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Addressing Heterogeneity of Maize Yield and Nitrogen Use Efficiency in India

Farm-specific Fertilizer Recommendation from the Nutrient Expert[®] Tool

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Nutrient management interventions in smallholder systems must address...

BIO-PHYSICAL

Topography
Climate
Genesis
Management



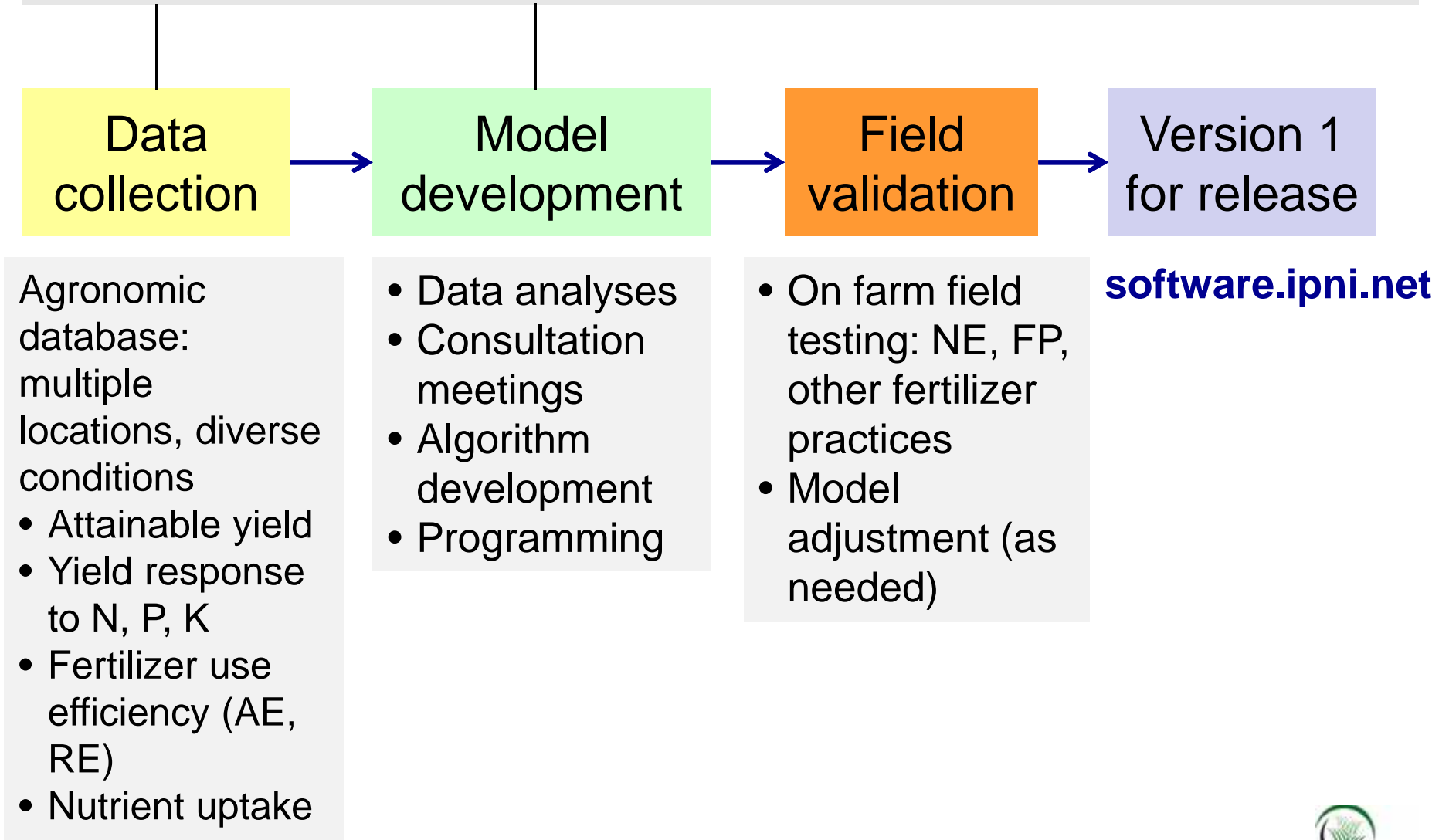
SOCIO-ECONOMIC

Resource
Education
Age
Access to input
Risk perception
Influence
Access to market
Land tenure
Farm size
On-farm/off-farm
income

