

Studies on Physicochemical Properties of Soil in the South-Eastern Zone of Barwani District of Madhya Pradesh

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Abstract: To optimize agricultural sustainability in the South-Eastern Zone of Barwani (Sendhwa), targeted intervention is required to address the soil's clay-to-clay-loam structure and its alkaline pH. While the region benefits from a high WHC and medium CEC, the critical deficiencies in SOC and essential N-P-K levels limit its current potential.

To overcome these constraints, farmers should implement Integrated Nutrient Management (I.N.M.) by combining balanced fertilization with regular organic amendments, such as manure or gypsum. Enhancing organic matter will improve soil structure and fertility, while precision irrigation can prevent degradation. These strategies provide a necessary baseline for transitioning toward natural farming, ensuring long-term crop quality for staples like cotton and soybean while maintaining environmental health.

Keywords: physicochemical, agricultural sustainability, soil organic carbon, organic amendments.

Introduction - This thesis entitled “**Studies On Physicochemical Properties Of Soil In The South - Eastern Zone Of Barwani District Of Madhya Pradesh**” investigates the physical and chemical properties of the soil in the south-eastern zone of the Barwani district of Madhya Pradesh.

Study area has great agricultural potential because of its vast areas of fertile land, divergent climate, generally optimal rainfall and large available group of workers. However, agriculture of study area was characterized by low production per unit area. This was a paradox, which invited researchers to investigate the causes of the problem and suggest feasible solutions. The comprehensive assessment of soil of the South-Eastern Zone of Barwani District (Sendhwa) is necessary, to understand its current physicochemical state for crop quality, agricultural sustainability and environmental management.

Objectives of the Research Work:

1. To characterize the physical and chemical parameters of the soil in South-eastern Zone of Barwani district (Sendhwa) to establish a baseline characterization of its health and suitability for agriculture.
2. Identify the knowledge gap regarding the soil's current physicochemical status and any major nutrient deficiencies or imbalances.
3. To promote natural farming and organic farming for sustainable agriculture.

Hypothesis of the Research Work:

1. The physicochemical properties of soil in the south-eastern zone of Barwani vary significantly between different land-use type, affecting soil fertility and crop productivity.
2. The availability of essential nutrients like N.P.K. influenced by the soil's physical and chemical properties such as soil structure, organic carbon content, soil-pH, EC and CEC.
3. The SOC positively correlated with soil-fertility. Lower SOC content associated with decreased soil-fertility.

Study Area: Barwani is situated on the south-western part of Madhya Pradesh (India), occupying an area of 5427 sq.km, and the holy river Narmada is its northern border. Generally, five types of soils are found in the district namely Kali-I, Kali-II, Kali-III, Halki Khadri and Bardi. The soils of Barwani district are classified as medium black cotton soils containing nearly 50% silt and clay together.

Sendhwa city belongs to the South eastern zone of Barwani district. Sendhwa is a small town situated 155 km, away from Indore towards Mumbai. Sendhwa is geographically located at 21°41'N 75°06'E to 21.68°N 75.1°E. It has an average elevation of 409 meters (1341 feet). It is also a Tehsil of Barwani District. The soil of Sendhwa is primarily composed of Black Cotton Soil (Vertisols). This is the dominant soil type in this area, characterized by its black color, high clay content and swelling-shrinking properties.



Fig-1: Map-Tahsil Sendhwa

Review of Literature: Sharma et al. (2015) found that Vertisols in Nignoti village (Indore) are generally low-to-medium in SOC (0.2%–0.8%) and neutral to alkaline (pH 7.0–8.0), with low salinity (EC 0.11–1.09 dS m⁻¹). Soil fertility analysis showed nitrogen (114–300 kg ha⁻¹) was low to medium, and phosphorus (6–30.4 kg ha⁻¹) was mostly low (22.5%) to medium (64.8%), while 97.6% of samples were high in available potassium.

Lohiya et al. (2018) studied the soils of Golpura Village, Dhar District (M.P.), found that the soil pH was neutral to alkaline with safe soluble salt levels, but exhibit low to medium organic carbon and low soil organic matter. These deficiencies are critical constraints requiring immediate attention for sustained crop production in the Malwa Plateau Agro-climatic Western Zone of M.P.

