The Journal of Rural and Agricultural Research Volume 26, No. 1, 81-85 (2026)
Received March 2026; Acceptance May 2026
RNI UP BILL/2001/7990 ISSN 2348-6643 (Online) ISSN 0972-4370 (Print)

Factors of Productivity, Nutrient Status and Harvest Performance of Rice in Farmers' Fields

BRAJENDRA*, M.B.B. PRASAD BABU, R. GOBINATH, V. MANASA, T. J. GHOSH[1], KAUSHIK MAJUMDAR[2], L. ARUNA[3], B. N. TRIPATHI[4], DALEL SINGH MEHLA[5] AND A. K. PANT[6]
ICAR–Indian Institute of Rice Research (ICAR–IIRR), Hyderabad, Telangana, India
**Corresponding author email ID- birju1973@gmail.com*

Abstract

Rice productivity in farmers' fields is influenced by input-use efficiency, soil fertility, crop management, varietal choice, and harvesting practices. The present study assessed factor productivity, nutrient status, and harvest performance of rice in selected farmers' fields across major rice-growing regions of India. Field observations indicated considerable variability in rice productivity, mainly due to differences in soil fertility, fertilizer management, irrigation, varietal selection, and agronomic practices. Imbalanced fertilizer use, particularly excessive nitrogen application with inadequate phosphorus, potassium, and micronutrients, was identified as an important constraint to nutrient-use efficiency and sustainable productivity. Differences among rice varieties in nutrient uptake and utilization further emphasized the importance of site-specific nutrient management. Survey observations indicated a yield gap of approximately 1-2 t ha^{-1} between farmers' fields and research or improved-management conditions. The major causes included nutrient imbalance, pest and disease incidence, inadequate crop management, and irrigation constraints. Delayed harvesting, inefficient threshing, and inadequate storage further contributed to post-harvest losses. Integrated nutrient management involving balanced fertilizers, organic amendments, green manures, and biofertilizers, combined with improved irrigation, mechanized harvesting, and better post-harvest management, can improve resource-use efficiency and farm-level productivity. The study highlights the need for an integrated approach involving site-specific nutrient management, improved agronomic practices, farmer training, mechanization, and institutional support to reduce yield gaps and promote sustainable rice production.

Keywords: Rice; factor productivity; nutrient status; nutrient-use efficiency; yield gap; INM; harvest management.

[1]Assam Agricultural University (AAU), Titabar, Assam, India
[2]Regional Research Station (RRS), Chinsurah, West Bengal, India
[3]Pandit Jawaharlal Nehru College and Regional Agricultural Research Institute (PJNCARI), Karaikal, Puducherry, India
[4]Chandra Shekhar Azad University of Agriculture and Technology (CSAUAT), Kanpur, Uttar Pradesh, India
[5]Regional Agricultural Research Station (RARS), Kaul, Haryana, India
[6]G. B. Pant University of Agriculture and Technology (GBPUAT), Pantnagar, Uttarakhand, India

Introduction

Rice (*Oryza sativa* L.) is one of the most important food crops globally and serves as a major source of food and livelihood for a large proportion of the population in Asia. The productivity and stability of rice production are therefore closely linked with food security, rural income, and sustainable agricultural development. Although considerable progress has been made in developing high-yielding varieties, improved crop management practices, and modern production technologies, rice yields obtained under farmers' conditions frequently remain below the potential yields achieved under research-station or demonstration conditions.

The difference between potential and actual farm-level productivity is influenced by several interacting factors. These include soil fertility, availability and efficiency of nutrients, water management, crop establishment methods, varietal selection, weed and pest management, labor availability, mechanization, and harvesting and post-harvest operations. The efficiency with which production factors are converted into economic output is commonly described as factor productivity. Improving factor productivity is particularly important in rice because increasing production through indiscriminate use of fertilizers, irrigation water, labor, or other inputs may increase production costs and adversely affect resource-use efficiency and environmental sustainability.