Farm-specific and Farmer-specific

Nutrient Expert[®]: development process

Site-specific nutrient management Principles, QUEFTS model




Nutrient Expert recommendation:

- Tailored to location-specific conditions
- Consistent with 4Rs:
 - right source
 - right rate
 - right time
 - right place

Nutrient Expert® for Hybrid Maize

Name and/or location: **Field size:** ha
Current yield: ton (FW) t/ha (15.5% MC) **Growing environment:**

Recommended alternative practice for hybrid maize
Yield goal: ton (FW) t/ha (15.5% MC)
Planting density: plants/ha **Distance between rows:** cm **Distance between plants:** cm



Growth stage	Days after planting	Soil moisture	Fertilizer sources	Weight of full bag (kg)	Amount (bags)
Basal	0	sufficient	1:1:1:1 Urea MOP	50 50 50	3.5 0.5 1
V6	25	sufficient	Urea	50	2
V7	35	sufficient	Urea	50	2

Other sources of nutrients:
 Crop residue (maize):
 Organic fertilizer: t
 N: kg
 P₂O₅: kg
 K₂O: kg

↑
Integration of organics

Right time

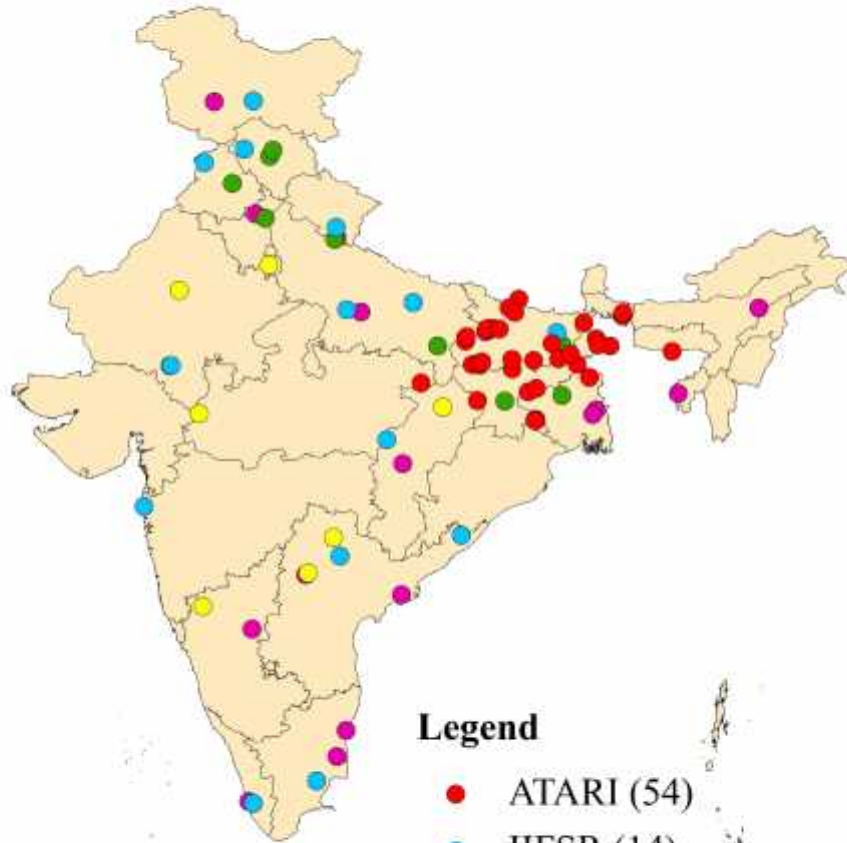
Right source

Right rate

Fertilizer rates are adjusted to field size.

