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Soil Classification of Punjab-Haryana Plain

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Abstract **:** The major aim of the present paper is to classify the soils of Punjab–Haryana plain. For achieving this purpose, the study is divided into three parts. First part deals with the physical and chemical properties of the soils of the study region. In second part, the soil classification of Punjab-Haryana Plain is made and the conclusions are drawn and suggestions are made in third part. The study has found that soils of Punjab-Haryana Plain are predominately loamy and sandy-loam, which are highly suitable for crop farming. The pH value of the soil of the region varies from 7.0 to 8.5 which are highly ideal for agricultural purposes. It is also found that soils of the study region are non-acidic in nature. On the basis of agronomic characteristics, soils of Punjab-Haryana Plain have been classified into eight types namely shiwalik soils, piedmont soils, loamy soils, sandy soils, silty clay soils, light loamy soils, sandy soils and rocky soils. Among these soil types, the highly suitable soils for crop farming are loamy, sandy loam, light loam and silty clay which yield high productivity per unit area. The problematic soils are shiwalik, piedmont, sandy and rocky where the fertility is low and require more plowing as well as manure for successful crop farming. The study has suggested that there is a dire need to nurture the soils with green manure and fertilizers for sowing successful crops like wheat, rice, cotton, pulses, maize, fodder etc. On the whole, soils of Punjab-Haryana Plain are suitable for cultivation of a number of crops.
Keywords- Agronomic, Soil Texture, Soil Structure pH value, Loamy and Sandy Soil.

1. INTRODUCTION

"The wealth of a nation lies in her soils and its intelligent development".
Moores, R.G. (1970)

Soil is a changed mass of material derived from minerals and containing the decomposition products of plants and animals (Sprengel, 1844). The soil contains two kinds of matter: organic, the part, which is combustible and inorganic, the part, which will not burn (Kent, 1856). The soil is the upper weathering layer of the solid earth crust. Soil is more or less loose and friable material in which, by means of their roots, plants may or do find a foothold and nourishment, as well as other conditions of growth (Hilgard, 1906). The soil is a natural body, differentiated into horizons of mineral and organic constituents, usually unconsolidated of variable depth, which differs from the parent material below in morphology, physical properties and constitution, chemical properties and composition, and biological characteristics (Joffe, 1949). In any agricultural operation, soil is of the utmost importance as it is the cradle for all crops and plants. The top soil having an average depth of about 15 to 20 cm on the face of the surface is the natural body of soil on which plants grow and the farming activities flourish. The standard of living of the people dependent on agriculture is often determined by the fertility and productivity of soils (Husain, 1996). Soil is the unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and shows the effects of genetic and environmental factors of: climate, macro- and microorganisms, conditioned by relief, acting on parent material over a period of time (SSSA, 1997). Soil is one of the most fundamental resources for producing food and fiber, thus fulfilling the diverse human needs and maintaining the global ecosystems (Doran, 2002). The natural unconsolidated mineral or organic matter on the surface of earth that has been influenced by parent material, climate, macro and microorganisms, and relief, all acting over a period of time to produce a material different from which it was derived in many physical, chemical, biological, morphological properties (Gregorich et.al, 2000). Soil exists at the boundary between the atmosphere and Earth's subsurface. It plays a critical role in the hydrologic cycle, in addition to serving as the location of most human activity. The soil has developed from parent material through biological and other factors of weathering. If time is sufficient, then horizons will have formed with differing physical and chemical properties. At greater depths the soil merges with additional unconsolidated material. Eventually at still greater depths, bedrock is encountered (Warrick, 2003). Scientifically, soil is a natural body consisting of weathered geological materials from the upper lithosphere (Earth's crust) in which minerals, organic matter from plants and other biotic residues, water, air and billions of living organisms are closely intermingled. Soil is the living upper part of the Earth's crust, a complex natural body and an integral part of the element cycles. It is the link between the atmosphere and geological formations of the Earth's crust. Moreover, soil is a biological habitat, gene pool, an element of the landscape, a part of our cultural heritage and in addition, a provider of raw materials. Agriculture depends on soil for the supply of water and nutrients, as well as for plant root fixation. Soil through their structures and their inhabitant species, perform numerous functions including nutrient and water storage,

filtering, buffering and as well as breakdown and conversion of matter and gases, thus playing a central role in the protection of water and beneficial exchange of gases with the atmosphere.

Properties of Soil

Although soil in general contains the same components, these differ in their properties and characteristics. These differences affect or determine the management of soils. Soils have many different properties like texture, structure, color and pH value. Soil properties combine to make soil useful for a wide range of purposes. These govern the types of plants grown in a soil and particular crops grown in a region. Some of the main soil properties that are important are discussed below:

I) Soil Texture

Soil texture, perhaps a soil's most permanent attribute, refers to the mixture of the sizes of its particles and the proportion of different sizes. Individual mineral particles are called soil separates. As no soil is made of uniform size, the texture of soil is determined by the relative amounts of various separates present (sand, silt and clay). The classification of soil separates used by the U.S. Department of Agriculture and their range in diameter size is shown in table no.1

Table No. 1
Soil Texture Grades

Sr. No.	Soil Grade	Diameter (mm)
1	Very coarse sand	2.0 – 1.0 mm
2	Coarse sand	1.0 – 0.5 mm
3	Medium sand	0.5 – 0.25 mm
4	Fine sand	0.25 – 0.10 mm
5	Very fine sand	0.10 – 0.05 mm
6	Silt	0.05 – 0.002 mm
7	Clay	< 0.002 mm

Source – United States, Department of Agriculture (NRCS), 1951

The textural class of soil is determined by the percentage of sand, silt, loam and clay. For some purpose, it is necessary to make fine distinctions in texture; the basic classes used in terms of size distribution.

Sand

Sand is loose and single-grained. The individual grains can be seen or felt readily. Squeezed in the hand when dry, sand falls apart when pressure is released. Squeezed when moist, it forms a cast but crumbles when touched.

Sandy Loam

A sandy loam is soil containing a high percentage of sand but having enough silt and clay to make it somewhat coherent. The individual sand grains can be readily seen and felt. Squeezed when dry, a sandy loam forms a cast that falls apart readily. If squeezed when moist, a cast can be formed that bears careful handling without breaking.

Loam

A loam is a soil having a relatively even mixture of different grades of sand, silt, and clay. It is mellow with a somewhat gritty feel but is smooth and slightly plastic. Squeezed when dry, it forms a cast that bears careful handling, and the cast formed by squeezing the moist soil can be handled freely without breaking.

Silt Loam

Silt loam is a soil texture dominated by silt particles with moderate fine sand and little clay. In a dry state, a silt loam appears cloddy, but the lumps can be broken readily. When pulverized, it feels soft with smooth sensation and floury. Under wet conditions, the soil runs together readily and puddles. Either dry or moist, silt loam forms a cast that can be handled freely without breaking. When moistened and squeezed between thumb and finger, it does not ribbon but has a broken appearance.

Clay Loam

A clay loam is a moderate fine-textured soil that usually breaks into clods or lumps that are hard when dry. When the moist soil is pinched between thumb and finger, it forms a thin ribbon that breaks readily, barely sustaining its own weight. The moist soil is plastic and forms a cast that bears much handling. When kneaded in the hand, clay loam does not crumble readily but forms into a heavy compact mass.

Clay

Clay is fine-textured soil that usually forms very hard lumps or clods when dry and is very plastic and usually sticky when wet. When the moist soil is pinched out between the thumb and finger, it forms a long flexible ribbon. Some clay that is very high in colloids is friable and lack plasticity at all conditions of moisture. Thus, soil texture determines the rate at which water drains through the saturated soil.

II) Soil Structure

Soil structure refers to the arrangement of soil particles into small clumps called *peds* or *aggregates*. The shape of the soil peds determines which of the structural types the soil exhibits: crumb or granular, plate-like or platy, blocky, prismatic, columnar, single grain and massive. It is the physical manifestation of the processes involved in soil development. Structure of the soil affects the pore space, size and distribution and therefore rates of air as well as water movement. Well-developed structure allows favorable movement of air and water, while poor structure retards the movement of air and water. Soil structure is often said to be the key to soil productivity since a fertile soil, with desirable soil structure and adequate moisture supply, constitutes a productive soil. Hence, productive agricultural soils have a soil structure that allows nutrient supply, good root penetration and a good exchange of air and water within the soil profile.

