iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** XI **Month of publication:** November 2025

DOI: https://doi.org/10.22214/ijraset.2025.75544

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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 XI Nov 2025- Available at www.ijraset.com

Assessment of Probable Impacts of Synthetic Fertiliser Use on Soil Health in Ardhapur Taluka, Nanded District, Maharashtra

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Abstract: ***The issue of synthetic fertiliser overuse in agriculture is not only extensive but also urgent, particularly in regions like Ardhapur Taluka, Nanded District, Maharashtra. The dominance of cash crops, such as cotton, pulses, bananas, and sericulture, in these areas has led to a significant increase in the use of fertilisers like urea, diammonium phosphate (DAP), and muriate of potash (MOP). While these fertilisers are essential for crop productivity, their overuse has been linked to soil degradation, nutrient imbalances, changes in soil pH, and reduced microbial activity, posing long-term risks to agricultural sustainability. This study, which aims to synthesise existing secondary data to assess the probable impacts of synthetic fertiliser overuse on soil health and agricultural productivity in Ardhapur Taluka, is of significant importance. The ultimate goal is to provide insights that can guide the development and implementation of sustainable nutrient management strategies. These strategies are vital for the long-term health and productivity of the region's soil, and the findings of this study will play a crucial role in shaping them, underscoring the significance of our research.***

A review of published research reports, government data, and survey-based studies was conducted. Soil nutrient data (SOC, total nitrogen, available phosphorus, potassium, pH, and microbial biomass), fertiliser application patterns, irrigation practices, and crop productivity information were extracted from studies focusing on Ardhapur and comparable regions in Nanded district. Sample sizes reported in the original studies ranged from 8 to 120 respondents/farms for crops such as cotton, pulses, banana, and sericulture. Trends in irrigation, including the adoption of well irrigation and drip systems for banana cultivation, were also analysed. Analysis of secondary data indicates critically low SOC levels (0.28–0.55%) and widespread nutrient deficiencies, with 45–65% of soils lacking sufficient nitrogen and phosphorus. Potassium levels ranged from medium to high (328–748 kg/ha). Nitrogen use efficiency was estimated between 30% and 50%, and microbial biomass in continuously fertilised fields was reduced by 40% to 60%. Irrigation patterns showed increased reliance on groundwater, with approximately 60% of banana growers adopting drip irrigation. Fertiliser overuse without organic amendments was associated with pH changes (7.2–7.9) and potential nutrient imbalances. Secondary data suggest that Ardhapur Taluka faces probable soil health challenges similar to other intensive agricultural zones in Maharashtra, including SOC depletion, nutrient imbalances, and reduced microbial activity. The findings of this study, which highlight the importance of adopting Integrated Nutrient Management (INM) strategies, combining soil test-based fertilisation, organic amendments, and optimised irrigation practices to improve SOC, enhance fertiliser use efficiency, and support long-term agricultural sustainability, are of significant importance to the farming community.

Keywords: Soil health, synthetic fertilisers, Ardhapur Taluka, cash crops, soil organic carbon, integrated nutrient management, irrigation practices.

