IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

4R Nutrient Stewardship:
Supporting Regional Food Security

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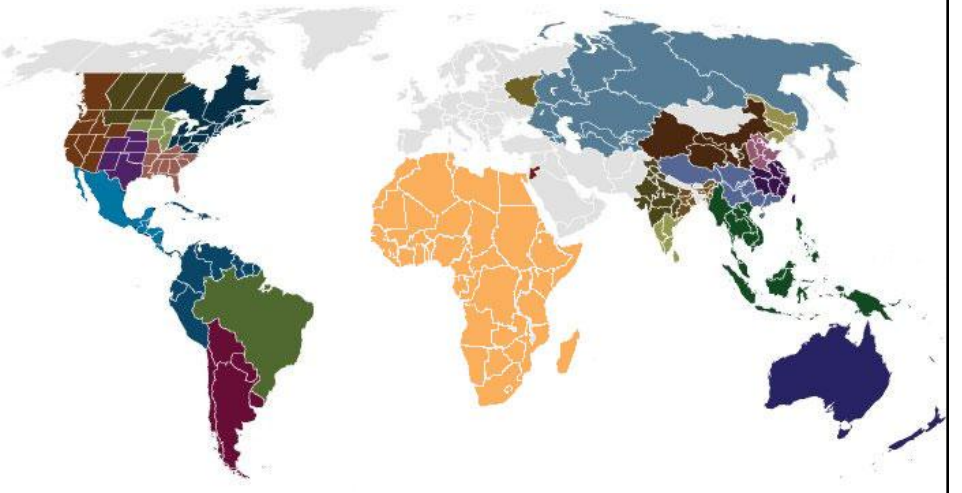
Agrium Inc.
Arab Potash Company
Belarusian Potash Company
CF Industries Holdings, Inc.
Compass Minerals Specialty Fertilizers
Incitec Pivot
International Raw Materials LTD.
Intrepid Potash, Inc.
K+S KALI GmbH
The Mosaic Company
OCP S.A.
PotashCorp
Qatar Fertiliser Company (QAFCO)
Simplot
Sinofert Holdings Limited
SQM
Uralkali

Formed in 2007 from the Potash & Phosphate Institute, the **International Plant Nutrition Institute** is supported by leading fertilizer manufacturers.

IPNI Mission

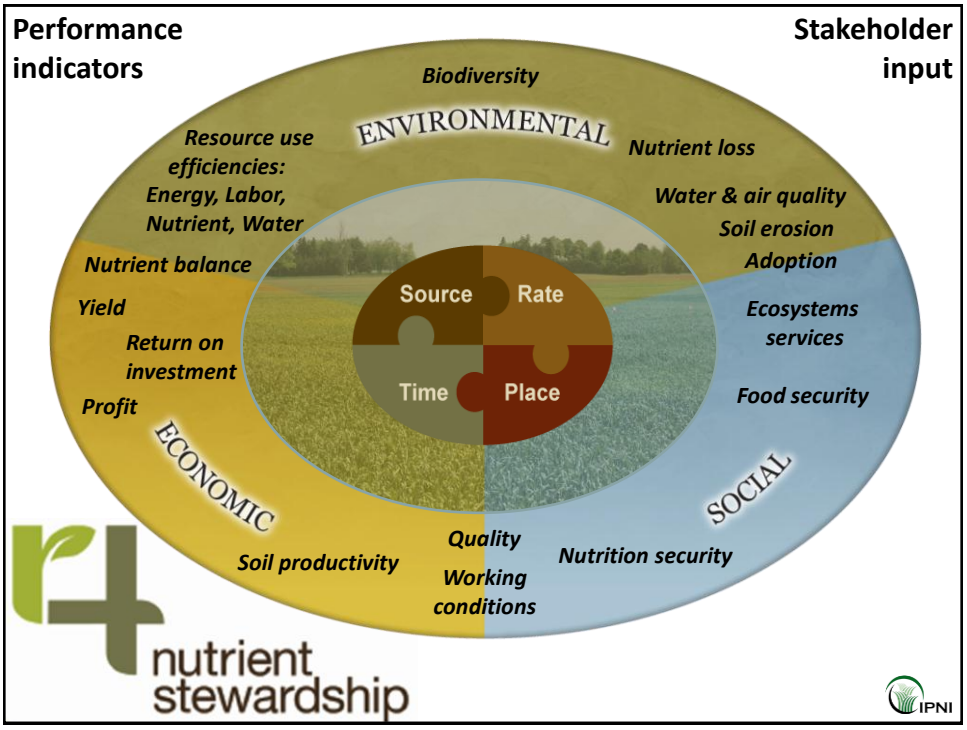
"to develop and promote scientific information about the responsible management of plant nutrition for the benefit of the human family."