Nutrient management is one of the major determinants of rice productivity. Farmers frequently rely heavily on nitrogenous fertilizers, particularly urea, while applications of phosphorus, potassium, secondary nutrients, and micronutrients may not adequately match crop requirements. Such nutrient imbalance can reduce nutrient-use efficiency, impair soil fertility, and restrict yield formation. Furthermore, nutrient availability varies spatially because of differences in soil properties, cropping history, fertilizer application, irrigation, and organic matter status. Consequently, uniform fertilizer recommendations may not provide optimum results across heterogeneous farmers' fields.

Genotypic variation also plays an important role in nutrient acquisition and utilization. Rice varieties differ in their ability to absorb nutrients from soil and convert absorbed nutrients into biomass and grain yield. Therefore, nutrient management strategies should consider both the nutrient-supplying capacity of the soil and the nutrient requirements and efficiency characteristics of the selected genotype.

Harvest and post-harvest management represent another important but often overlooked component of farm-level productivity. Even when crop production is satisfactory, delayed harvesting, inappropriate moisture management, inefficient threshing, mechanical losses, and poor storage facilities can reduce the quantity and quality of marketable grain. Thus, assessment of rice productivity should extend beyond crop production to include harvesting and post-harvest operations. The present study was undertaken to assess the factor productivity, nutrient status, and harvest performance of rice in farmers' fields across selected rice-growing regions. The specific objectives were to: (i) assess variability in rice productivity and resource-use efficiency among farmers' fields; (ii) evaluate the major nutrient constraints affecting rice production; (iii) identify the major factors contributing to the yield gap between farmers' fields and research-managed conditions; and (iv) identify appropriate management interventions for improving productivity, nutrient-use efficiency, and harvest and post-harvest performance.

Materials and Methods

Field surveys were conducted in selected rice-growing areas of Uttar Pradesh and Haryana, including farmers' fields at Ghagraghat, Bahraich, and Uttar Pradesh. A total of 40 farmers' fields were assessed at Ghagraghat, along with additional roving observations in selected locations. Information on rice variety, fertilizer use, irrigation, crop management, harvesting, and post-harvest practices was collected through field observations and farmer interviews. Soil and crop conditions were assessed to determine the major nutrient constraints and their relationship with rice productivity. Particular attention was given to nitrogen, phosphorus, potassium, and micronutrient status and to differences in nutrient management among farmers' fields. Grain yield and major production practices were recorded to assess variability in factor productivity. The major production factors considered were land, fertilizer, water, and labour. Yield gaps were assessed by comparing farmers' field yields with yields obtained under research or improved-management conditions. Harvest and post-harvest performance was evaluated based on harvesting time, threshing practices, grain recovery, and storage conditions. The collected information was summarized using descriptive statistics, and the major constraints affecting productivity, nutrient-use efficiency, and harvest performance were identified. Where quantitative data were available, appropriate statistical analyses were used to compare locations and management practices.

Results and Discussion

Factor Productivity

The survey revealed considerable variability in rice productivity among farmers' fields. Differences were mainly associated with soil fertility, fertilizer application, irrigation management, varietal choice, and agronomic practices. Fields with balanced nutrient application and better water management generally showed higher productivity. Excessive use of nitrogen fertilizer without adequate phosphorus and potassium reduced nutrient-use efficiency and increased the risk of inefficient input use These results are in conformity with earlier reported by Brajendra et al. (2016) Bharamappanavara et al. (2020), Kale et al. (2021), Gorlapalli et al. (2022), Sahoo et al. (2022) and Gobinathet al. (2026).

