Nutrient Expert®-based Fertiliser Recommendation Improved Wheat Yield and Farm Profitability in the Mewat

By Shashikant N. Bhende and Ashish Kumar

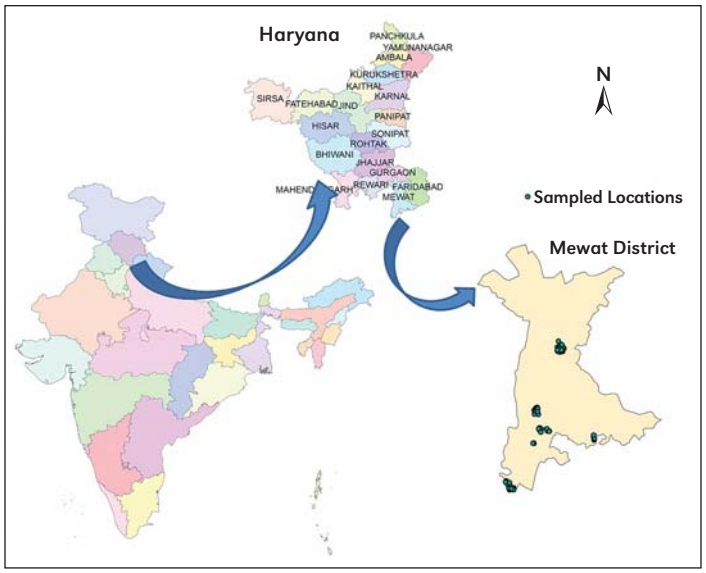
Nutrient Expert® was used to formulate and evaluate improved fertiliser management for wheat farmers in the Mewat region of Haryana. The resulting fertiliser recommendation produced higher yield and farm profit as compared to the farmers' fertilisation practices at a similar partial factor productivity of applied nutrients.

Mewat is a resource-challenged district in Haryana, where rain-fed agriculture is the main source of livelihood. The major cropping systems in Mewat are Pearl millet/Sorghum–Wheat, Fallow/Mustard, Guar–Wheat and Guar–Mustard. Mustard and wheat are the main crops in *rabi* season, which occupy 27,760 ha and 100,536 ha, respectively with an average productivity of 1.3 and 3.5 t/ha. In the *kharif* season, pearl millet is the major crop occupying 26,159 ha with the productivity of 1.3 t/ha.

Soils of Mewat district are generally deficient in most essential macro- and micro-nutrients (IRRAD, 2011). Average productivity of the main crops in the region, viz. mustard, wheat and pearl millet is lower than the state average productivity of these crops. Conventional farming practices, coupled with imbalanced application of nutrients are some of the major reasons for low crop productivity. This has made agriculture unprofitable for most farmers. Improved fertiliser management practices that necessarily include the use of balanced fertilisers, combined with the knowledge on how to adopt these practices, are required to improve crop productivity in the region.

Mosaic, a leading fertiliser producer of the world, lauched the "Krishi Jyoti" project in the Mewat region under its Corporate Social Responsibility (CSR) program in 2008-09. "Krishi Jyoti" (meaning "enlightened agriculture") aimed to improve the livelihood of farmers by helping them achieve enhanced farm profit through improved crop management practices.

The Nutrient Expert® (NE) fertiliser decision support tool for wheat, developed by the International Plant Nutrition Institute and its partner organisations, were used in the Krishi Jyoti project to help improve wheat yield in the region. NE is an easy-to-use, interactive computer-based decision tool that can rapidly provide nutrient recommendation for an individual farmer's field in presence or absence of soil testing data (Pampolino et al., 2012).



Geographical location of Mewat district and sampling locations.

NE-based recommendations were implemented in two

Abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; S = sulphur; Zn = zinc.

Farmers meet to discuss results of implementing Nutrient Expert® as a fertiliser recommendation tool in wheat.

consecutive wheat seasons, 2012-13 and 2013-14, in 40 and 60 farmers' fields, respectively. The farmers were chosen randomly from ten villages of the region. The most commonly grown wheat varieties (i.e., PBW343, PBW711 and PBW2329) of the area were sown in the first fortnight of November in both the years. Each farmer's field was divided into two separate sections. NE-based fertiliser recommendations were applied in one part of the field while existing farmers' fertilisation practice (FFP) was followed in rest of the field. The required amount of N, P and K were applied through urea, diammonium phosphate (DAP) and muriate of potash (MOP), while Zn and S were applied through zinc sulphate and bentonite-S sources.

The entire amount of P, K, Zn, and S were applied at crop establishment, while N was applied three times at 0, 20 to 25, and 40 to 45 days after sowing with one-third of the total amount applied at each split. Wheat varieties and all other management practices remained the same for both treatments in each farmer's field. The crop was harvested in the month of May of the following year and wheat grain yield from the NE and FFP treated plots were recorded based on the whole plot yield.

The yield in FFP plots (n=100) ranged from 2,750 to 5,500 kg/ha, with an average yield of 3,773 kg/ha. The average NE plot yield (n=100) was 5,226 kg/ha, with a range of 4,000 to 6,500 kg/ha (**Figure 1**).