In 2011 IPNI had 141 R&D projects
75% supporting increasing crop yields, or intensification

What is 4R?

4 nutrient stewardship



Source, rate, time, and place describe any nutrient application

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2. 4R technologies and practices

Right Source

Scientific Principle:

- Ensure a balanced supply of plant-available nutrients, utilizing all available sources (organic and inorganic).

Practices:

- Credit nutrients from manures and composts
- Credit nutrients from previous crops
- Assess use of enhanced-efficiency sources
    - Inhibitors of urease and nitrification
    - Coated fertilizers

Balanced nutrition And FUE in China

Reference	Crop	Treatment	
		N	NPK
		N recovery by crop,%	
Zhu, 1994	Barley	28	51
Jin, 2001	Wheat (11 yrs)	31	70
	Corn (5 yrs)	35	66

Farmers' Field Evaluation - IGP

Nutrient Expert (NE) for wheat vs Farmers' Practice (FP)

Conventional Tillage (n = 46)

Parameter	Unit	FP	NE	NE – FP	
Grain yield	kg/ha	3504	4436	932	***
Fertilizer N	kg/ha	134	141	6	**
Fertilizer P_2O_5	kg/ha	57	54	-2	ns
Fertilizer K_2O	kg/ha	13	76	63	***
Fertilizer cost	INR/ha	2436	2933	496	***
GRF[1]	INR/ha	36804	46742	9938	***

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

[1] GRF = gross return above fertilizer cost

Prices (in INR/kg): wheat = 11.20; N = 10.50; P_2O_5 = 16.22; K_2O = 7.50

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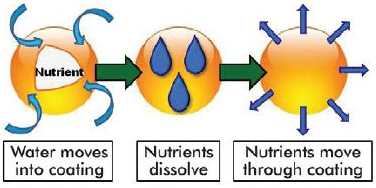
Cornell University
Cooperative Extension

Agronomy Fact Sheet Series **Fact Sheet 45**

Enhanced-Efficiency Nitrogen Sources

1. Synthetic organic compounds containing N
   - urea-formaldehydes, IBDU, triazones, etc.
2. Physical coating or barrier around soluble N fertilizer
   - Sulfur-coated or polymer-coated urea.
3. Stabilized materials
   - urease and nitrification inhibitors



Right Rate

Scientific Principle:

- Assess soil nutrient supply and plant demand for nutrients.

Practices:

- Soil test
- Deletion plots
- Balance crop removal
- Determine crop yield potential
- Assess fertilizer:crop price ratios

nutrient stewardship

Farmers' Field Evaluation

Nutrient Expert (NE) for maize vs Farmers' Practice (FP)

Andhra Pradesh (n = 27)

Parameter	Unit	FP	NE	NE – FP	
Grain yield	kg/ha	8568	9699	**1131**	***
Fertilizer N	kg/ha	288	203	-85	**
Fertilizer P_2O_5	kg/ha	153	54	-99	***
Fertilizer K_2O	kg/ha	68	74	6	ns
Fertilizer cost	INR/ha	9509	5459	-4050	**
GRF[1]	INR/ha	76167	91770	**15603**	***

