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# EVALUATION OF AGRICULTURAL SOIL HEALTH INDEX FOR SUSTAINABLE NUTRIENT MANAGEMENT IN ARMORI OF GADCHIROLI DISTRICT (M.S.)

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## ABSTRACT

Present study has been conducted in the Armori region of Gadchiroli district, during December 2024 to February 2025, for assessments of soil fertility and microbial populations. Nine soil samples were collected from three villages (V1, V2, V3) and analyzed for pH, organic carbon, macronutrients (N, P, K, S), and micronutrients (Zn, Mn, Fe, Cu). Soil pH ranged from 5.2 to 7.85, with Waghada Burdi (V2) having the highest pH. Electrical conductivity varied from 0.08 to 0.22 dS/m, and nitrogen levels ranged from 275 kg/ha in Arsoda to 310 kg/ha in Waghada Burdi. The Soil Health Index (SHI) ranged from 0.30 to 0.65, with Waghada Burdi showing the best soil health. The SHI, which integrates soil organic carbon, pH, conductivity, nutrient content, and microbial activity, revealed nutrient imbalances requiring targeted nutrient management interventions. The study highlights the importance of site-specific strategies, including organic practices, balanced fertilization, and soil conservation, to enhance productivity and ensure sustainable agriculture in the region.

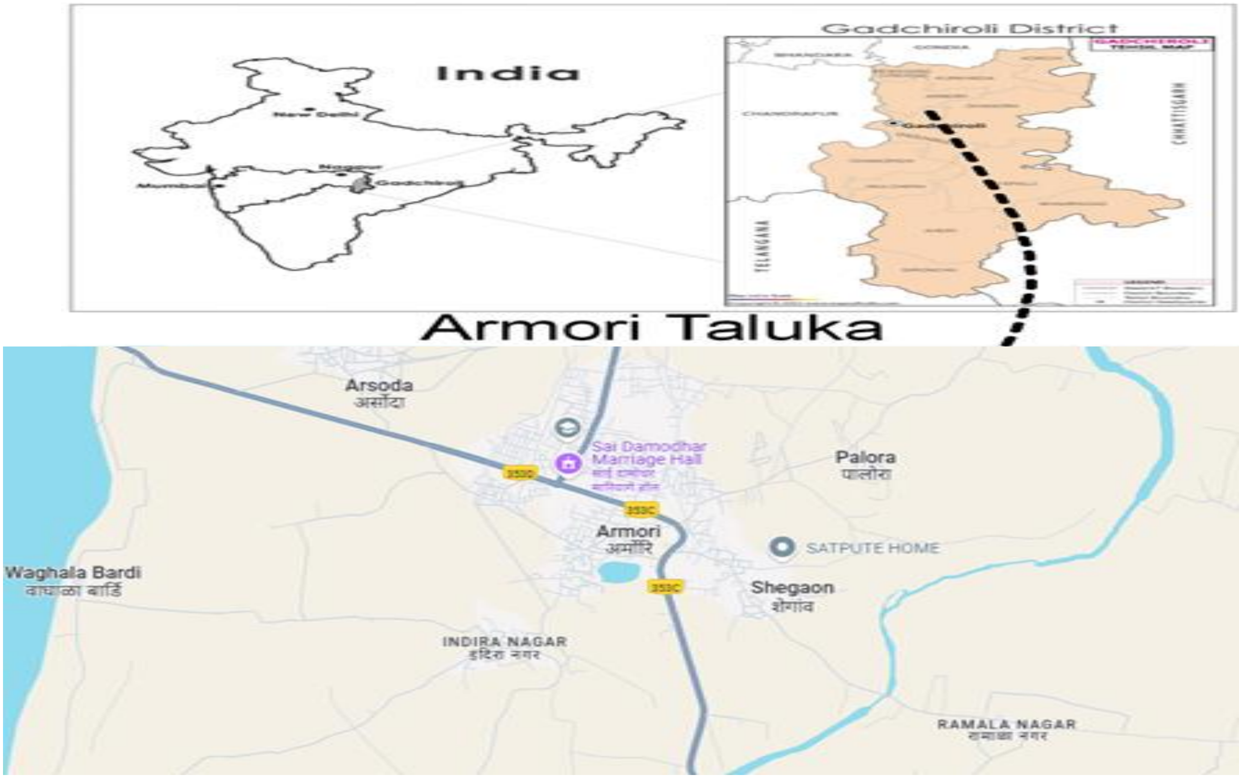
## INTRODUCTION

Soil health is the cornerstone of sustainable agriculture, influencing both crop productivity and environmental well-being. In the Armori region of Gadchiroli district, Maharashtra, the challenge of soil degradation and nutrient imbalances has become a pressing concern, threatening the future of farming. Traditional agricultural practices have led to a decline in soil quality, affecting yields and soil vitality (Kirschbaun *et al*. 2000). The Soil Health Index (SHI) offers a powerful tool to evaluate soil condition, integrating key indicators like organic carbon, pH, and nutrient content (Schloter *et al*. 2003). This study seeks to assess the SHI in Armori, uncovering valuable insights into the region's soil health and providing actionable recommendations for enhancing nutrient management(Velasquez *et al*. 2007, Bastida *et al*. 2006; Lemenih *et al*. 2005).