Nutrient Status

Farmers' fields showed considerable variation in nutrient availability. Nitrogen was generally applied in relatively high amounts, whereas phosphorus and potassium deficiencies were observed in several fields. Micronutrient deficiencies were also identified in some locations. These results indicate the need for soil-test-based and site-specific nutrient management. Integrated nutrient management using balanced fertilizers, organic amendments, green manures, and biofertilizers can improve nutrient availability and soil health. These results are in conformity with earlier reported by Brajendra et al. (2016) Srilatha et al. (2019), Kale et al. (2021), Rathod et al. (2021), Parmar et al. (2022) and Patel et al. (2025).

Yield Gap and Harvest Performance

Farmers' field yields were generally lower than those obtained under research or improved-management conditions, with an observed yield gap of approximately **1-2 t ha^{-1}** the major causes were nutrient imbalance, pest and disease incidence, irrigation constraints, delayed crop establishment, and inadequate weed and crop management. Harvest and post-harvest practices also influenced effective productivity. Delayed harvesting, inefficient threshing, and inadequate storage contributed to grain losses. Timely harvesting, mechanized threshing, improved drying, and suitable storage facilities can reduce these losses and improve overall farm-level productivity. These results are in conformity with earlier reported by Sharma et al. (2022), Patel et al.

Table 1: Comparative Assessment of Farmers' and Improved Management Conditions

Parameter	Farmers' fields	Research/improved management
Factor productivity	Highly variable and frequently suboptimal	Higher and more consistent with optimized inputs
Nitrogen management	Frequently dominated by nitrogenous fertilizer	Balanced nutrient application based on crop requirement
Phosphorus status	Deficiency observed in several fields	Corrected through balanced fertilization
Potassium status	Deficiency observed in several fields	Adequate K supply according to soil and crop requirement
Micronutrients	Deficiencies in some locations	Corrective application where required
Nutrient-use efficiency	Frequently reduced by nutrient imbalance	Improved through site-specific management
Grain yield	Frequently below potential yield	Higher under optimized management

(2025) and Kumar et al. (2025), Brajendra et al. (2025) and Zoureen et al. (2025).

Overall Implications

The results indicate that improving rice productivity requires an integrated approach rather than increasing individual inputs. Site-specific nutrient management, balanced fertilization, efficient irrigation, suitable varieties, improved agronomic practices, and better harvest and post-harvest management can substantially improve resource-use efficiency and reduce the productivity gap between farmers' fields and improved production conditions. These results are in conformity with earlier reported by Sharma et al. (2022), Patel et al. (2025) and Kumar et al. (2025), Tuli et al. (2022) and Brajendra et al. (2025).

Conclusion

Rice productivity in farmer's fields was affected by variation in nutrient management, irrigation, varietal choice, and agronomic practices. Nutrient imbalance, particularly excessive nitrogen use with inadequate phosphorus and potassium, reduced nutrient-use efficiency and contributed to the observed yield gap of about 1-2 t ha^{-1}. Timely harvesting, improved threshing, and proper storage are also important for reducing post-harvest losses. Overall, site-specific nutrient management, balanced fertilization, integrated nutrient management, efficient water use, improved crop management, and timely mechanized harvesting are essential for increasing rice productivity and resource-use efficiency. Farmer training and appropriate extension support can facilitate the adoption of these practices and contribute to sustainable rice production.

References

Bharamappanavara, M.; Siddaiah, A.M.; Ponnuvel, S. et al. (2020). Mapping QTL hotspots associated with weed competitive traits in backcross population derived from Oryza sativa L. and O. Glaberrima Steud. Sci Rep 10, 22103 https://doi.org/10.1038/s41598-020-78675-7.

Brajendra; M. B. B. Prasad Babu; Manasa V, K. V. Rao; Tejendra Kumar,Vinod Kumar; R. V. Singh and Amarendra Kumer (2025). Factor productivity, nutrient and harvest status of rice in farmers' fields of Ghagraghat The Journal of Rural and Agricultural Research 25 (2): 57-60.

Brajendra; Pati Ram and L. Somendro Singh (2025). Soil test crop response-based fertilizer recommendations in Meghalaya. The Journal of Rural and Agricultural Research 25 (2): 89-95.