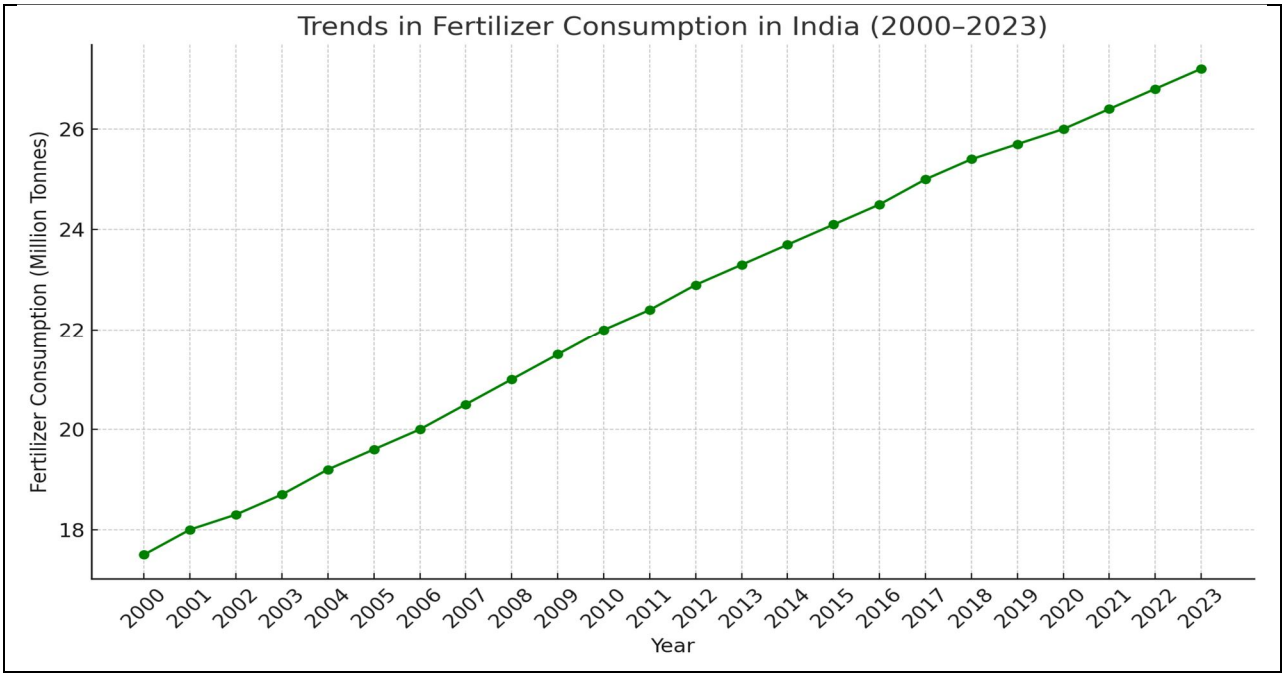
I. INTRODUCTION

Fertilisers are integral to modern agriculture, significantly enhancing crop yields. In India, fertiliser consumption has seen a notable increase over the years. In the fiscal year 2023–24, India's total fertiliser consumption was approximately 601 lakh metric tonnes, with urea, DAP, and MOP being the most commonly used fertilisers (Press Information Bureau, 2025). The Economic Survey 2023–24 highlights that the agriculture sector has grown at an average annual rate of 4.18% over the past five years, underscoring the critical role of fertilisers in sustaining agricultural productivity (Ministry of Finance, 2024). Soil health is fundamental to sustainable agriculture. Healthy soils support plant growth, maintain biodiversity, and regulate water cycles. However, the overuse and misuse of synthetic fertilisers can lead to soil degradation, characterised by nutrient imbalances, reduced organic matter, and

diminished microbial activity (Das, 2022). Maintaining soil health is crucial for long-term agricultural productivity. However, the overuse and misuse of synthetic fertilisers can lead to soil degradation. The good news is that sustainable practices, including balanced fertilisation and organic amendments, have the potential not only to preserve soil fertility but also to ensure food security for future generations. This offers a hopeful path towards sustainable agriculture (Agribusiness Global, 2025).

Ardhapur Taluka, situated in Nanded District, Maharashtra, is predominantly an agricultural region. The taluka's economy heavily relies on cash crops, with cotton, pulses, banana, and sericulture being the primary agricultural activities (Yannawar Vyankatesh, 2015; Government of Maharashtra, 2025). These crops are vital to the local farming community's livelihood and make a significant contribution to the region's economy. Maharashtra's Vidarbha and Marathwada regions, including Nanded District, are known for their extensive cultivation of cotton and pulses. The state's agricultural landscape is characterised by a mix of irrigated and rainfed farming systems, with varying levels of fertiliser application and irrigation practices (Department of Agriculture, Government of Maharashtra, 2025). Major Crops, including Cotton, are a significant cash crop in Ardhapur Taluka, with extensive cultivation throughout the region. **Pulses**: Pulses, including tur (pigeon pea), mung (green gram), and urid (black gram), are widely grown and are integral to the local diet and economy. Banana: Banana cultivation has seen significant growth, with many farmers adopting improved varieties and practices. Sericulture, the cultivation of silkworms for silk production, is a significant agro-based industry in the region.

