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# Soil health assesment of hot semi-arid regions of eastern Rajasthan through physical properties

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## Abstract
The soil research study was conducted in Eastern Rajasthan comprising three block of Jaipur district for the fertility evaluation of cultivable land of farmers from nine villages during the year 2021-22. A total of 27 soil samples were collected from different fields and for different depths varying from 0-45 cm and were analyzed for different soil physical properties (texture, colour, bulk density, particle density, porosity, water retaining capacity and specific gravity) The dominant soil texture found in the region was loamy sand as soil were low in clay and clay content which also affected the porosity and eventually the water holding capacity of these soils. The management techniques used by the farmers and the quantity of manure and fertiliser used over time were found to have a significant impact on soil health and quality. Because there is an insufficiency of research and lack of knowledge among farmers on layered characteristics of soil quality parameters in diverse sites around Jaipur region, this study will surely benefit the villages' agricultural community. This study gave information about nature and importance of physical properties of the soil, which could be helpful for the farmers to understand the capabilities and requirements of soil as well as type of irrigation system to be adopted so as to raise healthy harvests.

**Keywords:** Soil health, hot semi-arid, physical properties

## Introduction
One of the planet's most dynamic and intricate natural processes is referred to as "soil." It provides a medium for plant growth and satisfies the bulk of organisms' nutritional needs, making it essential for the existence of many sorts of life. Parent material undergoes biochemical weathering to generate soil, which is impacted by factors like climate, organisms, parent material, relief, and time. The most significant and priceless natural resource for supporting life on Earth is soil. It takes around 1000 years for an inch of topsoil to grow (Chandra and Singh, 2009) [4]. The development and implementation of soil, plant and nutrient management techniques that enhance plant production and soil, water, and air quality is one of the most urgent issues of the day. Without increasing the productive capacity of our vulnerable soils, humans would not be able to satisfy the needs for food and fibre from our expanding population.

Soil health is defined as "the state of a soil at a specific time, equivalent to dynamic soil attributes that fluctuate over time, whereas soil quality is defined as soil usefulness for a specific purpose across time, equivalent to inherent or stable soil quality". According to the USDA, there are four types of soil quality indicators: visual, physical, chemical, and biological indicators. Physical indicators for root growth, plant emergence speed, and water infiltration include depth, bulk density, aggregate stability, porosity, texture, and compaction (Das, 2004) [10].

## Site Details
India's largest state, Rajasthan, also has the seventh-highest population. The country's northwest is where it is situated. 3,42,239 kilo meters, or 11% of India's total land area, are covered by it. Sandal, saline, alkaline, and chalky (calcareous) soils are the most prevalent types in Rajasthan. There are also clay, loamy, black lava soil, and nitrogenous soils. Because to over-exploitation and intermittent rainfall of 360 mm per year, the ground water level is extremely low. Agriculture remains the backbone of Rajasthan's economy, with agriculture and related sectors accounting for 25.56 percent of the state's total GSDP in 2019-20. Rajasthan has 11.26 percent of the country's cattle population and produces 12.93 percent of the country's total milk and 32.89 percent of the country's wool.

Rajasthan is also one of India's largest organic agricultural states, with over 81,000 hectares of recognized organic farms (Ramana *et al.*, 2015) [20].
The study area covered various blocks of Jaipur in eastern part of Rajasthan. All the sampling sites were marked on geographical map of the state and district using the GPS coordinates and a detailed soil survey of the study area was carried out on a grid map prepared using GIS software. Jaipur district is located at latitude 75°7'8.73" E and longitude 26°9'12.4" N. The district's total geographical area is 11,06,148 hectares (11061.48 square kilometers). The city's total Gross Cropped Area is 8,48,313 hectares, with 6,63,167 hectares of Net Sown Area, of which only 3,02,428 hectares is Net Irrigated Area. Jaipur has a hot semiarid climate with temperature extremes (15-45 °C) and average rainfall of 650 mm. Annual potential evapotranspiration (PET) is around 1744.7 mm. The principal crops planted in the blocks during the kharif season are groundnut, Bajra, and kharif pulses, while wheat, mustard, barley, and gram are grown during the Rabi season. Tomato, Pea, Chili, Brijnal, Cabbage, and Cauliflower are the most popular vegetables while Ber, Bael, Aonla, Guava, and Lemon are some of the most popular fruits.