III) pH Value of Soil

Soil pH is widely accepted as a dominant factor that regulates soil nutrient availability, vegetation community structure, plant productivity and a range of soil processes. The value of soil pH is directly influenced by all five soil-forming factors (parent rock, climatic conditions, organisms, topography and time) and furthers the value of soil pH is dependent on the season influence, way of management, tested soil horizon, soil water contents, and time limit of sampling for analysis. By definition, the soil pH is a measure of the active hydrogen ion (H^+) concentration in the soil and also known as “soil reaction”. It is an indication of the soil’s acidity and alkalinity that affects nutrient availability and solubility in the soil. Soil acidity and alkalinity is extremely important because it has an effect on the decomposition of mineral rock into essential elements that plants can use. Availability of nutrients for plant uptake depends on soil pH. If the pH is out of balance, plants may not be able to use nitrogen even if an excessive amount is applied. The quality of irrigation water used can also have an effect on soil pH. Areas of the world with limited rainfall typically have alkaline soils while areas with higher rainfall typically have acid soils. Minerals in the soil’s parent material determine the pH of newly formed soils. pH is measured by using a logarithmic scale. The pH scale goes from 0–14 with pH 7 as the neutral point. As the amount of hydrogen ions in the soil increases, the soil pH decreases thus becoming more acidic. From pH 7 to 0 the soil is increasingly more acidic and from pH 7 to 14 the soil is increasingly more alkaline or basic. The pH range of 7.0 to 8.5 is ideal for most crops. Liming the soil raises the soil pH whereas the addition of nitrogen and sulphur lowers the soil pH. Classes of soil pH given by the United States Department of Agriculture, Natural Resources Conservation Services are depicted in table no. 2 given below:

Table No. 2
Classes of Soil pH Value

Sr. No.	Denomination	pH Range
1	Ultra acidic	< 3.5
2	Extremely acidic	3.5 – 4.4
3	Very strongly acidic	4.5 – 5.0
4	Strongly acidic	5.1 – 5.5
5	Moderately acidic	5.6 – 6.0
6	Slightly acidic	6.1 – 6.5
7	Neutral	6.6 – 7.3
8	Slightly alkaline	7.4 – 7.8
9	Moderately alkaline	7.9 – 8.4
10	Strongly alkaline	8.5 – 9.0
11	Very strongly alkaline	> 9.0

Source – United States, Department of Agriculture (NRCS), 1951

Table No. 3
Soil Types of Punjab-Haryana Plain

Sr. No.	Color	Soil Type
1	Light Pink	Shiwalik Soils
2	Light Brown/Beige	Piedmont Soils
3	Yellow	Loamy Soils
4	Light Green	Sandy Loam Soils
5	Pale Yellow	Light Loam Soils
6	Greyish	Silty Clay Soils
7	Orange	Sandy Soils
8	Dark Brown	Rocky Soils

Source: Department of Soils (PAU) Ludhiana and (HAU) Hisar

2. Classification of Soil of Punjab-Haryana Plain

Soil classification is a window into knowledge about soils at a given moment in time. It is like a snapshot that reveals the current condition without a clear glimpse of the past or the hints of the future. It helps us to compare the soil properties, organize our knowledge, facilitates the transfer of experience from one place to another and serves as a basis for more detailed evaluation of soil. Not surprisingly, different classification systems are in use worldwide, each system reflects the environment of its area but in the present context the basis of soil classification is agronomic. Based on agronomic classification Punjab-Haryana Plain is divided into eight categories, which are shown in Fig. 1 and Table no.3 are discussed below:

