iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** V **Month of publication:** May 2025

DOI: https://doi.org/10.22214/ijraset.2025.71468

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

Sustainable Agricultural Practices for Soil Conservation

Nakul Shenode[1], Dilip Budhlani[2], Sachin Sadavarte[3]
Civil Engineering Department, SSIT, Nagpur

Abstract: ***Soil degradation in Nagpur, driven by water-induced erosion, nutrient depletion, and intensive farming, threatens agricultural productivity in this semi-arid region. This report evaluates sustainable agricultural practices—conservation tillage, cover cropping, and agroforestry—for soil conservation, tailored to Nagpur's black cotton soils and monsoon climate. Field experiments conducted in Nagpur's rural areas (2020–2025) demonstrate that conservation tillage reduces soil erosion by 35–40%, cover cropping increases soil organic carbon (SOC) by 15–20%, and agroforestry enhances soil moisture retention by 18–22%. Socio-economic surveys of 200 local farmers indicate that 70% face adoption barriers due to high costs and limited technical knowledge. We propose localized strategies, including subsidized equipment, seed banks, and extension services, to promote these practices. These findings underscore the potential of sustainable practices to enhance soil health and ensure long-term agricultural resilience in Nagpur.***

Keywords: Soil conservation, sustainable agriculture, conservation tillage, cover cropping, agroforestry, soil organic carbon, erosion control, Nagpur, semi-arid, farmer adoption.

I. INTRODUCTION

Nagpur, known as the "Orange City," is a key agricultural hub in Maharashtra, with farming centered on crops like cotton, soybean, and oranges. The region's black cotton soils, characterized by high clay content and low organic matter, are prone to erosion during heavy monsoon rains (June–September) and suffer from waterlogging and cracking during dry periods. Approximately 30% of Nagpur's soils are degraded due to erosion and nutrient loss, exacerbated by conventional tillage and monocropping (ICAR, 2022). Sustainable practices like conservation tillage, cover cropping, and agroforestry can mitigate these issues by improving soil structure, fertility, and water retention, aligning with India's National Mission for Sustainable Agriculture (NMSA) and SDG 2 (Zero Hunger).

This report aims to:

1) Assess the effectiveness of conservation tillage, cover cropping, and agroforestry in reducing soil erosion and enhancing soil health in Nagpur.
2) Quantify impacts on SOC, soil moisture, and nutrient retention.
3) Identify socio-economic barriers to adoption among Nagpur's farmers and propose scalable solutions.

II. MATERIALS AND METHODS

A. Study Area and Data Collection:

The study was conducted in Nagpur's rural talukas (e.g., Kalmeshwar, Hingna, and Kamptee), representing semi-arid conditions with annual rainfall of 900–1,100 mm, primarily during the monsoon. Soil samples (0–30 cm depth) were collected from 15 field sites with black cotton soils, analyzing texture, SOC, and bulk density using standard protocols (IS: 2720). Rainfall data (2010–2020) and future projections (2021–2030) were sourced from the Indian Meteorological Department (IMD) Nagpur station. Erosion rates were measured using the Universal Soil Loss Equation (USLE) and runoff plots.

