

Nutrient Expert Improves Maize Yields while Balancing Fertilizer Use

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Nutrient Expert® (NE) is a simple and rapid tool for generating field-specific fertilizer recommendations. Results from 17 on-farm sites in five districts of Bihar showed that NE significantly increased maize yields and economic returns compared to the generalized State Recommendation (SR) and Farmers' Fertilization Practice (FFP). NE's impact on fertilizer use in maize shifted N and K application upwards while also lowering P application rates.

Bihar is one of the predominant maize-growing states in India as it produces about 9% of the country's total. But average maize yields in the state are much lower than their potential. One of the reasons for low maize yields is the lack of appropriate and balanced nutrient management strategies, especially for the recently introduced maize hybrids. Existing fertilizer recommendations in the state are also homogeneous in nature—prescribing a single rate of fertilizer for large areas without giving consideration to the variability in soil fertility that exists across farmers' fields. This has led to unsustainable use of fertilizer and the associated economic and environmental concerns. Fertilizer is a critical input in maize production, and its rational use is expected to improve productivity and economics of production while reducing the environmental footprint.

The principles of SSNM for maize have been integrated into a user-friendly decision support tool called Nutrient Expert® (Pampolino et al., 2012). The tool was developed for the South Asia Program of the International Plant Nutrition Institute (IPNI) in collaboration with the International Maize and Wheat Improvement Center (CIMMYT) to facilitate large-scale implementation of SSNM in farmers' fields. The software configuration is described in detail by Xu et al. (2014). The tool starts by asking a few simple questions to determine attainable yield and yield responses to fertilizer. It can work with or without soil testing, and can provide field-specific nutrient recommendation to millions of smallholder farmers who might not have access to soil testing, especially for multiple cropping systems. The tool integrates 4R Nutrient Stewardship principles (i.e., ensuring the right source is applied at the right rate, right time, and right place) into a fertilizer recommendation and suggests different levels of application rates based on varying target yields as well as growing environments. More importantly, it considers the environmental, economic and agronomic benefits simultaneously.

The performance of Nutrient Expert (NE) was evaluated in Bihar State by comparing its results against the SR and FFP. These on-farm experiments examined grain yield, economic returns, and NPK fertilizer use in 17 farmers' fields across five districts (Samastipur, Patna, Begusarai, Jamui, and Purnia) with winter maize during 2011 to 2012. The individual treatment plot size was 100 m² or higher. The SR treatment included uniform application of 120-60-40 kg N-P₂O₅-K₂O/ha. Farmers chose hybrid maize varieties with yield potentials



Bihar farmer (center) demonstrates dramatic improvement in maize yield resulting from Nutrient Expert recommendation. Dr. Shahi is pictured on the farmer's right and Dr. Dutta is standing on the farmer's left.

above 5 t/ha. The seed rate for all treatments was chosen to maintain a planting density of 65,000 to 85,000 plants/ha. Similar water management and plant protection measures were adopted for all treatments at each site. At harvest, the sampling area (located within the middle part of the plot) was selected randomly in each treatment plot to determine grain yield. Grain yields from all treatment plots were calculated at 15.5% moisture content.

The Impact of NE on Maize

Results suggested that both grain yield and the total biomass yield in NE-based fertilizer recommendation plots were significantly higher compared to SR and FFP treatments (**Figure 1**). The average grain yields were 8, 7.4 and 6.9 t/ha in NE, SR and FFP plots, respectively, which indicated a 10 to 15% increase in maize grain yield when using NE. Xu et al. (2014) achieved similar results in more than 400 on-farm trials conducted throughout China.

Abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; SSNM = site-specific nutrient management; ₹ = US\$61. Project #IPNI-2010-IND-509



