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Assessment of Physical Properties of Soil in the South-Eastern Zone of Barwani District of Madhya Pradesh

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Abstract: South-Eastern Zone of Barwani District has great agricultural potential because of its vast areas of fertile land, diverse climate, generally adequate rainfall and large labour pool. However, agriculture of study area is characterized by low production per unit area. This is a paradox, which invites researchers to investigate the causes of the problem and suggest feasible solutions.

Soil is the layer(s) of generally loose mineral and/or organic material that are affected by physical, chemical and biological processes at or near the planetary surface and usually hold liquids, gases and biota and support plants. There are some soils are red, some are black; some are deep and some are shallow; some are coarse textured and some are fine-textured. They serve in varying degree as a reservoir of nutrients and water for crops, provide mechanical anchorage and favourable tilth. The components of soils are mineral material, organic matter, water, air and biota, the proportions of which vary and which together form a system for plant growth; hence the need to study the soils physical properties in perspective.

The objective of the present study entitled **"Assessment of physical properties of soil in the South-Eastern Zone of Barwani District of Madhya Pradesh"**is to assessment of physical properties of soil to determine agricultural potentials and constraints for crop production of the soils of South-Eastern Zone of Barwani District.

Keywords: Soil Physical Properties, Soil-Texture, Soil-Structure, Soil-Porosity, Soil-Permeability, Water-Holding Capacity (WHC), Soil-Moisture, Soil-Colour.

Introduction - Physical properties of the soil include soil-texture, structure, porosity, permeability, water-holding capacity, moisture and colour etc. described as follows.

i. **Soil-Texture:**The proportion of sand, silt and clay particles in the soil.

ii. **Soil-Structure:** How soil particles are arranged into aggregates.

iii. **Soil-Porosity:** The amount of space within the soil, affecting water and air movement.

iv. **Soil-Permeability:** Soil permeability refers to the ability of soil to transmit water and air, influencing factors like drainage, water infiltration and groundwater flow.

v. **Soil-Water Holding Capacity:** Soil-WHC is a measure that quantifies the amount of water a soil can retain against gravity, influencing its ability to support plant growth and other soil processes.

vi. **Soil-Moisture:** The amount of water held within the pores of soil, representing the total water content of the soil, crucial for plant growth and microbial activity.

vii. **Soil-Colour:** Can indicate soil composition and organic matter content.

Soil continue change under the effect of physical factors like the parent material, time, the climate, the organisms present in it etc. [Solanki and Chavda, 2012.].Degradation of agricultural soils usually begins with the deterioration of the vegetative cover due to over grazing, wood-cutting, improper cultivation and bush fire [Weert and Lenselink, 1972].

These degradation lead to accelerated water-erosion, soil-compaction, increase in bulk density, decrease in soil-porosity and reduction in infiltration rate, surface crusting and loss of soil-fertility. Degradation of soils can occur due to depletion of SOM, extensive use of chemical-fertilizers and pesticides and reduction of biodiversity [Tilman et al., 2001].

Soil has a heterogeneous structure and its status affects ecosystem processes which control nutrients cycling [Fitter, 2005]. Avoiding soil-degradation and improving soil-health and fertility level could be achieved by performing sustainable soil management with an appropriate understanding of soil properties [Thapa and Yila, 2012].

Soil properties vary spatially and temporally from a field to a larger region scale and are influenced by both intrinsic (soil forming factors such as parent materials) and extrinsic

factors (soil management practices, irrigation, fertilization and crop rotation) [Cambardella and Karlen1999].

Hypotheses of the Research Work:

1. Soil's physical properties such as Soil-Texture, Soil-Structure, Soil-Porosity, Soil-Permeability, Water-Holding Capacity (WHC), Soil-Moisture, Soil-Colour, will differ across various locations within the study area.
2. The nutrient deficiency, infertile soil and soil-degradation will be higher in areas with poor soil physical properties.
3. Soil physical properties are suitable for natural farming, organic farming, integrate nutrient management and balance fertilization practices in crop production.

Objectives of the Research Work:

"Assessment ofphysical properties of soil in the South-Eastern Zone of Barwani District of Madhya Pradesh"was carried out with the followings objectives:

Primary Objectives:

1. To characterize the physical properties of soil in the South-Eastern Zone of Barwani District of Madhya Pradesh. This objective aims to provide a comprehensive understanding of the soil's physical properties and soil health.
2. To determine soil-moisture, soil-permeability, soil-porosity and soil-WHC, providing insights into its physical properties, soil -quality, fertility and crop productivity.
3. To determine the soil-textural class, soil-structure and soil-colour providing insights into its physical properties and soil quality.

Specific Objectives:

1. To promote natural-farming, organic-farming and sustainable agriculture, through examined the soil physical properties that ascertain the farmer's role in controlling the movement of chemical entities in the soil and food-chain.
2. To inform the relationship between soil physical properties and crop productivity, informing strategies for improved crop productivity, providing insights into crop selection and land use planning.

Study Area:

The South-Eastern Zone of Barwani (Sendhwa City): Sendhwa city belongs to the Barwani district in South Western part of Madhya Pradesh. Sendhwa is a small town situated 155 kms away from Indore towards Mumbai. Sendhwa is geographically located at 21°41N75°06 E21.68°N75.1°E.It has an average elevation of 409 meters(1341feet). It is also a Tehsil of Barwani District. The city is bordered by Maharashtra state to the south Gujarat state to the west, Dhar district to the north and Khargone district to the east.

The climate of the region is divided into four seasons. Winter from December to February, summer from March to May, rainy from June to September and autumn for October to November. May is the hottest month in the year and December is the coldest. The peak temperature of the city during day time is 42 to 45 degree Celsius in May and low temperature during night is 6 to 10 degree Celsius in December. Humidity during rainy season is about 70%. The average rainfall in the city is about 831mm.

Sendhwa area is classified as a semi-arid tropical (SAT) region which falls under Central Plateau and Hill Region (Zone VII) of agro-climatic zone.The soil of Sendhwa, a tehsil in Barwani district of Madhya Pradesh, India, is primarily composed of Black Cotton Soil (Vertisols).This is the dominant soil type in this area, characterized by its black colour, high clay content and swelling-shrinking properties. Source: www.nagarpalikasendhwa.org.

Factors Influencing to Soil Properties: The soil-properties in the South-Eastern Zone of Barwani District is influence by factors like:

i. Geology: Basalt, sandstone, and shale rocks.
ii. Topography: Hilly to undulating terrain.
iii. Climate: Semiarid, Tropical to subtropical climate with high rainfall.
iv. Vegetation: Forests, agricultural lands, and grasslands.
v. Dominant Clay Minerals: Montmorillonite, Vermiculite.

Major Crops of City: The soil in South-Eastern Zone of Barwani District is suitable for various crops like Cotton, Soybean, Wheat, Maize, Sugarcane, Pulses, and Oilseeds. Drought-tolerant crops (e.g., cotton, pulses) are suitable in the area. Irrigation management is crucial for crop growth. [NBSSLUP].There are 59.90% Cultivators and 18.16% agricultural labourers has been recovered in Sendhwa tahsil. There are 60.32 % area is cultivable and 30.39 % of total cultivable area is irrigated [Census of India 2011].

Methods of Determination:

Soil Sample Collection and Preparation: To analysing the physical properties of soil total of 15 fully representative surface soil samples (at a depth of 0-15 cm) were collected randomly from **South-Eastern Zone (**21km around the Sendhwa city) **of Barwani District of Madhya Pradesh**from farmers field during Apr-May, 2025 by using soil sampling auger and spade. The exact location of each sample was recorded using a Global Positioning System (GPS. After air drying soil samples were sieved through a 2 mm size sieve. The prepared samples were used for determination of various physical properties of soil(Table.1).

Table-1: Methods of Determination of Physical Properties of Soil Samples Collected from the South-Eastern Zone of Barwani District of M.P.

S.	Soil-Physical Properties	Methods of Determination
1.	Soil-Texture Status	Hydrometer Method and Textural-Triangle Method
2.	Soil-Structure Status	Dry Aggregate Analysis [Gupta and Ghil Dyal, 1998]
3.	Soil-Porosity Status	The Water Saturation Method
4.	Soil-Permeability Status	Falling Head Permeameter Method.

5.	Water-Holding Capacity Status	Field Capacity Method [(Veihmeyer and Hendrickson (1931)]
6	Soil-Moisture Status	Gravimetric Method
7.	Soil-Colour Status	Munsell Soil-Colour Chart Method

Table-2 (see in last page)

Results: According to finding of research work (Table-2) results was as follows:

Soil-Texture Status of the South-Eastern Zone of Barwani: In general out of 15 soil samples 60 % soil samples were fall under clay texture class status, 6.66 % samples under clay loam texture, 20% samples under silty clay loam and 13.33% soil samples were fall under sandy clay loam texture class status. The general statistics calculated from 15 soil samples revealed that the clay percent ranged from 30-70 %, with a mean value of 47.06%. The silt percent ranged from 13-52% with a mean of 30.13%. The sand particle ranged in between 13-54 % with a mean of 22.8 %.

Soil-Structure Status of the South-Eastern Zone of Barwani: In general out of 15 soil samples, 20% samples fall under Crumb status, 13.33 % samples Granular structure and 66.66% samples were categorized under Blocky structure status.

The Aggregate Stability Status of the South-Eastern Zone of Barwani: In general out of 15 soil samples, 60% samples fall under Weakly-developed status, 40% samples were categorized under moderate-developed status.

Soil-Structure Aggregate Size Status of the South-Eastern Zone of Barwani: The general statistics calculated from 15 soil samples revealed that the coarse size particles ranged from 8- 16% with mean of 11.6%, medium coarse size particles ranged from 25-37% with mean of 31.06%, fine particles ranged from 11-23% with mean of 16.13% and very fine particles ranged from 30-48% with mean value of 41.2%.

Soil-Porosity Status of the South-Eastern Zone of Barwani: The general statistics calculated from 15 soil samples revealed that the Soil-Porosity ranged from 28 - 53 %, with a mean value of 40.73%.In general 26.66 % samples fall under low porosity status and 46.66% samples were categorized under moderate and 26.66% samples high in Soil-Porosity status.

Soil-Permeabilityof the South-Eastern Zone of Barwani: The general statistics calculated from 15 soil samples revealed that the soil-permeability ranged from 1.7 - 6.5 cm/h, with a mean value of 4.10 cm/h.In general 33.33 % samples fall under moderate soil-permeabilitystatus, 46.66% samples were categorized under low soil-permeability status and 20% samples fall under very low soil-permeability status.

Soil-Water-Holding-Capacity Status of the South-Eastern Zone of Barwani: The general statistics calculated from 15 soil samples revealed that the Soil-WHC ranged from 37 - 57%, with a mean value of 47.86 %. In general 13.33% samples fall under medium status, 53.33% samples in high WHC status and 33.33% samples were categorized under very high WHC status.

Soil-Moisture of the South-Eastern Zone of Barwani: The general statistics calculated from 15 soil samples revealed that the during pre-monsoon season (May-June) soil-moisture percentage ranged from 11-21% with a mean value of 16.4 %. In general 93.33% soil samples were fall under dry condition and 6.66% soil samples were fall under moist condition.

Soil-Colour Status of the South-Eastern Zone of Barwani: In general statistics calculated from 15 soil samples revealed that the 13.33% soil samples fall under dark brown (10YR 3/3), 6.66% very dark grayish brown (10YR 3/2), 33.33 % very dark brown (10 YR 2/2) and 46.66% soil samples were fall under Black colour with 10YR 2/1 munsell colour notation according to Munsell Soil Colour Chart.

Interpretation and Discussion: The clayey texture, high water holding capacity,blocky structure,weakly developed aggregate stability,low soil permeability,moderate porosity,dry condition during pre-monsoon season and black soil colour, all this physical properties of soil of the South-Eastern Zone of Barwani District indicated that the soil has good physical condition for crop production that is beneficial for crops productivity such as a crops like cotton, soybeans, groundnut, pulses, sugarcane, banana, papaya, vegetables and citrus fruits. However, this also suggests that the soil may be prone to waterlogging, requiring careful irrigation management.It suggested that during dry condition irrigation might be necessary to optimal maintain plant growth.

Outcomes of Research Work: Soil of South-Eastern Zone of Barwani District werefound ingood physical properties/ condition and has a strong agricultural potentials for crop production.

Recommendation for Future Work: Periodic assessment of soil fertility status, nutrients availability and study on physicochemical properties of soil in South-eastern Zone of Barwani district is recommended to optimize crop productivity and to maintain soil health and quality.

Conclusion: The findings of research work would be useful for managing soil resources, crops selection, land use planning of the South-Eastern Zone of Barwani District on sustainable basis. This kind of research would be helpful to motivate and promote an approaches like Natural Farming, Organic Farming, Integrate Nutrient Management and Balance Fertilization practices in crop production.There is need to similar study on physicochemical properties of soil in the study area.

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

Sam-ple No.	Location	Latitude	Longitude	Soil Porosity %	% WHC	Soil- Permeability Cm/ hr K27 °C
1.	Front of Suraj Nagar Niwali Rd. Sendhwa, 451666, Mp., Ind.	21.682784°	75.076104°	32	46	6.1
2.	Kunjari, 451666, Mp., Ind.	21.677331°	75.013432°	35	39	6.5
3.	Niwali, 451666, Mp., Ind.	21.678974°	74.916619°	28	55	6.5
4.	Gram BakeeUrfGoi Old AB Rd Near Advantage City Semalya, 451666, Mp., Ind.	21.719874°	745.117313°	36	49	1.8
5.	Gram Salikalan AB Rd., 451449, Mp., Ind.	21.775589°	75.165871°	42	51	3.8
6.	Balsamund Old AB Rd., 451449, Mp., Ind.	21.811221°	75.174386°	38	37	4.1
7.	Near ChhotiBijasanMandirPipaldhar Sendhwa, 451666, Mp., Ind.	21.663243°	75.081412°	38	47	4.5
8.	Gawadi AB Rd. , 451666, Mp., Ind.	21.641352°	75.077619°	41	48	3.8
9.	Bhawargarh, 451666, Mp., Ind.	21.583604°	75.063914°	53	53	5.7
10	Julwaniya, Balwadi -Sendhwa Rd, 451666, Mp., Ind.	21.673644°	75.113648°	46	48	2.5
11.	Bhamanya, Balwadi-Sendhwa Rd., 451666, Mp. , Ind.	21.626184°	75.129402°	52	52	2.8
12.	Shahpura,Balwadi-Sendhwa Rd., 451666, Mp., Ind.	21.619015°	75.145604°	52	48	1.8
13.	Front of Swami- Vivekananda College Barwani Rd., 451666, Mp., Ind.	21.696338°	75.088242°	30	57	6.2
14.	Gram Dondwada Barwani Rd , 451666, Mp., Ind.	21.778465°	75.023126°	51	43	1.7
15.	Palsud , Barwani Rd, 451447, Mp., Ind.	21.831016°	74.952324°	37	45	3.8

Sample No.	Soil Colour	Soil Structure (Shape of Particles)	Aggregate Stability	Aggregate Size			
				Coarse %	Medium %	Fine %	Very Fine %
1.	10 YR 3/3 Dark Brown	Blocky	Weakly Developed	15	29	14	42
2.	10 YR 2/2 Very Dark Brown	Crumb	Weakly Developed	13	31	14	42
3.	10 YR 3/3 Dark Brown	Blocky	Weakly Developed	16	25	13	46
4.	10 YR 2/1 Black	Blocky	Weakly Developed	12	29	13	46
5.	10 YR 2/1 Black	Granular	Moderately Developed	11	36	23	30
6.	10 YR 2/2 Very Dark Brown	Crumb	Weakly Developed	10	31	11	48
7.	10 YR 2/1 Black	Granular	Moderately Developed	11	37	19	33
8.	10 YR 3/2 V. D. Grayish Brown	Blocky	Moderately Developed	11	33	15	41
9.	10 YR 2/1 Black	Blocky	Weakly Developed	12	31	18	39
10	10 YR 2/1 Black	Crumb	Moderately Developed	10	27	18	45
11.	10 YR 2/1 Black	Blocky	Weakly Developed	8	31	17	44
12.	10 YR 2/1 Black	Blocky	Weakly Developed	9	31	19	41
13.	10 YR 2/2 Very Dark Brown	Blocky	Weakly Developed	14	34	15	37
14.	10 YR 2/2 Very Dark Brown	Blocky	Moderately Developed	9	33	16	42
15.	10 YR 2/2 Very Dark Brown	Blocky	Moderately Developed	13	28	17	42

		Soil-Texture			
Sample No.	% Soil Moisture-Premonsoon	Clay %	Sand %	Silt %	Soil Texture
1.	15	40	27	33	Clay
2.	16	30	52	18	Sandy Clay Loam
3.	13	65	15	20	Clay
4.	11	55	16	29	Clay
5.	19	34	15	51	Silty Clay Loam
6.	18	33	54	13	Sandy Clay Loam
7.	16	35	13	52	Silty Clay Loam
8.	21	34	14	52	Silty Clay Loam
9.	13	60	18	22	Clay
10	20	56	18	26	Clay
11.	17	56	18	26	Clay
12.	19	57	15	28	Clay
13.	13	70	14	16	Clay
14.	17	45	24	31	Clay
15.	18	36	29	35	Clay Loam

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