Soil quality can be defined as the fitness of a specifickind of soil, to function within its capacity and withinnatural ormanaged ecosystemboundaries, to sustainplant and animal productivity, maintain or enhance waterand air quality, and support human health and habitation(Jeffries*et al*.2003 and Janssen and de Willigen 2006). Consideration of soil as a finite and living resource, led to theconcept of soil health defined as the continued capacityof soil to function as a vital living system, within eco-system and land-use boundaries, to sustain biologicalproductivity, maintain or enhance the quality of air andwater, and promote plant, animal and human health(Spaccini *et al*. 2001, Loveland and Webb, 2003).Though the use of soil health has emerged in recentyears, variation in ability of soils to suppress plantdiseases is known since many decades (Janvier *et al*.2007). Parsi*et al*.(2005) described the suppressivesoils in which disease severity or incidence remains low,(Janvier *et al*.2007)

**METHODOLOGY:-**

**Study Area Selection:**
The study was conducted in Armori Taluka, located in the Gadchiroli district of Maharashtra. Three representative villages- Palora (V1), Waghada Burdi (V2), and Arsoda (V3) were selected for soil sample collection. These villages reflect the typical agricultural landscape of the region, providing a comprehensive overview of local soil conditions.




Google map of Study Area Armori region (V1 Palora, V2- Waghada Burdiand V3- Arsoda)

**Soil Sampling:** Nine soil samples were carefully collected from a depth of 10-15 cm across the three selected villages. To ensure accurate representation of soil conditions, samples were gathered from various agricultural fields within each village. Multiple collection points were included to account for soil variability across the area (Janssen and de Willigen 2006; Parsi *et al*. 2005; Lal, 2004)

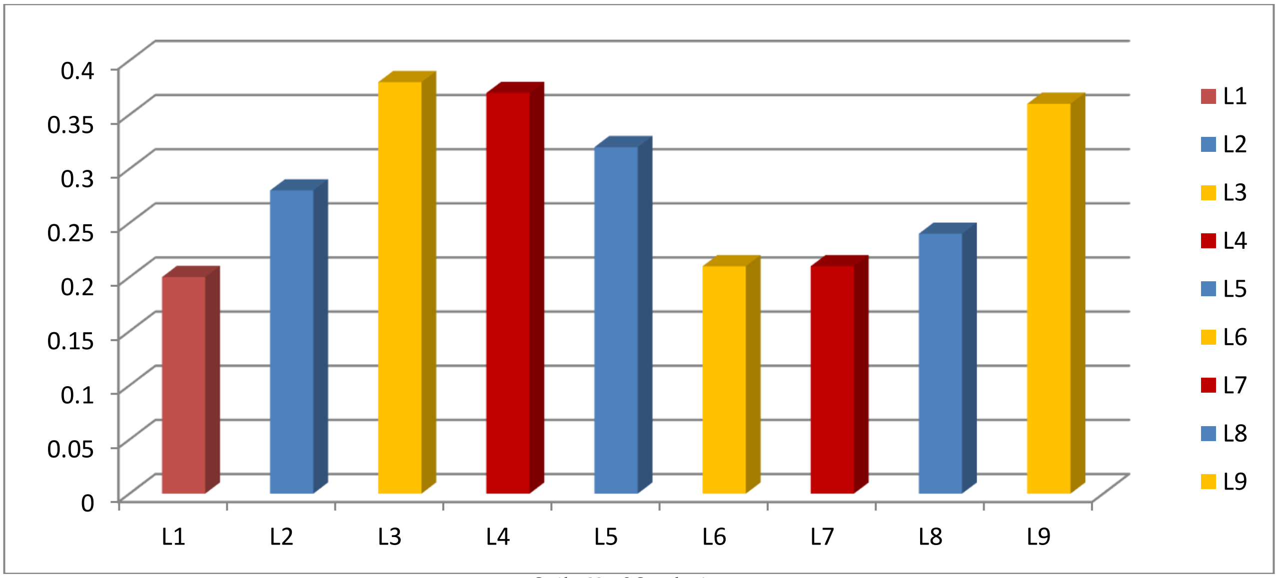
**Soil Analysis:** The collected samples were processed and analyzed using the advanced Bhu-Vision KRISHI-RASTAA Soil Testing System, a cutting-edge IoT-based platform recently introduced in India for rapid agricultural soil analysis. The samples were tested for a range of parameters: pH, electrical conductivity, organic carbon, available nitrogen, phosphorus (P2O5), potassium (K2O), available sulfur, and essential micronutrients (Zn, Mn, Fe, Cu). Based on these parameters, a composite index was calculated to evaluate the soil's overall fertility and derive the SHI.