2.1 Shiwalik Soils

These soils are lying along the Shiwalik foothills in study area, covering the parts of the districts of Pathankot, Hoshiarpur, S.B.S. Nagar, Roopnagar, S.A.S. Nagar, Panchkula, Ambala and Yamunanagar. These soils contain a mixture of clay, sand, silt and pebbles. These soils are very thin in depth and are covered by shrubs and forests. The color of the Shiwalik soils ranges between reddish brown to olive brown. Owing to the undulated and dissected topography, presence of numerous seasonal torrents etc., these soils are subjected to water erosion. The heavy rains and steep slopes of land also supplement the soil erosion and as a result the soils are not coherent in nature. The major soil groups formed in this zone are loamy sand and clayey along with the presence of pebbles and sand. Due to

loose structure, these soils are poor in fertility but are good for orchards and agroforestry. Crops such as wheat, barley, gram, pulses, oilseeds, maize etc. can be grown though the yield is low.

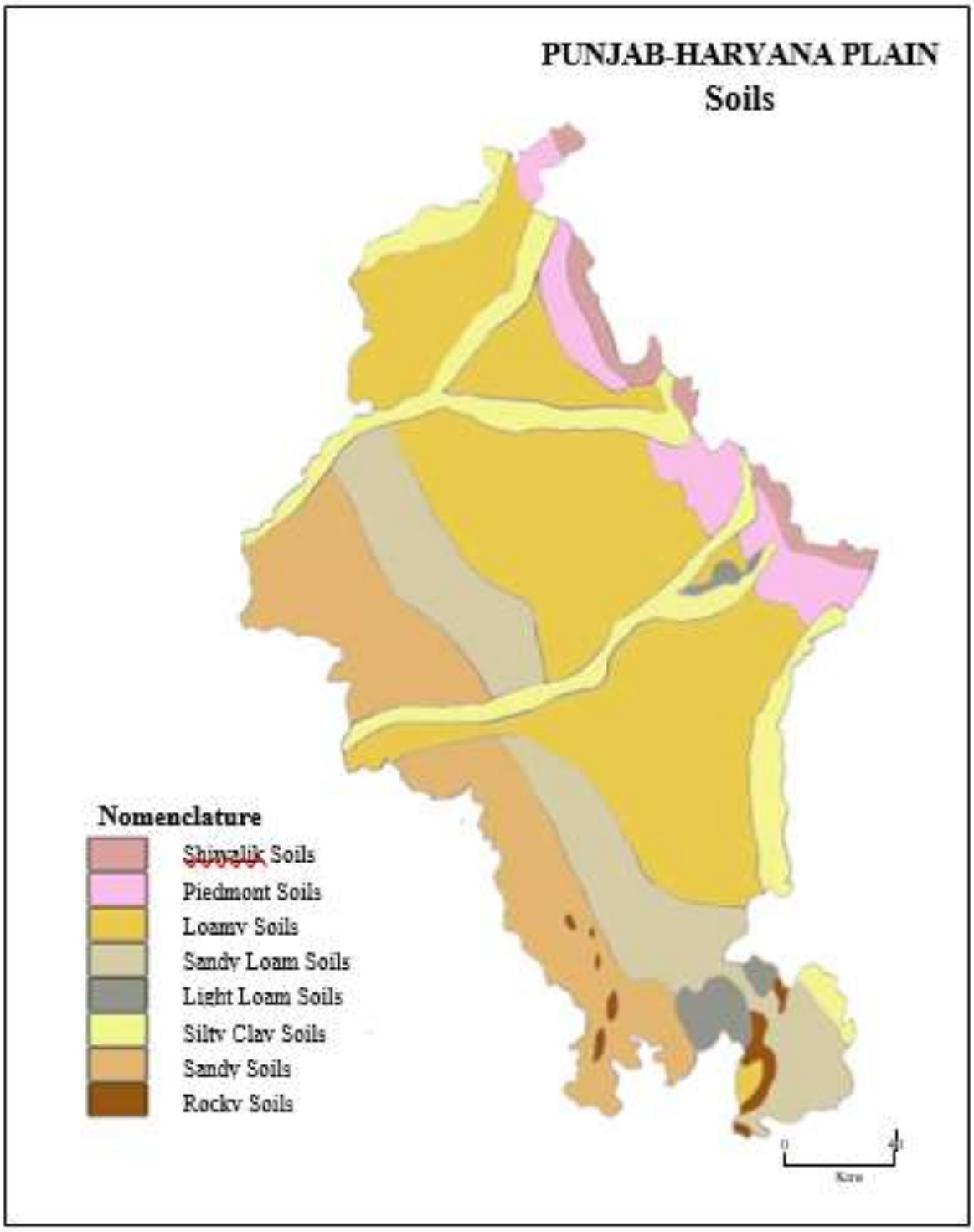
2.2 Piedmont Soils

Piedmont soils are formed in the Shiwalik foothill areas lying between the hills and plain and cover some parts of the districts of Pathankot, S.B.S. Nagar, Roopnagar, S.A.S. Nagar, Panchkula, Ambala, Yamunanagar and major parts of Hoshiarpur district. The structure of these soils is loose due to poor humus material, whereas soil texture is sandy, loamy, gravelly, clayey loam, silt loam etc. Near the Shiwaliks, soils are coarse and have conglomerates, pebbles, stones etc. Here alluvial fans are formed due to the seasonal torrents, which descend from the nearby hills. This zone is also affected by a large scale of soil erosion resulting in a thin layer of soil and poor productivity. These are problematic soils that are subjected to water erosion and the texture of the soil is coarse. Here, subsoil water is very deep which is uneconomical for pumping out for irrigation purposes. A variety of crops are grown like wheat, barley, pulses, oilseeds, maize and sugarcane, but the yield is low owing to low soil productivity.

2.3 Loamy Soils

Loamy soils have crumb structure, which is very important for agricultural purposes because these soils have the capacity to hold air as well as water. In local dialect, these are known as *Bhangar soils* and cover about 40 percent of the total geographical area of the study region including major parts of the districts of Tarn Taran, Amritsar, Gurdaspur, Jalandhar, Kapurthala, S.B.S. Nagar, Ludhiana, northern Firozpur, Moga, northern Sangrur, Fatehgarh Sahib, Patiala, Kurukshetra, Kaithal, Ambala, Karnal, Panipat, Sonipat and Jind, central