Deficient Nutrient	Recommendation to correct deficiency
Zinc	Apply 25-30 kg/ha zinc sulfate as basal

Nutrient Expert On-Station Evaluation/Research with ICAR institutes

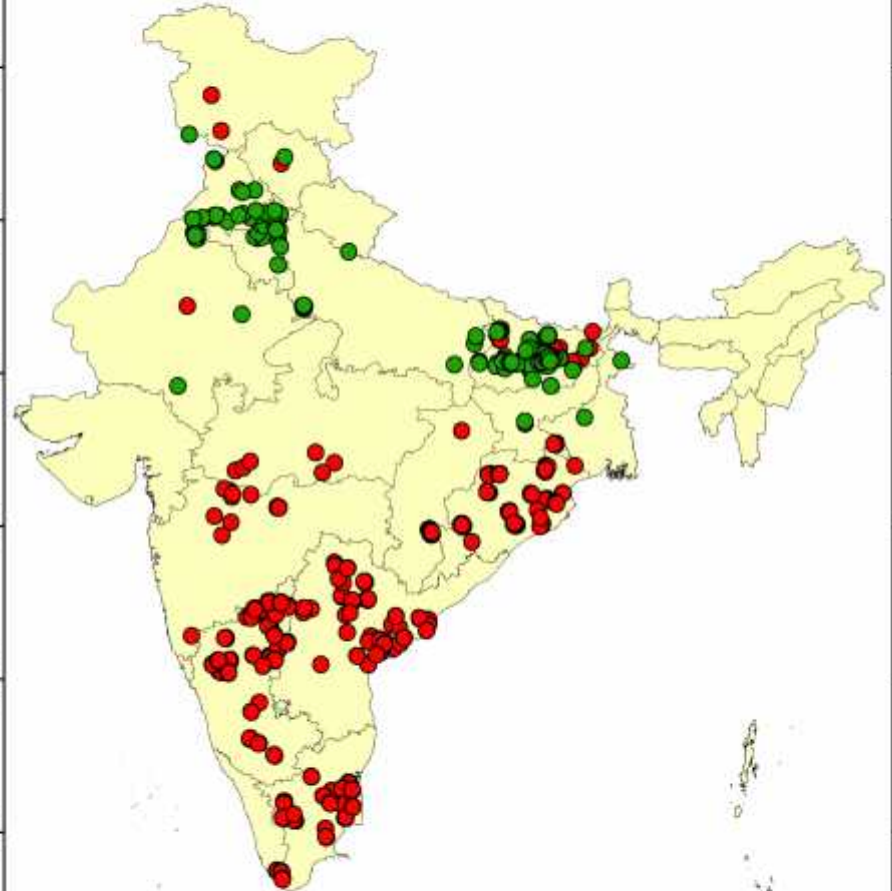


Legend

- ATARI (54)
- IIFSR (14)
- IIWBR (11)
- IIMR (11)
- IIRR (17)



IPNI Maize and Wheat NE on-farm trial sites (2010-till date) (Each point represents several on-farm experiments)



- Wheat (n=896)
- Maize (n=1192)



Field Performance of Nutrient Expert® (NE) for Rice, Wheat and Maize in India (2010-14)

