Soils of Rice Ecosystems in Kerala

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Definition - Rice/ Paddy soils

- Occur mostly in low landscape positions .inundated naturally or by water introduced by gravity.
- Soil is kept flooded or saturated throughout the growing period of the rice crop.
- Flooding causes profound changes in view morphological, physical, chemical and biological properties of soil in view of the anaerobic conditions on flooding
- Anaerobic conditions trigger oxidation-reduction potentials of Fe and Mn compounds resulting in characteristic hydromorphic features of mottling.
- Another dominant feature is the presence of gleyed horizon which is the zone of reduction.
- Degree of reduction varies with the position of the water table.
- Surface layers of the soil profile have the characteristic oxidized layer due to the oxidizing power of the rice root system.
- The oxidized surface layers and the reduced sub surface layers are the characteristic features of the rice soils (De Datta, 1981).

Salient Electrochemical features of flooded soils

- Depletion of molecular oxygen
- Chemical reduction of the soil, or a decrease in redox potential
- Increase in pH of acid soils and decrease in pH of calcareous and sodic soils
- Increase in specific conductance
- Accumulation of toxic products of C and N reduction
- Wider C : N ratio due to OC accumulation
- Increase in supply and availability of nitrogen through accumulation of NH_4 - N
- Increased availability of phosphorus, silicon, and molybdenum
- Decrease in concentrations of water-soluble zinc, copper and Manganese
- Generation of carbon dioxide, methane, and toxic reduction products such as organic acids and hydrogen sulfide in organic matter rich soils
- Toxicity of aluminum and iron in potential acid sulfate and ill drained soils

Distribution of Rice soils

- Five agro-ecological zones and twenty three agro-ecological units delineated in the State
- Basis for the classification is variations in climatic, landform and soils.
- Rice growing areas of Kuttanad, Pokkali ,Kole and Kaipad are identified in the Coastal plain zone under AEU 4,5.6.and 7 respectively on the basis of hydrological conditions in the coastal zone requiring unique management strategies.
- Rice is also cultivated in Onattukara, Wayanad, Palakkad and the ribbon valley soils of the midland laterite regions extending from South to North of Kerala under AEU ,20,18,19 respectively

Onattukara sandy soils

- The special agro-ecological unit Onattukara Sandy Plain (AEU 3) is delineated for the sandy plains
- Distributed in the midlands from coast and covering parts of Kollam and Alappuzha districts and covers an area of 67447 ha.
- Soils are grayish sandy very deep, well drained, single grained structure with shallow water table at places
- Soils are extremely acid to strongly acid with pH ranging from 3.5 to 5.5 and increase in sub soil acidity
- Organic matter content is in general low with higher levels in the surface horizon due to organic matter addition and decrease in the content with depth in the profile.
- Cation exchange capacity (CEC) is very low ranging from 3.8 to 4.4 cmol kg -1 and low content of exchangeable bases
- Salinity is a problem only in areas adjacent to the coast with electrical conductivity (EC) showing wide variation ranging from less than 2 to 7 d Sm-1 depending on season (Nair et al, 2013).

- Oorumundakan lands which form part of Onattukara region are distributed in the coastal areas of Karunagappally Taluk in Kollam District are prone to sea water ingress.
- Have dark grey surface soils developed from sandy lacustrine deposits.
- Soils are extremely acidic, very deep with shallow water table and are poor in available nutrients and bases.
- Saline resistant rice variety *orumundakan* is cultivated in these lands.
- Organic carbon was low in 62 % of soil samples.
- Phosphorus build up was recorded in 85 % of samples, K was medium in 58 %.
- Wide spread deficiency of secondary nutrients (Ca, Mg and S) was observed.
- Among the micro nutrients, 51 % soils were deficient in copper

Kuttanad Soils

- A special agro-ecological unit (AEU 4) delineated to represent the waterlogged lands distributed in Alappuzha, Kottayam and Pathanamthitta districts cover ing 126931 ha.
- Majority of these lands are below, at or just above sea level
- Soils are Hydromorphic often underlain by potential acid-sulphate sediments and have unique hydrological conditions.
- Seawater ingress in Kuttanad causes problems of salinity
- Salinity is controlled through bunds and barrages to facilitate rice cultivation.
- Soils of the Kuttanad area have been further sub divided into Kari, Kayal and Karappadam based on differences in physico-chemical characteristics and physiographic position.

