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Implementing field-specific nutrient management in rice-based cropping systems

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Contents of presentation

- What is field-specific nutrient management?
- What are principles for implementing improved nutrient management?
- What are challenges to implementation?
- How can implementation be facilitated?

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What is field-specific nutrient management?

- **Using the principles of site-specific nutrient management (SSNM) to develop and implement effective nutrient management at the field level**

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What is field-specific nutrient management?

- **Using the principles of site-specific nutrient management (SSNM) to develop and implement effective nutrient management at the field level**

- **Effective implementation involves:**
  - **Optimally supplying a crop with essential nutrients as and when needed**
  - **Achieving high yield and high profit from fertilizer use**

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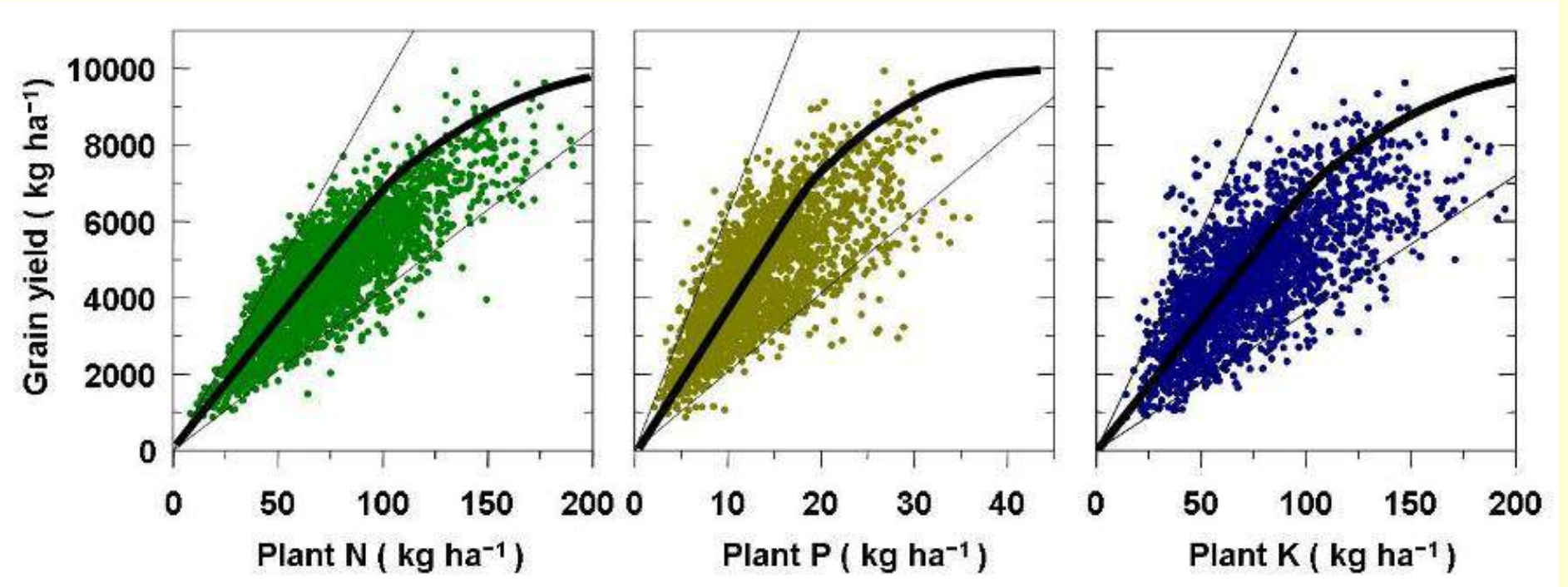
SSNM matches fertilizer use with nutrient needs of the crop

The uptake of N, P, and K by rice increases in proportion to grain yield



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Witt et al. 1999. Field Crops Res 63:113-138

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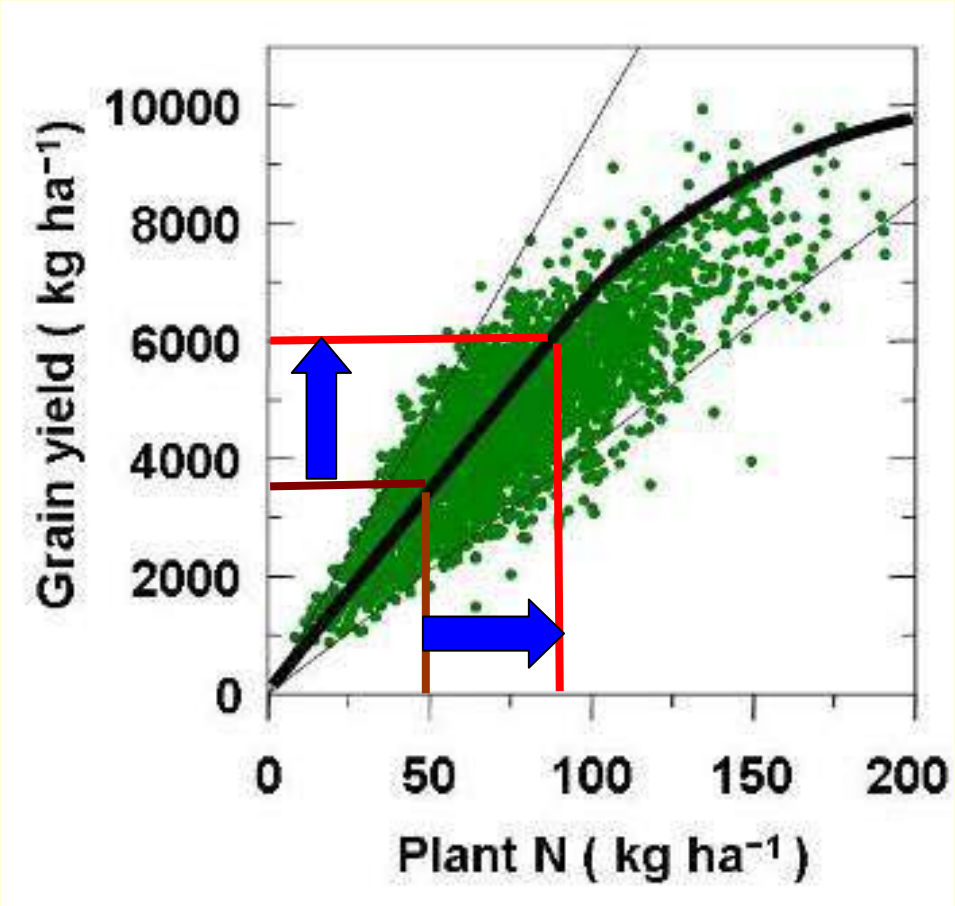
Three steps in the SSNM approach