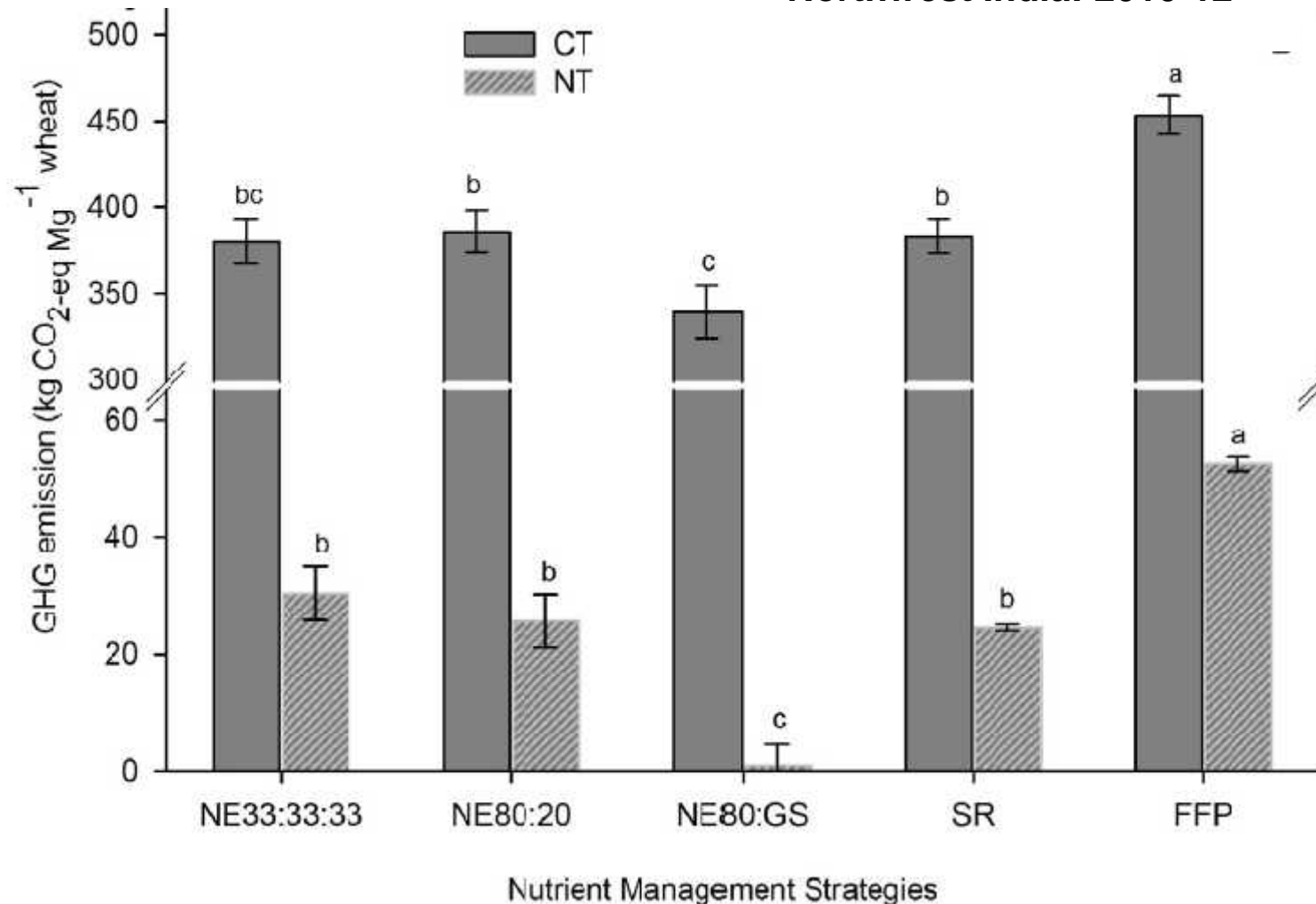
Parameter	Unit	Effect of NE (NE – FFP)					
		Wheat		Maize		Rice	
		(n = 701)		(n = 412)		(n = 323)	
Grain yield	t/ha	+0.79	***	+1.27	***	+1.16	***
Fertilizer N	kg/ha	-8	***	-6	ns	+26	***
Fertilizer P ₂ O ₅	kg/ha	-4	***	-16	***	-5	*
Fertilizer K ₂ O	kg/ha	+54	***	+22	***	+2	ns
Fertilizer cost	USD/ha	+17	***	-1	ns	+3	ns
Gross profit	USD/ha	+163	***	+256	***	+235	***

***, **, *: significant at <0.001, 0.01, and 0.05 level; ns = not significant



Nutrient Expert[®] reduced GHG emission in wheat with increased yield and profit

Northwest India: 2010-12



Source: Sapkota et al. 2014, Field Crops Res. 155: 233-244

Fertilizer recommendations addressing variability in regional growing environment

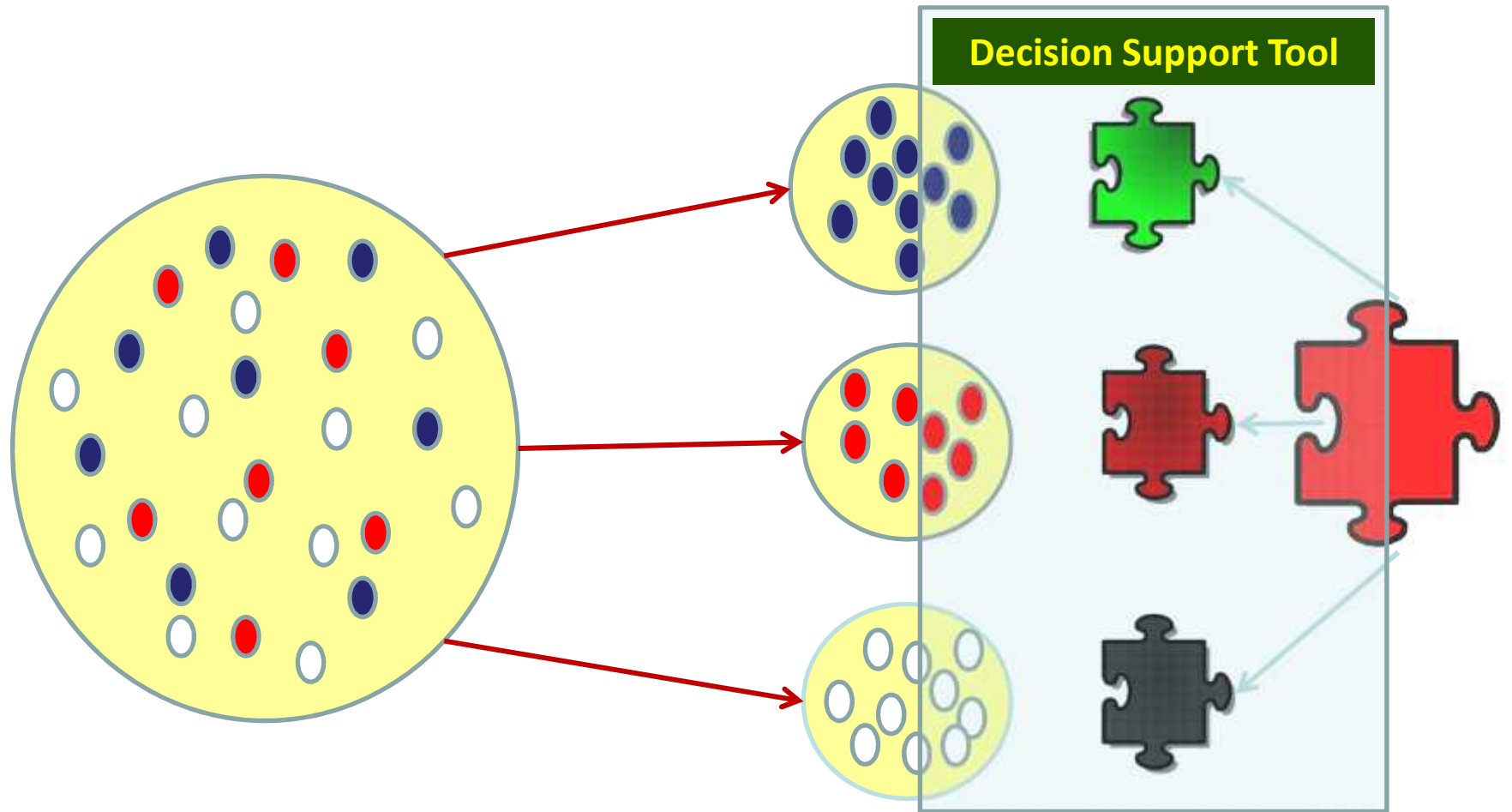
- **Eastern India**
 - Alluvial heavy to light textured soils
 - Traditional maize growers
 - Small farms
 - Resource poor farmers
 - Low fertilizer input
 - Low yields except for some areas growing winter maize
- **Southern India**
 - Red, Lateritic, Black and Alluvial soils
 - Market –driven non-traditional maize growers
 - Larger farms
 - Resource rich farmer
 - High fertilizer input
 - High maize yields