Kari soils Contd

- Total Magnesium levels are high ranging from 3.8 to 14.8 cmol kg $^{-1}$ evidently due to the marine nature of the deposits.
- Sulphate-sulphur status recorded very high values ranging from 0.98 to 1.29 per cent at one meter depth clearly indicating the presence of sulphur rich marine.
- Soils revealed ultra acid to extremely acid condition in majority of samples. Organic carbon was high in 65 % of soil samples.
- Phosphorus build up was recorded in 54 % of samples,
- Available K was medium in 47 %.
- Wide spread deficiency of secondary nutrients (Ca and Mg) was observed.
- Boron deficiency was observed in 43 % soil samples

Kayal Soils

- Soils are reclaimed lake beds mainly distributed in Kottayam and Alappuzha districts.
- Poorly drained, deep, very strongly acid (pH 4.5) in the surface layers with increasing acidity in the sub soil layers recording a pH of less than 3.5
- Organic matter content ranges from 9.2 to 19.2 per cent with sub surface layers showing an increasing trend.
- CEC shows an increasing trend with depth ranging from 26.4 to 58 cmol kg^{-1}.
- Extremely acid to very strongly acid condition in majority of samples. Organic carbon was high in 82 % of soil samples.
- Available P` build up was recorded in 67 % of samples, while available K was medium in 50 %.
- Wide spread deficiency of Ca and Mg was observed.
- Boron deficiency was observed in 43 % soils samples.

Karappadam Soils

- Soils are mostly developed from riverine alluvium and occur along the banks of rivers
- Marine sediments also occur at deeper layers with sulphur bearing minerals.
- Organic carbon levels are much lower than Kari soils ranging from 2.9 to 8.6 per cent with increasing content in the lower depth of the profile.
- pH is extremely acid (4.4) in the surface soil with ultra acid (< 3.5) at lower depth.
- Organic carbon was low in 37 % of soil samples.
- Phosphorus build up was recorded in 61 % of samples
- K was medium in 37 % samples.
- Wide spread deficiency of Ca, Mg and S was observed.
- Boron deficiency was observed in 56 % soil samples.

Pokkali soils

- Pokkali soils belongs to another special agro-ecological unit (AEU 5) delineated to cover the lowlands, often below sea level in coastal areas
- Distributed in Ernakulam and parts of Thrissur and Alappuzha covering 39765 ha.
- Hydrology and soils are similar to those in Kuttanad.
- Seawater inundation is not controlled and hence soils are acid saline.
- Special kind of rice production system locally known as *Pokkali* along with fish culture is done in lowlands.
- Inorganic fertilizer supplements are not made use of in the cultivation of rice as soils are enriched with remnants of fish culture

Kole soils

- Occur in the Kole Lands agro-ecological unit covering 71142 ha. in coastal part of Thrissur and southern coastal parts of Malappuram
- Occur below sea level and has problems of seawater ingress
- Controlled through barrages and weirs to facilitate rice cultivation.
- Soils are hydromorphic acid clays often underlain by potential acid sulphate sediments.
- Are imperfectly drained, deep, dark brown, developed from alluvium with Silty clay texture throughout the profile
- Soils of the outer fringes have mottled sub surface horizons and mostly developed from colluvial sediments of the adjoining laterite hills.
- Some regions of the Kole area have organic deposits in the lower layers, the depth of occurrence often varies.
- Organic matter content in the surface layers varies from 2.7 to 4.2 per cent

Kole Soils Contd

- Sub surface layers it ranges from 28.9 to 69.9 per cent in the lowest layers with organic deposits.
- Soils are extremely acid (pH 4.2) in the surface layers and decreases to 2.6 (ultra acid) in the lower layers.
- EC is 0.5 dSm^{-1} in the surface soil and increases to 15 dSm^{-1} in the lower layers showing wide fluctuations with season especially in regions adjacent to coast.
- CEC values are high in the surface soils varying from 12.6 to 48.6 cmol kg^{-1}.
- Exchangeable base status is also fairly high in the surface soils
- Medium levels of OC and P and low levels of K.
- Ca deficiency is observed in some areas while Mg shows wide spread deficiency.
- Copper, Zn and B deficiencies have been observed in some areas

