

**IRRI**

INTERNATIONAL RICE RESEARCH INSTITUTE

# **Nutrient Management in Rice - Past, Present, Future -**

**Achim Dobermann**

IFA Crossroads Asia-Pacific, Manila

30 October 2012

**IRRI**



**Site-specific nutrient management**

**Mega trends**

**New opportunities**

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## Farms in Asia are small and variable



Nutrient needs depend on many factors

- Season
- Soil
- Climate
- Crop residues
- Past crop
- Management

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Nutrient omission plot technique to estimate crop nutrient requirements for expected yield gain

1992-2003



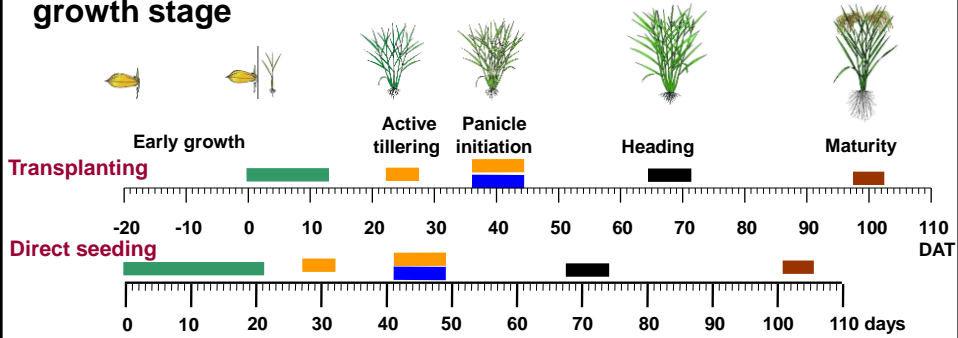
K. Cassman, A. Dobermann, C. Witt, R. Buresh, IRRI

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# Principles & tools for managing N by growth stage

1992-2005



### Early

- Apply only moderate amount of N
- Increase amount in proportion to crop yield

### Active tillering & PI

- Apply at critical growth stages
- PI application at 60 days before harvest
- Vary N based on crop N needs and status

### Heading

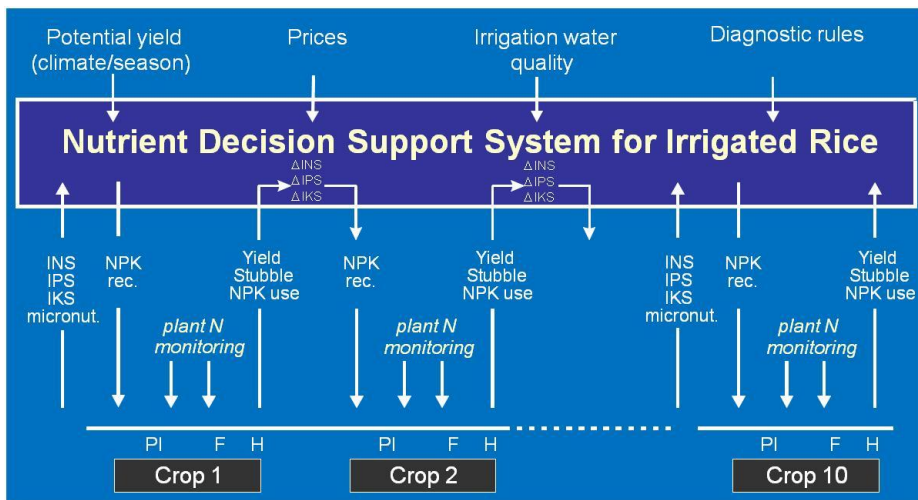
- Diagnose need for extra N



S. Peng, K. Cassman, C. Witt, R. Buresh, A. Dobermann, IRRI



1996



Dobermann & White, Nutr. Cycl. Agroecosyst. 53 (1999): 1-18



Project proposal on

1996

### Field-specific integrated nutrient management in intensive irrigated rice systems

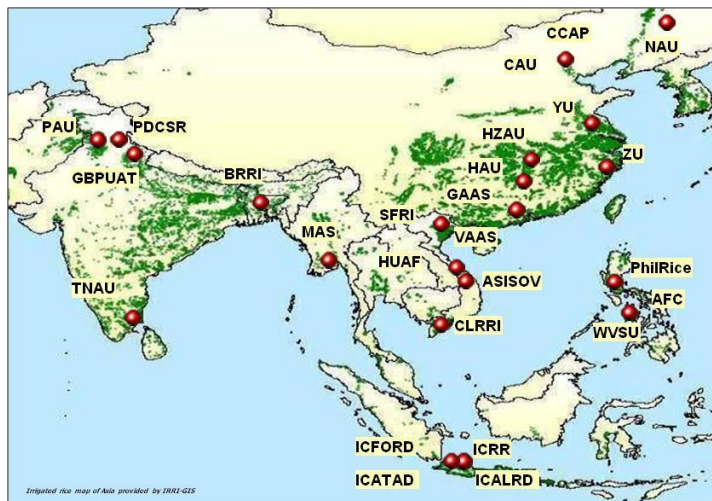
Submitted by: **IRRI**  
International Rice Research Institute  
P.O. Box 933, Manila 1099, Philippines

To: The International Fertilizer Industry Association (IFA)  
Paris, France  
Potash & Phosphate Institute (PPI)  
Singapore  
International Potash Institute (IPI)  
Basel, Switzerland

August 1996



### 16 years of field research as science basis for 'precise' field-specific nutrient management



10-20% more yield  
 30-50% less N losses  
 Less fossil fuel  
 Less N<sub>2</sub>O emissions  
 Less water pollution  
 Less pests  
 At least 10% more profit



### Science is well documented

**Rice**

**Nutrient Disorders & Nutrient Management**

Rice ecosystems  
 Nutrient management  
 Nutrient deficiencies  
 Mineral toxicities  
 Tools and information

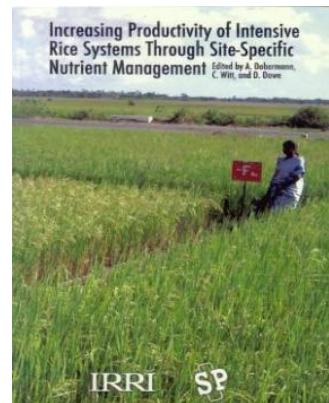
**Rice**  
 A Practical Guide to Nutrient Management

Achim Dobermann and Thomas Fairth

Nutrient management  
 Nutrient deficiencies  
 Mineral toxicities  
 Tools and information

Edited by Thomas Fairhurst, Christian Witt, Roland Buresh, and Achim Dobermann

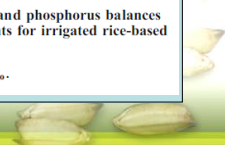
*Revised 2007 Edition*



Plant Soil  
 DOI 10.1007/s11054-010-9441-z  
 REGULAR ARTICLE

**Field-specific potassium and phosphorus balances and fertilizer requirements for irrigated rice-based cropping systems**

Roland J. Buresh · Mirasel F. Pangoliao · Christian Witt



# How to bring this to farmers?



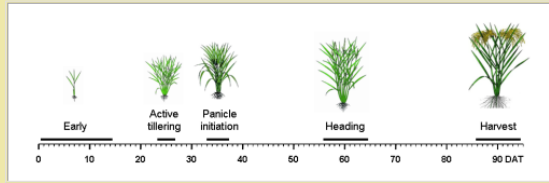
## Exploring dissemination

2000-2010

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# Focus on innovative tools that enable local decision making since 2008

**Location:** Nagcarlan, Laguna, Region IV-A **Variety:** PSB Rc82 (Peñaranda)  
**Field Size:** 1 ha **Transplanted:** 101-110 days from seed to harvest  
**Season:** wet season **Seedling:** Less than 23 days



**Other inputs:**

1. Crop residue: low
2. Organic materials: none
3. Other organic materials: none
4. Composted straw: none
5. Sediment input: none

Based on answers to simple questions, a farmer receives an **actionable** fertilizer recommendation for a specific rice field.

Values are adjusted to actual field area: **1 ha**

Growth Stage	DAT*	Current Yield: 100 sacks at 50 kg/sack 4.5 t/ha (14% MC)	Attainable Yield (14% MC): 115 sacks at 50 kg/sack 5 t/ha (14% MC)
Early	0-14	14-14-14: 3 bags	14-14-14: 3.5 bags
Active tillering	23-27	Urea: 1 bag	Urea: 1 bag
Panicle Initiation	33-37	Urea: 1 bag	Urea: 1.5 bags

\* DAT - Days after transplanting



<http://www.irri.org/nmrice>



## Smartphone



## Personal computer



## GSM phone



## Toll-free number

Interactive Voice Response (IVR)



SMS

**Nutrient Manager for Rice Philippines Version 2.2**

Farmer's name: Juan  
 Mobile phone number: 01111111111  
 Field name: By Road  
 Location: Peñaranda, Nueva Ecija, Region III  
 Direct seeded: 101-110 Days from seed to harvest  
 Field size: 4 ha

Rice crop per year: two  
 Season: dry season  
 Variety: NSEC Rc222 (Talagan 18)

NMRice v02.2 For field By Road of Juan w/ 76 sacks of paddy on 4 hectares using NSEC Rc222 in dry season w/ soil management practice: apply 2 bags 14-14-14 at 12-18 days after sowing (DAS), 39 kg urea 28-32 DAS, 1 bag urea 8-10 kg NPK 42-47 DAS.

Values are adjusted to actual field area: 4 ha

Growth stage	DAT**	Attainable yield*** 46 sacks at 50 kg/sack 4.4 t/ha (14% MC)
Early*	12-16	14-14-14: 2 bags
Active tillering	23-27	Urea: 29 kg
Panicle initiation	33-37	Urea: 1 bag NPK: 10 kg

- Country databases**
- Variety traits
  - Climate-based yield targets
  - Irrigation water quality
  - Soils
  - Major pests
  - Susceptibility to floods
  - Input providers

Cloud-based server

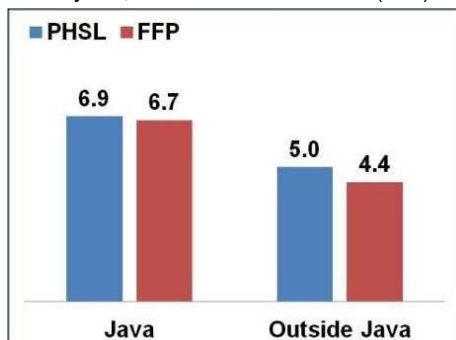
2012

R. Buresh, IRRI

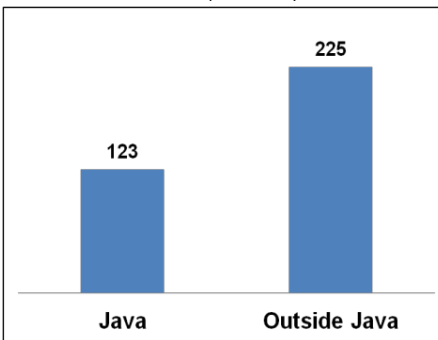


## **Nutrient Manager (PHSL) recommendation increased yield and profit compared to farmer's fertilizer practice (FFP) in Indonesia**

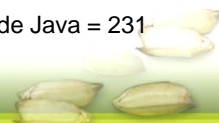
Grain yield, 14% moisture content (t/ha)



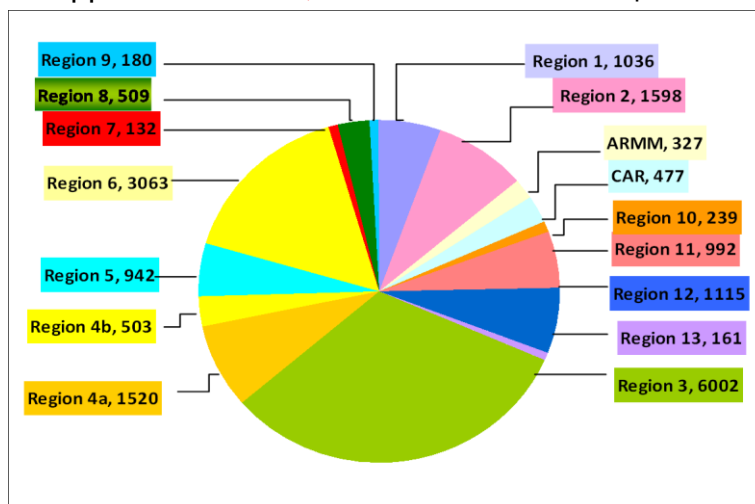
Added net benefit (US\$/ha)



2011-12 wet season; Number of farmers: Java = 75; Outside Java = 231  
R. Buresh, IRRI



## **NMRice fertilizer recommendations by region in the Philippines. Total of 18,796 from Jan 2012 – 30 Sept 2012**



Source: IRRI NM webapps analytics; includes web and Android but not IVR





## New products for delivering actionable farming advice and information

### Local products

- Provide personalized advice in local languages
- Link to other services
- For use by extension, service providers and crop advisors

Before season planning tools      Mid-season problem solving tool

Nutrient Manager

Crop Manager

Rice Doctor

### Global products

- Globally applicable information based on scientific principles
- Teaching tools
- For use by technical experts, researchers, decision makers

### Rice Knowledge Bank

Rice Doctor

Nutrient Teacher

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## Mobile apps under development

### Nutrient Manager Rice

Philippines  
Indonesia  
Bangladesh  
West Africa  
Tamil Nadu  
NW India (R-W)  
NE Thailand

### Rice Crop Manager

Philippines  
Indonesia  
S Vietnam

### Rice Crop Doctor

Philippines  
Indonesia

[webapps.irri.org](http://webapps.irri.org)

### Maize Crop Manager

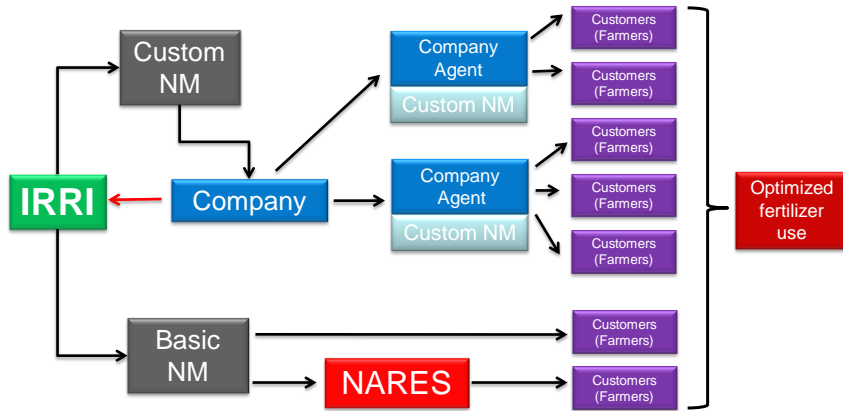
Bangladesh  
Philippines

R. Buresh, IRRI

Color coding for year of release: 2012    2013

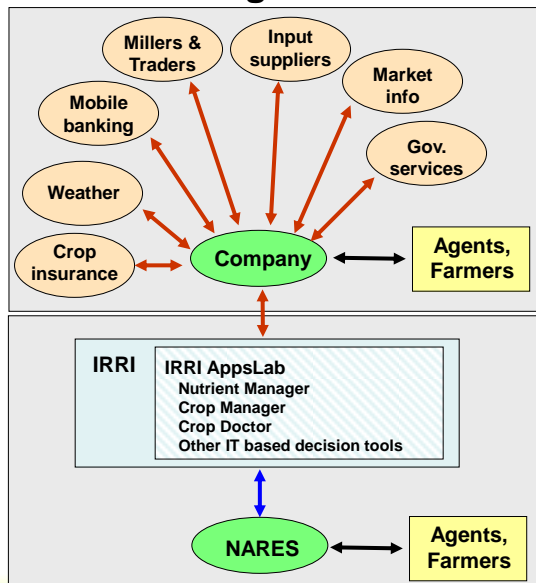
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## Customized NM software interfaces for licensing to companies



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## What will be the right business models?



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## Site-specific nutrient management

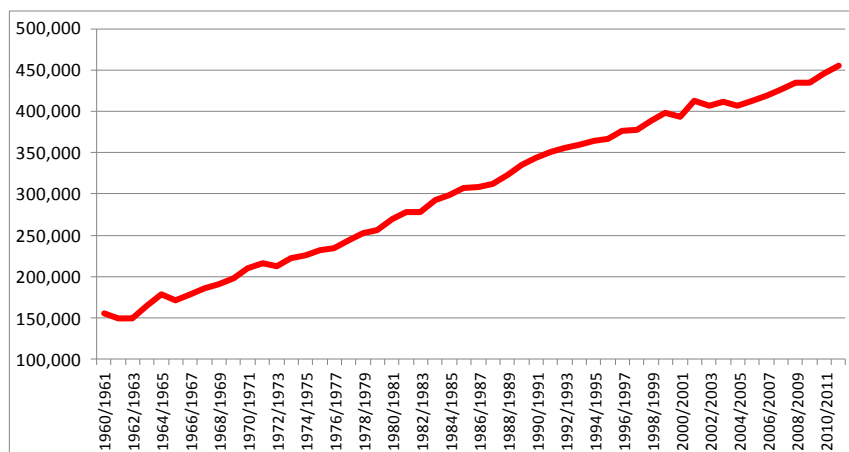
### Mega trends

### New opportunities

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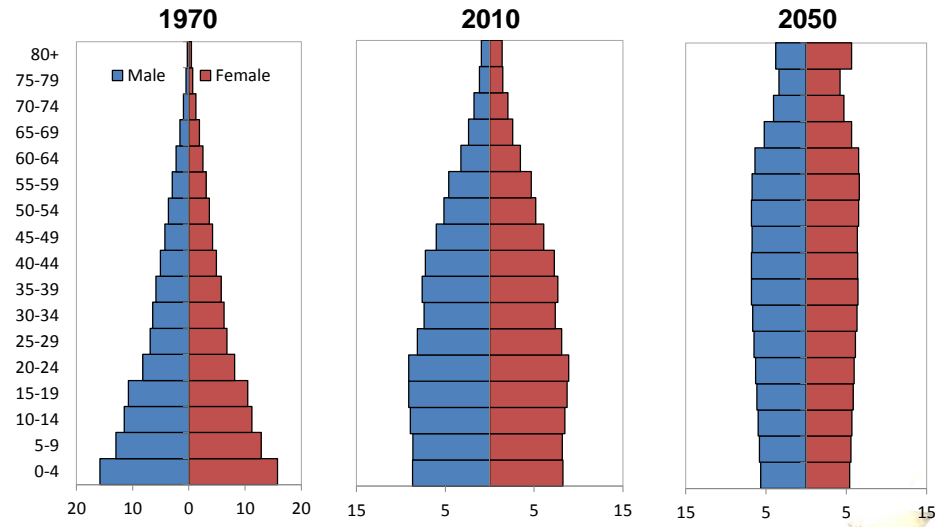
## No slowdown in global rice consumption

1000 tons milled rice



IRRI

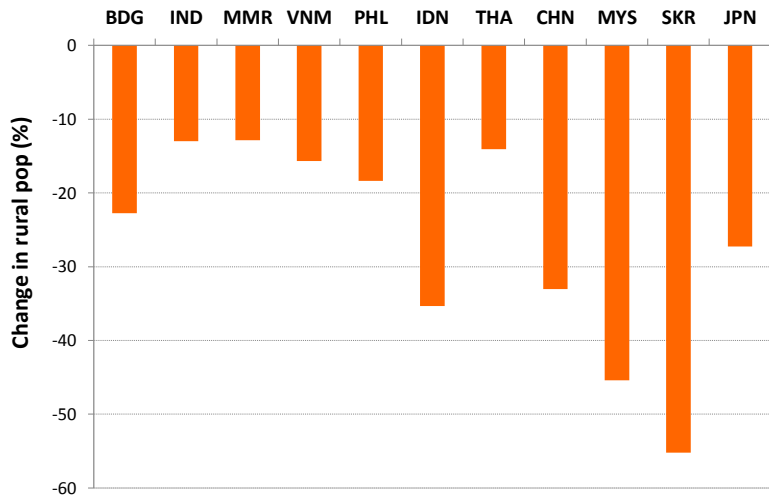
## Population Structure in Asia, 1970-2050



H. Bhandari, IRRI

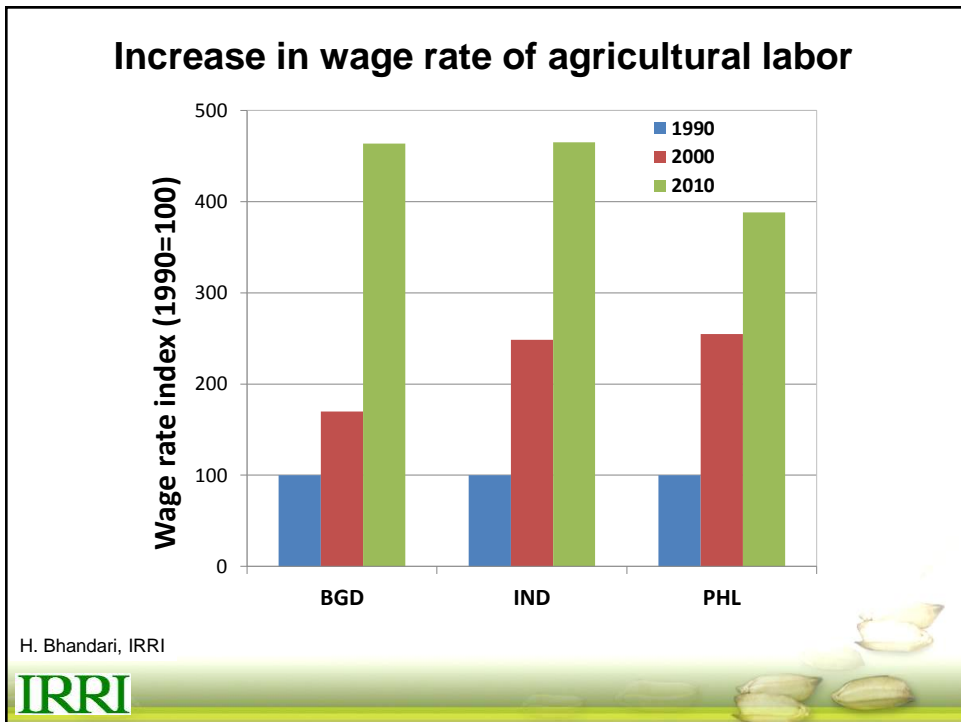


## Change in rural population in Asia, 1960-2010

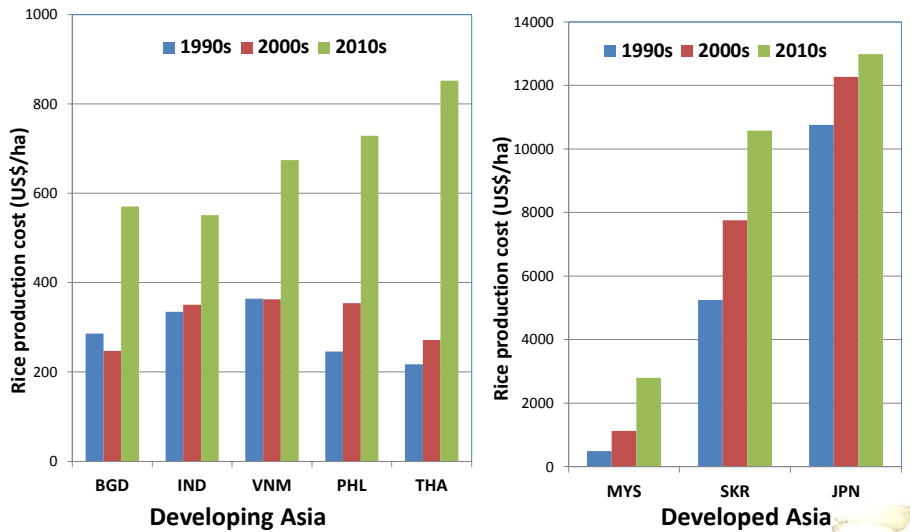


H. Bhandari, IRRI





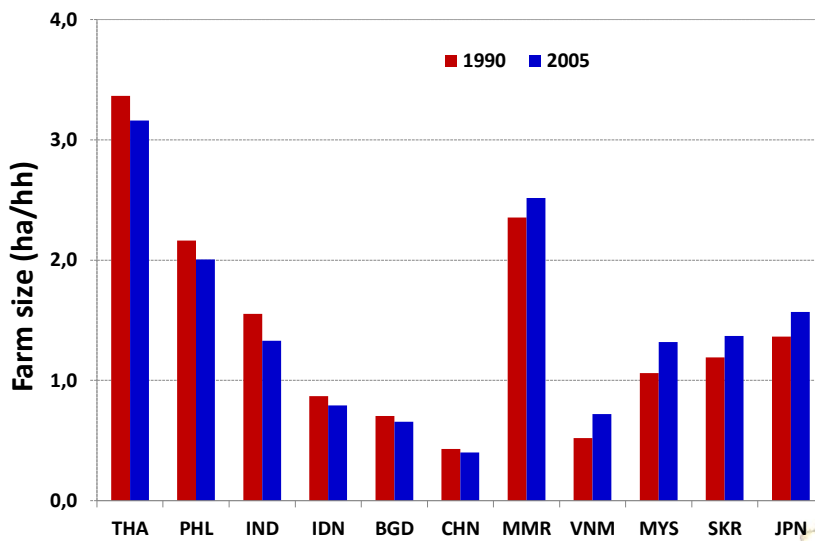
## Rice production cost in Asia



H. Bhandari, IRRI



## Trends in farm size in Asia, 1990-2005



H. Bhandari, IRRI



Site-specific nutrient management

Mega trends

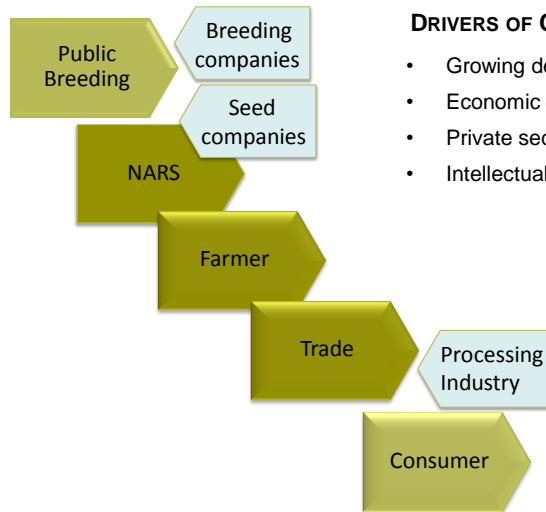
**New opportunities**

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**Crop genetics  
revolution?**

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## RICE SEED VALUE CHAIN



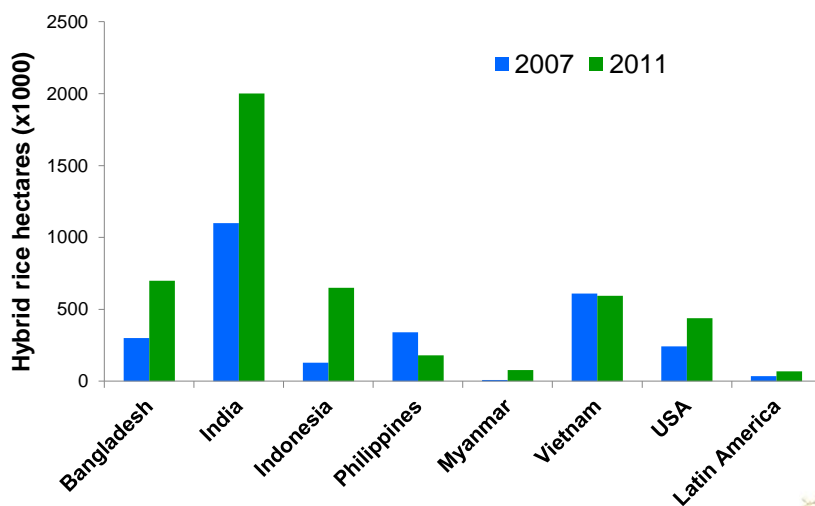
### DRIVERS OF CHANGE

- Growing demand (food, energy, etc.)
- Economic growth in emerging markets
- Private sector involvement
- Intellectual property

E. Nissilae, IRRI



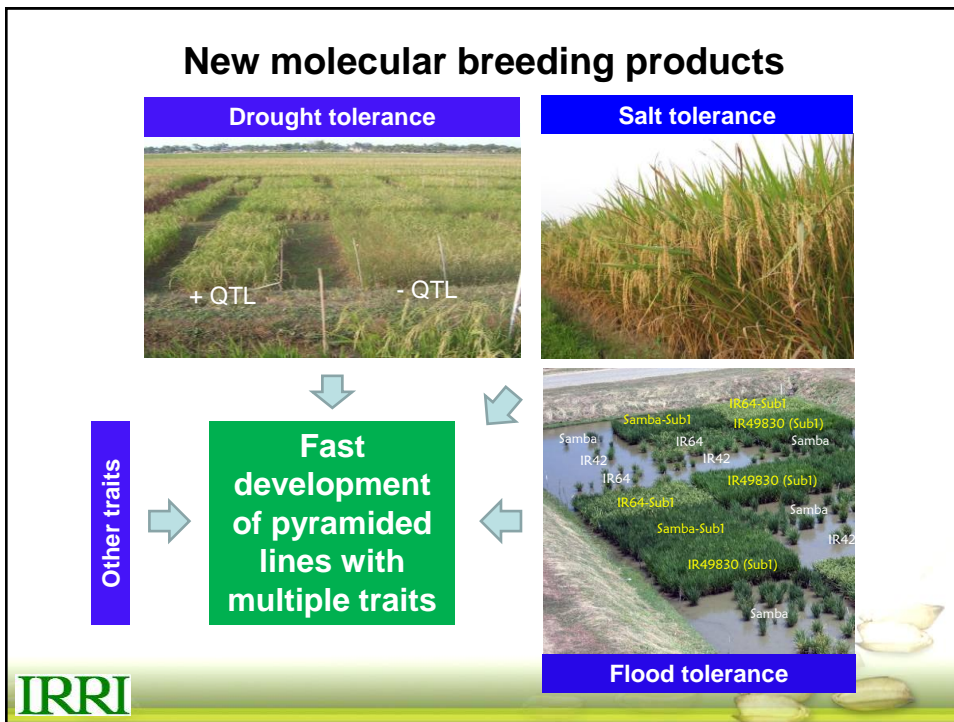
## Changes in hybrid rice area outside China



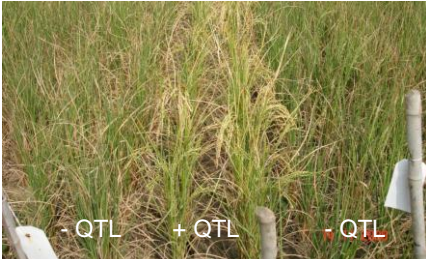

F. Xie, IRRI









## 2 in 1: Drought + submergence tolerance





- 2 or 3 drought yield QTLs pyramided in Swarna-sub1
- No yield penalty if no stress
- >1 t/ha yield advantage under stress
- Not transgenic

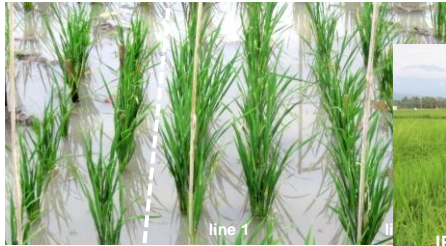
Swarna
Swarna + DTY

IRRI drought team



## New genes for tolerance to nutrient deficiency

-P soil, irrigated



IR74

IR74+Pstol1

Pstol1 breeding lines in the field

**Enhanced early root growth**  
**Enhanced nutrient uptake (N, P)**

LETTER

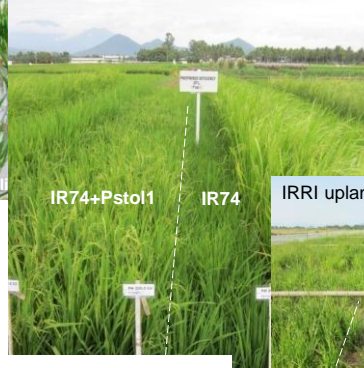
doi:10.1038/nature11346

The protein kinase Pstol1 from traditional rice confers tolerance of phosphorus deficiency

Rico Gamuyao<sup>1</sup>, Joong Hyoun Chin<sup>1</sup>, Juan Pariasca-Tanaka<sup>2</sup>, Paolo Pesaresi<sup>3</sup>, Sheryl Catausan<sup>1</sup>, Cheryl Dalid<sup>1</sup>, Inez Slamet-Loedin<sup>1</sup>, Evelyn Mae Tecson-Mendoza<sup>4</sup>, Matthias Wissuwa<sup>2</sup> & Sigrid Heuer<sup>1</sup>

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+NPK fertilizer

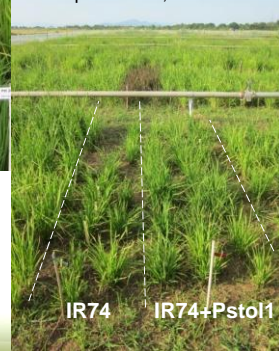


IR74+Pstol1

IR74



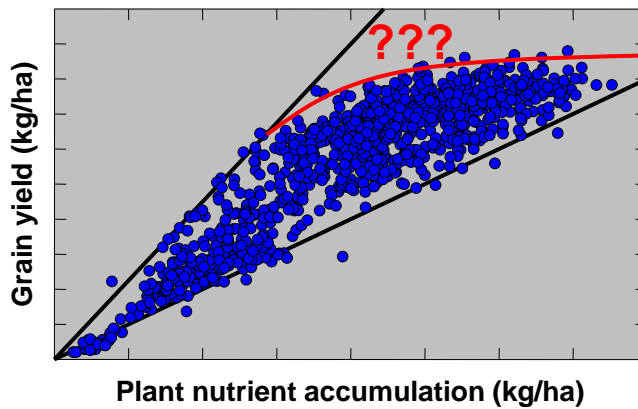
IRRI upland farm, -P fertilizer



IR74

IR74+Pstol1

## Is it really possible to increase the internal nutrient utilization efficiency?



**Conservation of matter?**  
**Trade-offs?**

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# Mechanized systems & integrated value chains

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## Mahindra Samridhi: Rice machinery & services

**Primary Tillage**

<b>Soil Testing</b>	<b>Agri Counseling</b>	<b>Demonstration</b>	<b>Agri Clinic</b>
<b>Agri Institution Visit</b>	<b>Farmers' Library</b>	<b>Toll Free Helpline</b>	<b>Tech Interface</b>

**Mahindra Samridhi**  
Annadata Helpline  
1800-425-4085

Sanjeev Goyle, Mahindra, India

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## Growers out-source seedling establishment, transplanting & agronomic service

**syngenta**

**Tegra™**

Certified, transplanted seedlings set to deliver maximum yield potential in the first 60 days, supported and stress free



1  
**Transplanting and agronomy service**



2  
**Maximize tillers first 60 days**



3  
**GroMore™**

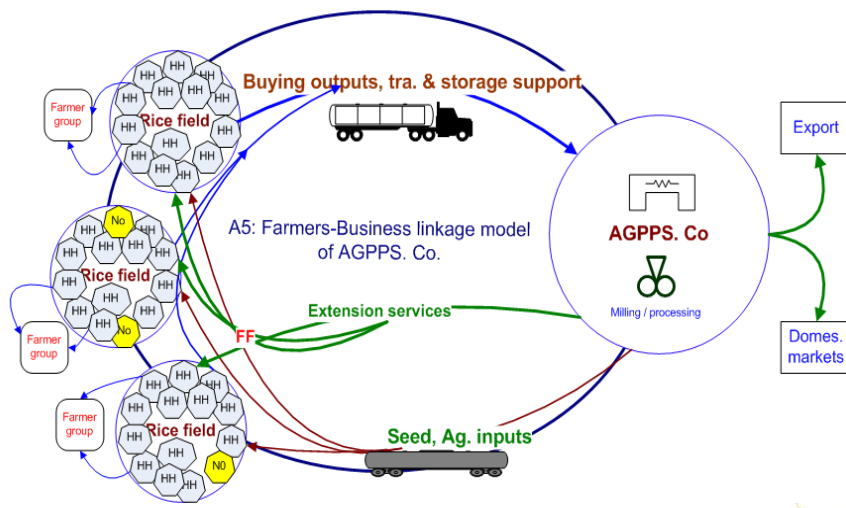
Full service from Tegra agronomist for the first 60 days of crop establishment

Retailer provides products to farmer

David Hosking, Syngenta

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## “Small Farmer - Large Field” model AGPPS Co. , South Vietnam



Pham Van Du, MARD, Vietnam

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## GAP for branded, traceable rice



Farmer's handbook for Viet GAP

Pham Van Du, MARD, Vietnam



## Sustainable Rice Platform (SRP)

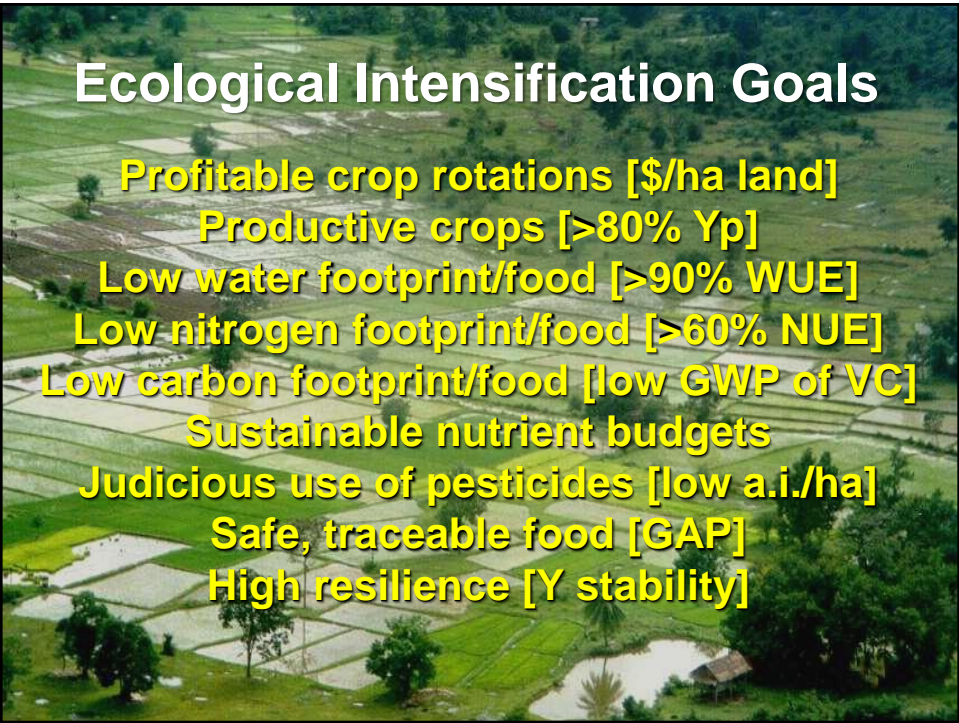


- Develop *global standards for best practices* of sustainable rice production (global rice GAP)
- Develop quantifiable *sustainability targets*
- Develop and promote *decision-support tools*
- Promote the adoption of best practices and sustainability criteria

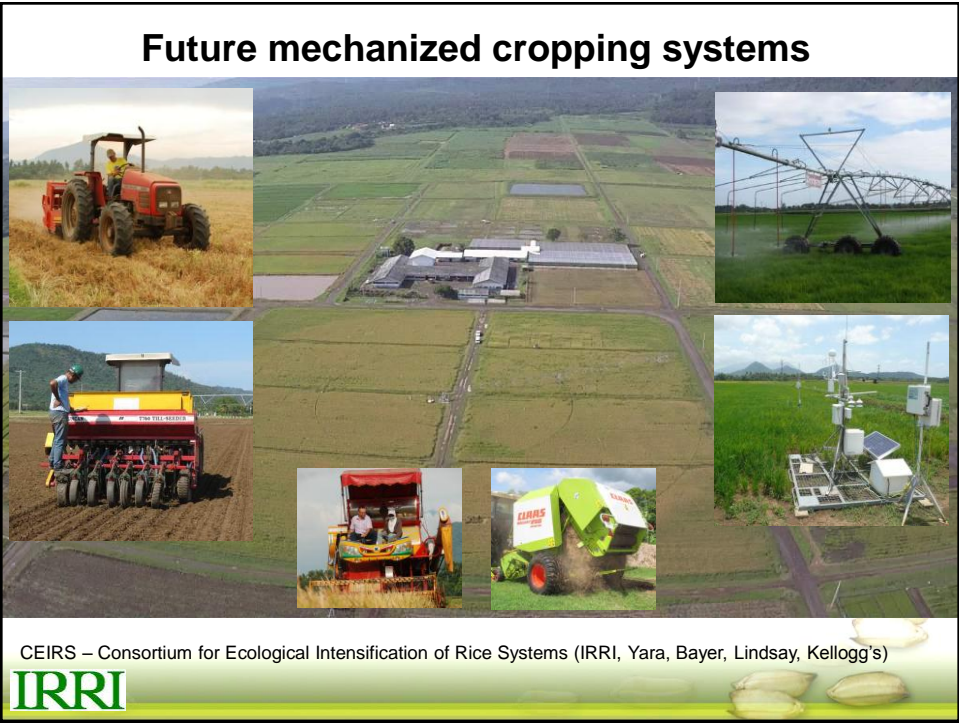


# Ecological Intensification Goals


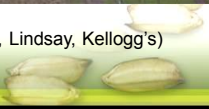
- Profitable crop rotations [\$/ha land]
- Productive crops [ $>80\%$  Yp]
- Low water footprint/food [ $>90\%$  WUE]
- Low nitrogen footprint/food [ $>60\%$  NUE]
- Low carbon footprint/food [low GWP of VC]
- Sustainable nutrient budgets
- Judicious use of pesticides [low a.i./ha]
- Safe, traceable food [GAP]
- High resilience [Y stability]



## Future mechanized cropping systems



CEIRS – Consortium for Ecological Intensification of Rice Systems (IRRI, Yara, Bayer, Lindsay, Kellogg's)

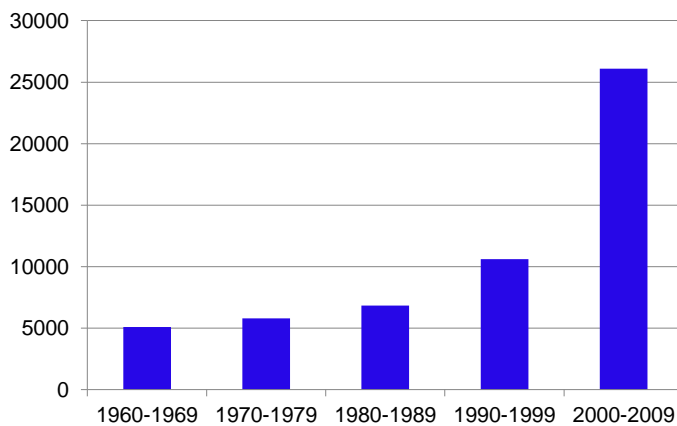
## Who will invest more in R&D?

- IRRI:
  - Total annual budget: ~85 million US\$
  - NM-related R&D: ~ 2 million US\$
- Technology & life sciences companies, Syngenta, Bayer, Monsanto,.....:
  - >15% of revenue
- Fertilizer industry: ???

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## Patents

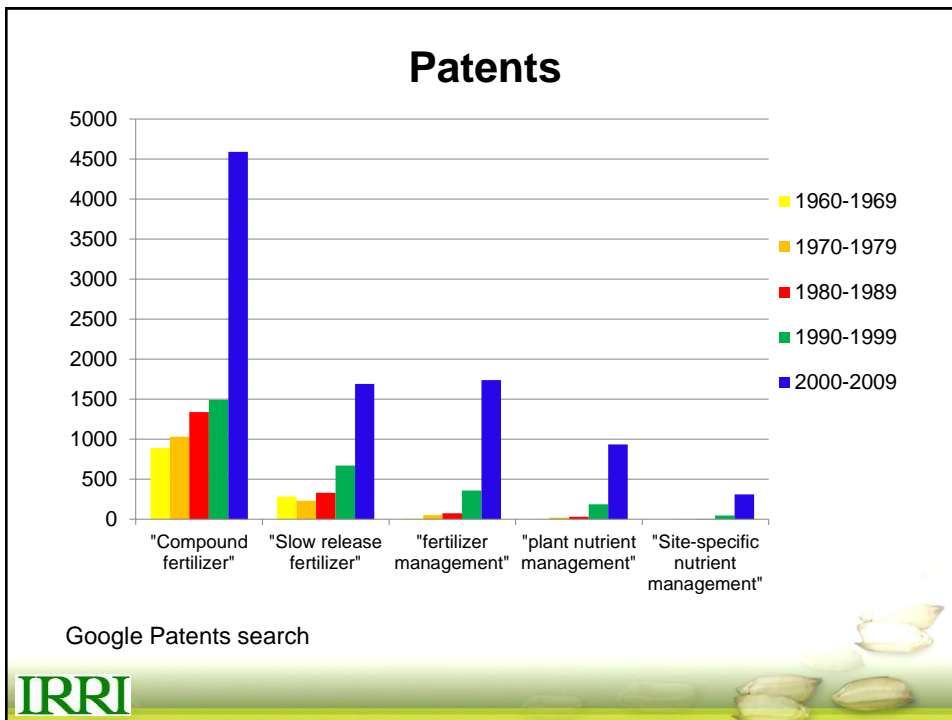
"Fertilizer"



Google Patents search for "fertilizers", includes:

- new fertilizers
- new application devices
- new manufacturing processes
- organic/biofertilizers

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- ### Innovation opportunities
- Nitrogen
    - Raising NUE as integral part of business models
    - Genetic engineering: nitrogen-fixing rice
  - Digital agriculture services
    - ICT tools and new business models for those
    - Young professional agronomists and scientists
  - Ecological intensification/future systems
    - NM technology for mechanized systems (DSR, GAP, etc.)
  - Truly smart fertilizers
    - Breakthroughs that are equivalent to Bt or RR corn
  - Soil and crop diagnostics
    - Capitalize on the revolutions in genomics, IT, physics, biology, chemistry, material sciences
-



Rice  
Science  
for a Better  
World

<http://www.grisp.net>

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