·62	0·38
	HcBdS	Holambi loam on 1-3 % slope, high ground water, saline	4·60	0·16

LEGEND

SOIL SERIES	MAPPING UNIT	DESCRIPTION	AREA IN ha.	PERCENTAGE
DARYAPUR	D	Dominantly loam to silt loam 25-100 cm from surface, calcareous	377·41	13·12
	DbA	Daryapur sandy loam on 0-1 % slope	37·82	1·32
	DbAS	Daryapur sandy loam on 0-1% slope, saline	27·70	0·96
	DbB	Daryapur sandy loam on 1-3 % slope	10·00	0·34
	DbBS	Daryapur sandy loam on 1-3 % slope, saline	170·17	5·89
	DbB2S	Daryapur sandy loam on 1-3 % slope, moderately eroded	36·84	1·28
	DcA	Daryapur loam on 0-1 % slope.	11·66	0·41
	DcAS	Daryapur loam on 0-1 % slope, saline	4·56	0·15
	DcB	Daryapur loam on 1-3 % slope	19·40	0·67
	DcB2	Daryapur loam on 1-3 % slope, moderately eroded	4·20	0·14
	DcB2S	Daryapur loam on 1-3 % slope, moderately eroded, saline	28·26	0·98
	DcBS	Daryapur loam on 1-3 % slope, saline	6·60	0·22
	DcBdS	Daryapur loam on 1-3 % slope, high ground water, saline	28·20	0·71
NABHA	Na	Dominantly loam to silty clay loam 25-100 cm from surface	560·74	19·46
	NabA	Nabha sandy loam on 0-1% slope	17·90	0·62
	NabB	Nabha sandy loam on 1-3 % slope	5·00	0·17
	NaCA	Nabha loam on 0-1 % slope	339·07	11·75
	NaCAS	Nabha loam on 0-1% slope, saline	8·97	0·32
	NacAd	Nabha loam on 0-1% slope, high ground water	55·18	1·93
	NacB	Nabha loam on 1-3% slope	51·33	1·77
	NacBS	Nabha loam on 1-3% slope, saline	15·98	0·56
	NadA	Nabha clay loam on 0-1% slope	37·14	1·28
	NadAS	Nabha clay loam on 0-1 % slope, saline	12·50	·44
	NadAd	Nabha clay loam on 0-1 % slope, high ground water	8·91	0·31
	NadB	Nabha clay loam on 1-3% slope	1·30	0·04
	NadBS	Nabha clay loam on 1-3 % slope, saline	7·46	0·25
HISSAR	Hi	Dominantly loam to silty clay loam 25-100 cm from surface, calcareous	330·14	11·77
	HibB	Hissar sandy loam on 1-3% slope	7·30	0·25
	HibBS	Hissar sandy loam on 1-3 % slope, saline	13·40	0·46
	HicA	Hissar loam on 0-1 % slope	164·42	5·68
	HicAS	Hissar loam on 0-1 % slope, saline	20·20	0·71
	HicAd	Hissar loam on 0-1 % slope, high ground water	6·20	0·22
	HicB	Hissar loam on 1-3 % slope	42·54	1·48
	HicBS	Hissar loam on 1-3 % slope, saline	33·54	1·17
	HidA	Hissar clay loam on 0-1 % slope	5·92	0·21
	HidB	Hissar clay loam on 1-3 % slope	12·98	0·44
	HidBS	Hissar clay loam on 1-3 % slope, saline	26·34	0·92
	HidB2dS	Hissar clay loam on 1-3 % slope, moderately eroded, high ground water, saline	5·30	0·18
GHOGA	G	Dominantly silty clay loam to clay 25-100 cm from surface	164·75	5·62
	GcA	Ghoga loam on 0-1 % slope	44·92	1·56
	GcAd	Ghoga loam on 0-1 % slope, high ground water	6·60	0·22
	GdA	Ghoga clay loam on 0-1 % slope	104·96	3·55
	GdAS	Ghoga clay loam on 0-1 % slope, saline	2·43	0·08
	GdAd	Ghoga clay loam on 0-1 % slope, high ground water	5·84	0·20
KHAMPUR	K	Dominantly silty clay loam to clay 25-100 cm from surface, calcareous	31·84	1·10
	KcAd	Khampur loam on 0-1 % slope, high ground water	16·60	0·57
	KdAS	Khampur clay loam on 0-1% slope, saline	15·24	0·53
SANTOSH	Sn	Dominantly clay loam to loam over sandy loam or loamy sand 25-100cm from surface, calcareous	18·56	0·63
	ShbA	Santosh sandy loam on 0-1% slope	2·04	0·08
	SncAd	Santosh loam on 0-1% slope, high ground water	6·00	0·21
	SncB	Santosh loam on 1-3 % slope	0·84	0·04
	SncBdS	Santosh loam on 1-3 % slope, high ground water, saline	4·40	0·15
	SndA	Santosh clay loam on 0-1 % slope	5·28	0·18
SANOTH	S	Dominantly clay loam to loam over sandy loam or loamy sand 25-100cm from surface, calcareous.	35·40	1·24
	ScA	Sanoth loam on 0-1% slope	9·20	0·32
	ScAd	Sanoth loam on 0-1 % slope, high ground water	26·20	0·92
NAGAR	N	Dominantly sandy loam over clay loam 25-100 cm from surface	4·44	0·14
	NbAS	Nagar sandy loam on 0-1 % slope, saline	3·36	0·11
	NcAdS	Nagar loam on 0-1 % slope, high ground water, saline	1·08	0·03
WAZIRABAD	W	Highly variable textures 25-100 cm from surface, calcareous	9·00	0·31
	WbA	Wazirabad sandy loam on 0-1% slope	9·00	0·31
COMPLEX	G	Undifferentiated soils	17·90	0·61
	G1	Hamidpur - Santosh series, Complex	5·28	0·18
	G2	Hamidpur - Daryapur, Razapur series, Complex	7·36	0·25
	G3	Nabha - Kakra series Complex	5·26	0·18
	OTHERS	Gullied land (GG)	32·50	1·12
MISCELLANEOUS		Habitation, Roads, Tracks, Ponds, Canal, Brick kiln etc.,	609·65	21·54
		Grand Total	2885·00	100·00