1. Set an attainable yield:
Determine total nutrient needed

2. Estimate indigenous nutrient supply:
Obtain as much yield as possible from indigenous nutrient

3. Apply nutrient to fill gap:
In case of P and K also apply nutrient to maintain soil fertility

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Principles on nutrient management for rice are well documented

www.irri.org/irrc/ssnm (creative commons license)

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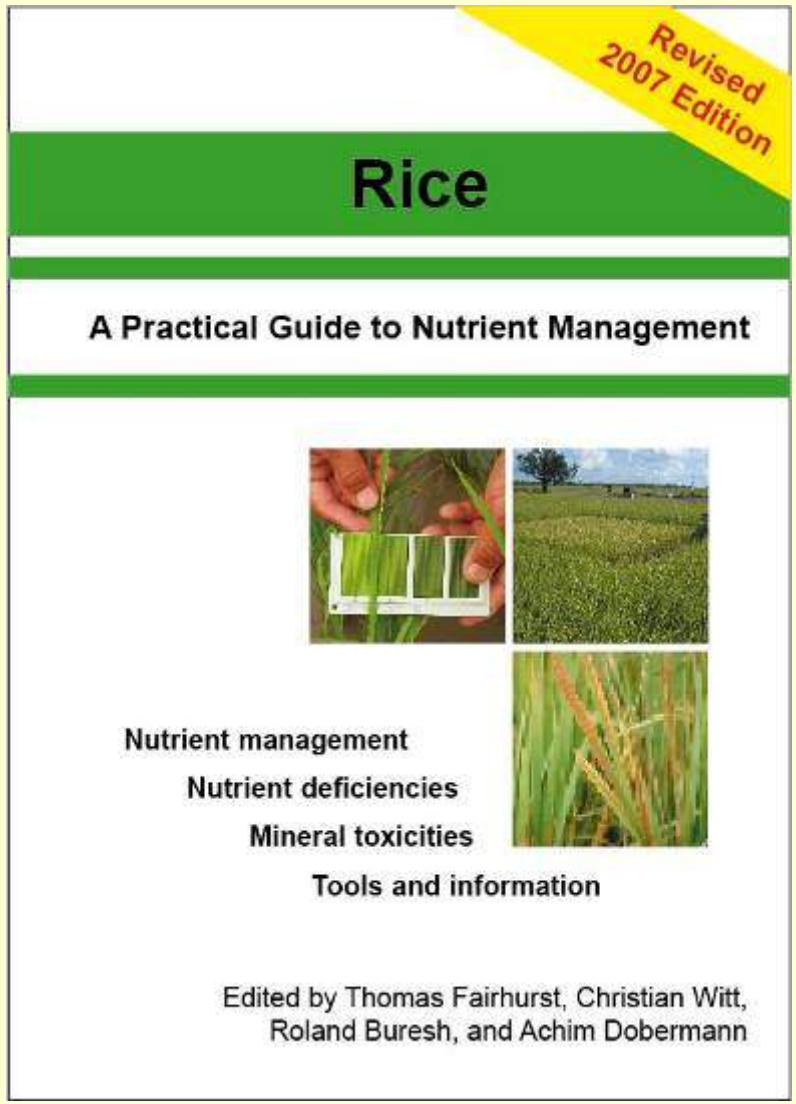
Second edition of Practical Guide in 2007

Translations are in progress



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What are principles for implementing improved nutrient management for rice?

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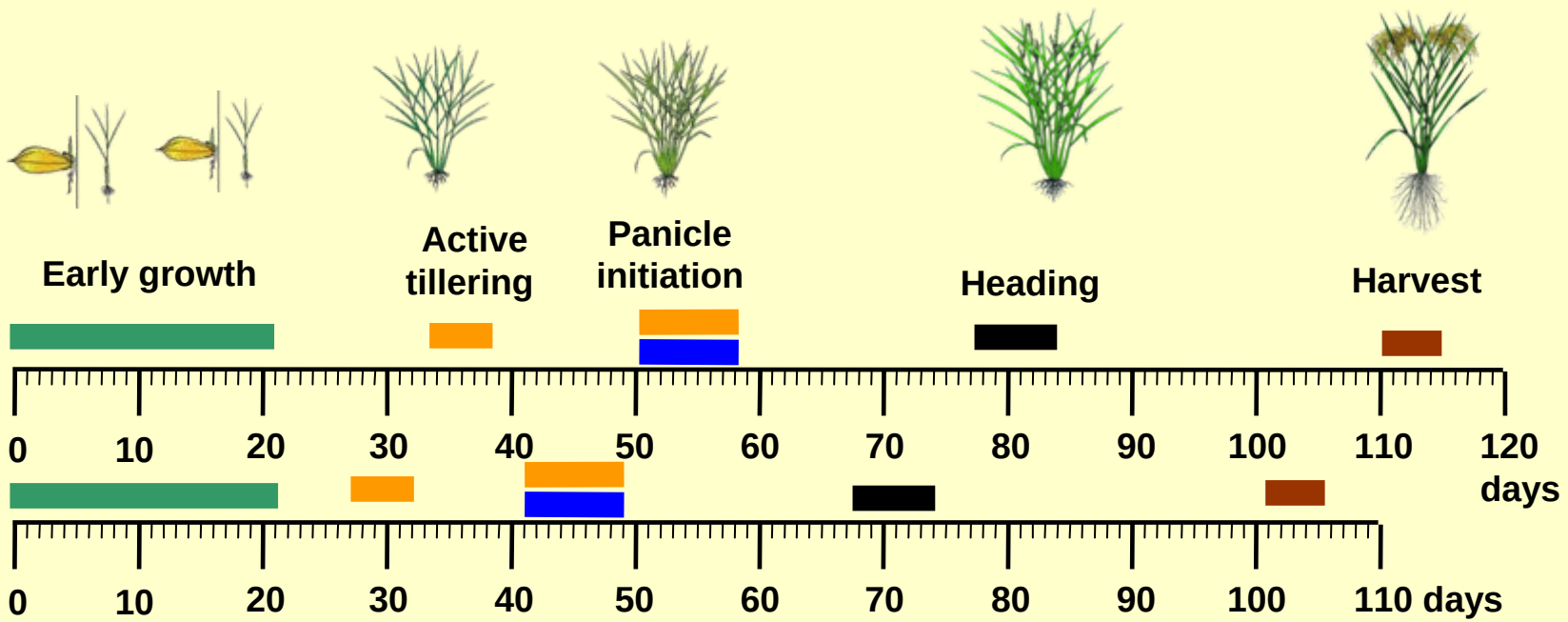
Manage fertilizer by crop growth stage



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Improving N management for rice

- **Before crop establishment:**
  - **Estimate the total fertilizer N needed**
  - **Determine the rate for first N application**

- **Within the season:**
  - **Adjust N applications to match crop needs**

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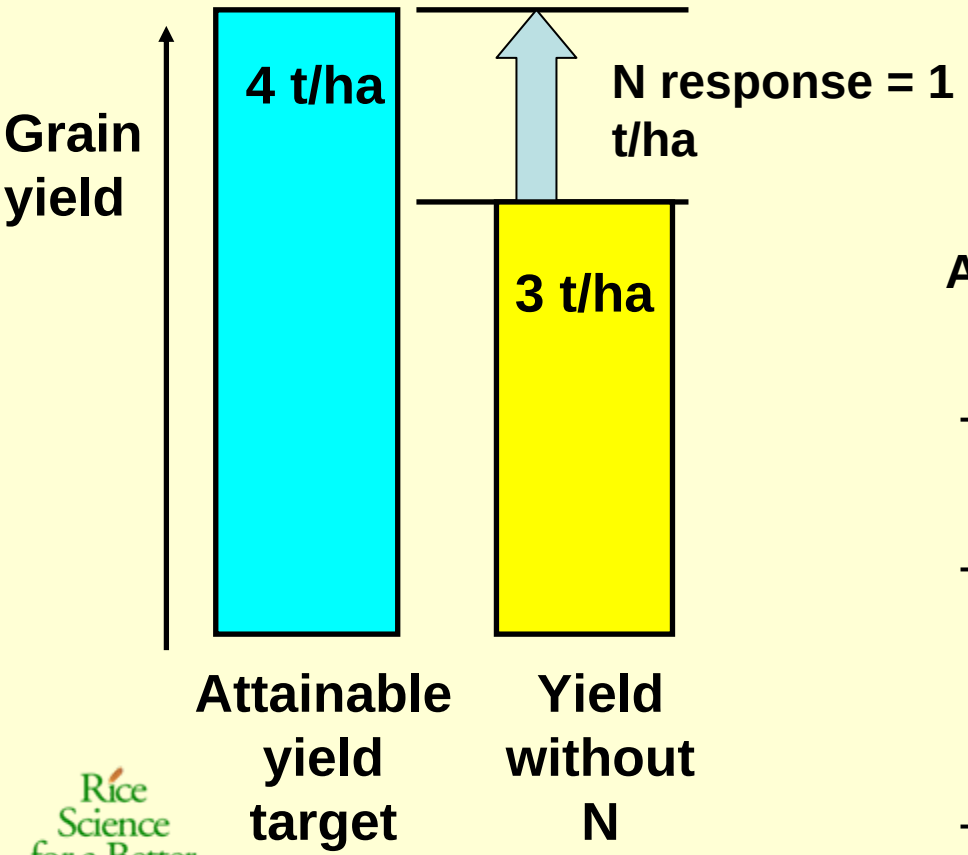
Approach for setting pre season N rate

1. Set an attainable yield target
2. Estimate indigenous N supply = yield without fertilizer N
3. Estimate response to N
4. Estimate N rate based on response to N and a target efficiency for fertilizer N (AEN)



$$N = (N\ response * 1000)/AEN$$

AEN = kg grain increase/kg N applied

AEN (kg grain/kg N)	N rate (kg N/ha)
16	62
20	50
25	40

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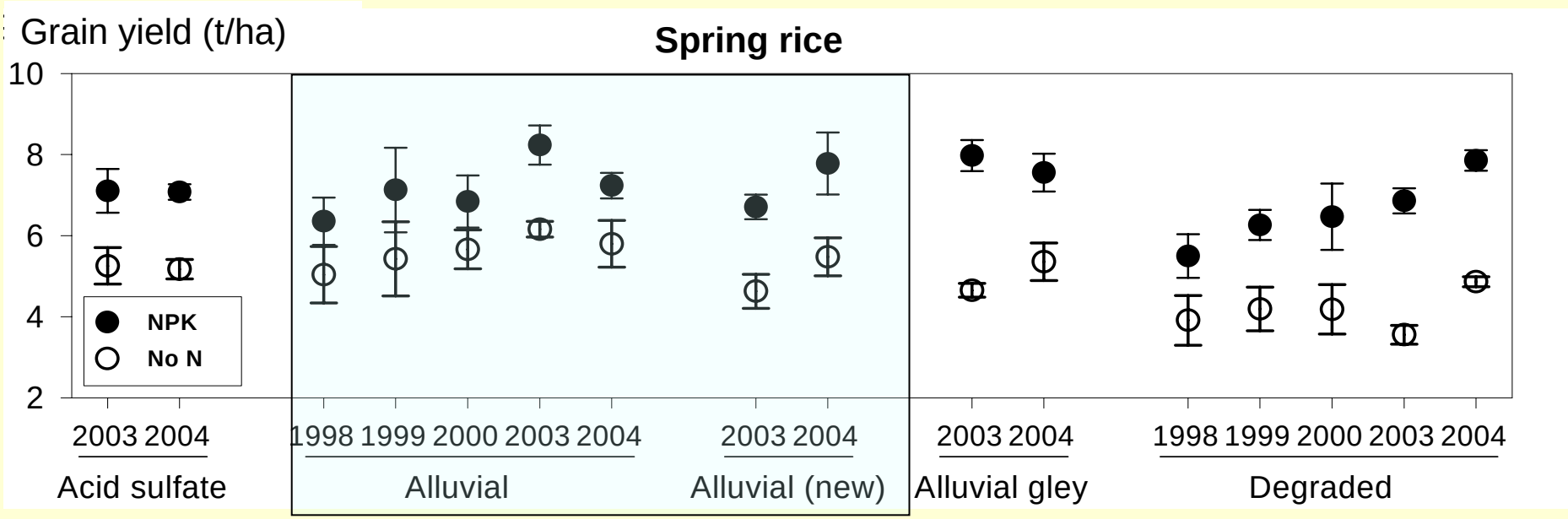
Variations in attainable yield and yield without N in Red River Delta, Vietnam



Alluvial soil:

Attainable yield = 6 – 8 t/ha
Yield without N = 4 – 6 t/ha

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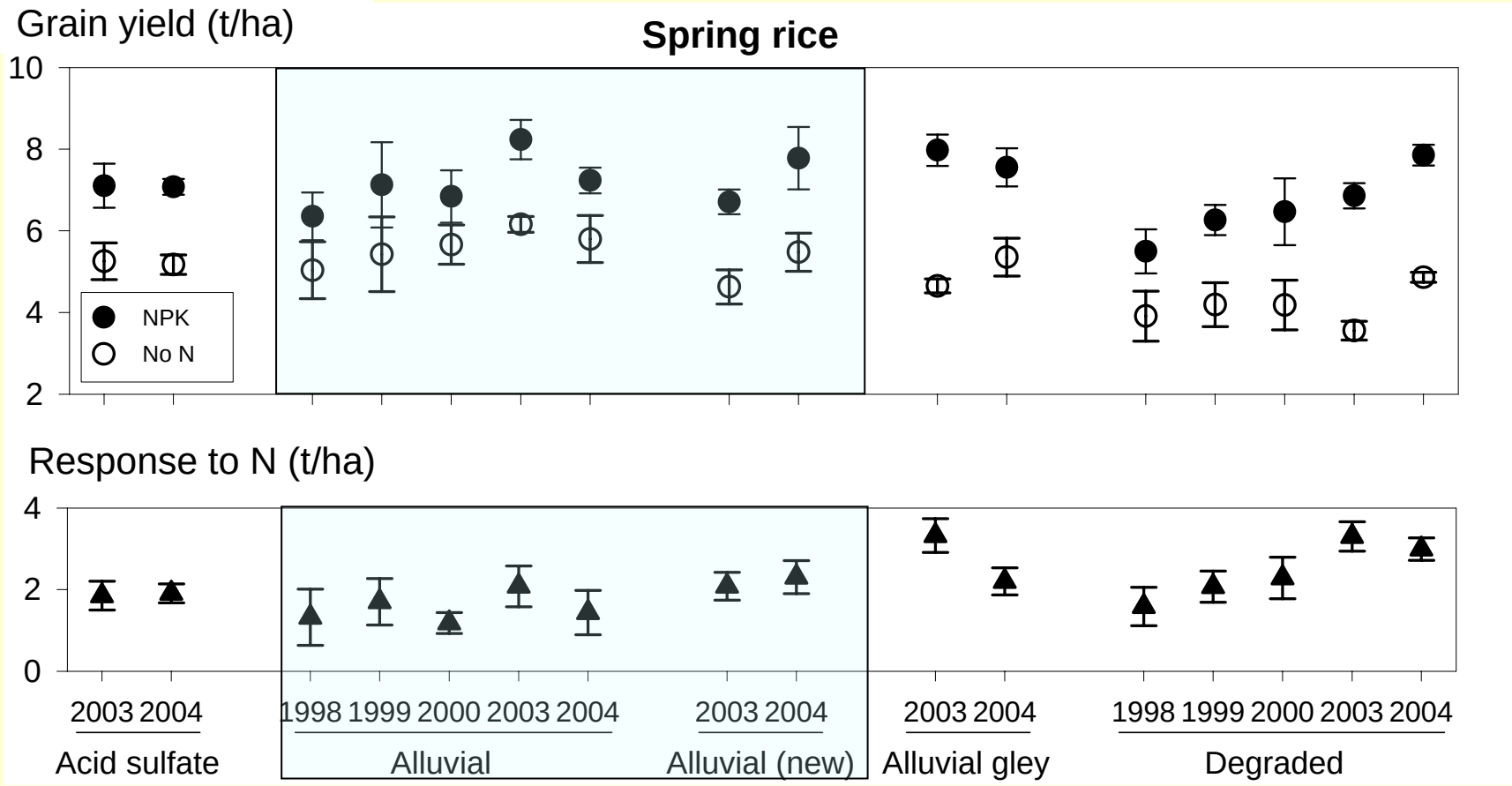
(T.T. Son et al., unpublished)

Rice response to N is not more variable than attainable yield or yield without N



Alluvial soil:

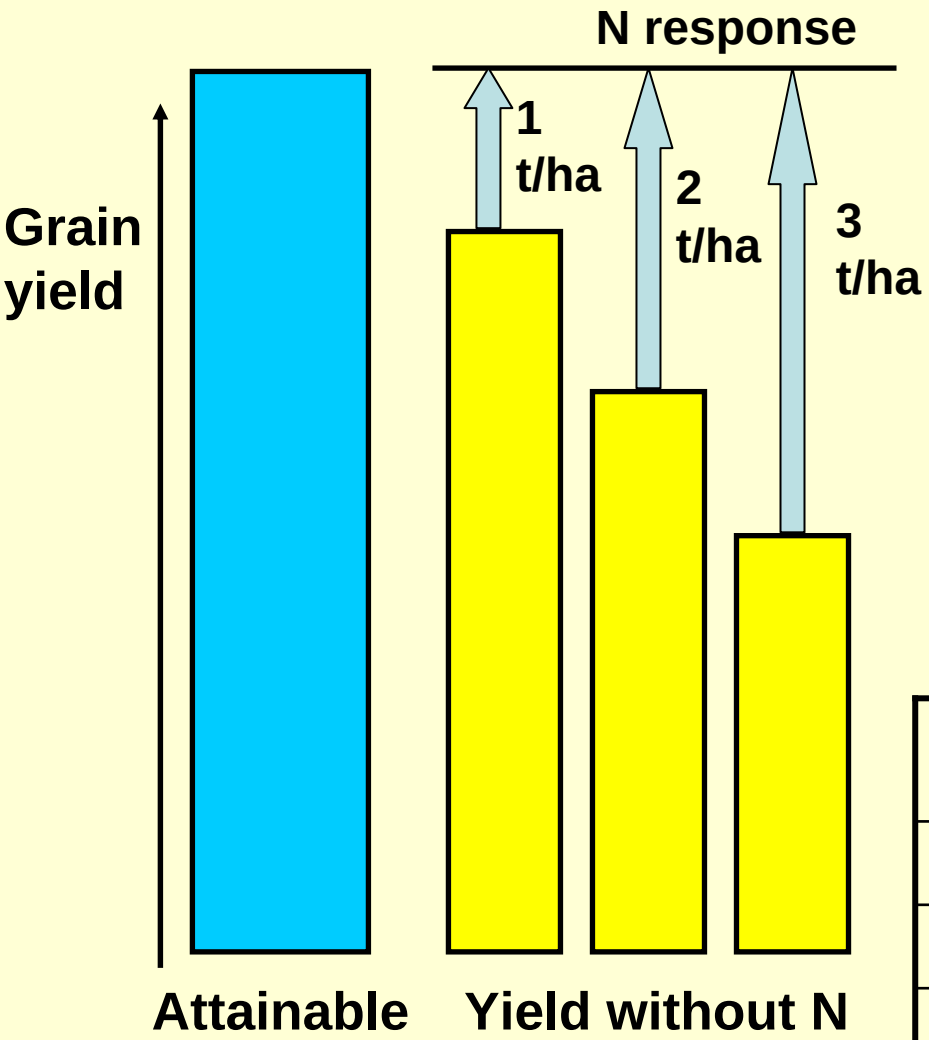
Attainable yield = 6 – 8 t/ha

Yield without N = 4 – 6 t/ha

N response = 1 – 2 t/ha

(T.T. Son et al., unpublished)

Need for N is related to crop response to N



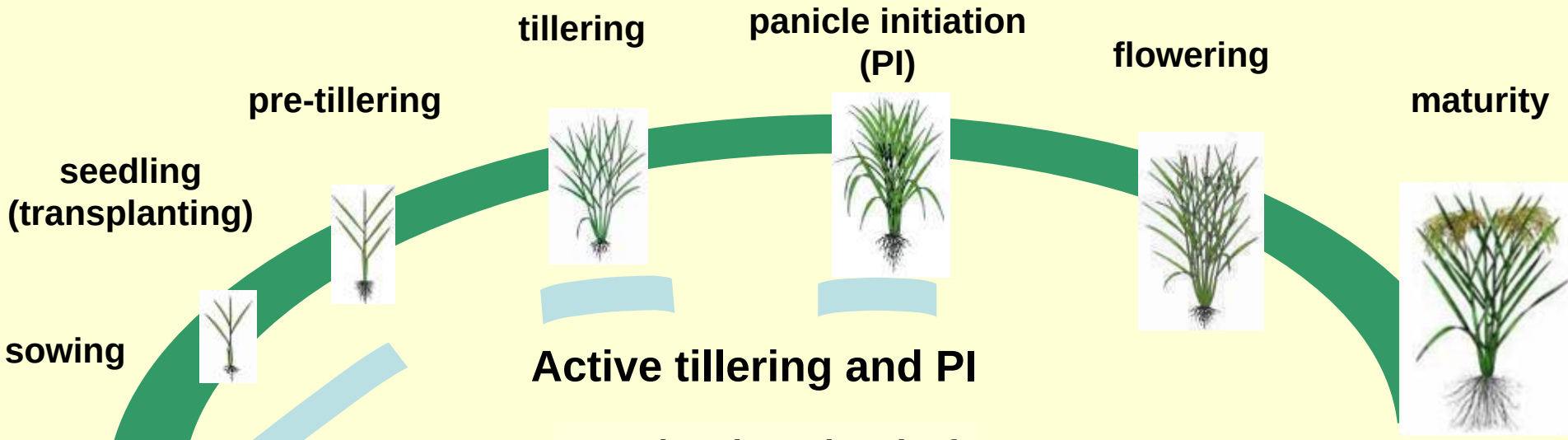
1. Estimate response to N
2. Estimate N rate based on response to N and target efficiency for fertilizer N (AEN)

N = (N response*1000)/AEN

AEN = kg grain increase/kg N applied

N response (t/ha)	Target AEN	Estimated N rate (kg N/ha)
1	16 to 18	55 to 60
2	18 to 20	100 to 110
3	20 to 25	120 to 150

Apply fertilizer N to match crop needs for N



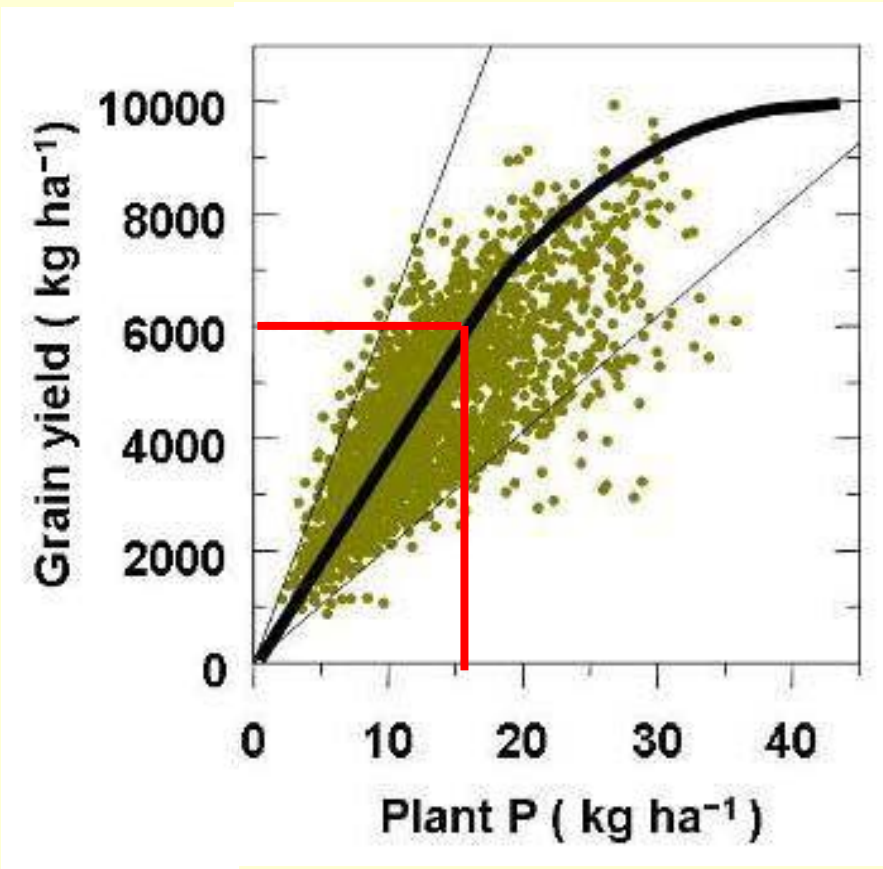
Early N

- Apply only a moderate amount
- Increase N rate with increasing response to N

Active tillering and PI

- Apply N based on leaf N status
- Adjust N rate based on anticipated crop response to N
- Achieve optimal tiller number and LAI

The uptake of P by rice increases in proportion to grain yield



A mature rice crop takes up about 2.6 kg P or 6 kg P_2O_5 per 1 ton of grain yield

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Principles of P management for rice

- **The need of a crop for P depends on:**
  - **Anticipated crop yield**
  - **Estimated supply of 'native' or 'indigenous' P**

- **On soils with high soil P or no rice response to P, apply about 4 kg P_2O_5 per ton of rice grain yield to maintain soil P fertility**

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Recommended P_2O_5 rates

according to yield target and P-limited yield

Yield target (t/ha) →	4	5	6	7	8
Yield in 0-P plots (t/ha)	Fertilizer P_2O_5 rate (kg/ha)				
3	20	40	60		
4	15	25	40	60	
5		20	30	40	60
6			25	35	45
7				30	40
8					35

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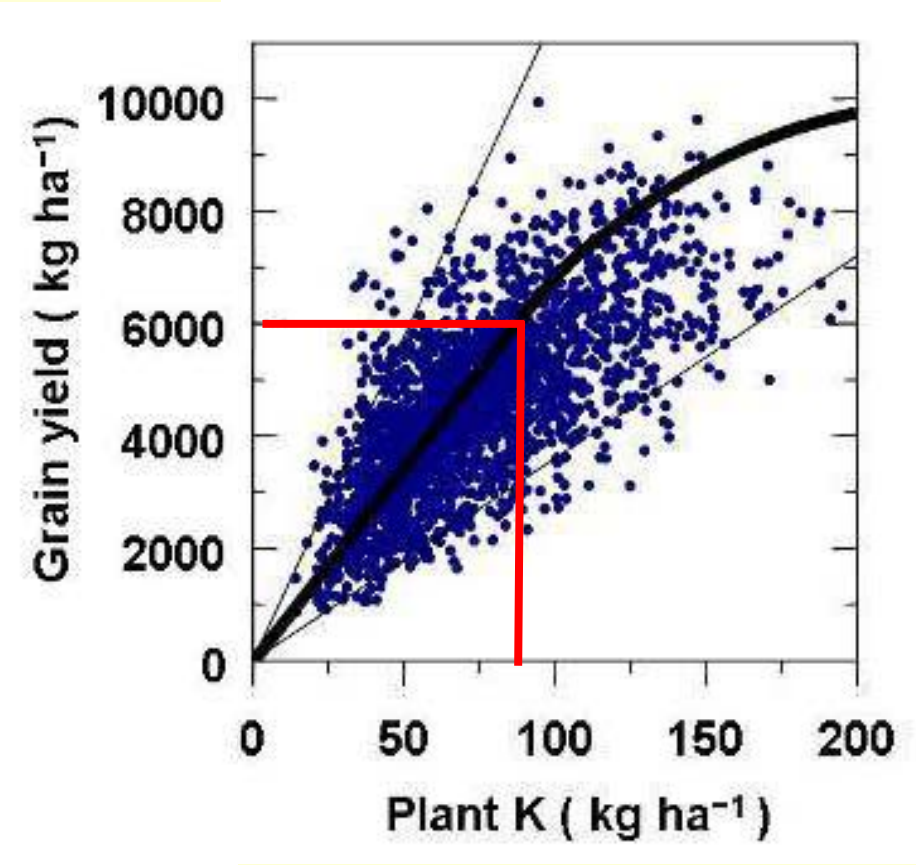
Fairhurst et al. 2007. Rice: A practical guide to nutrient management.

The uptake of K by rice increases in proportion to grain yield



A mature rice crop takes up about 15 kg K or 18 kg K_2O per 1 ton of grain yield

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Improving K management for rice

- **The need of a crop for K depends on:**
  - **Anticipated crop yield**
  - **Management of crop residues**
  - **Estimated supply of ‘native’ or ‘indigenous’ K**

- **Apply at least some of the needed fertilizer K early -- to the young crop**

Recommended K_2O rates

according to yield target and K-limited yield at medium straw input

Yield target (t/ha) →	4	5	6	7	8
Yield in 0-K plots (t/ha)	Fertilizer K_2O (kg/ha)				
3	30	60	90		
4	0	35	65	95	
5		20	50	80	110
6			35	65	95
7				50	80
8					65

2 to 3 t/ha straw input

Fairhurst et al. 2007. Rice: A practical guide to nutrient management.

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K management for rice

- Important for grain filling
- Supplied by irrigation water and minerals deposited by floods
- Enable farmers to determine merit of additional fertilizer K

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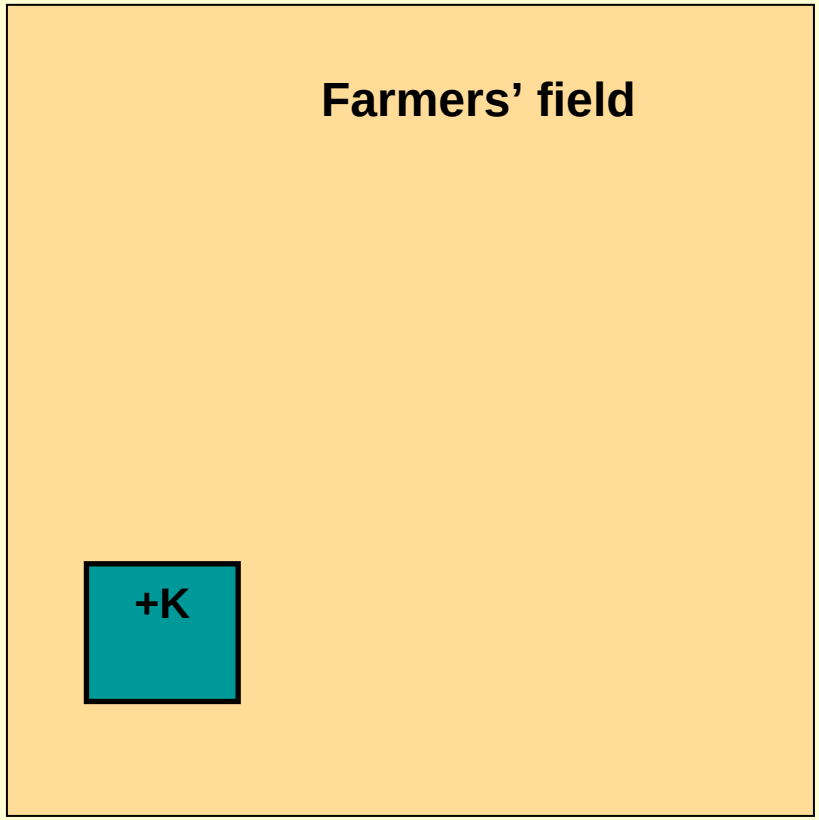
Farmers can use small plots to determine whether additional fertilizer K is profitable

Use of K addition plot technique



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An often overlooked challenge to implementation

- Technical experts and projects frequently give different guidelines and information on nutrient management
- Field technicians can receive a multitude of sometimes inconsistent information
- Best management practices (BMP) can differ among organizations and projects

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Examples of available recommendations on PK management

- **Soil based approaches**
  - **Soil tests, without yield target**
  - **Soil tests, with single yield target**
  - **Soil tests, with multiple yield targets**
  - **Soil or nutrient response maps**
  - **Agro-ecological zones**
- **Plant based approaches**
  - **Nutrient balances (omission plot technique)**
  - **Crop responses (MOET, omission plot technique)**
- **‘Modeling’ approaches**

Calibrations for each can differ on whether maintenance applications are or are not incorporated into the recommendation

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How can implementation be facilitated?

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Approach of Irrigated Rice Research Consortium (IRRC)

- **Help establish multi-institutional partnerships across research and extension on best management practices**
  - **Facilitate consensus on fundamental irrefutable scientific principles**
  - **Help identify scientific principles to build consensus**

- **Help develop appropriate tools and skills for local extension of the public and private sector**

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The Nutrient Manager

- **A computer-based decision tool to assist in the wide spread dissemination of improved nutrient management for rice**
- **Rapidly provides a printable fertilizer guideline based on reply to ~10 simple multiple-choice questions for a rice field or rice-growing area**
- **Targeted for field technicians and extension workers**

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The Nutrient Manager

- **Totally consistent with SSNM literature and guidelines (e.g., Rice Practical Guide and web site)**
- **N, P_2O_5, and K_2O guidelines are developed through dialogue and consensus building based on scientific principles**
- **Prototype versions under field testing in Indonesia and the Philippines**

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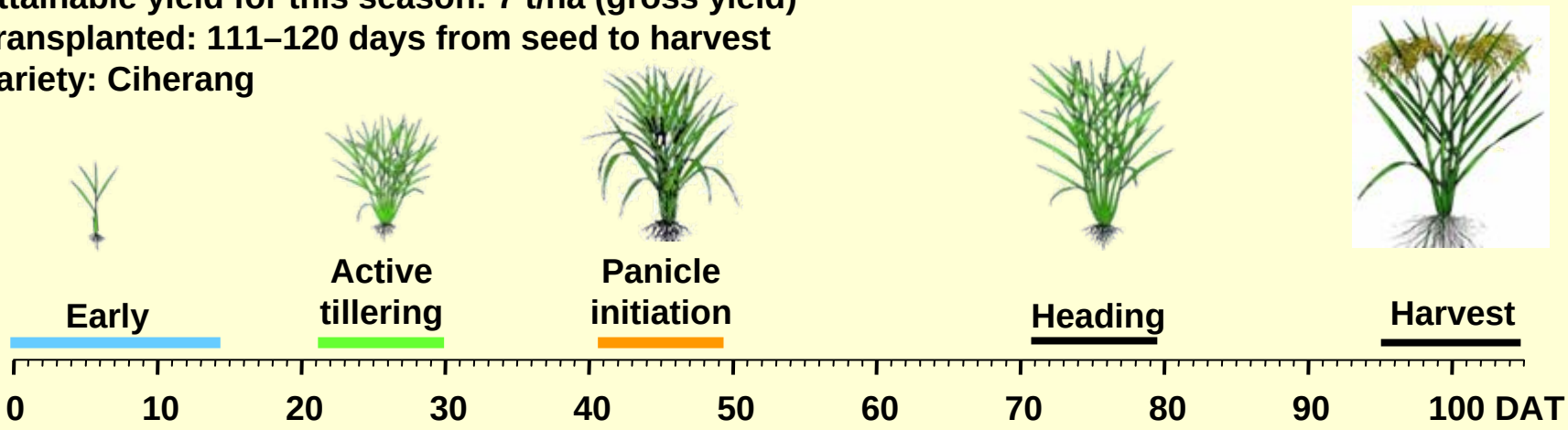
Sample of a printable output

Attainable yield for this season: 7 t/ha (gross yield)
Transplanted: 111–120 days from seed to harvest
Variety: Ciherang



Growth stage	Days after transplanting	N		P_2O_5	K_2O
		kg/ha		kg/ha	kg/ha
Early	0 – 14	25-30		25-30	30
Active tillering	23 – 28	LCC = 3	45	0	0
		LCC = 3.5	35		
		LCC = 4	0-25		
Panicle initiation	42	LCC = 3	45	0	0
		LCC = 3.5	35		
		LCC = 4	0-25		

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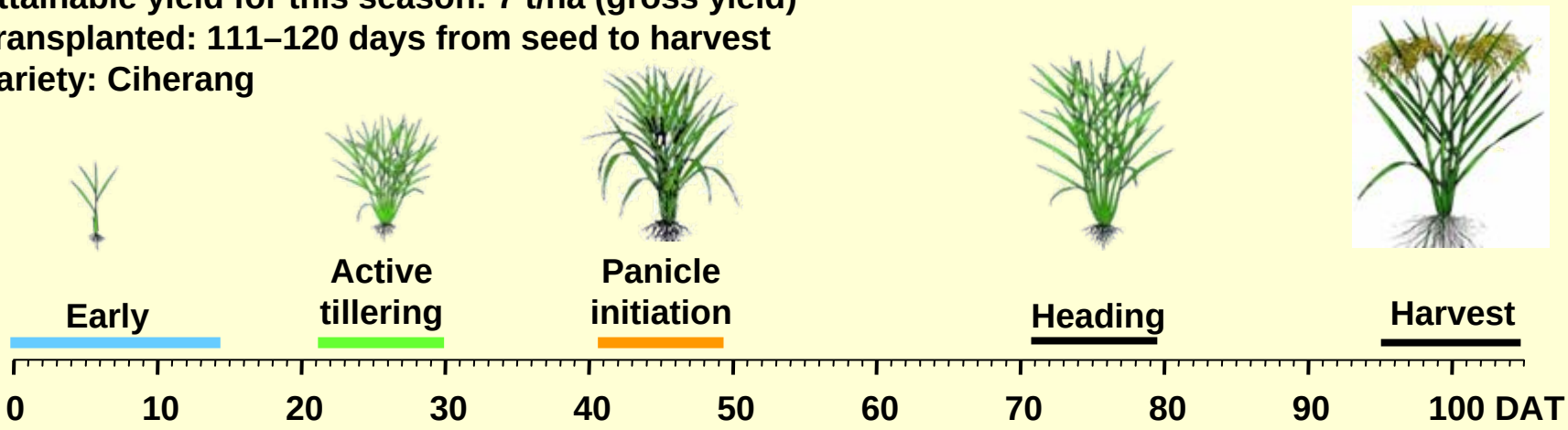
Sample of a printable output with fertilizers

Attainable yield for this season: 7 t/ha (gross yield)
Transplanted: 111–120 days from seed to harvest
Variety: Ciherang



Early application (0-14 DAT):	
Phonska (15-15-15-10S) (bag/ha):	4
OR	
Urea (bag/ha):	1
SP36 (bag/ha):	1.5
KCl (bag/ha):	1

First topdressing (23-28 DAT):

	Urea (bag/ha)
LCC = 3	2
LCC = 3.5	1.5
LCC = 4	0 – 1

Second topdressing (42 DAT):

	Urea (bag/ha)
LCC = 3	2
LCC = 3.5	1.5
LCC = 4	0 – 1

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N guidelines for rice
Information needed

- **Early N application**
  - N rate depends on crop response to N (attainable yield with N fertilizer minus yield without fertilizer)
- **N topdressing**
  - Determine critical growth stages for N application from growth duration and planting method for rice
    - Panicle initiation: 55-60 days before harvest
    - Active tillering: midway between early N and PI
  - N rate for topdressing is based on:
    - Expected crop response to N
    - Within season adjustment of N is based on crop need as indicated by leaf color

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P guidelines for rice
Information needed

- **Expected rice yield**
  - **Crop need for P is directly related to attainable yield and the yield response to fertilizer P application.**
- **Information on expected yield response or soil indigenous P supply can be obtained with the following options:**
  - **Yield response to fertilizer P from omission plots (NPK – 0P)**
  - **Soil P level based on soil test kit, lab analysis, or soil map**
  - **Historical use of P fertilizer**
    - **Use to develop P guideline when soil test P is not known**
    - **Historical P use < P removal by crop: assume low soil P**
    - **Historical P use > P removal by crop: assume high soil P**

K guidelines for rice
Information needed

- **Expected rice yield**
  - **Crop need for K is directly related to attainable yield and the yield response to fertilizer K application.**
- **Information on expected yield response or soil indigenous K supply can be obtained with the following options:**
  - **Yield response to fertilizer K from omission plots (NPK – 0K)**
  - **Soil K level based on soil test kit, lab analysis, or soil map**
- **Consider management of crop residues**
  - **Used in combination with soil test or omission plot results**
  - **Basis for K rate when soil test K or omission plot result is not known**

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Field moist yield as reported by a farmer must be cross referenced to yield at 14% moisture, which is used in SSNM literature

Which of the following should be used to determine yield at 14% moisture from gross yield reported by farmers?

Yield at 14% moisture	Yield at 20% moisture	Yield at 25% moisture	Yield at 25% plus impurities
4	4.3	4.6	4.8
5	5.4	5.7	6
6	6.5	6.9	7.2
7	7.5	8.0	8.4
8	8.6	9.2	9.6

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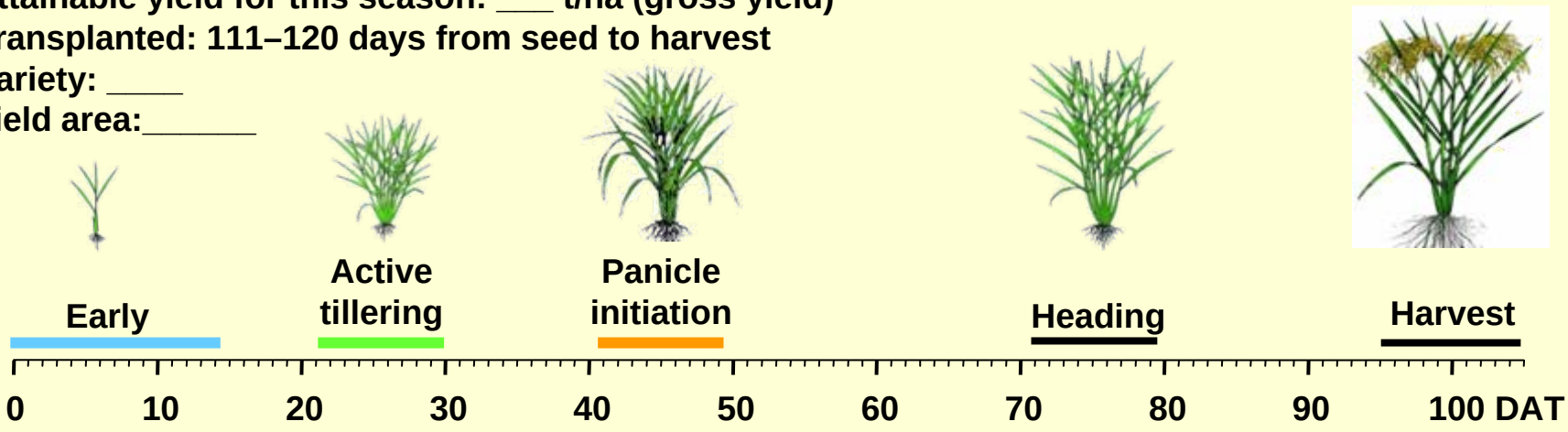
Sample of a printable output with fertilizers

Attainable yield for this season: ___ t/ha (gross yield)
Transplanted: 111–120 days from seed to harvest
Variety: _____
Field area:_____



Early application (0-14 DAT):

NPK (15-15-15) (kg):	XX
or	
Urea (kg):	XX
TSP (kg):	XX
KCl (kg):	XX

First topdressing (23-28 DAT):

Urea (kg)

XX

Second topdressing (42 DAT):

Urea (kg)

XX

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Additional considerations in development of 'Nutrient Manager' for rice

- Need estimate of nutrient value of organic inputs
- Need information on growth duration of rice variety used by farmer
- Need verification of guidelines
- Require evaluation with farmer participation

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Development of Nutrient Manager (January-June 2008)

- **Indonesia**
  - Initial field testing completed
  - Revised version completed
  - Under evaluation in 5 provinces from April
- **Philippines**
  - Initial field testing underway
  - Revised version under development
  - Consultations in April-May
  - Evaluate from June
- **West Bengal : partnership with IPNI**
  - Module under development
- **China**
- **Southern Vietnam**

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Acknowledgement

- Swiss Agency for Development and Cooperation (SDC)
- International Fertilizer Industry Association (IFA)
- International Potash Institute (IPI)
- International Plant Nutrition Institute (IPNI)

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