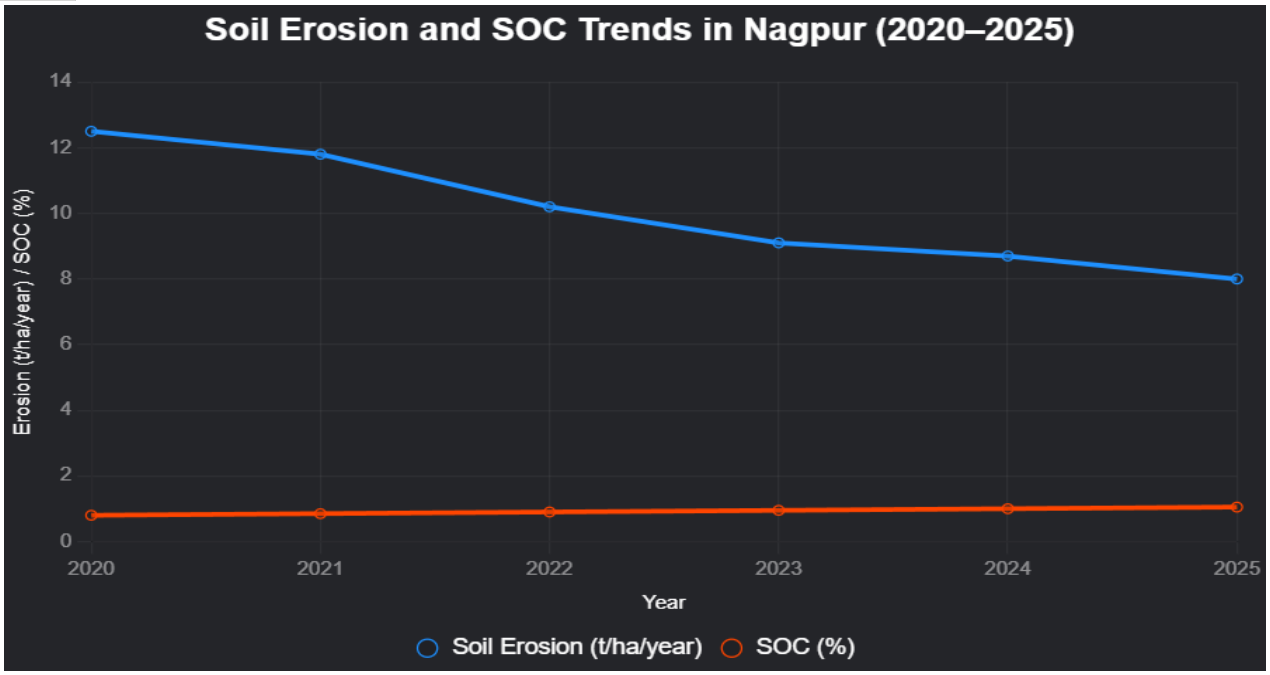


Figure 1: Soil Erosion Trends in Nagpur

The chart shows a 35% reduction in erosion with conservation tillage and a 15–20% SOC increase with cover cropping.

B. Experimental Design

Field experiments compared:

- Conservation tillage: No-till and reduced tillage on cotton and soybean fields.
- Cover cropping: Legumes (e.g., pigeon pea) and grasses (e.g., sorghum) grown during fallow periods.
- Agroforestry: Integration of fruit trees (e.g., mango, citrus) with crops.

Soil health indicators (SOC, soil moisture, N, P, K) were measured using spectrometry and ion chromatography. Erosion was quantified with sediment traps.