Surveyed By:- A.L. Das, R.K. Saxena & K. S. Verma
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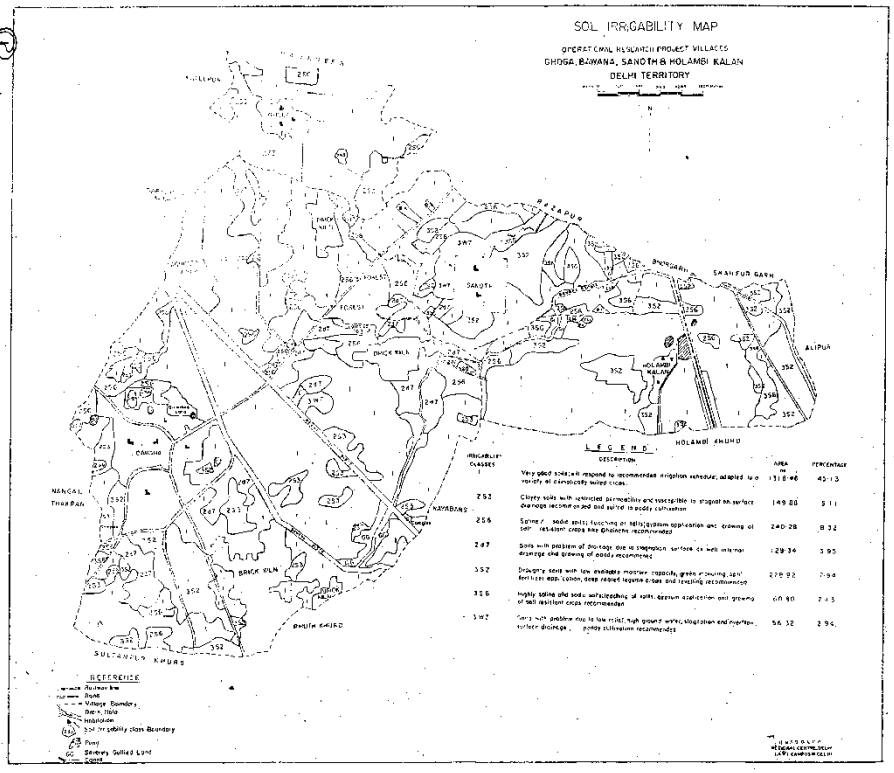
SOIL IRRIGABILITY MAP
OPERATIONAL RESEARCH PROJECT VILLAGES
GHOGA, BAWANA, SANOTH & HOLAMBI KALAN
DELHI TERRITORY
N
BAWANA
GHOGA
SANOTH
HOLAMBI KALAN
ALIPUR
SHAHPUR GARH
BAKHTAWARPUR
BRICK KILN
FOREST
CANCHAN
NANGAL THAKRAN
NAYABANS
SULTANPUR KHURD
LEGEND
DESCRIPTION
IRRIGABILITY CLASSES
AREA in
PERCENTAGE
Very good soils; will respond to recommended irrigation schedule; adapted to a variety of climatically suited crops.
253
131.46
40.13
Clayey soils with restricted permeability and susceptible to stagnant surface drainage; recommended rice and wheat in paddy cultivation
149.80
5.11
Saline / sodic soils; flushing of salts/gypsum application and growing of salt resistant crops like dhaincha recommended
256
240.28
8.32
Soils with problem of drainage due to stagnation surface as well internal drainage and growing of paddy recommend
287
129.34
3.95
Droughty soils with low available moisture capacity, green manuring, split fertilizer application, deep rooted legume crops and levelling recommended
352
226.92
7.94
Highly saline and sodic soils; gypsum application and growing of salt resistant crops recommended
316
69.80
2.43
Soils with problem due to low relief, high ground water, irrigation and multiple surface drainage, paddy cultivation recommended
342
56.32
2.94
REFERENCE
Railway line
Road
Village Boundary
District Boundary
Irrigability class Boundary
Pump
Salinity Sulfied Land
Canal