SOILS OF WEST BENGAL

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(Communicated by R. N. Chakravarti, F.N.I.)

(*Received August 7; read December 6, 1957*)

INTRODUCTION

In the state of West Bengal the major practice of cultivation is paddy and it is so intensively cultivated that it is hardly possible to demarcate the lands for rice grown and not rice grown as, out of the total area of about 12.3 million acres under cultivation, paddy occupies almost 10.0 million acres. Throughout the year the practice of paddy cultivation can be seen in some places or other as there are various varieties which can be grown well under different soil climatic conditions. Yet the main growing season of paddy is from June to December when the ideal climatic condition for paddy cultivation under waterlogged condition prevails all over the state. Though the annual average rainfall over the entire state exceeds 40 inches, the required minimum for growing paddy crops as stated by de Geus (1954), there remain to be investigated the factors that account for different performances like varietal, manurial and cultural practices of paddy at different places. Since these in turn depend mostly on the soil factor, a knowledge of different kinds of soils growing paddy is essential for proper formulation of agronomy, fertiliser practice, irrigation requirements and such others. We have been surveying these soils for the last four years and a system of classification of soils has been evolved as shown below (Table I).

The different types of soil occurring in West Bengal have been described and discussed in the following pages and a tentative map indicating their distribution has been given (Text-fig. 1). In the genetical classification of soils of the State the genetic method adopted by the Soil Survey Staff (1951), United States Department of Agriculture has been followed.

LATERITE AND LATERITIC SOILS

These soils occur in the districts of Birbhum, Burdwan, Bankura and Midnapur. The land is undulating and has many tiny rivulets. These rivulets are dry except during rains. Soil erosion varies from slight to very high. At places the honeycomb structured laterite beds have been exposed. Surrounding these are terraced paddy fields, extending down to the bed of the rivulets. The paddy fields are yellowish grey on top and red below.

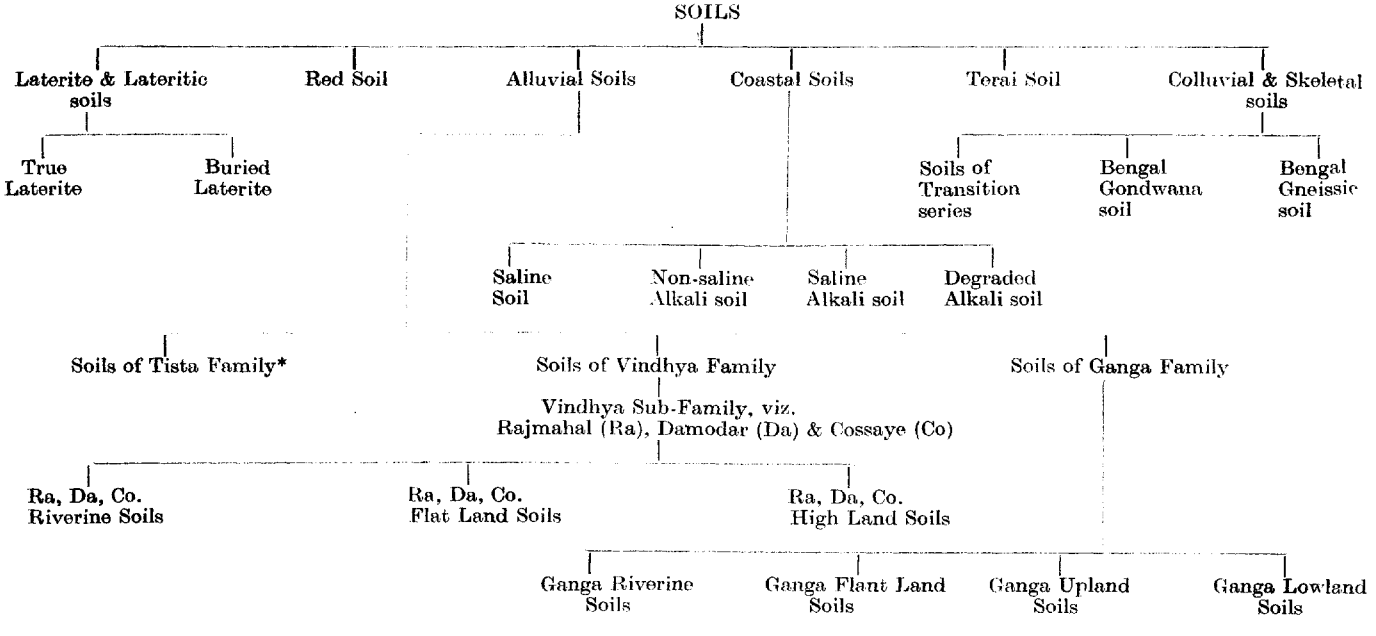
The soils are acidic (*p*H 5.5 to 6.5), poor in calcium, organic matter, available phosphate and in bases. The topsoils are poor in iron due to leaching and accumulation takes place in deep subsoils.