Kaipad soils

- Occur under Kaipad Lands (AEU 7)as isolated stretches of waterlogged lands along the coast of Kozhikode, Kannur and Kasaragod districts
- Extends over 24209 ha and often below sea level, do not have any protection against sea water inundation.
- Hydromorphic, acid-saline, clay soils are often underlain by potential acid sulphate soils developed from sulphur rich marine sediments
- Soils have clay to clay loam texture in the surface layer with sandy loam in the sub surface layers.
- Surface soils are strongly acid (pH 5.1) with ultra acid (pH 2.8 to 3.1) in the lower layers.
- Surface soils are high in organic matter.

Kaipad soils contd

- CEC of the surface soils are also high (49.1 cmol kg^{-1})
- The EC shows wide seasonal variations ranging from 2.2 to 15 dSm^{-1}. The low salinity phase occurring during the monsoon period permits rice cultivation in mounds.
- Strongly acid pH, medium levels of N and P and low levels of K. Deficiency of Mg and B is acute while Ca and S deficiency is observed in some areas.
- Copper and Zn are adequate with deficiency observed in some areas.
- Inorganic fertilizer supplements are not made use of in the cultivation

Brown hydromorphic soils

- Developed on nearly level, narrow valleys of lateritic terrain of midlands and foot hills from alluvial and colluvial deposits and inherits the properties of laterite soils.
- Occur in lower landscape position and consequent periodic inundation with water makes the soil poorly drained.
- Some of these areas have been reconfigured for cultivation of upland crops like banana, vegetables and coconut.
- Hydromorphic features like mottles and gleyed lower layers are common
- The low activity clay soils have low nutrient retention capacity, poorly supplied with basic cations and suffer from multi nutrient deficiencies
- The soils are deep, non gravelly and have a clayey texture strongly acid (4.5)in the surface and decreasing with depth in sub surface layer.
- Organic matter content is 1.6 per cent in the surface horizon and decreases with depth.
- CEC i increases with depth ranging from 9.6 to 12.4 cmol kg^{-1} and base saturation ranging from 38 to 42 per cent in the profile.
- Organic carbon and K show medium levels with high buildup of available P.
- Adequate levels of Ca, S, Cu and Zn with deficiency of Mg and B

Rice soils of Wayanad Plateau

- Occur in the gently sloping valleys of the Wayanad Central and Eastern plateau with elevations greater than 1200 m above MSL,
- Developed mainly from colluvial debris from the surrounding hilly portions.
- Soils are deep, dark grayish brown with sandy loam to sandy clay surface texture and clay loam to clay subsoil.
- Majority of soils are extremely acid to very strongly acid.
- Soils of isolated stretches of paddy fields in the north eastern part have slightly acid to neutral pH.
- They are rich in bases and have moderate slow permeability and have high production potential for paddy.
- Organic carbon and K levels are medium with high levels of P.
- Deficiency of Ca, S, Cu, Zn and B are observed

Rice soils of Palakkad Central and Eastern Plain

- Occurs in Alathur, Kuzhalmannam, Nemara and Chittoor Block transitional between Black soils of Eastern Chittoor and laterite soils of South West Alathur.
- Deep, non gravelly, clay or loam with neutral to slightly acidic and fairly well supplied with bases.
- Copper and Zn are in adequate levels while B is deficient
- The intensively cultivated soils are fertile supporting a variety of crops..

Black cotton soils of Palakkad

- These are swell-shrink black soils found in Chittoor Taluk of Palakkad District.
- They are distributed in nearly level plains or lower landscape position and low lands.
- Smectite clay soils exhibits swell-shrink behavior has high water and plant nutrient retention capacity but has poor workability.
- Deep, non gravelly clay, alkaline reaction, saturated with bases and often contain calcium carbonate.
- Surface soils have neutral to slightly acid reaction. medium in major nutrients and adequate levels of Ca, Mg, S, Cu and Zn, deficiency of B observed in some areas

Reference

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Thank You