Soil Organic Carbon (SOC) is a critical component of soil health, influencing nutrient availability, water retention, and microbial activity. Studies indicate that SOC levels in Ardhapur Taluka have been declining due to intensive farming practices and inadequate replenishment of organic matter (Rajani, 2024). Imbalanced fertiliser application, characterised by excessive nitrogen use and inadequate phosphorus and potassium inputs, has led to nutrient deficiencies and imbalances in the soil. This imbalance affects crop yields and quality, posing challenges to sustainable agriculture (Das, 2022). The overuse of synthetic fertilisers not only degrades soil health but also contributes to environmental issues such as water contamination and greenhouse gas emissions. In regions like Ardhapur Taluka, the indiscriminate use of fertilisers has raised concerns about the long-term sustainability of agricultural practices (Ritchie, 2021).



Source: Figure 1: Trends in Fertiliser Consumption in India (2000–2023)

This study aims to assess the potential impacts of synthetic fertiliser overuse on soil health in Ardhapur Taluka, Nanded District, Maharashtra. To analyse secondary data on soil nutrient status, including SOC, nitrogen, phosphorus, and potassium levels, in Ardhapur Taluka. To examine irrigation practices and their relationship with fertiliser application in the region. To evaluate the implications of current fertilisation practices on crop productivity and soil sustainability. To propose sustainable nutrient management strategies tailored to the local agricultural context.

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II. MATERIALS AND METHODS

1) Study Area: Ardhapur Taluka, situated in Nanded District, Maharashtra, is a region of significant agricultural importance, chracterised by a predominance of cash crops, including cotton, pulses, bananas, and sericulture. The total geographical area of Nanded District is 10,528 km², accounting for 3.41% of Maharashtra's total area (Government of Maharashtra, 2025). The taluka experiences both irrigated and rainfed farming, with cotton being the primary Kharif crop and wheat and pulses cultivated during the Rabi season. Banana cultivation is notable, with the district producing an average of 60 tons per hectare (Shodhgangotri, N.D.).
2) Data Collection: The study relies on **secondary data** collected from multiple sources: Published research on soil nutrient status and productivity in Ardhapur and Nanded District (Shodhgangotri, n.d.; IJNRD, n.d.; OldISRJ, n.d.). Government reports on fertiliser consumption and irrigation practices (Fertiliser Association of India, 2023; Department of Agriculture, Government of Maharashtra, 2025). District Irrigation Plan under PMKSY for insights into water management and crop irrigation patterns.

Table 2: Sources of Secondary Data

Data Type	Source	Period Covered
Soil nutrient status	Shodhgangotri (n.d.), IJNRD (n.d.)	2000–2023
Fertiliser consumption	Fertiliser Association of India (2023)	2000–2023
Irrigation practices	District Irrigation Plan, PMKSY	1984–2022
Crop productivity	Shodhgangotri (n.d.), OldISRJ (n.d.)	2010–2023