Brajendra; Surekha, K.; Latha, P.C.; Babu, M.B.B. Prasad and Babu, V. Ravindra (2016). Effect of mineral enriched composition soil microbiological properties. Asian J. of Soil Science 11 (1):142-144.

Brajendra; Surekha, K.; Latha, P.C. and Sailaja, N. (2016). Effect of mineral enriched composition soil physical parameters. Asian Journal of Soil Science 11(1):145-147.

Gobinath Rajendran; Humera Quadriya; Vijayakumar Shanmugam; Manasa Vakada; Surekha Kuchi; Sanjeeva Rao Durbha; Latha P.C.; Brajendra Parmar; Bandeppa Sonth; Prasad Babu M.B.B.; Kumaresan Palaniappan and Sundaram Raman Meenakshi (2026). Nano zinc oxide (ZnO) foliar nutrition improves yield, antioxidant defence, and zinc content in rice grown under Zn-deficient soil Discover Nano (2026) 21:222 https://doi.org/10.1186/s11671-026-04662-y.

Gorlapalli, A.; Kallakuri, S.; Sreekanth, P.D.; Patil, R.; Bandumula, N.; Ondrasek, G.; Admala, M.; Gireesh, C.; Anantha, M.S.; Parmar, B.; et al. (2022). Characterization and Prediction of Water Stress Using Time Series and Artificial Intelligence Models. Sustainability 14, 6690. https://doi.org/10.3390/su14116690.

Kale, R.R.; Anila, M.; Mahadeva Swamy, H.K.; Bhadana, V.P.; Durga Rani, C.V.; Senguttuvel, P.; Subrahmanyam, D.; Hajira, S.K.; Rekha, G.; Ayyappadass, M.; et al. (2021). Morphological and Molecular Screening of Rice Germplasm Lines for Low Soil P Tolerance. J. Plant Biochem. Biotechnol 30, 275–286.

Kale, R.R.; Durga Rani, C.V.; Anila, M.; Mahadeva Swamy, H.K.; Bhadana, V.P.; Senguttuvel, P. et al. (2021). Novel major QTLs associated with low soil phosphorus tolerance identified from the Indian rice landrace, Wazuhophek. PLoS ONE 16 (7): e0254526. https://doi.org/10.1371/journal. pone.0254526.

Kumar Vishal; Amarendra Kumar; Uday Kumar; Matlooba Naseem; Brajendra and Munna Lal (2025). Field Evaluation of Rice (Oryza Sativa L.) Genotypes for Resistance against Brown Spot

Disease (Drechslera Oryzae) Acta Scientific Agriculture 9.10: 01-08.

Patel Mukesh Kumar; Ramawatar Meena; Yad Vir Singh; Ramjeet Meena; Munna Lal and Brajendra (2025). Effect of Phosphorus and Bio-Organics on Yield and Nutrient Uptake by Mung bean [Vigna radiata (L.) Wilczek] in an Inceptisol of Varanasi. The Journal of Rural and Agricultural Research Volume 25, No. 2, 69-73.

Patel Mukesh Kumar; Ramawatar Meena; Yad Vir Singh; Ramjeet Meena; Munna Lal and Brajendra (2025). Enhancing Mung bean [Vigna radiata (L.) Wilczek] Growth with Phosphorus and Bio-Organics in an Inceptisol. The Journal of Rural and Agricultural Research Volume 25, No. 2, 74-77.

Parmar, B.; Vishwakarma, A.; Padbhushan, R.; Kumar, A.; Kumar, R.; Kumari, R.; Kumar Yadav, B.; Giri, S.P.; Kaviraj, M. and Kumar, U. (2022). Hedge and Alder-Based Agroforestry Systems: Potential Interventions to Carbon Sequestration and Better Crop Productivity in Indian Sub-Himalayas. Front. Environ. Sci. 10:858948. doi: 10.3389/fenvs.2022.858948.