Figure 1



Source: Dept. of Soils- (PAU) Ludhiana and HAU, Hisar

parts of Fatehabad, northern parts of Hisar, Sirsa and Rohtak districts. Loamy soils are well drained, rich in phosphorus and potash but poor in nitrogen. These soils are also known for their fertility and ability to produce numerous crops like wheat, rice, maize, cotton, pulses, oilseeds, fodder, vegetables, sugarcane etc.

2.4 Sandy Loamy Soils

These soils lie between the category of loamy and sandy soils and are formed in an elongated belt, which runs in north-west to south-east direction. These are granular as well as porous in nature. Such soils contain a high proportion of sand as compared to silt and clay and are permeable in nature. Thus, these soils have good water and air holding capacity. Dry farming can be done successfully in sandy loamy soils because of its capacity of retaining moisture. If irrigation is provided, these soils yield high and a variety of crops can be grown. It covers the parts of Firozpur, Faridkot, Bathinda, Barnala, Sangrur, Fatehabad, Jind, Rohtak, Jhajjar, Sonipat, Gurgaon, Faridabad and Mewat districts.

2.5 Silty Clay Soils

Silty clay soils are found in flood plains of the river in the study region. These soils are not only found in one compact belt but are also confined along the rivers banks *Ravi, Beas, Satluj, Ghaggar-Markanda and Yamuna*. Silty clay soils are considered as young soils which are made up of material brought and deposited by the rivers in their flood plains.

Owing to the mixture of silt, clay and sand, these are also called *Dakkar soils*. Their permeability and air holding capacity is low but water holding capacity is more. Such soils are sticky when wet and hard when dry and contain high content of organic matter. These are heavy soils which need more ploughing for preparation of sowing the crops. Such soils are fertile soils because every year the river deposits new alluviums. Silty clay soils are found in the areas along river courses in districts of Pathankot, Gurdaspur, Amritsar, Tarn Taran, Firozpur, Fazilka, Moga, Ludhiana, Hoshiarpur, S.B.S. Nagar, Sangrur Mansa, Patiala, Fatehabad, Sirsa, Hisar, Ambala, Kurukshetra, Kaithal, Karnal, Panipat, Sonipat and Faridabad. A variety of crops can be grown in such soil such as wheat, rice, gram, pulses, sugarcane, maize, fodder, etc.