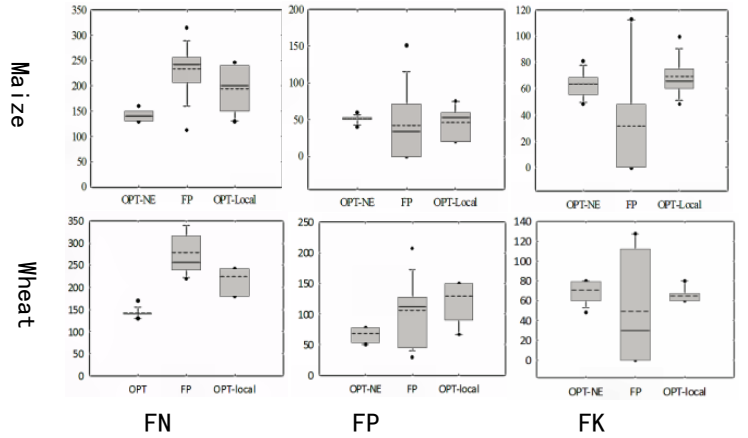
***, **, *: significant at <0.001, 0.01, and 0.05 level; ns = not significant

[1] GRF = gross return above fertilizer cost

Prices (in INR/kg): maize = 10.00; N = 11.40; P_2O_5 = 32.20; K_2O = 18.80

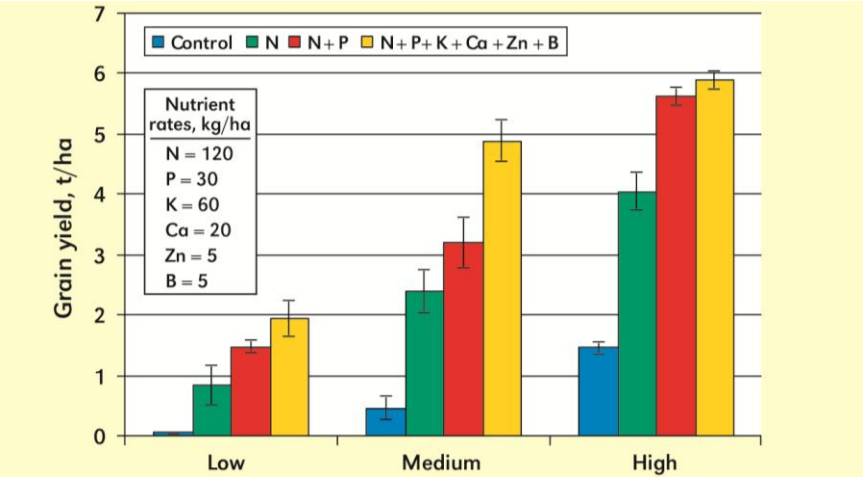
China - Nutrient Expert impact on Fertilizer N recommendations

- Summer maize: N saved by -24~131kgN/ha, average 94kg/ha(40.1%)
- Winter wheat: N saved by 95-177kg N/ha, average 135kg/ha(48.3%)



Right fertilizer rate differs for each field

Zimbabwe Soil Quality



Zingore et al., 2011

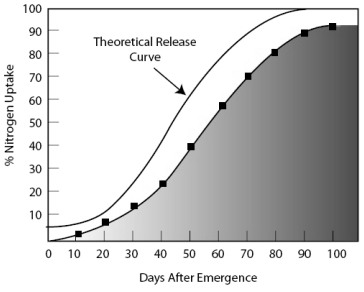
Right Time

Scientific Principle:

- Assess timing of crop uptake, soil nutrient supply, weather, loss risks and field operation logistics.

Practices:

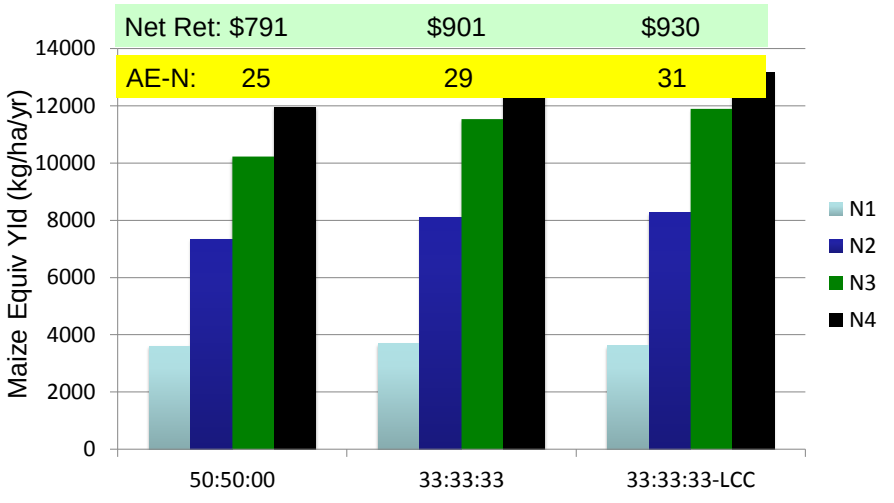
- Split-application for increased FUE
- Suit tillage and planting operations



nutrient stewardship

Maize-Wheat in Karanataka

Maize equivalent yields – kg/ha/yr



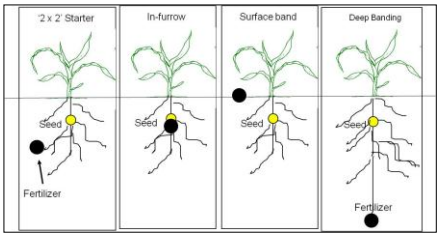
Right Place

Scientific Principle:

- Place nutrients where they are accessible to the crop.

Practices:

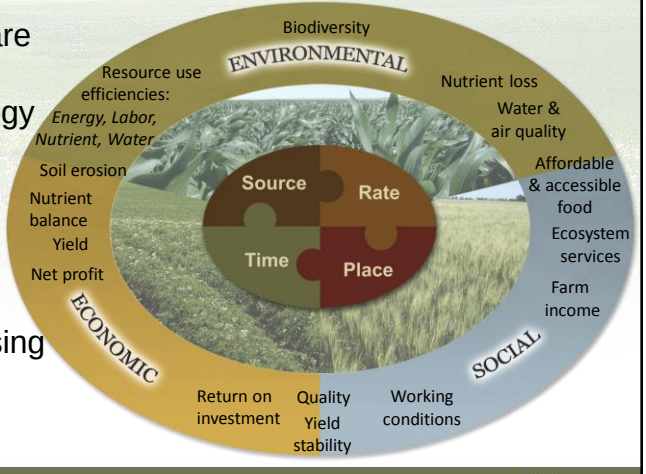
- Site-specific sensing technologies
- Starter placement near seedlings



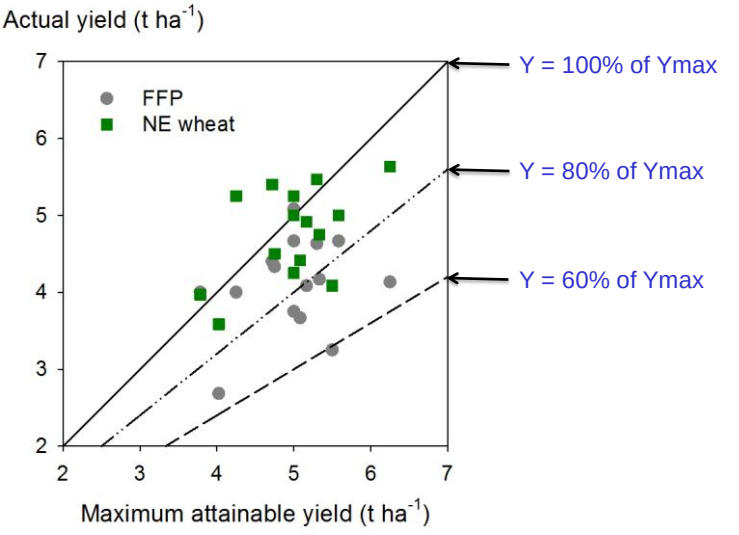
Moving from Broadcast Application to Placement – Especially for P and K

4R Nutrient Stewardship to close the Yield Gap

- Achieving future food security will require increased yields
- Local solutions are required
- Current technology exits to capture significant yield increases
- Combining technologies is critical to increasing success



Wheat yield with FFP and NE relative to the maximum attainable yield (Ymax)

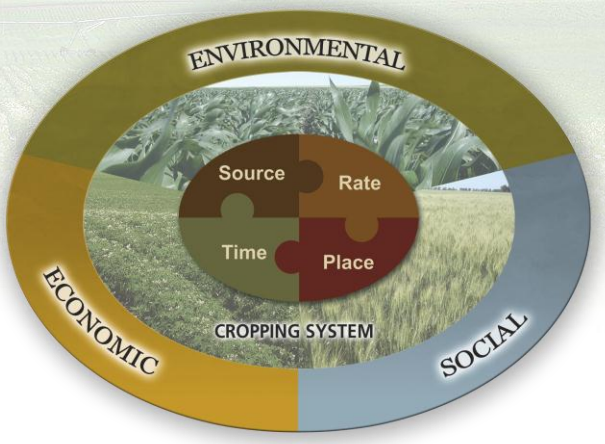


Examples of practical choices

Source	Rate	Time	Place
◆ Commercial fertilizer ◆ Livestock manure ◆ Compost ◆ Crop Residue	◆ Test soils for nutrients ◆ Calculate economics ◆ Balance crop removal	◆ Pre-plant ◆ At planting ◆ At flowering ◆ At fruiting	◆ Broadcast ◆ Band/drill/inject ◆ Variable-rate application

The 4Rs connect to the cropping system

- Soil water, air, and temperature influence nutrient availability



- genetic yield potential
- weeds
- insects
- diseases
- mycorrhizae
- soil texture & structure
- drainage
- compaction
- salinity
- temperature
- precipitation
- solar radiation

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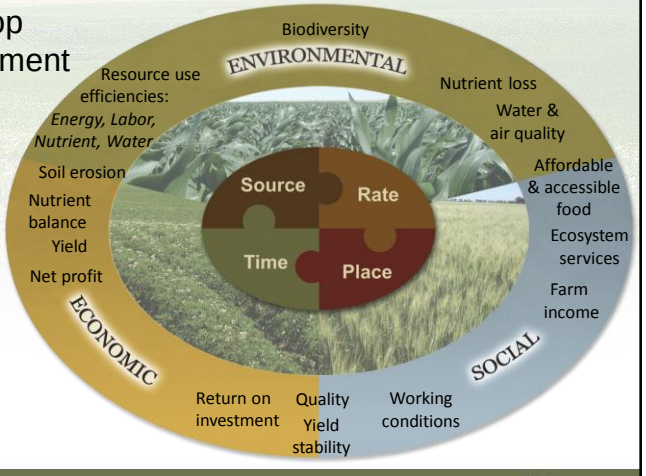
The 4Rs influence many performance indicators

- social, economic and environmental performance
- influenced by crop and soil management as well
- whole system outcomes



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Nutrient Management in South Asia:
Building a better tool box

SSNM instead of State recommendations

New Genetics

Water Mgt

Nutrient Expert to deal with poor Soil testing infrastructure

Including secondary and micronutrients to deal with Multi-nutrient Deficiencies

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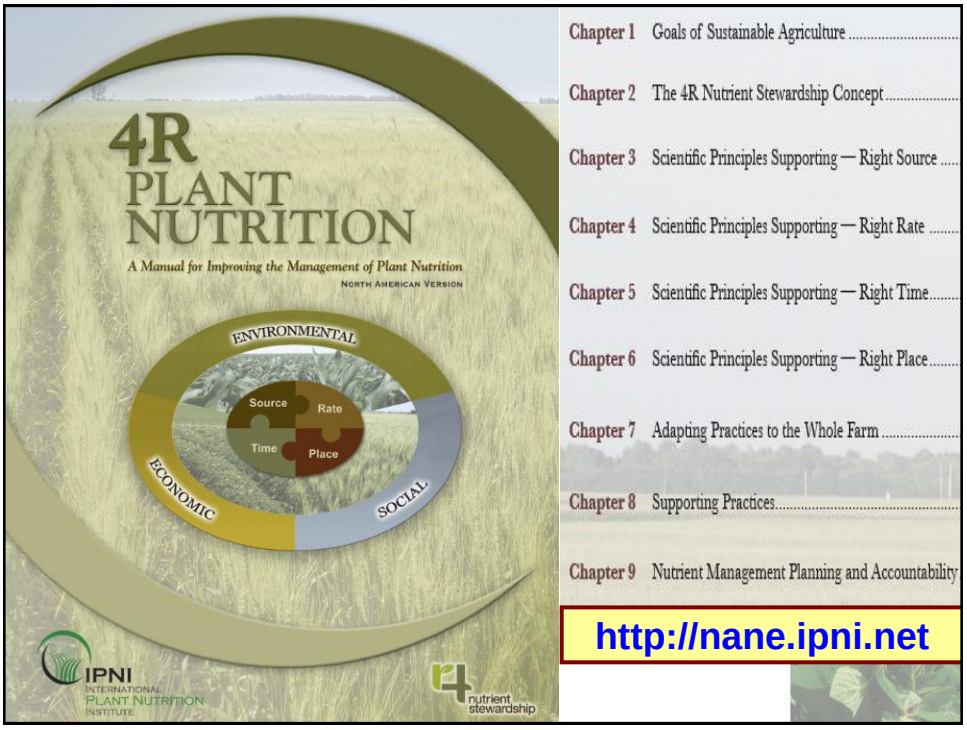
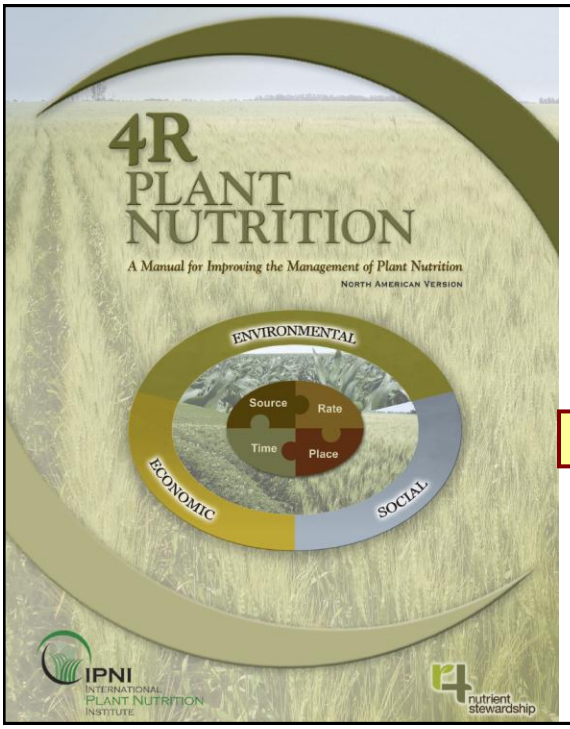
Post-harvest Mgt

Village-based grid maps
To address spatial variability



Summary

1. **The right source, rate, time and place for any nutrient application is the combination producing the most sustainable outcome for stakeholders: Production – Profit - Environment**
2. **Finding ways to better report field performance of production systems will also help meet expectations for improvement in environmental and social impacts.**
3. **Nutrient management is only one of several crop management factors which need to be addressed in improving the sustainability of future food production systems.**



www.ipni.net/4R