These soils in general are responsive to manuring; phosphate and nitrogen increase the yield by about 2.5 and 4 maunds per acre respectively.

Buried Laterite (Occurring at a depth of 10 ft. and below)

The occurrence of the honeycomb laterite pan with laterite below could be met with in the places examined. Over this has been laid down an alluvium, by the floods of the Dwarekeswar, the Damodar and the Cossaye. This might have

TABLE I



* Study of different characteristics and their classification is under investigation.

occurred in prehistoric ages, when the adjoining coal bearing Gondwana tracts may have been formed due to violent geological disturbances. Over the laterite pan lies a layer of heavier soil with occasional dolomite in it. Here concretions do not occur in a layer, but are scattered in the profile from 8 ft. to 10 ft., varying in length from 2 to 5 inches. The concretions and the silty clay accumulation seem to be a riverborne deposit. Over these (the burried laterite and the dolomite ridden heavy soil), stands the present profile of Damodar flat land. The surface layer appears to be younger in formation. This tract occurs in the districts of Birbhum, Bankura, Burdwan and Midnapore. Increase in yield of paddy with nitrogen is not significant. When phosphate is added along with it high responses are obtained, indicating a typical phosphate deficient tract.

Red Soils

These soils occur in the districts of Birbhum, Burdwan, Bankura, Midnapore, Malda and in West Dinajpore. The soils are coloured Red or Brown having variable thickness, with or without occasional lime concretions in the profile and morrum or feldspar below. Pisolitic concretions containing sesquioxide at places increase in great numbers. At some places these have become numerous and have formed laterite like blocks. At these places the surface vegetation peculiarly enough has also changed from Sal to Palas. When this happens the area gives chessboard appearance of Red soil, Lateritic soils and Laterites, and they occur in such a close proximity that it has been shown separately in the map as Lateritic Red soil group. These soils are mildly acidic (*p*H 6.0 to 6.6), poor in calcium, organic matter, available phosphate and bases. Iron is poor on the top and increases with depth. Paddy grown in these soils responds well to nitrogenous and phosphatic manuring.

Alluvial Soils

The soils of the alluvial tract can be divided into two families depending upon the nature of the parent material, i.e., alluvial deposits from which they have been derived. The coined names given to the families are :

Ganga Alluvium:—All these soils, which have originated from the Gangetic alluvium have been given the family name "Ganga alluvium".

Vindhya Alluvium:—The family name "Vindhya alluvium" has been coined for the soil association which has been formed from the alluvium brought down by the rivers, originating from Rajmahal hills and Chottanagpur plateau, a physiographic continuity of the Vindhya ranges.

Vindhya Family

Rajmahal, Damodar, Cossaye Riverine

These associations having different soil types are characterised by profiles, having layers, without a regular sequence, immature, irregular layeration, with occasional bands of sand. Sands are coarse and are yellowish brown in colour. These soil associations occur in the districts of Murshidabad, Birbhum, Bankura, Burdwan, Hooghly and Midnapore.