2.6 Light Loamy Soils

These are called *seoti soils* in the local dialect. These are not only found in compact belts but are scattered in three patches in the study area. These patches are found in the central parts of the Ambala district, eastern parts of Rewari and north-western parts of Gurgaon district. The proportion of the sand is high in lightly loam soils. Their capacity of air holding is more and water holding is less. These soils are well drained. If irrigation were provided, such soils can produce bumper crops like wheat, bajra, maize, rice, cotton, oilseeds, grams, pulses, sugarcane etc.

2.7 Sandy Soils

In sandy soils, the proportion of sand is high. These soils are permeable in nature and have low water holding capacity while air-holding capacity is high. These soils are largely confined to sand dunes effective areas of Punjab-Haryana plain, especially lying in the western parts of the study region. It is a continuous belt, which runs from Fazilka district in the north to Mahendragarh district in the south with certain exceptions. It covers the parts of the districts of Fazilka, Bathinda, Mansa, Sangrur, Hisar, Sirsa, Fatehabad, Bhiwani, Rohtak, Jhajjar, Rewari and Mahendragarh. High content of salt is found in these soils. The underground water in the belt of sandy soils is saline and alkaline which is unfit for tubewell irrigation. Their fertility is very low and texture is coarse. Sandy soils are very responsive to the growing of crops like grams, pulses, bajra, jowar, oilseeds etc. If irrigation is provided crops like wheat, rice, pulses, oilseeds, bajra, cotton can be grown.

2.8 Rocky Soils

Such soils are the residual of Aravalli hills and are found in the south-western parts of the study region. Their spatial occurrence is largely confined to the districts of Gurgaon, Mewat, Mahendragarh, Rewari, Bhiwani, and Jhajjar. These soils lie on the rocky surface of the Aravallis and are very thin in depth. They are subjected to erosion by seasonal streams as well as by winds. The high stoniness and poor fertility of rocky soils restrict agricultural production.

3. Conclusion

It is concluded that a variety of soils are found in Punjab-Haryana plain. Shiwalik soils are mainly distributed along the Shiwalik hills in the northern and eastern parts of the study region. These soils consist of a heterogeneous mixture of sand, clay and pebbles. Although they are low in fertility they are good for orchards and agroforestry. Piedmont soils are formed in the Shiwalik foothill areas lying between the hills and plains and run from Pathankot district to Yamunanagar district in the north to south-east direction along the Shiwalik soils. These soils are also low in fertility whereas loamy soils are found in the central parts of the study region in a continuous belt with the certain exception of flood plain of the rivers. Flood Plain soils are well-drained, rich in phosphorus and potash, but poor in nitrogen and are known for their fertility whereas sandy loam soils are found between the categories of loamy soils and sandy soils. Such soils have good water and air holding capacity because these soils have a high proportion of sand as compared to silt and clay and are permeable in nature. A variety of crops can be grown. In case of silty clay soils these are formed in flood plains of the rivers Ravi, Beas, Satluj, Ghaggar and Yamuna and are locally referred to as Dakkar soils. These have a high proportion of silt and clay while the sand content remains low. Owing to the composition their permeability and air holding capacity is low but water-holding capacity is more. As a result crops like wheat, rice, sugarcane, grams, pulses and fodder can be grown. It is further found that sandy soils lying in the western parts of the study region runs from Fazilka districts to Mahendragarh district. These soils have high salt content, their water-holding capacity is low and air holding capacity is high. Due to these characteristics, sandy soils are low in fertility. Nevertheless, with adequate irrigation, a variety of crops can be grown in such soils, whereas rocky soils are the residuals of Aravalli hills and found in south-western parts of the study region comprising the southern districts namely Gurgaon, Mewat, Mahendragarh, Rewari, Bhiwani and Jhajjar. Hardly any crops can be grown successfully in such soils. On the whole it is deduced that the study region has a variety of soils which are suitable for crop farming except the rocky soils.

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