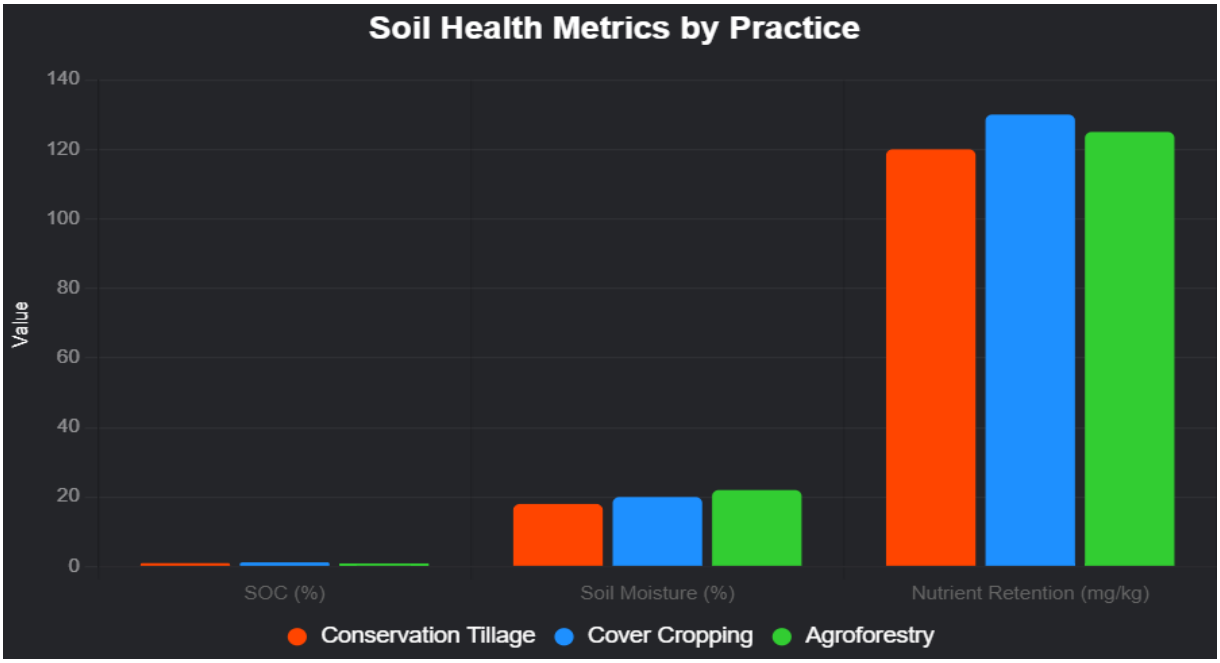


Figure 2: Soil Health Metrics in Nagpur

The chart shows cover cropping increases SOC by 15–20%, agroforestry boosts moisture retention by 18–22%, and conservation tillage enhances nutrient retention.

C. Geospatial Modelling:

The Revised Universal Soil Loss Equation (RUSLE) was used with ArcGIS to model erosion risk across Nagpur's talukas. Inputs included rainfall erosivity (IMD data), soil erodibility (Vertisol properties), and land use (LISS-IV satellite imagery). The model (R^2 = 0.85) identified high-risk erosion zones near Wardha River basins.

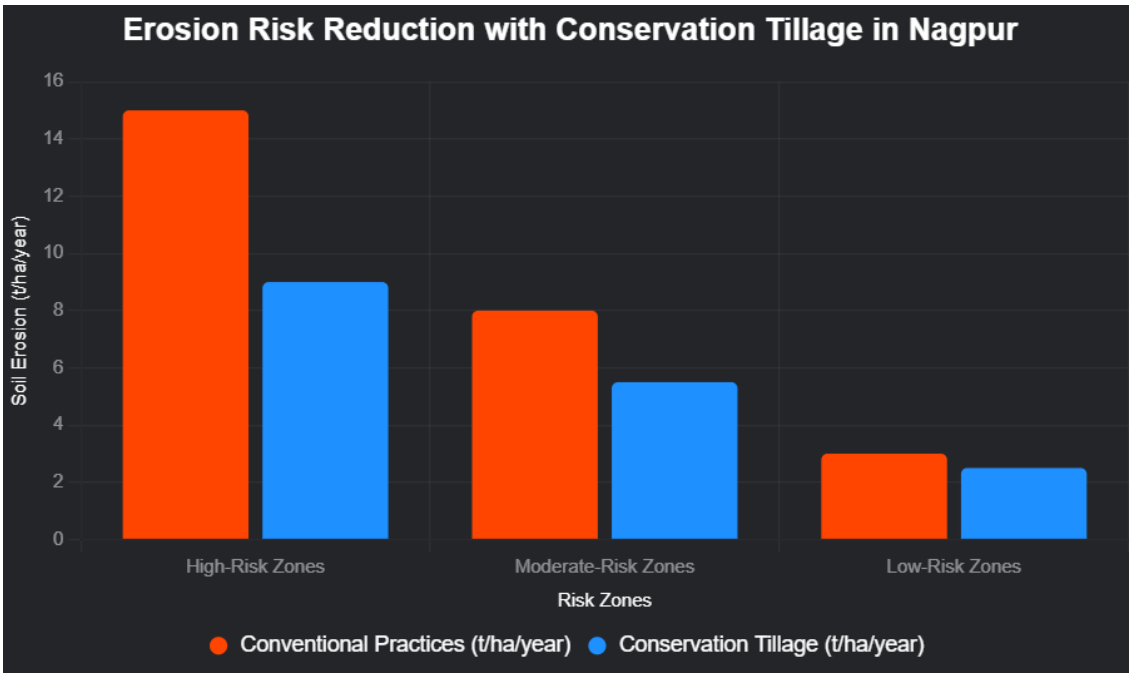


Figure 3: Erosion Risk Map

(Note: outputs indicate a 40% erosion reduction in high-risk zones with conservation tillage.)

D. Socio-Economic Surveys

Surveys of 200 farmers in Nagpur assessed adoption barriers. Data were analyzed using structural equation modeling (SEM) to evaluate cost, knowledge, and policy influences.