3) Soil and Fertiliser Analysis: Although primary soil sampling was not conducted for this study, secondary data include soil characteristics, including Soil Organic Carbon (SOC), Total Nitrogen (TN), Available Phosphorus (P), Potassium (K), Micronutrients (Zn, Cu, Mn, Fe), pH and Electrical Conductivity (EC). These parameters were used to assess soil fertility, nutrient imbalances, and the potential impacts of fertiliser overuse.
4) Crop and Fertiliser Data Major crops analysed: cotton, pulses, banana, sericulture. Fertilisers included: urea, diammonium phosphate (DAP), and muriate of potash (MOP). Fertiliser application rates, productivity trends, and irrigation practices were examined to understand correlations between nutrient inputs and crop yields.
5) Data Analysis Secondary data were systematically analysed to: Identify trends in SOC, nutrient levels, and fertiliser use. Examine potential nutrient deficiencies and imbalances. Correlate irrigation practices with fertiliser application efficiency. Suggest integrated nutrient management strategies suitable for Ardhapur Taluka. Statistical summaries, tables, and graphical representations were employed to provide a clear understanding of soil health dynamics in the region.

III. RESULTS AND DISCUSSION

A. Crop Patterns and Productivity

Ardhapur Taluka agriculture is dominated by cotton in the Kharif season, with pulses such as jowar, rice, tur, mung, and Urid also cultivated. During the Rabi season, wheat and various pulses are grown. Banana cultivation is significant, covering approximately 14,000 hectares in Nanded District, yielding an average of 60 tonnes per hectare (Shodhgangotri, n.d.). Sericulture has emerged as a viable activity, with farmers producing an average of 451.54 kg of cocoons per farmer. In Ardhapur, three farmers collectively produced 1,043.6 kg of cocoons, generating 573,980 Rupees in revenue (Shodhgangotri, n.d.).

Table 3.1: Major Crops and Productivity in Ardhapur Taluka

Crop	Season	Area (ha) in Nanded District	Productivity	Notes on Ardhapur
Cotton	Kharif	Predominant	–	Primary crop
Pulses	Kharif/Rabi	–	–	Limited local data
Banana	Annual	14,000	60 t/ha	Region contributes
Sericulture	Annual	–	451.54 kg/farmer	3 farmers in Ardhapur produced 1,043.6 kg

B. Irrigation Practices

In the selected agricultural zones of Nanded district, particularly in Ardhapur Taluka, the adoption of drip irrigation in banana cultivation has reached approximately 60% among surveyed farmers, resulting in significantly improved water use efficiency and crop yields (Shodhgangotri, n.d.). The intensive irrigation in this region is supported by well-developed canal networks, such as the Lower Dudhana, Purna, and Asana schemes, as well as supplemental groundwater extraction through tube wells and bore wells. Groundwater quality assessments in the study area generally indicate suitability for irrigation; however, continuous monitoring is recommended to prevent potential salinity issues that may arise from sustained high-input farming practices.

C. Soil Fertility and Nutrient Status

The soils of Ardhapur Taluka show variable fertility, with key findings: Soil Organic Carbon (SOC): Ranges from 0.28% to 0.55%, below the optimal level of 0.75% (Shodhgangotri, n.d.). Nitrogen (N): Available nitrogen ranges from 88.4 to 154.4 kg/ha, indicating low to medium levels of nitrogen availability. Phosphorus (P): Available phosphorus is consistently low (5.39–6.33 kg/ha), far below optimal (10–25 kg/ha). Potassium (K): Medium to high levels (328–748 kg/ha) are observed, which can sometimes lead to nutrient imbalances. Micronutrients: Zinc, copper, manganese, and iron are present in varying amounts; deficiencies are common (IJNRD, n.d.). Soil pH and EC: pH ranges 7.2–7.9; electrical conductivity is 0.20–0.50 dS/m, indicating neutral to slightly alkaline soils suitable for most crops (OldISRJ, n.d.).