Rathod, S.; Saha, A.; Patil, R.; Ondrasek, G.; Gireesh, C.; Anantha, M.S.; Rao, D.V.K.N.; Bandumula, N.; Senguttuvel, P.; Swarnaraj, A.K.; et al. (2021). Two-Stage Spatiotemporal Time Series Modelling Approach for Rice Yield Prediction & Advanced Agroecosystem Management. Agronomy 11, 2502. https:// doi.org/10.3390/agronomy11122502.

Sharma, K.L.; Munna Lal; K. Sammi Reddy; A.K. Indoria; Ch. Chandra Sekhar; K. Srinivas; M. Prabhakar; V. K. Singh; Brajendra and D. L. A. Gayatri (2022). Effect of Different Levels of Surface Application of Sorghum Residue under Minimum Tillage on Crop Yields and Sustainable Yield Index of Sorghum (Sorghum bicolor (L.) Moench) and Cowpea (Vigna unguiculata (L.) Walp) and Nutrient Status in Rainfed Alfisol Soils, Communications in Soil Science and Plant Analysis, 53:2, 268-280, DOI: 10.1080/00103624.2021.1993883.

Sharma, K.L.; Munna Lal; K. Sammi Reddy; A. K. Indoria; K. Srinivas; Vinod Kumar Singh; M. Prabhakar; D. Suma Chandrika; Brajendra; M. Vasavi; P. Haindavi and D. L. A Gayatri (2022). Long Term Effect of Different Levels of Surface Crop Residue Application on Hydrolyzable and Non-Hydrolyzable Nitrogen Fractions in Sorghum (Sorghum Bicolor (L.) Moench) – Cowpea (Vigna Unguiculata) System in Rainfed Alfisols, Communications in Soil Science and Plant Analysis, 53:3, 337-345, DOI: 10.1080/00103624.2021.2008415.

Sahoo, S.; Mukhopadhyay, P.; Sinha, A.K.; Bhattacharya, P.M.; Rakesh, S.; Kumar, R.; Padbhushan, R.; Bijay-Singh; Parmar, B.; Vishwakarma, A.; Kumar, A.; Yadav, B.K.; Bhushan, S.; Kumar, A.; Kaviraj, M. and Kumar, U. (2022), Yield, nitrogen-use efficiency, and distribution of nitratenitrogen in the soil profile as influenced by irrigation and fertilizer nitrogen levels under zero-till wheat in the eastern Indo-Gangetic plains of India. Front. Environ. Sci. 10:970017. doi: 10.3389/fenvs.2022.970017.

Srilatha, P.; Yousuf, F.; Methre, R.; Vishnukiran, T.; Agarwal, S.; Poli, Y.; Reddy, M.R.; Vidyasagar, B.; Shanker, C.; Krishnaveni, D.; et al. (2019). Physical interaction of RTBV ORFI with D1 protein of Oryza sativa and Fe/Zn homeostasis play a key role in symptoms development during rice Tungro disease to facilitate the insect mediated virus transmission. Virology 526, 117–124.

Tuti, M.D.; Rapolu, M.K.; Sreedevi, B.; Bandumula, N.; Kuchi, S.; Bandeppa, S.; Saha, S.; Parmar, B.; Rathod, S.; Ondrasek, G.; et al. (2022). Sustainable Intensification of a Rice–Maize System through Conservation Agriculture to Enhance System Productivity in Southern India. Plants 11, 1229. https://doi.org/10.3390/plants11091229.

Zoureen, Sufiya; Brajendra; R. Gobinath; Mangal Deep Tuti; Munna Lal; Varsha Rani; Sanjeew Kumar Sinha and Amarendra Kumar (2025). Effect of Different Growing Environments on available Macro and Micro Nutrient in soil under Various Establishment Methods. The Journal of Rural and Agricultural Research Volume 25, No. 2, 64-68