**Data Interpretation and Analysis:** The gathered data was thoroughly analyzed to identify nutrient deficiencies, imbalances, and emerging soil health trends (Jeffries *et al*. 2003). This analysis provided a clear understanding of the current soil condition, pinpointing areas that required targeted intervention for optimal nutrient management (Masto *et al*. 2007 and Sangha *et al*. 2005).

**Sustainable Recommendations for Improvement:** Drawing from the soil health assessment, tailored nutrient management strategies were recommended to enhance soil health and ensure long-term agricultural productivity. These recommendations included promoting organic farming practices, optimizing fertilizer usage, and implementing soil conservation techniques to restores soil vitality and foster sustainable farming practices in the region.

**Table 1: Statistical analysis of soil chemical properties, available macronutrients, and available micronutrients in the Armori region of Gadchiroli District during December 2024 to February 2025.**

| Soil Properties | (V1) | | | (V2) | | | (V3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 | L9 |
| pH | 5.69 | 5.3 | 6.6 | 7.75 | 6.0 | 6.2 | 5.5 | 6.1 | 5.4 |
| EC (dS/m) | 0.09 | 0.07 | 0.12 | 0.20 | 0.21 | 0.05 | 0.07 | 0.17 | 0.20 |
| Organic Carbon (%) | 0.20 | 0.28 | 0.38 | 0.37 | 0.32 | 0.21 | 0.21 | 0.24 | 0.36 |
| Organic Matter (%) | 0.35 | 0.30 | 0.59 | 0.63 | 0.49 | 0.29 | 0.33 | 0.23 | 0.39 |
| Available Nitrogen (kg/ha) | 261 | 180 | 310 | 305 | 287 | 180 | 190 | 180 | 220 |
| Available Phosphate (kg/ha) | 5.01 | 3.5 | 8.7 | 4.7 | 7.8 | 6.2 | 3.5 | 3.9 | 4.4 |
| Available Potasium (kg/ha) | 203 | 185 | 230 | 35 | 235 | 170 | 210 | 200 | 190 |
| Available Sulphur (mg/kg) | 3.15 | 2.9 | 4.3 | 3.0 | 3.1 | 2.5 | 2.7 | 2.8 | 3.3 |
| Available Zinc (mg/kg) | 0.72 | 0.68 | 0.79 | 0.72 | 0.77 | 0.70 | 0.58 | 0.65 | 0.73 |
| Available Iron (mg/kg) | >5 | 4.5 | 6.3 | 5.8 | 6.1 | 4.9 | 4.9 | 4.1 | 5.4 |
| Available Manganese (ppm) | 3.45 | 3.2 | 4.6 | 4.1 | 4.3 | 3.5 | 3.2 | 3.1 | 3.2 |
| Available Copper (mg/kg) | 0.38 | 0.39 | 0.39 | 0.42 | 0.37 | 0.32 | 0.42 | 0.40 | 0.32 |
| **SQI - Soil Health Index** | **0.54** | **0.48** | **0.61** | **0.64** | **0.55** | **0.46** | **0.49** | **0.52** | **0.53** |