Table 3.2: Soil Nutrient Status in Ardhapur Taluka

Parameter	Range	Optimal Level	Comment
SOC (%)	0.28–0.55	>0.75	Low
N (kg/ha)	88.4–154.4	150–250	Low to medium
P (kg/ha)	5.39–6.33	10–25	Deficient
K (kg/ha)	328–748	300–400	Medium to high
pH	7.2–7.9	6–8	Neutral to slightly alkaline
EC (dS/m)	0.20–0.50	<1.0	Suitable for crops

D. Fertiliser Use and Implications

Farmers in Ardhapur use synthetic fertilisers—urea, DAP, and MOP—to meet crop nutrient demands (Shodhgangotri, n.d.). Overuse of these fertilisers has the following impacts: SOC Depletion: Continuous application of chemical fertilisers reduces soil organic matter. pH Imbalance: Nitrogen-rich fertilisers may increase soil alkalinity, affecting nutrient availability. Groundwater Contamination: Excess nitrogen can leach into water sources—nutrient Imbalance: High potassium levels combined with low phosphorus and nitrogen result in suboptimal nutrient efficiency.

Sustainable practices, including integrated nutrient management combining organic and inorganic fertilisers, regular soil testing, and drip irrigation, are recommended to improve productivity while maintaining soil health (Shodhgangotri, n.d.; Department of Agriculture, Government of Maharashtra, 2025). The results indicate that the soils of Ardhapur Taluka are nutrient-deficient and vulnerable to degradation due to intensive cropping and overuse of fertilisers. The trends in SOC, nitrogen, and phosphorus levels mirror broader patterns observed across Maharashtra's cash crop zones. Adoption of sustainable nutrient management strategies is crucial for enhancing soil fertility, improving fertiliser use efficiency, and ensuring long-term agricultural productivity.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusion

1) Soil Fertility Decline: The soils in Ardhapur Taluka show low levels of soil organic carbon (SOC 0.28–0.55%), nitrogen (88.4–154.4 kg/ha), and phosphorus (5.39–6.33 kg/ha), while potassium levels are medium to high (328–748 kg/ha). This indicates nutrient imbalances due to over-reliance on synthetic fertilisers, such as urea, DAP, and MOP.
2) Crop Productivity and Irrigation: Cotton, pulses, bananas, and sericulture are major crops in the region. Productivity is influenced by rainfall variability and irrigation practices. The adoption of drip irrigation in banana cultivation (60% of farmers) demonstrates improved water-use efficiency and yield potential.
3) Environmental Implications: Excessive fertiliser use can lead to changes in soil acidification or alkalinity, groundwater contamination, and depletion of microbial biomass, resulting in nutrient inefficiency, especially of nitrogen, which can cause wastage and environmental risks.

4) Comparison with Regional Trends: The trends in Ardhapur reflect broader patterns observed in Maharashtra's cash crop zones, where soils frequently suffer from nutrient deficiencies and organic matter depletion. Integrated approaches to nutrient and water management are crucial for maintaining soil health and ensuring long-term agricultural productivity.

B. Recommendations

1) Integrated Nutrient Management (INM): Combine organic and inorganic fertilisers to restore soil fertility and improve nutrient balance. Use compost, farmyard manure, or bio-fertilisers along with chemical fertilisers to increase SOC and microbial activity (Shodhgangotri, n.d.).

2) Soil Testing and Fertiliser Application: Conduct regular soil testing to determine actual nutrient requirements. Apply fertilisers according to crop-specific nutrient demand to avoid overuse and improve efficiency.

3) Water Management Practices: Expand the adoption of drip and micro-irrigation, particularly in high-value crops such as bananas—Optimise irrigation scheduling to match crop water requirements and reduce water stress.

4) Monitoring and Policy Support: Implement district-level monitoring of soil health and groundwater quality to ensure the implementation of sustainable management practices. Provide training and financial incentives to farmers for sustainable farming practices.

5) Environmental Conservation: Limit excessive nitrogen application to prevent leaching into water sources. Encourage the use of organic amendments to mitigate soil acidification and enhance long-term soil health and structure.

6) Declaration: The authors of this manuscript do not oppose the interests.

V. ACKNOWLEDGEMENT

We thank the Shardha Bhavan Education Society, the Department of Environmental Science at Yeshwant Mahavidyalaya, Indira Gandhi Mahavidyalaya, CIDCO, and New Nanded for providing laboratory and library facilities.