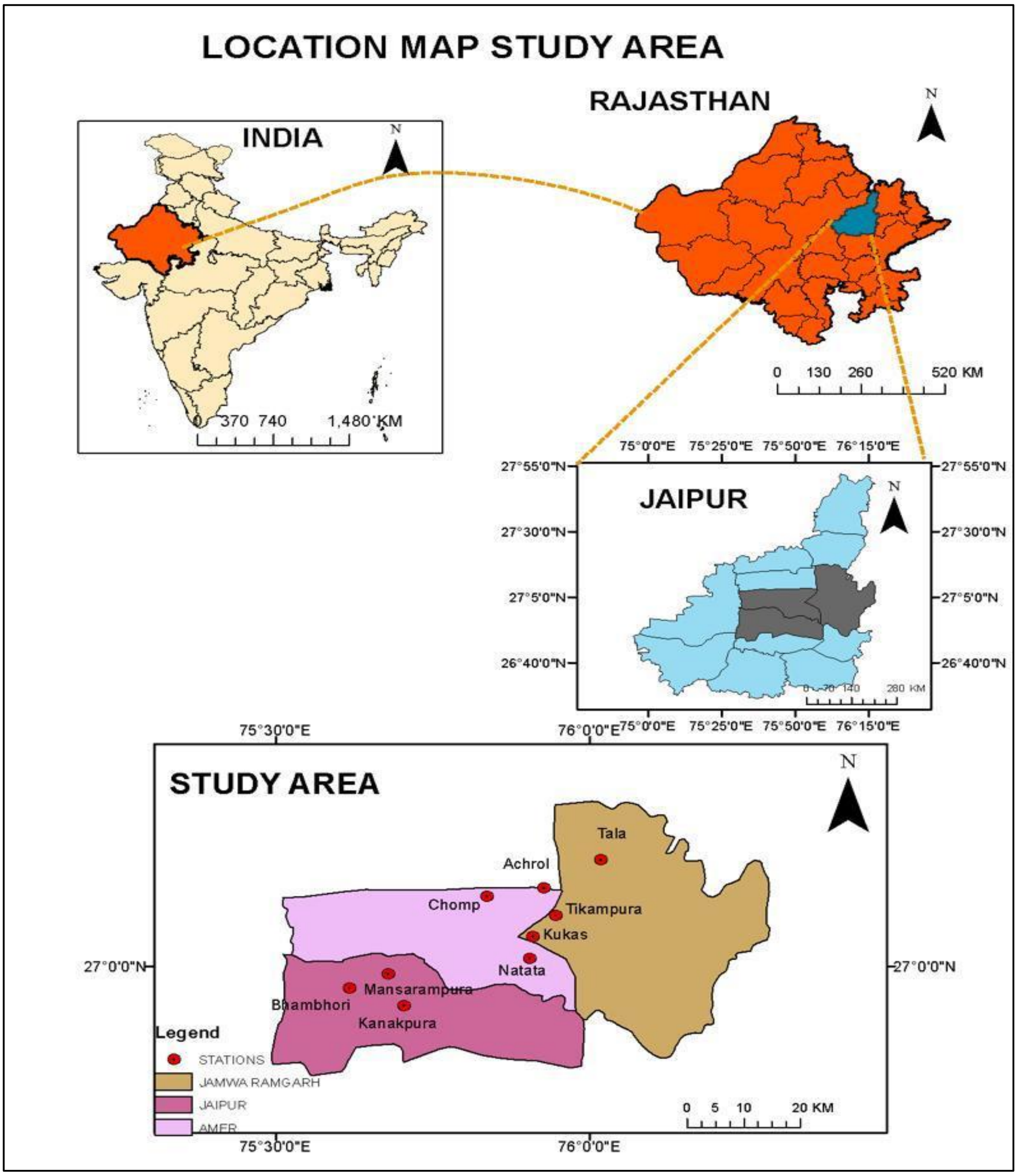


**Fig 1:** Location map study area

## Methodology

Three blocks ($B_1$, $B_2$, and $B_3$) in the Jaipur district were selected for the survey's sample collection, and each block contained three villages ($V_1$ to $V_9$). Using a 1m precision electronic GPS unit, the latitude and longitude of each site were recorded and using the coordinates a map was plotted using GIS. In order to compare the depth-wise distribution of nutrient availability, three samples of increasing soil horizon depth ($d_1$, $d_2$, $d_3$), i.e., from 0 to 15 cm, 15 to 30 cm, and 30 to 45 cm, were taken from each sampling location. 27 (9×3) composite soil samples totalling around 1 kilogramme each were gathered.

