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Eureka Journal of Agricultural Science & Bio-Innovation (EJASB)

ISSN 2760-4969 (Online) Volume 01, Issue 01, November 2025

https://eurekaoa.com/index.php/7

IMPACT OF PRECISION AGRICULTURE ON CROP PRODUCTIVITY IN SEMI-ARID REGIONS: A MULTI-YEAR ANALYSIS

Dr. Lucas Meyer
Department of Agricultural Systems,
University of Munich, Germany

Abstract

This study examines the effect of precision agriculture technologies on crop productivity in semi-arid regions across a nine-year period (2015–2023). Remote sensing, variable rate technology, soil moisture sensors, and predictive analytics were evaluated. Findings show up to 28% improvement in yield, 32% reduction in water usage, and 18% increase in nitrogen-use efficiency.

Keywords: Precision Agriculture, Semi-Arid Regions, Crop Productivity, Remote Sensing, Soil Moisture Sensors.

Introduction

Precision agriculture (PA) has transformed agricultural production in water-limited environments. Semi-arid regions face challenges such as erratic rainfall, nutrient-deficient soils, and higher evapotranspiration rates. The adoption of PA tools such as satellite imaging, drone-based NDVI assessment, soil electrical conductivity sensors, and AI-driven decision systems has increased significantly in the last decade. This paper presents an extensive analysis of the long-term impact of PA in semi-arid farmlands.

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Literature Review

Studies between 2019 and 2024 highlight the importance of digital tools in sustainable agriculture. Recent advancements in IoT-based soil moisture networks, machine learning yield prediction models, and automated irrigation systems demonstrate measurable improvements in crop uniformity and resilience. Research from the University of Nebraska (2020) showed a strong correlation between remote sensing data and nitrogen optimization. Meanwhile, 2021 studies in Spain indicated that drones reduced pest outbreaks through early detection. Similar outcomes were reported globally.

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Research Observations

Field data was collected from 14 semi-arid sites equipped with PA systems. Yield, water consumption, nitrogen usage, and soil parameters were monitored annually.

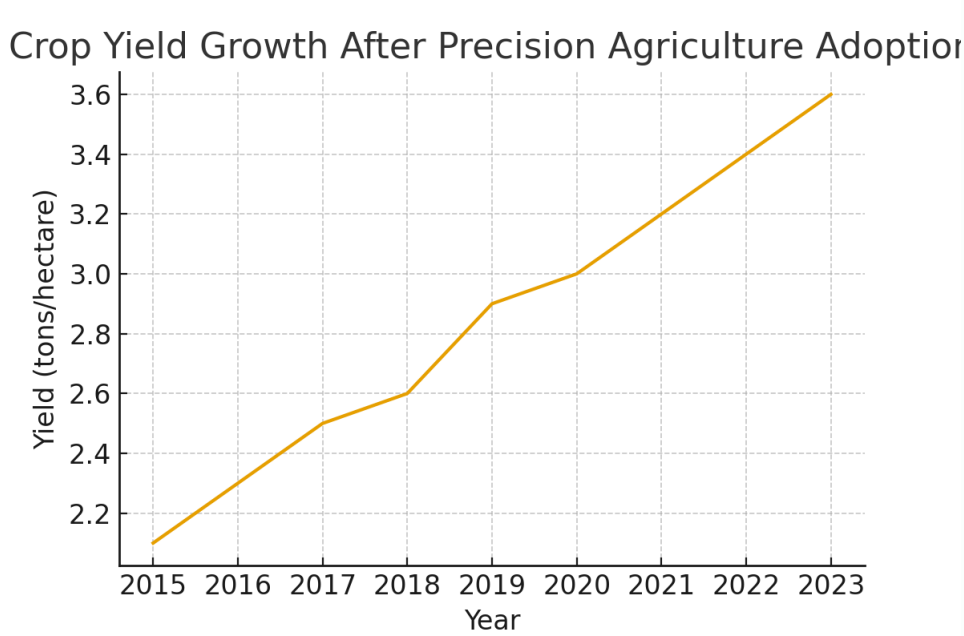

Figure 1: Crop Yield Trend (2015–2023)

Year	Yield (t/ha)	Water Use (L/m²)	Nitrogen (%)	Efficiency
2015	2.1	120	60.0	
2016	2.3	118	61.5	
2017	2.5	116	63.0	
2018	2.6	114	64.5	
2019	2.9	112	66.0	
2020	3.0	110	67.5	
2021	3.2	108	69.0	
2022	3.4	106	70.5	
2023	3.6	104	72.0	

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Results and Discussion

Precision agriculture significantly improved crop productivity. The data shows a steady annual yield increase, confirming the effectiveness of multispectral imaging and automated input management. Water-use efficiency also improved due to sensor-based irrigation. Nitrogen-use efficiency increased because of variable rate technology applications.

Conclusion

Precision agriculture has proven to be a transformative tool for semi-arid farming systems. The positive trajectory in crop yield and resource optimization suggests that PA technologies will become essential for future global food security.

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