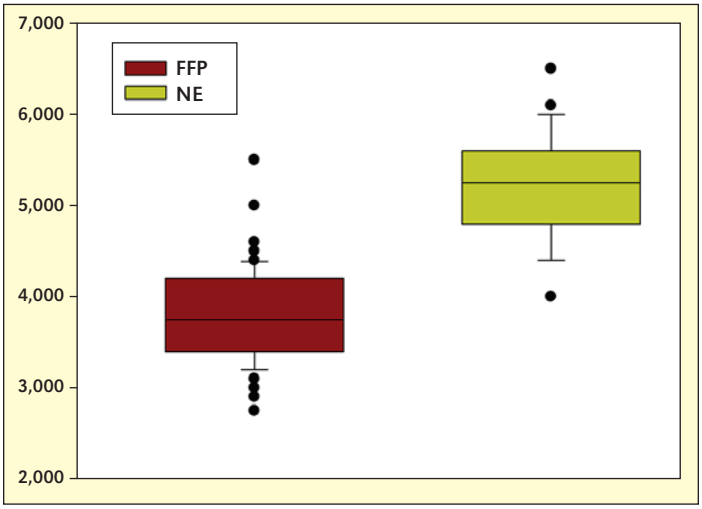


Figure 1. Yield variability in FFP and NE treatments in farmers' fields of Mewat. Boxes represent data within the first and third quartiles (interquartile range). The thin line denotes the second quartile or median. Lines extending beyond the interquartile range denote the 10th to 90th percentile of the data. Statistical outliers are plotted as individual points outside these lines.

The yield variability in FFP treatments were higher than the NE-treated plots. NE estimates the attainable yield in a particular location based on historical data and through assessment of constraints such as drought, soil acidity, nutrient deficiency, or the existence of problem soils. Fertiliser recommendations from NE are based on this attainable yield assessment as well as estimation of cropping system nutrient balance for each field. Such algorithms generally produce recommendations that are aimed at achieving similar attainable yields for farmers within a pre-defined domain. This could be the reason for lesser yield variability in the NE treatments as compared to the FFP.

Average application of N, P_2O_5 and K_2O in farmers' fields were 117, 54 and 0 kg/ha, respectively. The average recommendation by NE was 122, 62 and 83 kg/ha of N, P_2O_5 and K_2O, respectively (**Figure 2**). The average N and P application

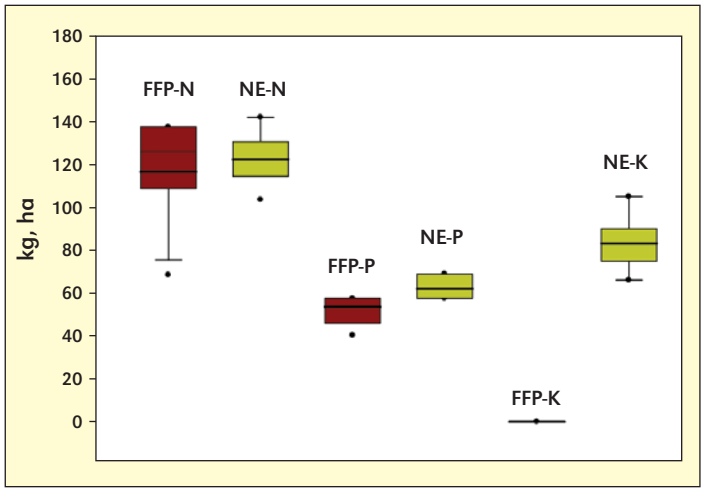


Figure 2. Comparison of N, P, and K application rates in FFP and NE. Boxes represent data within the first and third quartiles (interquartile range). The thin line denotes the second quartile or median. The thicker line within the boxes represent the mean. Lines extending beyond the interquartile range denote the 10th to 90th percentile of the data. Statistical outliers are plotted as individual points outside these lines.

rates were similar in FFP and NE, while farmers did not include K in their fertilisation schedule (**Table 1**). Cropping system nutrient balance is one of the major drivers of site-specific fertiliser recommendation.

Table 1. Agronomic and economic performance of Nutrient Expert® for wheat (NE) as compared to farmers' fertiliser practice (FFP) across all sites and years.

Parameter	FFP	NE	NE-FFP	
Grain yield, kg/ha	3,773	5,226	1,453	***
Fertiliser N, kg/ha	117	123	6	ns
Fertiliser P_2O_5, kg/ha	54	62	8	**
Fertiliser K_2O, kg/ha	0	83	83	***
Fertiliser cost, ₹/ha	4,911	10,190	5,279	***
GRF*, ₹/ha	53,566	70,813	17,247	***

*** and **: significant at <0.001 and 0.01 level; ns = not significant. Prices (₹/kg): wheat = 15.50; N = 16.90; P_2O_5 = 48.76; K_2O = 26.67; Zn = 152.00; S = 44.4; GRF = Gross Return over Fertiliser Cost.

NE, while estimating cropping system nutrient balance, assessed that farmers are not applying the required amount of K to their crops and recommended adequate amounts of K to wheat to reduce K mining from the soils. Comparing the nutrient application rates between the two treatments showed that the K application rates differ significantly between them (**Table 1**). It can be inferred that the yield advantage achieved through NE is mainly driven by higher K application rates.

Fertiliser cost increased significantly due to higher K application in the NE treatment as compared to FFP (**Table 1**). However, the gross return over fertiliser cost (GRF) in the NE

treatment was significantly higher than the existing farmers' practice (₹17,247/ha) due to the additional wheat yield of nearly 1.5 t/ha. The results highlighted that field-specific fertiliser recommendation by the NE can substantially improve farmers' yield and profitability over their existing practices. This study also clearly indicated that adequate K application in wheat would be critical to improve yield and profitability of farmers. Adequate and balanced application of K would be particularly critical in water constrained areas like Mewat as adequate K within the plant reduces drought stress leading to less yield penalty under water stress conditions.

The partial factor productivity (PFP) of the applied nutrients (kg grain/kg applied nutrients) was estimated for all the farmers' fields for both the treatments (**Figure 3**). The average PFP under farmers' practice was 23 kg grain/kg applied nutrient, with a broad range of 14 to 54 kg grain/kg applied nutrient. For NE, the mean PFP was 20 kg grain/kg applied nutrient, and the range was 14 to 26 kg grain/kg applied nutrient. The lower average PFP in the NE plot was due to higher NPK application (267 kg/ha) as compared to FFP (171 kg/ha). The 96 kg/ha of extra NPK application, mainly driven by an average K_2O application of 83 kg/ha (**Figure 2**), produced 1,453 kg/ha of additional yield. However, due to climatic and water constraints the yield increment per unit of additional nutrient application was not high enough (15 kg grain/kg of extra NPK addition) to produce high overall PFP. However, the yield and economic advantage of the NE treatment were significantly higher than the FFP. The results highlighted an important point that improving nutrient use efficiency cannot be the singular goal of a nutrient management strategy, as inadequate application of nutrient will compromise yield and profitability. Rather, achieving higher yields and profitability with reasonably high PFP should be the goal of an improved nutrient management strategy that will be economically profitable and environmentally sustainable.

Side-by-side comparison of wheat grown under Nutrient Expert® (left) and Farmers' Fertilization Practice (right).

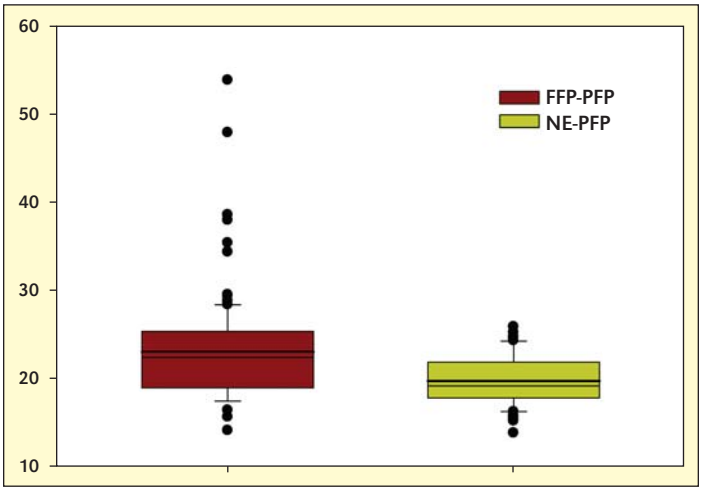


Figure 3. Partial factor productivity in FFP and NE treatments in farmers' fields. Boxes represent data within the first and third quartiles (interquartile range). The thin line denotes the second quartile or median. The thicker line within the boxes represent the mean. Lines extending beyond the interquartile range denote the 10th to 90th percentile of the data. Statistical outliers are plotted as individual points outside these lines.

The NE fertiliser decision support tool-based recommendation significantly improved wheat yield and farmer profitability in Mewat region of Haryana. The capacity of NE to develop a field-specific fertiliser recommendation without soil testing is a significant step towards providing science-based fertiliser recommendations to a large segment of smallholder farmers who do not have access to soil testing. The results showed that adequate and balanced application of K is critical for improving wheat yields in the water-stressed region of Mewat. Estimations in this study suggested that improving nutrient use efficiency cannot be a singular objective of improved nutrient management strategies, rather must be accompanied by higher yield and profitability for the farmers. BCSA

Dr. Bhende is Country Agronomist (Shashikant.Bhende@mosaicco.com) and Mr. Ashish Kumar is Agronomy Associate with Mosaic India Private Ltd., Gurgaon, India.

References

IRRAD. 2011. Mapping Soil Fertility of Mewat, Haryana. Institute of Rural Research and Development, Haryana, India.

Pampolino, M.F., C. Witt, J.M. Pasuquin, A. Johnston, M.J. Fisher. 2012. Computers and Electronics in Agric. 88:103-110.