**List of the selected blocks and villages**

**Table 1:** List of the selected blocks and villages

| Blocks | Villages | | Latitude (N) | Longitude (E) |
|---|---|---|---|---|
| **$B_1$** Jamwa Ramgarh | $V_1$ | Natata | 27°00’48.67” | 75°54’12.70" |
| | $V_2$ | Tikampura | 27°05’25.29” | 75°56’46.21” |
| | $V_3$ | Tala | 27°11’25.22” | 76°01’05.37” |
| **$B_2$** Amber | $V_4$ | Kukas | 27°03’08.64” | 75°54’30.96” |
| | $V_5$ | Chomp | 27°07’28.27” | 75°50’09.45” |
| | $V_6$ | Achrol | 27°08’23.60” | 75°55’34.53” |
| **$B_3$** Jaipur (Jhotwara) | $V_7$ | Mansarampura | 26°59’10.96” | 75°40’39.79” |
| | $V_8$ | Bhambhori | 26°57’37.29” | 75°36’57.20” |
| | $V_9$ | Kanakpura | 26°55’45.22” | 75°42’11.80” |

**Analysis of samples**

The collected soil samples were analysed in laboratory for various physical properties. Physical parameters included soil texture, colour, bulk density, particle density, porosity, water retaining capacity and specific gravity. The data recorded during the course of investigation was subjected to statistical analysis by the method of analysis of variance (ANOVA) technique. The type adopted for the experiment was two-factor analysis without replication.

## Results and Discussion

**Physical properties**

Physical properties of soil include soil texture, colour, porosity, water retaining capacity, specific gravity along with bulk density and particle density. These properties depend on the amount, size, shape, arrangement and mineral composition of its particles. These properties also depend on organic matter content and pore spaces. These properties affect processes such as infiltration, erosion, nutrient cycling, and biologic activity and the suitability of soil for different uses.

**Soil texture**

In texture analysis the mechanical composition revealed that sand, silt and clay contents in soils of Jaipur district varied from 77.00 to 84.70 and 9.10 to 14.80, 5.10 to 9.10 per cent respectively. Clearly, sand was found to be the dominant fraction in all the soils, whereas, silt and clay were presented in low proportion. Majority of soil were grouped under textural category loamy sand. Results were found in sync with those of Aasim *et al.,* 2022.

**Soil colour**

The colour varied from brown (7.5YR 4/4) to brownish yellow (10YR 6/6) in 0-15 cm depth; from dark brown (7.5YR 3/2) to brownish yellow (10YR 6/8) in 15-30 cm depth and from brownish yellow (10YR 6/8) to very dark grayish brown (10YR 3/2) in 30-45cm depth of soil profile. Surface soil showed darker colour than the subsurface soil due to presence of more organic matter. Yellow colour of soil was pertaining to presence hydrated iron oxides. The brown colour indicated that the soil contains a relatively large amount of iron oxides in addition to organic matter.

**Bulk density**

The bulk density of soils varied from 1.237 Mg $m^{-3}$ to 1.401 Mg $m^{-3}$ with mean value of 1.307 Mg $m^{-3}$ and was found to increase with depth due to more compaction in the subsurface horizons. On the other hand, particle density of soils varied from 2.518 Mg $m^{-3}$ to 2.590 Mg $m^{-3}$ with mean value of 2.567 Mg $m^{-3}$ and was found to decrease with depth although the change was quite less and no significant difference was found due to site. Similar results were obtained by Wankhade *et al.*, 2011 [25].