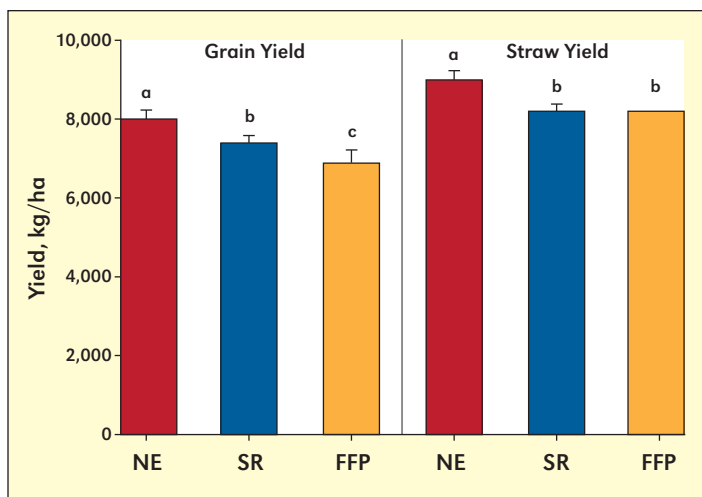


Figure 1. Average (n = 17) grain and straw yields of maize in Nutrient Expert (NE), State Fertilizer Recommendation (SR) and Farmer Fertilization Practice (FFP) treatment plots. Yield component numbers with different letters are significantly different at $p \leq 0.001$.

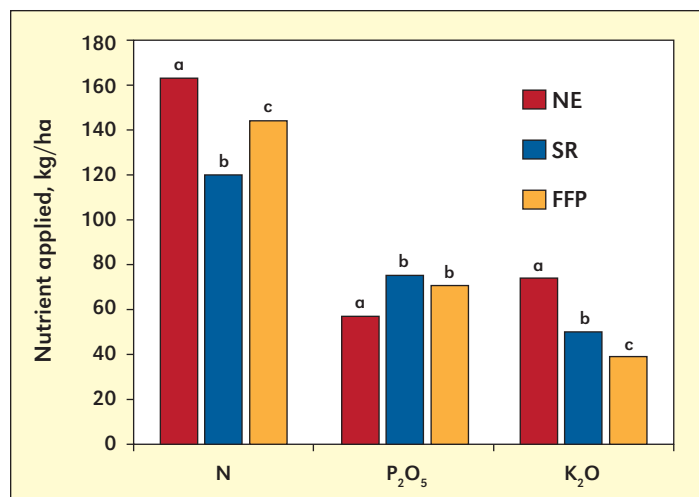


Figure 2. Average (n = 17) N, P₂O₅ and K₂O applied in Nutrient Expert (NE), State Fertilizer Recommendation (SR) and Farmer Fertilization Practice (FFP) treatment plots. Numbers within each nutrient with different letters are significantly different at $p \leq 0.05$.

Gross return on investment, ₹		
Nutrient Expert	State recommendation	Farmer's practice
14a	13b	13b
Net return on investment, ₹		
13a	12b	12b

2011/12 Costs/Prices: Urea = ₹12/kg N, SSP = ₹45/kg P₂O₅, KCl = ₹27/kg K₂O, Price of maize grain: ₹11/kg.
Numbers within rows with different letters are significantly different at $p \leq 0.07$.

Similar to grain yield increases, NE plots showed significant increase in gross returns over fertilizer cost compared to SR and FFP treatment plots (**Table 1**). Also, there was either no change or no significant increase in farmers' fertilization cost in NE plots compared to SR and FFP plots.

The average recommended N and K₂O were significantly higher with NE, while the average recommended P₂O₅ was significantly lower, compared to SR and FFP (**Figure 2**). Fertilizer N application in FFP ranged from 105 to 188 kg/ha, with an average of 144 kg/ha across different trial sites. Similarly, P₂O₅ application rates in FFP ranged from 39 to 147 kg/ha, with an average of 71 kg/ha, while K₂O application rates varied from 0 to 107 kg/ha, with an average value of 39 kg/ha. The NE-based fertilizer recommendation suggested an N application range between 130 and 190 kg/ha, P₂O₅ applica-

tion between 44 and 64 kg/ha and K₂O application between 55 and 105 kg/ha, with average values being 163-57-74 kg N-P₂O₅-K₂O/ha. The ranges of nutrient application rates narrowed with NE compared to FFP, which suggested that NE was able to better manage the variability in growing environments in Bihar and can therefore be a reliable tool for site-specific fertilizer application.

Summary

Nutrient Expert enables farmers to dynamically adjust fertilizer application rates based on crop requirement, growing environment, and target yield in their fields, which resulted in better maize yields and economic returns in Bihar, while also balancing fertilizer use compared to FFP and SR. We expect that the user-friendliness of NE and its robust estimation of site-specific nutrient recommendation will be attractive to Bihar extension specialists working with its 1.5 million farmers and their intensively cultivated maize areas. **DC**

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Reference

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