Region	Difference in Nutrient Expert-based fertilizer recommendation and Farmers' Practice				
	N (kg/ha)	P ₂ O ₅ (kg/ha)	K ₂ O (kg/ha)	Yield (kg/ha)	PFP _N (kg N/kg N)
South India	- 33.8***	- 40.8***	8.7**	677***	4.3*
East India	6.5*	-15.0**	28.0**	1482***	6.0***

Fertilizer recommendations need to match temporal variations within locations

Region	Difference in Nutrient Expert-based fertilizer recommendation and Farmers' Practice				
	N (kg/ha)	P ₂ O ₅ (kg/ha)	K ₂ O (kg/ha)	Yield (kg/ha)	PFP _N (kg N/kg N)
Andhra Pradesh					
Rainy Season	-43 ^{***}	-6 ^{NS}	8 ^{NS}	1541 ^{***}	16 ^{***}
Winter Season	-49 ^{**}	-66 ^{***}	11 ^{NS}	1192 ^{***}	11 ^{***}
Bihar					
Rainy Season	25 ^{***}	15 ^{***}	51 ^{***}	1345 ^{***}	4.2 ^{***}
Winter Season	-1.6 ^{***}	-6.3 ^{***}	44.5 ^{***}	1163 ^{***}	6.9 ^{***}