The positions of these associations have been indicated in the accompanying map. These associations have an innundated sandy phase, which gets periodically submerged. These soils respond well to nitrogen but give poor response to phosphate except in one or two soil types in these regions. These soils are mostly neutral (*p*H 6.5 to 7.2) and have an average lime and base status.

Rajmahal, Damodar, Cossaye Flat Lands

These soil associations occupy almost a flat topography, away from the influence of floods from which the Vindhya Riverine lands suffer. Due to incomplete weathering the distinct soil horizons could not be formed. Yet in the soil profiles layers can be distinguishable, to some extent by their colour, moisture contents, root penetration, texture and other physical characteristics.

There is very slight illuviation of sesquioxides in the lower layers. Calcium, potassium and clay indicate that a process of weathering and leaching has started, as a result of which *p*H tends to become slighly acidic. There are occasional dolomite concretions of fairly big sizes occurring at random in the profile. The mode of distribution of these concretions indicate that these are flood borne deposits and have not been formed *in situ*. Brown iron concretions of irregular size occur in lower layers which do not effervesce with hydrogen peroxide indicating absence of manganese in them.

These soil associations occur in the districts of Murshidabad, Birbhum, Bankura, Burdwan, Hooghly and Midnapore. Their locations have been shown in the accompanying map.

These soils are mildy acidic (*p*H 5.8 to 6.8); calcium, iron and other bases are low on top and increase with depth. They respond well to the application of nitrogen, whereas phosphate gives response only in the clay types where addition of nitrogen does not give increased paddy yield.

Rajmahal, Damodar, Cossaye Highlands

These soil associations occur in the districts of Murshidabad, Birbhum, Burdwan Hooghly, Bankura and Midnapore. Their positions are indicated in the accompanying map. These are associations of different soil types, having mature profiles. Leaching of clay, sesquioxides, alkaline earths and alkali metals and their accumulation in the lower horizon are evident. Mottlings are present. Dolomite concretions occur, often in thick layers. These soils are mildly acidic, *p*H. 5.8 to 6.9, which increases with depth. Calcium and other bases are low on top but increase in the subsoils. Phosphate content is low. Leaching of iron from top soil and accumulation in subsoil have taken place.

Response to nitrogen is low and to phosphate lower still. The yield of paddy can hardly be increased by 3 mds. per acre by application of nitrogen.

Ganga Family of Soils

Ganga Riverine

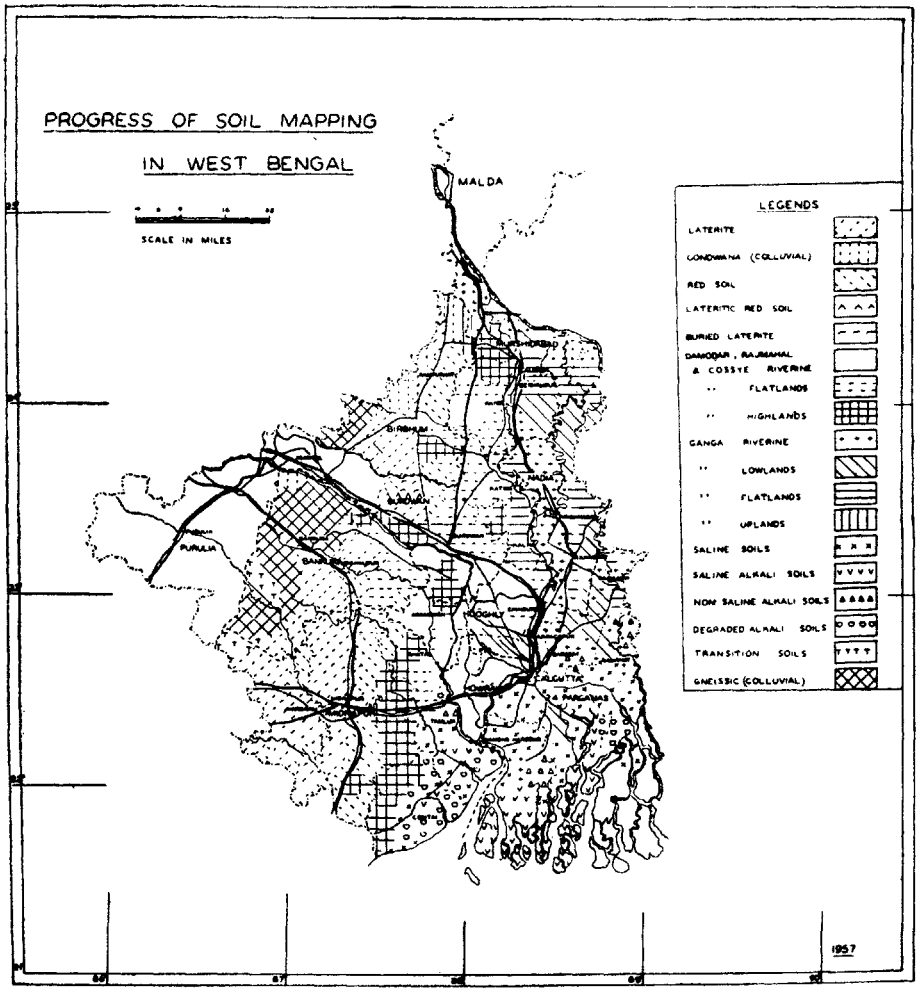
This kind of soil is found in the districts of Murshidabad, Malda, 24-Parganas, Burdwan and Hooghly and has been indicated on the map. This association of soils has an immature profile. Chemical and morphological observations show that one or two sandy layers are often found in the profiles examined. Sand fractions consist mostly of finer fractions, grey or greyish white in colour, having occasionally small plates of mica which shine in reflected light. These soils are rich in calcium. Free calcium carbonate occurs over most of the area either in the surface soils or within 2 to 3 ft. in the profile. The yield of paddy grain in this tract can hardly be increased by over 3 mds. per acre by application of nitrogen. Addition of phosphate does not give economical response.

Ganga Flat Land

This soil association occurs in the districts of Murshidabad, Nadia, 24-Parganas, Burdwan and Hooghly. It has a slightly more mature profile than the riverine soil. Slight illuviation of clay to the lower layer has taken place. Sesquioxides,

alkaline earths and metals all indicate slight leaching from the top and accumulation at the bottom. At places the subsoils still contain free calcium carbonate. The sand fraction is predominantly finer in size and whitish grey in colour.

No significant response in yield of paddy with phosphate fertilisers is found, whereas the increased yield of paddy with nitrogenous fertilisers is about 3 mds. per acre.



TEXT-FIG. 1.

Ganga Low Land

This association of soils occurs in places where depressions have been created due to the meandering of different rivers. The abandoned river courses and depressions, caused by strong diluviation by river currents, receive the washings from the surrounding flat or riverine lands. The Ganges also deposits a large amount of silt and clay in its diurnal tidal flows and ebbs. These factors have

been responsible for gradual filling up of river beds and marshes found in different localities. During rains these appear like lakes, where reeds mostly grow. Cultivation of *aman* paddy is carried out in the shallower places and of *boro* in the deeper ones.

This association is characterised by a profile having clay in the top horizon, followed by subsoils which are often very light, even consisting of riverborne loess or coarse sand. At places calcium carbonate concretions are met with. The profiles observed in this association of soils closely resemble lacustrine deposits, as stated by the U.S. Soil Survey Staff (1951), and have been found to lie over riverine profiles.

This occurs in the districts of Murshidabad, Nadia, 24-Parganas, and Hooghly. Their positions have been indicated on the map.

Field experiments show that application of nitrogen increases the yield of paddy by about 3 mds. per acre ; the increase due to phosphate is not significant.

Ganga Upland

Soils on older alluvial fans, alluvial planes and terraces, have more or less well-developed profiles. These profiles have moderate accumulation of clay in them and a high concentration of lime in the form of concretions, in the subsoil, as a result of continuous movement of calcium from the surface horizons.