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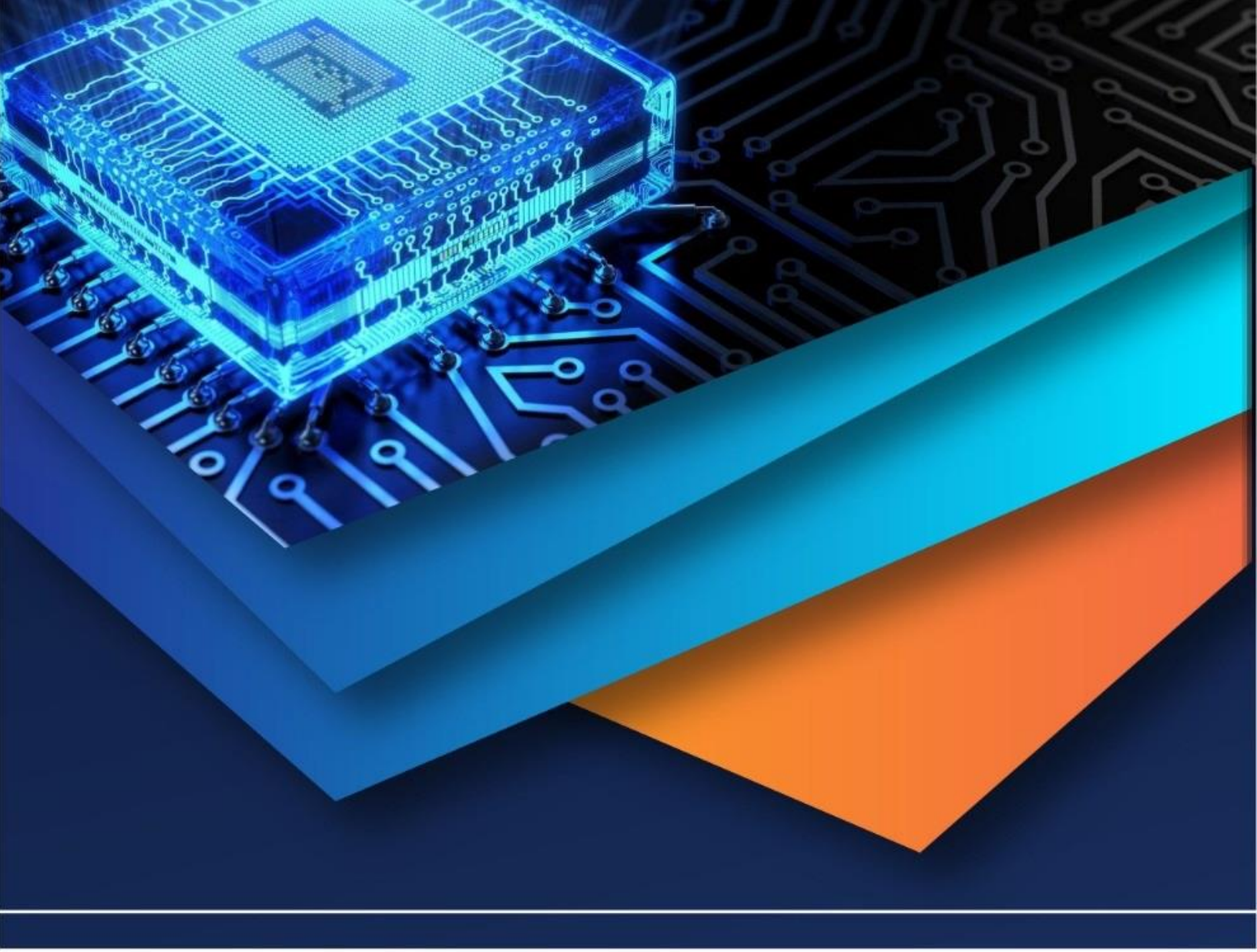

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