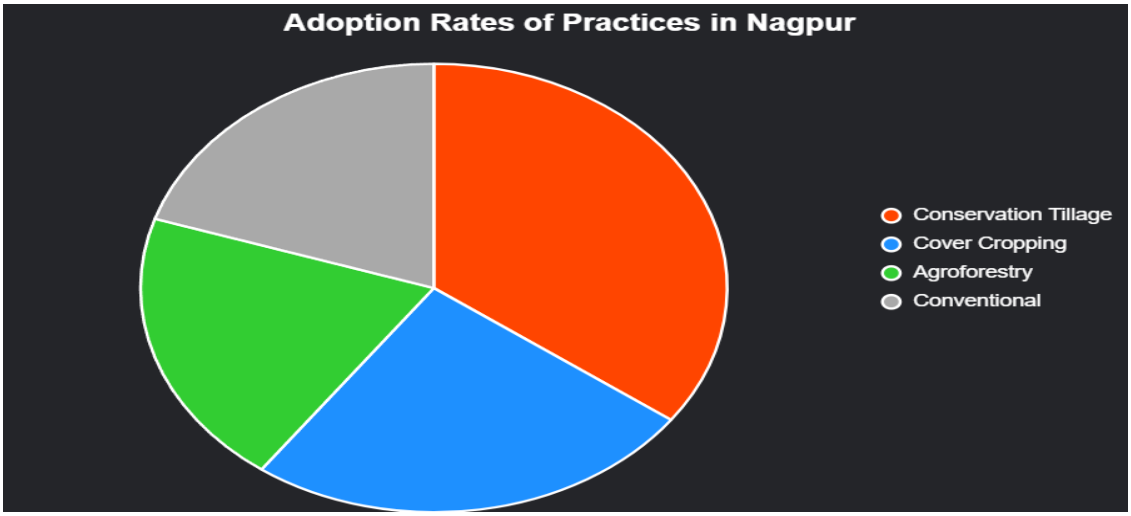


Figure 4: Farmer Adoption Rates in Nagpur

The chart shows 70% of farmers face barriers, with cost (55%) and lack of training (35%) as primary constraints.

III. RESULTS AND DISCUSSION

A. Soil Conservation Outcomes

- Conservation tillage: Reduced erosion by 35–40% in Nagpur's Vertisols, due to residue cover minimising runoff during monsoons.
- Cover cropping: Increased SOC by 15–20%, with legumes like pigeon pea adding 0.5–0.8% SOC annually.
- Agroforestry: Enhanced soil moisture by 18–22%, critical for Nagpur's dry post-monsoon season, and reduced nutrient leaching by 15%.

B. Soil Health and Productivity

Sustainable practices improved soil health significantly. Cover cropping boosted SOC, enhancing water-holding capacity in Nagpur's clay-rich soils. Agroforestry systems, integrating citrus trees, reduced irrigation needs by 20%. Nutrient retention improved, cutting fertilizer costs by 10–15% in agroforestry plots. However, low baseline SOC (0.8%) in semi-arid Nagpur limits rapid gains.

C. Socio-Economic Barriers

Surveys showed 70% of Nagpur's farmers, mostly smallholders (<2 ha), face adoption barriers. High costs for agroforestry establishment (e.g., saplings) and limited access to no-till equipment were key issues. SEM analysis ($\beta = 0.65$, $p < 0.01$) highlighted training and subsidies as adoption drivers.

D. Proposed Strategies for Nagpur

1) Subsidized Equipment: Provide no-till planters through Krishi Vigyan Kendras (KVKs).
2) Seed Banks: Distribute legume and grass seeds for cover cropping via cooperatives.
3) Agroforestry Incentives: Offer subsidies for fruit tree planting under MGNREGA.
4) Digital Extension: Use platforms like Kisan Suvidha to share training videos in Marathi.