**Soil pH of Study Area**

**RESULT AND DISCUSSION:-**The findings from the current study, along with the related discussion, have been summarized under the following headings:

**Soil Health Analysis:** The soil property data, as shown in Table 1, reveals significant variations across the study locations. The soil pH ranged from slightly acidic at 5.2 in Arsoda (V3) to mildly alkaline at 7.75 in Waghada Burdi (V2), with electrical conductivity (EC) spanning from 0.06 to 0.22 dS/m. Organic carbon content varied between 0.21% and 0.38%, while nitrogen levels ranged from 150 kg/ha in Waghada Burdi (V3) to 310 kg/ha in Palora (V1). Waghada Burdi (V2) emerged as the standout location, boasting the highest levels of potassium 230 kg/ha and the best Soil Health Index (SHI) of 0.65, indicating superior soil health. In contrast, Palora (V1) and Arsoda (V3) showed potential for improvement, particularly in nitrogen, potassium, and organic matter content, to boost overall soil health. These findings are in line with the work of Lemenih *et al.* (2005), Lal (2004), Spacciniet *al.* (2001), and Loveland&Webb (2003), whose studies emphasized the importance of the Soil Health index in evaluating and managing soil health effectively.

**Data Interpretation and Analysis:-**
The soil analysis results reveal notable differences between locations. Arsoda (V3) exhibited slightly acidic soil (pH 5.2), which could limit nutrient availability; while Waghada Burdi (V2) had a neutral pH (7.75) and the highest SHI of 0.65, suggesting optimal soil health. Organic carbon levels were moderate, with room for improvement in Waghada and Palora (V1). Nitrogen and potassium levels were generally sufficient but would benefit from further enhancement in Palora and Arsoda to support better fertility and crop growth. Palora (V1) had a relatively higher potassium level 280 kg/ha compared to Waghada Burdi (V3), but both areas showed room for improvement in organic matter and nutrient balance to further enhance soil health.

**Sustainable Recommendations for Improvement:-**
Based on the soil health assessment results, to improve soil health in Palora (V1) and Arsoda (V3), it is recommended to enhance organic matter levels by incorporating compost, crop residues, and green manures, especially in areas with low organic carbon content. To improve nutrient management, crop rotation with nitrogen-fixing legumes should be practiced, while organic fertilizers and potash-based applications can help address potassium deficiencies. Phosphorus and sulfur deficiencies in Arsoda can be corrected by applying phosphorus and sulfur fertilizers, ensuring balanced nutrient availability. To boost microbial activity and improve soil fertility, the use of microbial inoculants is encouraged. Additionally, for Arsoda's slightly acidic soils, applying lime will help raise the pH, enhancing nutrient availability. Lastly, regular soil testing is essential to monitor soil health, track nutrient levels, and ensure that interventions are timely and effective, supporting sustainable agricultural practices in the region. Another limitation of most of the available studies is that efforts have been made to measure soil characteristics in surface soil and not in the whole profile (Sparling *et al.* 2004). While simultaneous analysis of physical, chemical and biological characteristics of soil is required to evaluate sustainability/ unsustainability of different management practices, Most of the studies in developing countries have looked at physical and chemical characteristics only.

## CONCLUSION

The present study concluded that soil health in the region varies significantly across locations and its soil quality and soil health have been proposed (Table 1).Waghada (V2) demonstrated the best soil health, with optimal pH, nutrient levels, and the highest Soil Health Index (SHI) of 0.65, indicating superior fertility. In contrast, Palora (V1) and Arsoda (V3) showed moderate soil health with deficiencies in nitrogen, potassium, organic carbon, and phosphorus content. To improve soil health in these areas, it is recommended to enhance organic matter through compost, crop residues, and green manures, implement crop rotation with nitrogen-fixing legumes, and apply targeted fertilizers to address deficiencies. Additionally, the use of microbial inoculants and regular soil testing will ensure long-term soil fertility and sustainability. These practices will optimize soil health and promote sustainable agricultural productivity in the region.

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