Conceptual Framework for Technology Targeting in Smallholder Systems

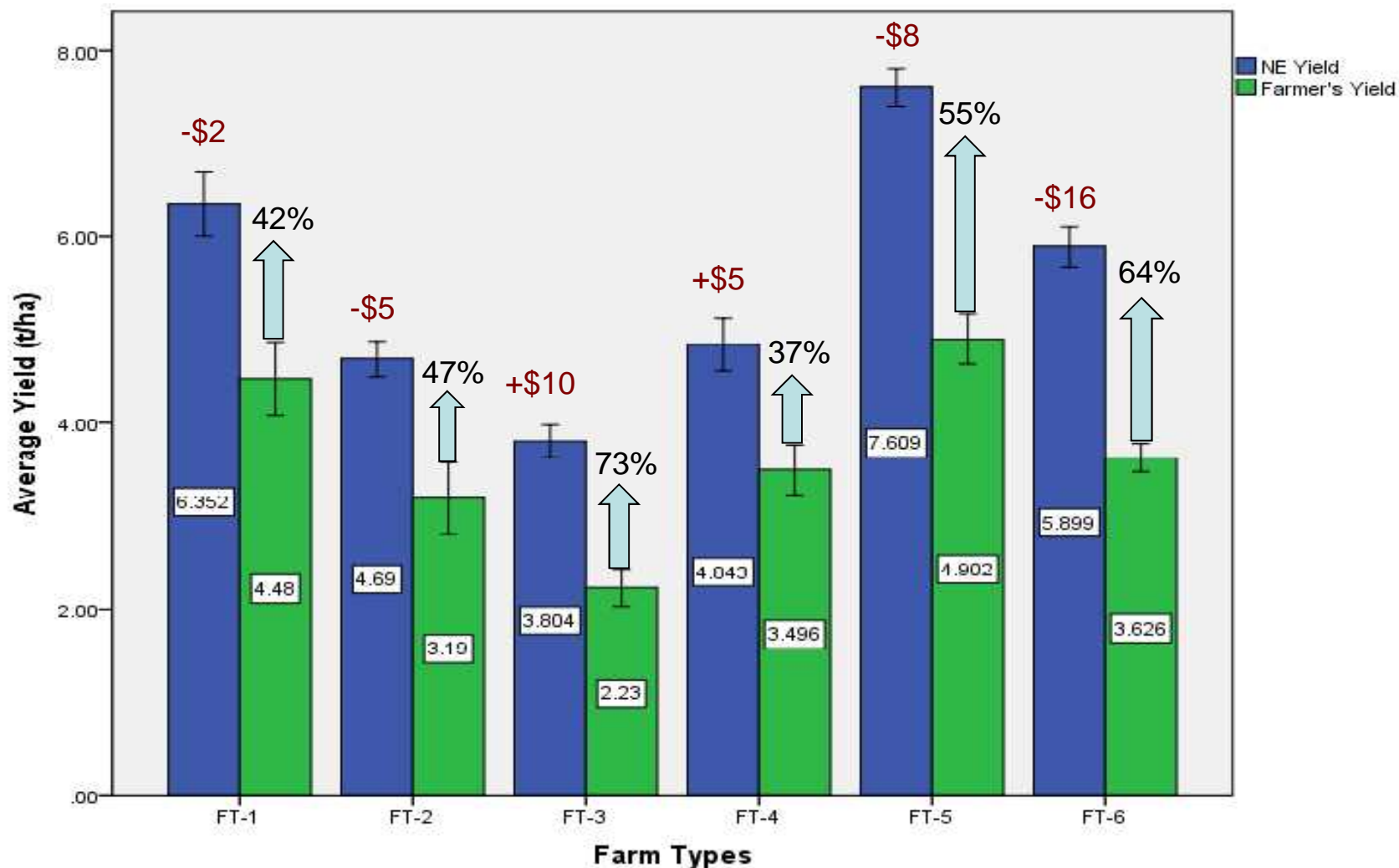


Farm typology Flexible recommendations

Farm Typologies	Description
Farm Type 1 (16)	Moderate-resourced commercial maize grower
Farm Type 2 (9)	Exclusive cultivators with large holding and large family
Farm Type 3 (37)	Low-yielding new maize growers
Farm Type 4 (16)	Moderately resourced family farms
Farm Type 5 (28)	Traditional maize grower
Farm Type 6 (21)	Resource-rich commercial maize growers



Fertilizer Recommendation based on Farmer Resources



Farm Type 1 [Moderate-resourced commercial maize grower]

Farm Type 2 ['Exclusive cultivators' with large holding and large family]

Farm Type 3 [Low-yielding new maize growers]

Farm Type 4 [Moderately resourced family farms]

Farm Type 5 [Traditional maize grower]

Farm type 6 [Resource-rich commercial 'seed producers']

Matching Fertilizer Recommendations to farmers' resource endowment can produce large gains in N use Efficiency

Region	Difference in Nutrient Expert-based fertilizer recommendation and Farmers' Practice				
	N (kg/ha)	P ₂ O ₅ (kg/ha)	K ₂ O (kg/ha)	Yield (kg/ha)	PFP _N (kg N/kg N)
Type 1	-11.5 ^{NS}	-69.7 ^{***}	4.2 ^{NS}	1871 ^{***}	11.5 [*]
Type 2	-71.3 ^{NS}	-73.2 ^{**}	4.8 ^{NS}	1749 ^{**}	23.6 [*]
Type 3	39.7 ^{***}	-52.0 ^{***}	-17.8 ^{***}	1592 ^{***}	0.47 ^{***}
Type 4	21.3 ^{***}	-3.2 ^{***}	18.2 ^{***}	1436 ^{***}	5.6 [*]
Type 5	-38.4 ^{***}	-12.8 ^{***}	47.7 ^{***}	2708 ^{***}	28.8 [*]
Type 6	-78.0 ^{***}	-141.0 ^{***}	-30.2 ^{***}	2272 ^{***}	27.3 ^{***}

Summary

- NE recommendations significantly improved yield and profitability in on-farm validation trials over existing farmers' practices.
- NE-based recommendations adequately addressed the regional and temporal variation in maize growing environments in India.
- Besides improving yield and profitability, matching fertilizer recommendations to regional, seasonal and farmers' resource endowment can produce significant gains in N use efficiency



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Thank you