**Porosity**

Porosity of the soils varied from 44.804% to 51.114% with a mean value of 48.496%. The maximum mean pore space was recorded in V4 (Kukas) with a value of 51.114% which is due to low bulk density i.e. 1.098 Mg $m^{-3}$. The minimum mean pore space was recorded in V1 (Natata) with a value of 44.804% which is due to high bulk density i.e. 1.503 Mg $m^{-3}$. The porosity in depths varied from 61.795% to 35.611%. The result showed that soil porosity is very much influenced by bulk density, more the soil compacted, less will be the pore space. Also, pore space was found to decrease with increase in depth attributed to increase in compaction in the subsurface. More or less similar findings were reported by Kumar *et al.*, 2017 [14-16].

**Water Retaining Capacity**

the maximum mean water holding capacity was found 49.837% at V4 (Kukas) due to high clay content of 9.10% and minimum 38.133% which was found at V2 (Tikampura) due to low clay content of 5.10%. Water holding capacity of different soil depths varied from 25.250% to 54.510%. These variations were due to clay, silt and organic carbon content and low WHC in sandy soils due to high sand and less clay content. This reveals that WHC of soil increases with increasing percentage of clay and silt particles in the soil as silt and clay particles have much higher surface area than sand particle to hold more amount of water. These findings were in line with that of Pandey *et al.*, 2018 [18].

**Specific Gravity**

The maximum mean specific gravity was 2.372 for V1 (Natata) while the minimum mean specific gravity was found out to be 2.220 for V4 (Kukas). Specific gravity of different soil depths varied from 1.779 to 2.757. The specific gravity increased with the increase in soil depth. Similar results were reported by Meena *et al.*, 2009.

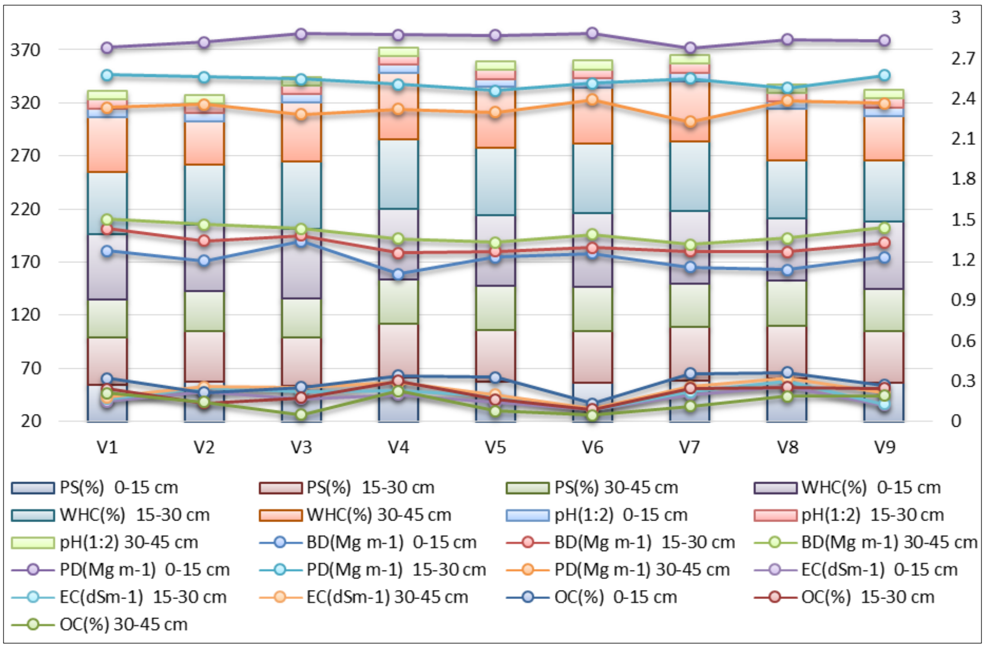


**Fig 2:** Physical properties of soils of the research area

## Conclusion

The dominant texture of soils was loamy sand and the water holding capacity of the soils were low because of which drip irrigation systems should be preferred. The soils were mostly of light colored indicating low organic carbon and organic matter thus pointing to the need of incorporating organic farming practices which eventually would also help in improving the bulk density of the soils. Porosity was found moderate and decreased with increase in depth due to compaction in sub-surface layers. The water holding capacity of the soils were low because of which drip irrigation systems should be preferred in order to improve the quality of produce and increase the percentage yield of crops thereby adapting to sustainable fashion of farming.

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