IV. CONCLUSION

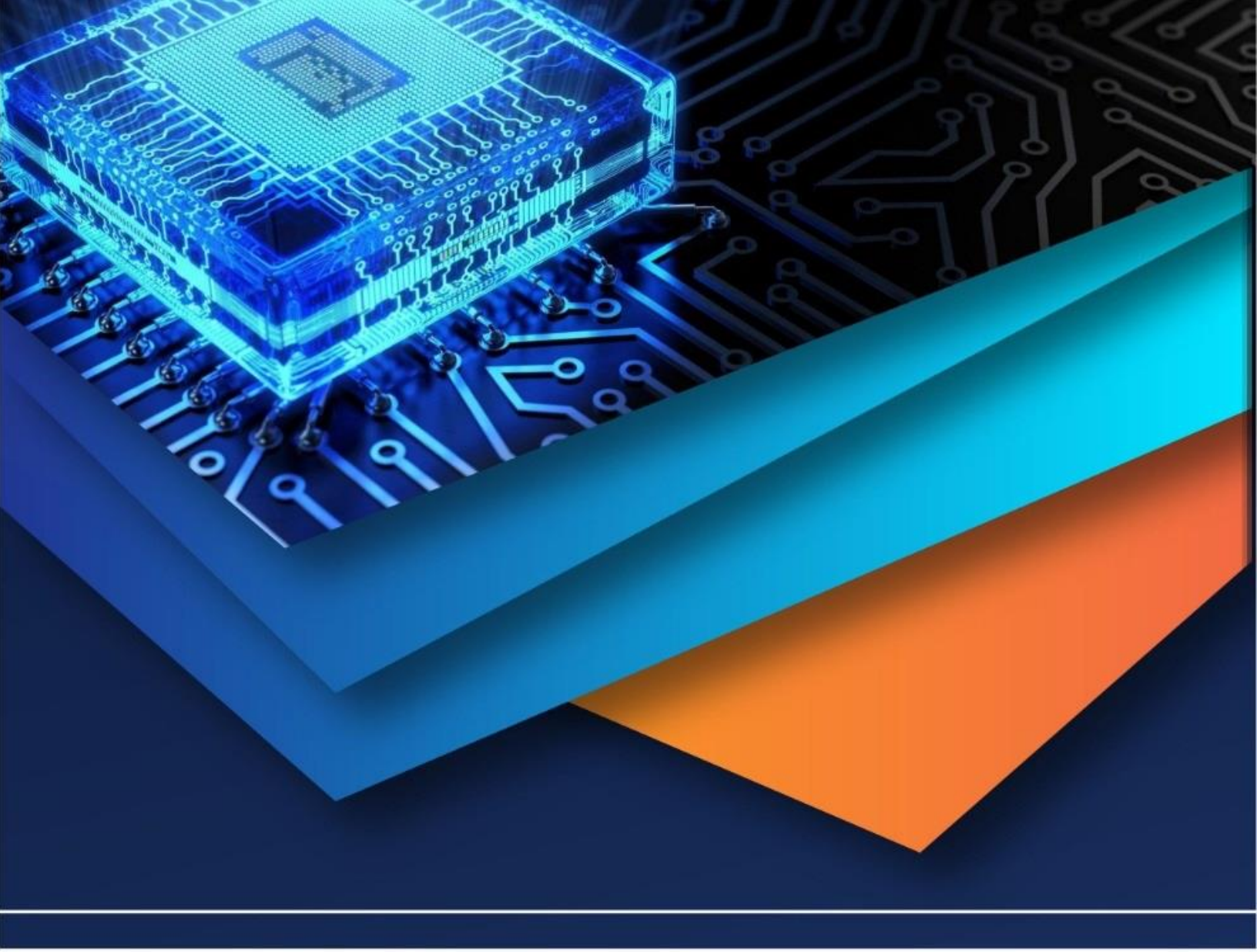
Conservation tillage, cover cropping, and agroforestry are effective for soil conservation in Nagpur, reducing erosion by 35–40%, increasing SOC by 15–20%, and improving moisture retention by 18–22%. However, adoption is limited by costs and knowledge gaps. Localized strategies, leveraging Nagpur's KVKs and government schemes, can scale these practices. Future research should focus on low-cost technologies and participatory models to ensure sustainable agriculture in Nagpur's semi-arid landscape.

V. ACKNOWLEDGMENTS

We thank the Indian Council of Agricultural Research (ICAR), Nagpur, for soil analysis support, and the IMD, Nagpur, for climate data. We appreciate the cooperation of Nagpur's farming communities and feedback from anonymous reviewers.

REFERENCES

[1] Lal, R. (2020). Soil Carbon Management: Global Perspectives. CRC Press.
[2] Hasanuzzaman, M., & Biswas, J. C. (2023). Sustainable Agriculture and Soil Conservation. Springer.
[3] Lal, R., & Six, J. (2021). Conservation agriculture for soil health and carbon sequestration. Soil and Tillage Research, 209, 104966.
[4] Nair, P. K. R., & Kumar, B. M. (2022). Agroforestry for soil conservation and climate resilience. Agroforestry Systems, 96(5), 789–805.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY