IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

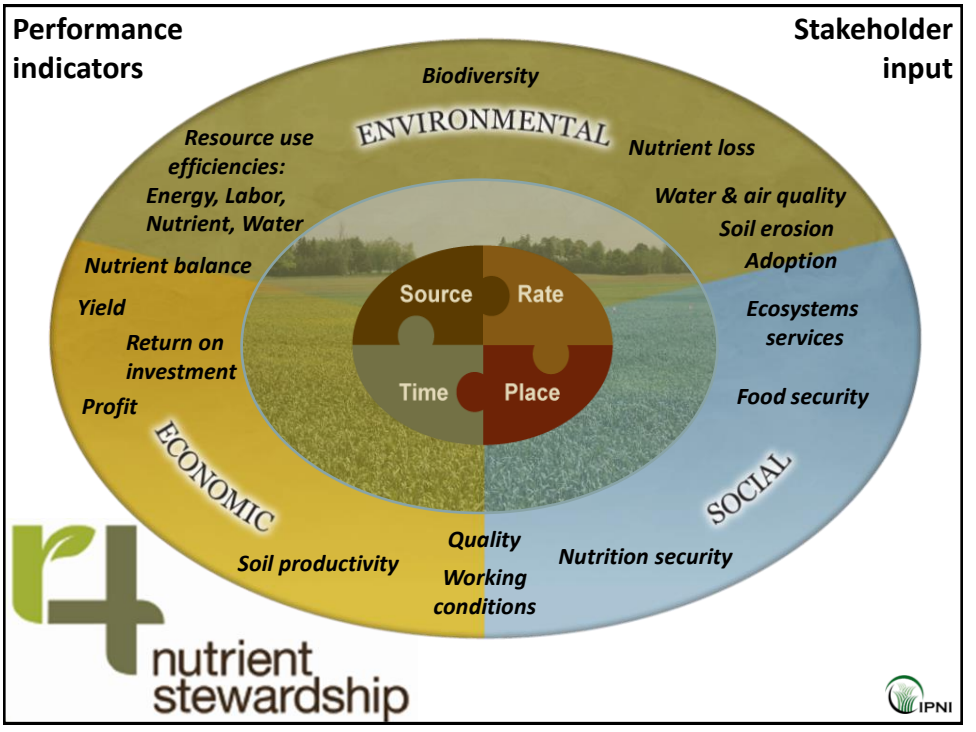
4R Nutrient Stewardship for Improved Nutrient Use Efficiency

Adrian Johnston, Vice President Asia & Africa
Thomas Oberthur, Director, Southeast Asia
Mirasol Pampolino, Agronomist, Southeast Asia

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.

What is 4R Nutrient Stewardship?



4R technologies and practices

4 nutrient stewardship

IPNI

Southeast Asia Program of IPNI

IPNI

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

4 nutrient stewardship

IPNI

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

Access to a range of fertilizer products is often a major challenge for small holders

Nutrient Expert Hybrid Maize Field evaluation in Indonesia

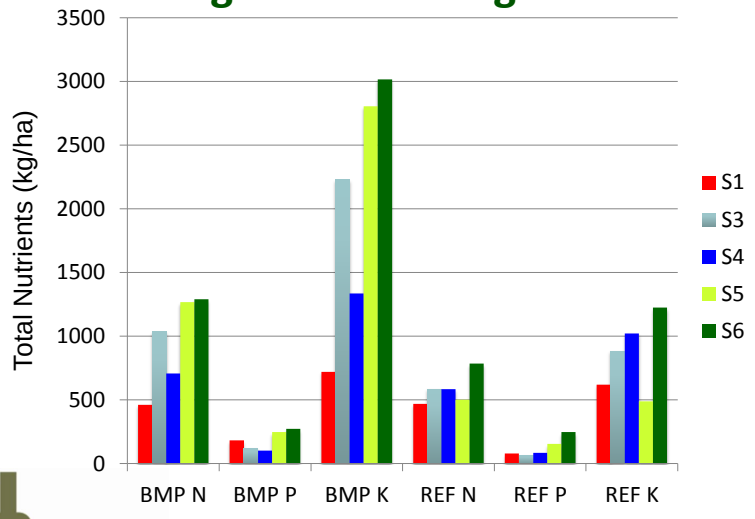
Parameter	Unit	FFP	NE	Difference (NE – FFP)	
Grain yield	t/ha	7.5	8.4	**0.9**	***
Fertilizer N	kg/ha	173	160	-12	ns
Fertilizer P_2O_5	kg/ha	43	33	-10	*
Fertilizer K_2O	kg/ha	28	41	+13	**
Fertilizer cost	USD/ha	126	126	0	ns
Gross return above seed & fertilizer	USD/ha	1761	2032	**+271**	***

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

Data from 22 farmers' fields in five sites under irrigated (rice-rice-maize) and favorable rainfed (maize-maize) environments, 2010-2011

Seed cost: USD 5.08/kg; Price of maize grain: USD 0.27/kg; Price of fertilizer: actual local prices; USD 1 = IDR 8850

Right Source of Nutrients for Oil Palm
Organic and Inorganic



nutrient stewardship

IPNI

Right Source, Organic and Inorganic

Yield of fresh fruit bunches (FFB) per year

Parameter	Levels	Treatment		Δ	P>|T
		BMP	REF		
Yield	All	26.0	22.6	3.4	<0.001
	Site 1	30.5	29.0	1.5	0.017
	Site 2	28.4	23.0	5.4	<0.001
	Site 3	23.7	18.9	4.8	<0.001
	Site 4	22.3	19.8	2.5	0.000
	Site 5	20.7	17.1	3.6	<0.001
	Site 6	30.2	27.5	2.7	<0.001
	Yr 1	26.5	23.5	3.0	<0.001
	Yr 2	25.6	21.7	3.9	<0.001
	Yr 3	26.0	22.4	3.6	<0.001
	Yr 4	25.8	22.6	3.2	<0.001

nutrient stewardship

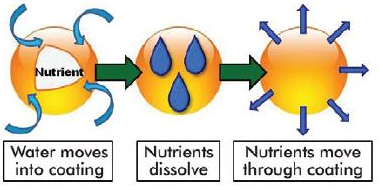
IPNI

Slow & Controlled Release Fertilizers

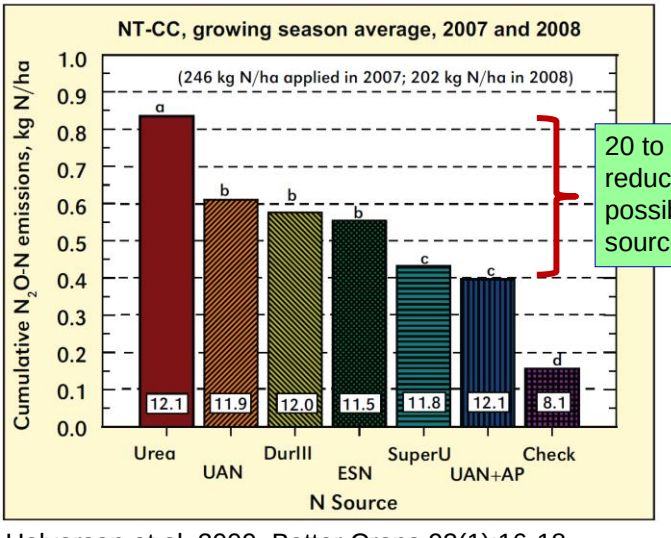
1. Synthetic organic compounds containing N
   - urea-formaldehydes, IBDU, triazones, etc.
2. Physical coating or barrier around soluble N fertilizer
   - Sulfur-coated or polymer-coated urea.
3. Stabilized materials
   - urease and nitrification inhibitors

N-Serve

AGROTAIN INTERNATIONAL, LLC



Nitrogen Rate and Source Effects on N_2O Emissions in No-till Continuous Corn



Halvorson et al. 2009. Better Crops 93(1):16-18

IPNI

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

4R nutrient stewardship

IPNI

Selecting the Right Rate in Oil Palm

Fertilizer rates are determined based on:

- Soil analysis of planting sites
- Nutrient balance = input – removal
- Tissue testing in mature stands
- Plantation trials evaluating FFB yield responses

IPNI

Selecting the Right Rate in Oil Palm

Plantation Intelligence – a new approach to fertilizer management:

- Concept uses plantation data on block yield and fertilizer management, along with soil, weather, etc.
- Helps to identify where the yield response is best and allows for further improvement…intensification.
- Helps in determining where to harvest with limited labor.

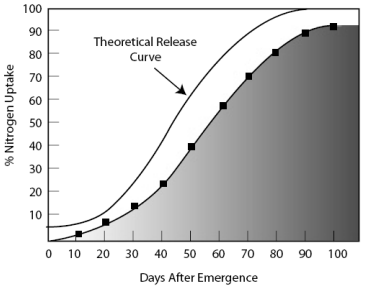
Right Time

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



4 nutrient stewardship

IPNI

Right Time, On Site Blending

Blending allowed for 4 applications of N, P, K, Mg, S, and B per year at reasonable labour requirements

Normal estate practice is 2 applications of N as Urea, K, Mg, S and B, and 1 application of P, N and S as Ammofos)

nutrient stewardship

IPNI

Right Time, On Site Blending

	N	P	K	Mg
Fertilizers blended, applied 4x per year				
Supplied in fertilizers (kg/ha)	134.6	12.2	243.0	26.5
Removed and fixed (kg/ha)	78.7	8.7	107.2	16.1
Fertilizer recovery efficiency (FRE, in %)	*58.5*	*71.5*	*44.1*	*60.8*
Fertilizers applied as straights				
Supplied in fertilizers (kg/ha)	129.2	11.7	233.3	25.4
Remnoved and fixed (kg/ha)	68.5	8.3	87.2	15.9
Fertilizer recovery efficiency (FRE, in %)	*53.0*	*71.2*	*37.4*	*62.3*

Details will be presented Forthcoming PIPOC 2013 Conference in Kuala Lumpur, November 19 - 21
Effect of nutrient application frequency on nutrient uptake in oil palm production on sandy soils
Jóska Gerendás[1], Bayu Utomo[2], Kusnu Martoyo[2], Christopher R. Donough[3], Thomas Oberthür[3]
1 – K+S Kali GmbH; 2 – PT Sampoerna Agro Tbk; 3 – IPNI SEAP

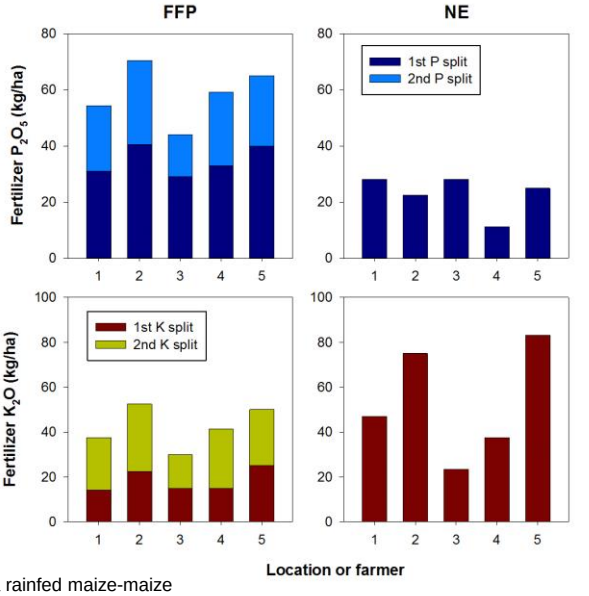
nutrient stewardship

IPNI

Timing of fertilizer N application on Maize (days after sowing): NE vs FFP

Fertilizer application	North Sumatra (n = 5)		Central Lampung (n = 5)	
	NE	FFP	NE	FFP
1st	7	15	7	9-14
2nd	25	40-45	25	23-35
3rd	38	-	35	35-45
4th	-	-	60	-

Fertilizer P & K: rate and splitting



Data: North Sumatra rainfed maize-maize

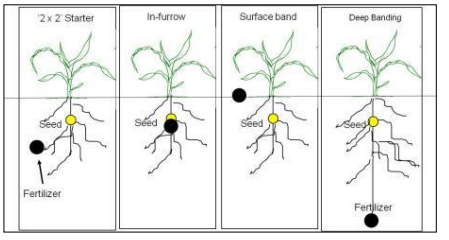
Right Place

Scientific Principle:

- Place nutrients where they are accessible to the crop.

Practices:

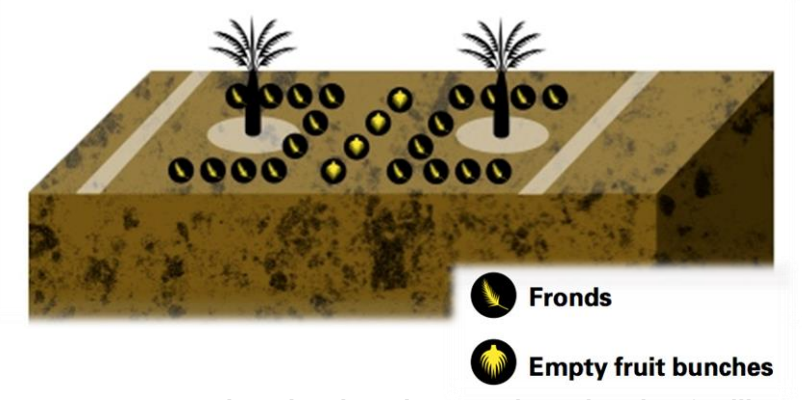
- Site-specific sensing technologies
- Starter placement near seedlings



nutrient stewardship

IPNI

Right Place, BMP

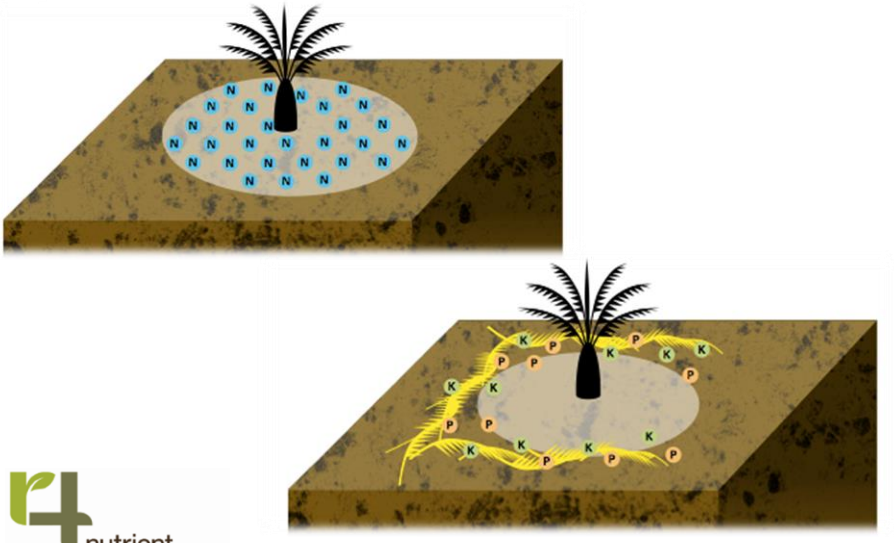


IPNI has developed BMPs also related to fertilizer placment, i.e. box application of fronds, and nutrient application within the circle (urea) and other on the edges of circle and on the fronds

nutrient stewardship

IPNI

Right Place, BMP

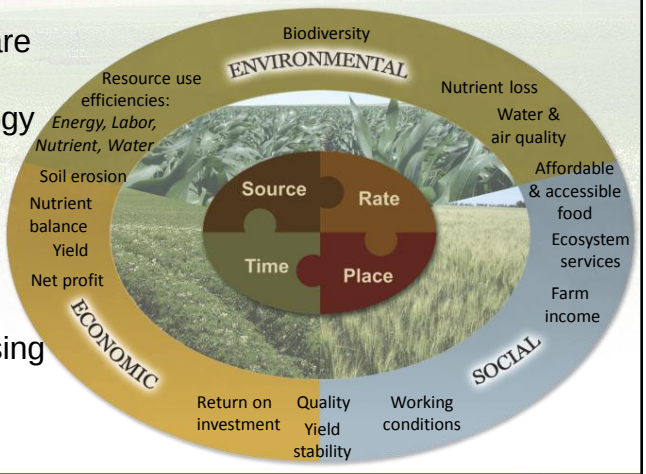


Improving FUE with Placement

- On nutrient deficient soils, placement can play an important role in improving yield and NUE.
- On nutrient surplus soils, placement is of little significance.
- Placement of fertilizer is a challenge in small holder farms

4R Nutrient Stewardship to close the Yield Gap

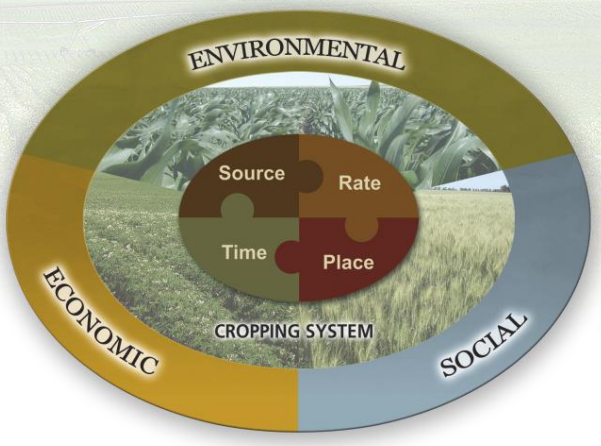
- Achieving future food security will require increased yields
- Local solutions are required
- Current technology exits to capture significant yield increases
- Combining technologies is critical to increasing success



4R PLANT NUTRITION — 4 nutrient stewardship

The 4Rs connect to the cropping system

- Soil water, air, and temperature influence nutrient availability

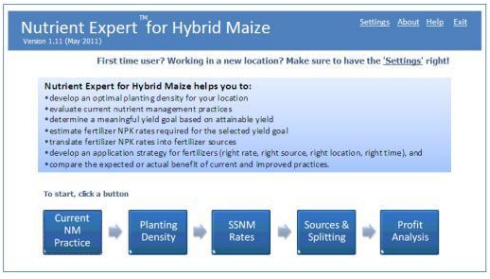


- genetic yield potential
- weeds
- insects
- diseases
- mycorrhizae
- soil texture & structure
- drainage
- compaction
- salinity
- temperature
- precipitation
- solar radiation

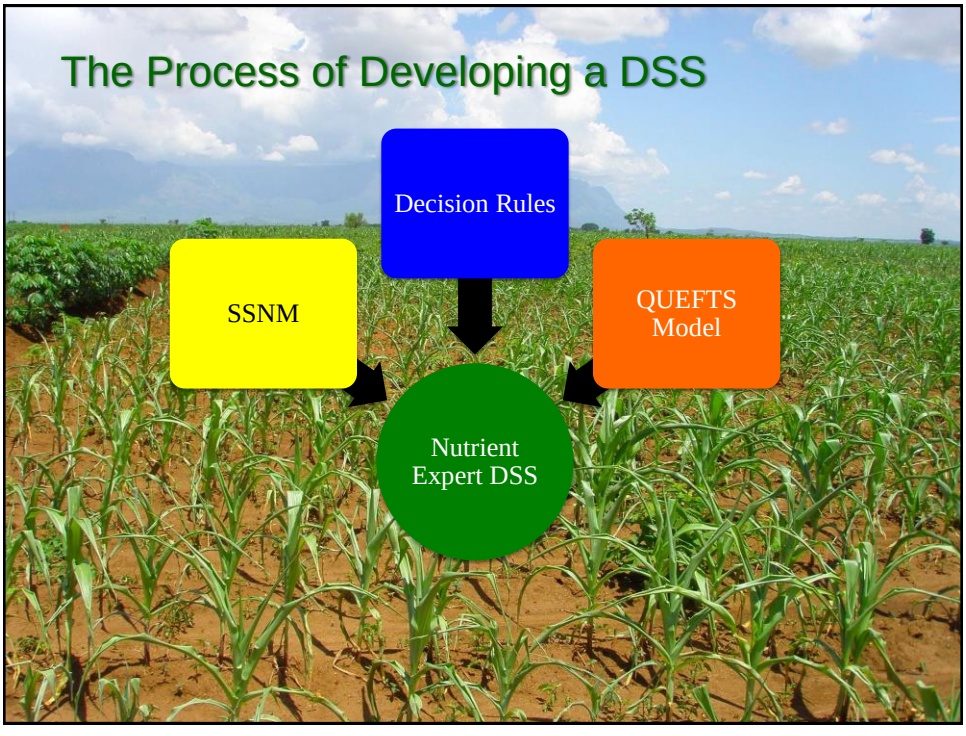
4R PLANT NUTRITION — 4 nutrient stewardship

Making 4R Nutrient Stewardship Work

4R nutrient stewardship =

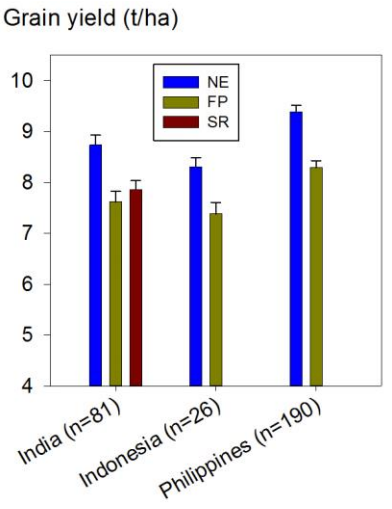


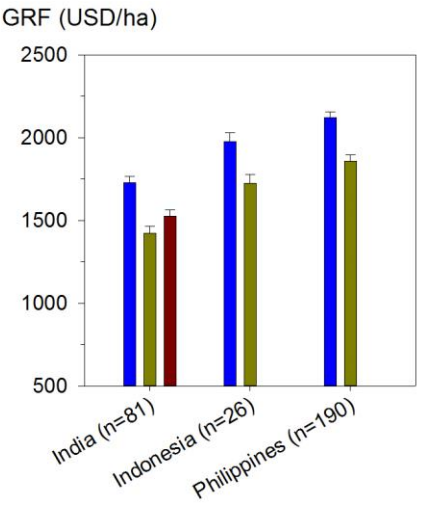
- Nutrient Expert Decision Support System software provides the opportunity to integrate the 4R principles into a fertilizer recommendation.
- This has proven particularly successful where soil testing infrastructure is weak, expensive or not timely for multiple cropping systems.



Field validation results
Nutrient Expert for Hybrid Maize

India, Indonesia, Philippines (2010-2013)





GRF = gross returns above seed and fertilizer costs

Nutrient Expert recommendation:

- tailored to location-specific conditions
- consistent with 4R approach

Name and/or location: Here; Site A Field size: 1 ha

Current yield: 110 cavan (FW) 5.3 t/ha (15.5% MC)

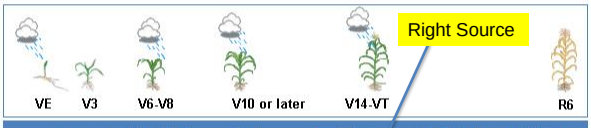
Growing environment: Favorable rainfed

Recommended alternative practice for hybrid maize

Yield goal: 165 cavan (FW) 8.0 t/ha (15.5% MC)

Planting density: 69,444 plants/ha

Distance between rows: 60 cm Distance between plants: 24 cm



Right Source

Growth stage	Days after planting	Soil moisture	Fertilizer sources	Weight of full bag (kg)	Amount (bags)
Basal	0	sufficient	14-14-14	50	6.5
			Urea	50	0
			MOP	50	0.5
V6	25	sufficient	Urea	50	2.5
V10	35	sufficient	Urea	50	2

Right Time

Other sources of nutrients:

Crop residue (maize): high

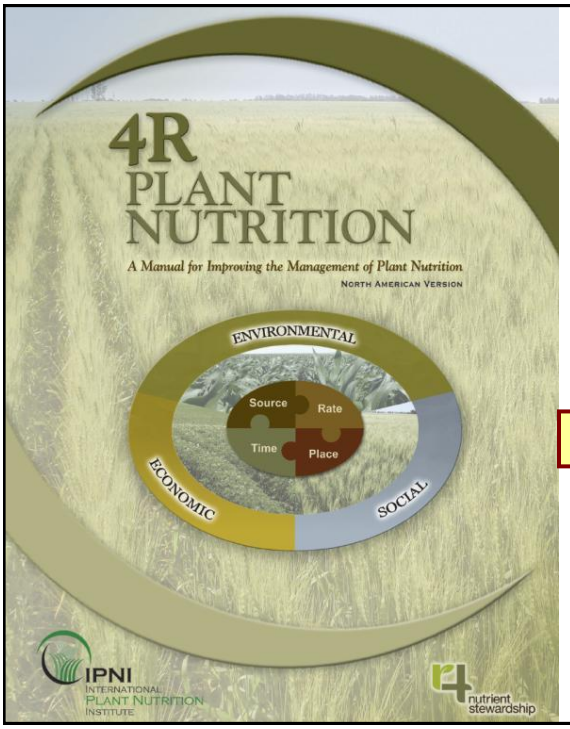
Organic fertilizer: 0 t

Fertilizer rates are adjusted to field size

Right Rate

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