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## Can sustainable intensification boost agricultural productivity and fertiliser use efficiency? Insights from wheat systems in the eastern Indo-Gangetic Plains

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### Abstract

Sustainable intensification (SI) is promoted within smallholder farming systems to improve agricultural productivity and reduce negative environmental externalities associated with agri-food systems. In the Indo-Gangetic Plains (IGP) of South Asia, early sowing of wheat has been considered as an important strategy to increase productivity and reduce negative impacts of excessive fertiliser usage, because early wheat sowing can minimise physiological distress associated with terminal heat stress and plants may be more effective at nutrient uptake than late sown wheat. Surprisingly, however, there is a lack of empirical evidence about this coming from on-farm survey data, despite the recognised importance of nutrient use efficiency in the IGP's high-input farming systems. We address this gap by utilising the large-scale farm survey data collected from the eastern Uttar Pradesh and Bihar states of India. We employ an instrumental variable approach to control the potential endogeneity that arises from both observed and unobserved sources of heterogeneity. We find that early sowing of wheat improves all nitrogen, phosphorus, and potash use efficiency ranging from 5–7%, 4–7%, and 3–7%, respectively, as well as 6–7% gain in productivity. However, these impacts are unevenly distributed. Early sowing of wheat on large farms and farms applying doses of fertiliser exceeding the states recommendation are less impacted in terms of gain in productivity and fertiliser use efficiency. Findings suggest that while SI has potential to boost wheat productivity and fertiliser use efficiency, significant policy initiatives are required to minimise the over-application of fertilisers and mitigate the negative environmental externalities associated with agri-food systems in the Indo-Gangetic Plains of South Asia.

**Keywords:** Early sowing of wheat, fertiliser use efficiency, impact heterogeneity, instrumental variable approach, South Asia