These soils are characterised by their clay like nature and the presence of a lime horizon. Sesquioxide and clay become immobile. The high clay content of the soil in the event of rising of level of water table below the ground to the surface during rainy season makes this type of land eminently suitable for cultivation of *aman* paddy. Phosphate contents of these soils are low and the same can be said for nitrogen and potash.

This soil association occurs in the districts of Murshidabad and Birbhum and its position is shown in the map.

Coastal Soils

These soils are of tidal origin. After alluvial tracts these form the next important *aman* paddy growing tract of the state. The soils of this tract have been formed from deposits brought by tidal currents. The original deltaic branches of the Ganges choked up because the headwater had been cut off, as a result of which numerous tidal flats were formed. These were subsequently bunded to prevent ingress of sea water. Sluices are constructed to allow the escape of rain water, which gradually dissolved away the salt from the soil. These soils are rich in plant nutrients and support a good stand of paddy, so long the rain water stands in the field to dilute the salt. Parent deposits are either rich in calcium or magnesium or consist of half decomposed organic matter.

Taking all these soil forming factors into account, soils are classified in the following types, as has been done by the U.S. Salinity Laboratory Staff (1954) after examining the soils in the field as well as analysing them in the laboratory:

(i) *Saline soils*, (ii) *Non-saline alkali soils*, (iii) *Saline alkali soils*, (iv) *Degraded alkali soils.*

These soils are met with in the districts of 24-Parganas, Midnapore and Howrah. Positions of these soil associations are shown in the accompanying map.

Saline soils

Soils with salt content greater than 0.15% and exchangeable sodium percentage less than 15, are grouped under this head. The *p*H of this kind of soil varies between neutral to slightly alkaline.

Saline Alkali soils

Soils with salt content greater than 0.15% and exchangeable sodium percentage more than 15, are grouped under this soil association. *p*H of this type of soil generally reads over 7.5 and the soil particles remain flocculated in a soil water mixture.

Non-saline Alkali soils

In this kind of soil the salt content is less than 0.15%, whereas the exchangeable sodium-percentage is greater than 15. *p*H of this kind of soil also lies on the alkaline side.

Degraded Alkali soils

Though these are Non-saline Alkali soils having exchangeable sodium percentage above 15, yet the *p*H is acidic. The lime content and to some extent the other base status of this kind of soil is low and acidic *p*H is for the presence of predominant hydrogen ion.

Terai Soils

The next group of soils which grow paddy are the Terai soils. They are derived from the mountain region of the Himalayas. These soils are brought down by the hilly rivers, the Tista, the Mahananda, the Torsa, the Jaldaka and their numerous tributaries which bring material from heights of above 10,000 ft. and deposit it about 200 to 300 ft. above sea level. The deposits are mostly sandy and of raw humus type and are deep black to grey black in colour. They occupy a good amount of paddy areas of Jalpaiguri, Darjeeling and Cooch-Behar districts.

These soils are very light in texture and are highly porous. During rains, due to the precipitation becoming greater than the rate of infiltration through these soils, the area gets water-logged as a result of which *aman* paddy can be grown.

Due to severe leaching by rain and presence of a good amount of organic matter the soils are acidic, *p*H 4.7 to 5.8, and are poor in bases and available plant nutrients.

A combination of nitrogen and phosphate has been found to increase the yield of paddy.

Colluvials and Skeletal Soils

The soils next in area are colluvials derived from the hills which are extension of the Chottanagpur plateau. These skeletal soils, containing large amounts of coarse sand and gravel grow poor and uncertain paddy crop and occur in the western part of Birbhum and Bankura and in the Asansol sub-division. These are divided into the following categories :

Bengal Gondwana Soils

These soils are derived from the parent rocks which have been formed during the Gondwana period.

Bengal Gneissic Soils

The soils that are formed from the parent Gneissic rocks.

Transition Soils

Parent rocks from which these soils are formed are of Sub-metamorphic type similar to those of Bijawar and Gwalior series.