There are so many workers in the state of Madhya Pradesh in different areas who made studies on physicochemical properties of soil of agricultural land and their quality aspects. However, review of literature clearly reveals that “till date” no systematic study and investigation work has been done to evaluate and monitor the physicochemical properties of soil of the south-eastern zone of Barwani district of (MP).

Materials and Methods: 133, random composite soil sample(0-20 cm) were collected across various land uses in the south-eastern zone of Barwani district (21 km radius of Sendhwa city) using a “V”-shaped method. Samples were air dried, sieved (2 mm), and analysed for key physicochemical parameters, with G.P.S. data mapped for spatial distribution analysis in future work. The key physicochemical parameters which are mentioned as follows:

Table-1: List of Specific Materials and Methods Used in Analyzing Physicochemical Parameter of Soil Samples Collected from the South-Eastern Zone of Barwani District of M.P.

S.	Physicochemical Parameters	Materials and Methods Used to Determine
Physical Soil Parameters Including:		

1.	Soil-texture	Soil Particle Size Analysis by Bouyoucos Hydrometer Method and texture determined by Texture-Triangle Method.
2.	Soil-structure	Dry Aggregate Analysis Method described by Gupta and Ghil Dyal, 1998. Visual Evaluation of Soil Structure (VESS) Method.
3.	Soil-porosity	Water Saturation Method.
4.	Soil-permeability	Falling Head Permeameter Method.
5.	Soil-Water Holding Capacity (WHC) (1931).	Field Capacity Method defined by Veihmeyer and Hendrickson
6.	Soil-moisture	Gravimetric Method.
7.	Soil-colour	Munsell Colour System (Munsell Soil Colour Chart).
Chemical Soil Parameters Including:		
8.	Soil-pH	Glass Electrode on Digital pH Meter.
9.	Soil-Electrical Conductivity (EC)	Digital EC Meter.
10.	Soil-Organic Carbon (SOC)	Walkley and Black Wet Oxidation Method.
11.	Soil-Cation Exchange Capacity (CEC)	Ammonium Acetate Method, Sodium concentration determined by Flame Photometer.
Major Nutrients Including:		
12.	Avail-Nitrogen (N)	Alkaline permanganate method (Subbiah and Asija, 1956)
13.	Avail- Phosphorus (P)	Olsen’s method (for alkaline soils) using Spectrophotometer.
14.	Avail-Potassium (K)	Ammonium acetate method using Flame Photometer.
15.	Avail-Sodium with Exchangeable Sodium Percentage (ESP)	Ammonium Acetate Method using a Flame Photometer or Atomic Absorption Spectrophotometer.

Role of Physicochemical Properties in Soil Quality and Correlation Analysis: Soil suitability is primarily driven by physical properties like texture, structure, and porosity, which dictate water infiltration, aeration and root penetration. High WHC and optimal permeability ensure that plants remain hydrated and soil organisms thrive, while soil color serves as a vital indicator of organic matter and drainage conditions.

On a chemical level, soil pH (ideally 6.0–7.0) and EC regulate nutrient availability and microbial activity. SOC and CEC are critical for maintaining structure, preventing

erosion, and facilitating nutrient cycling. Together, these factors create a stable environment for essential macronutrients: Nitrogen supports leaf growth and photosynthesis; Phosphorus enables germination and flowering; and Potassium regulates enzyme activity and disease resistance. Additionally, elements like Sodium play a focused role in maintaining cell integrity and osmotic balance, ensuring overall plant resilience and higher yields.

Results & Discussion: The soil in the South-eastern zone of Barwani (M.P.), is characterized as clay to clay loam with a blocky structure and high WHC. While it's moderately alkaline pH and medium CEC are generally suitable for crops like cotton, soybean, and citrus, the study identifies critical constraints: low SOC and deficiencies in N.P.K., indicating their immediate attention for sustain crops production. Despite low permeability and a risk of waterlogging, the soil maintains a non-sodic status with safe salinity levels.

The soils are require careful water management to prevent waterlogging and require increased soil organic matter (SOM) to improve structure. Implementing soil management, conservation agricultural practices and regular monitoring of soil-health are essential for crop production and agricultural sustainability. To achieve sustainable high yields and prevent soil degradation, the research recommends integrated nutrient management, regular organic amendments (like gypsum or manure), and precision irrigation to balance the soil's natural fertility with its physical limitations.

Table-2: Status of Physicochemical Parameters of Soil Samples Collected from the South-Eastern Zone of Barwani District of M.P.

S.	Physicochemical Parameters	Results
	Physical Soil Parameters Including:	
1.	Soil-texture	Clay to Clay Loam in texture.
2.	Soil-structure	Blocky in structure which contains very fine aggregate particles with weakly developed to well-developed aggregate stability status, fragile soil structure.
3.	Soil-porosity	Moderate porosity.
4.	Soil-permeability	Categorized in low to very permeability class.
5.	Soil-Water Holding Capacity (WHC)	High to very high water holding capacity.
6.	Soil-moisture	Soil of study area classified as ustic moisture regime with swell and shrink properties, which could grow rain-fed crops. Dry in pre-monsoon, wet in monsoon, moist in post monsoon.

7.	Soil-colour	Soil characterized as black (10YR 2/1) to dark brown (10YR 3/3) in colour.
	Chemical Soil Parameters Including:	
8.	Soil-pH	Moderately alkaline pH range.
9.	Soil-Electrical Conductivity (EC)	EC of soil found less than one mS/cm-1, with a mean value of 0.59 mS/cm-1, which was normal for total soluble salt concentration.
10.	Soil-Organic Carbon (SOC)	Low in available SOC content (74.43% soil samples exhibited low SOC content in soil).
11.	Soil-Cation Exchange Capacity (CEC)	Medium to high CEC
	Major Nutrients Including:	
12.	Avail-Nitrogen (N)	Low available-N (81.20% samples fall under low available-N status).
13.	Avail- Phosphorus (P)	Low to medium in available-P (48.87% samples fall under low status, 42.82% samples under medium P status).
14.	Avail-Potassium (K)	High in available-K (69.92% samples were categorized under high in available-K status).
15.	Avail-Sodium with Exchangeable	Sodium Percentage (ESP) High available-Na content but low ESP value indicated no significant Na-issue in soil.

Conclusion and Recommendations: In conclusion, the study established that soils in the south-eastern Barwani district face significant nutritional deficiencies and have physicochemical properties that limit agricultural potential. The identified nutrient deficiencies and imbalances need to be addressed to improve crop yields sustainably.

Natural farming and organic agricultural practices play an important role in increasing organic carbon, N. P.K.in the soil. Natural farming used organic manure such as cow dung, compost, green manure and jivamrit instead of chemical fertilizers, which are the natural sources of these nutrients for plants, improve soil quality and promote nutritional cycle by making the soil healthy and fertile, making durable and long -term production possible. In short "Adoption of natural farming is the demand of the hour".

This research provides a critical baseline for developing targeted soil management strategies, including the use of organic amendments and balanced fertilizer applications tailored to the specific needs of the region's soil.

Recommendations of the Research Work:

1. Boost Soil Fertility: Apply organic amendments (manure, compost, mulch, crop residues) and bio-fertilizers to increase carbon (SOC), N.P.K. levels and microbial

activity.

2. Implement Conservation Practices: Adopt reduced tillage, contour bunding, cover cropping, and crop rotation to minimize erosion, prevent compaction, and improve water retention.

3. Adopt Sustainable Farming: Promote organic and natural farming techniques, including the use of indigenous seeds and botanical extracts.

4. Nutrient & Pest Management: Use soil testing (Soil Test Crop Response) and Integrated Plant Nutrient/Pest Management (I.P.N.S./I.P.M.) to balance organic and inorganic inputs. Combine organic amendments (manure, compost, green manure) with balanced chemical fertilizers (N.P.K.) using Soil Test Crop Response (S.T.C.R.) methods.

Suggestions for Future Research Works:

1. Conduct Soil-Test Crop Response (S.T.C.R.) correlation studies for N.P.K. and micronutrients, specifically targeting rain-fed and dryland systems.

2. Evaluate how different land management practices and fertilizer regimes affect soil organic carbon and sustained crop productivity.

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