TABLE II

Approximate Chemical Composition of the Soils (Constituents as per cent of air-dry soils)

Soils	*p*H	CaO	K_2O	P_2O_5	Carbon	Nitrogen
Laterite & Lateritic soils	5.5—6.5	0.1—0.4	0.1—0.4	0.01—0.05	0.05—0.5	0.01—0.08
Red Soils	6.0—6.6	0.1—0.5	0.1—0.8	0.01—0.05	0.05—0.5	0.01—0.05
Ganga Family:						
(a) Ganga-Riverine soils	7.5—8.2	1.0—5.0	0.3—0.7	0.10—0.15	0.20—0.3	0.02—0.05
(b) Ganga Flat land soils	7.0—8.0	1.0—6.5	0.4—1.0	0.10—0.15	0.30—0.5	0.04—0.06
(c) Ganga-Upland soils	6.0—7.5	0.5—2.0	0.1—0.4	0.03—0.06	0.30—0.5	0.03—0.06
(d) Ganga-Lowland soils	7.0—8.2	0.6—3.0	0.1—0.4	0.06—0.1	0.50—1.0	0.05—0.09
Vindhya Family:						
(a) Vindhya-Riverine soils	6.5—7.2	0.3—0.6	0.1—0.45	0.025–0.04	0.05—0.15	0.005–0.02
(b) Vindhya-Flat land soils	5.8—6.8	0.4—0.7	0.1—0.2	0.01—0.05	0.10—0.4	0.02—0.05
(c) Vindhya-High land soils	5.8—6.9	0.3—0.6	0.4—0.5	0.02—0.05	0.20—0.5	0.03—0.06
Coastal soils:						
(a) Non-Saline alkali soils	7.2—8.3	0.45–0.8	0.5—1.5	0.10—0.2	0.20—0.6	0.04—0.08
(b) Saline soils	6.5—7.6	0.6—0.8	0.3—1.0	0.06—0.1	0.30—0.8	0.05—0.1
(c) Degraded alkali soils	5.0—7.0	0.4—0.5	0.4—0.8	0.07—0.15	0.50—2.0	0.05—2.0
(d) Saline alkali soils	7.5—9.0	0.4—0.8	0.5—1.0	0.10—0.15	0.20—0.6	0.04—0.07
Terai soils	4.7—5.8	0.1—0.2	0.1—2.0	0.10—0.2	0.80—3.0	0.09—0.2
Colluvial & Skeletal Soils :						
(a) Gneissic	5.5—7.5	0.25–2.0	0.2—1.3	0.02—0.2	0.15—0.7	0.02—0.11
(b) Gondwana	6.0—7.0	0.10–0.50	0.2—0.6	0.02—0.06	0.30—0.8	0.03—0.08
(c) Transition	5.5—7.0	0.08–0.65	0.3—0.7	0.03—0.07	0.20—0.6	0.02—0.08

The areas where these types of soils occur have undulating topography. The paddy fields are terraced among the black coloured boulders of giant size or rock surfaces or hills or eroded lands. The land on the top of the undulated topography is often left without cultivation, due to the difficulty of holding rain water in those places. Those lands, when allowed to remain as such for long periods, turn gradually into Sal or Palas jungles.

Analytical Results

The chemical constituents that are required for the growth of paddy have been estimated in the above mentioned different types of soils following the method of analysis given by de Sigmond (1938), Williams (1928) and Wright (1939). The figures are shown in Table II.

Acknowledgements

Thanks are due to the staff of Soil Survey Project, West Bengal, Shri D. Roy, Shri P. Roy, Shri P. Gupta, Shri A. Neogi, Shri S. Bhattasali and Miss B. Roy for their inestimable help during the progress of this work and to Dr. S. K. Mukerji, Agricultural Chemist, West Bengal, for his kind guidance. The authors are also indebted to Shri Sisir Kumar Ghose, for his earnest help in taking soil monoliths from different places.

Summary

The soils of the State of West Bengal have been classified under different categories and their characteristics have been studied. The distribution of each kind of soil has been shown in an accompanying map. A brief description of each of these soils is given. Chemical constituents of these soils are also given.

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Issued December 26, 1957