SSNM: an approach for optimizing nutrient use in intensive rice production

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Site-specific nutrient management (SSNM) is a plant-based approach for managing the nutrient needs of rice in intensive production systems. It provides principles and tools for 'feeding' rice with nutrients as and when needed to achieve high yields while optimizing use of nutrients from indigenous sources.

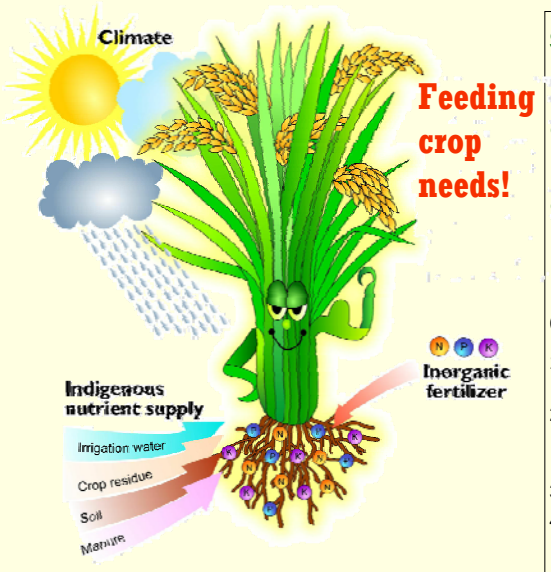
SSNM in three steps

Step 1: Establish a yield target.

- Estimate grain yield attainable with farmers' crop management when NPK constraints are overcome.
- The yield target reflects the total amount of nutrients that must be taken up by the crop.
- It is location- and season-specific, depending on climate, cultivar, and crop management.

Step 2: Effectively use existing nutrients.

- Estimate nutrient-limited yields or grain yields attainable from the indigenous supply of nutrients.
- Determine nutrient-limited yield with nutrient omission plots, which is the yield for a crop not fertilized with the nutrient of interest but fertilized with other nutrients.
  - N-limited yield: no N, with PK
  - P-limited yield: no P, with NK
  - K-limited yield: no K, with NP
- Calibrate soil tests for P and K against the omission plot technique, considering the need to maintain soil fertility.



Step 3: Apply fertilizer to fill the deficit between crop needs and indigenous supply.

- Distribute the required fertilizer N in several applications during the growing season to best feed the crop need for supplemental N.
- Apply sufficient amounts of P and K to overcome deficiencies and maintain soil fertility.

Guidelines for applying fertilizer

1. Apply only a moderate amount of fertilizer N to young rice.
2. Apply N from tillering onward based on leaf N status as determined with the leaf color chart (LCC).
3. Apply all fertilizer P near transplanting or sowing.
4. Apply fertilizer K twice – 50% near transplanting or sowing and 50% at early panicle initiation.

Optimizing N use efficiency

1. Estimate the total fertilizer N required for rice in a typical season.
   - It is based on yield response to N (yield target minus N-limited yield) and efficiency of fertilizer N use (Table 1).
2. Distribute fertilizer N to best match the crop need for N.
   - Apply only a moderate amount of fertilizer N to young rice.
   - Use the LCC to adjust the dose of N or determine the timing of N application (Fig. 1) from tillering onward.

Table 1. Estimation of fertilizer N required for rice based on yield response to fertilizer N and efficiency of fertilizer N use (AE_N). Estimate the current AE_N achieved by farmers and select a higher AE_N for the new and improved N recommendation.

Agronomic efficiency (kg grain increase/kg N applied) →	15	18	20	25
Yield response (t ha^{-1}) ↓	Fertilizer N rate (kg ha^{-1})			
1	65	55	50	40
2	130	110	100	80
3	195	165	150	120
4		220	200	160
5			250	200

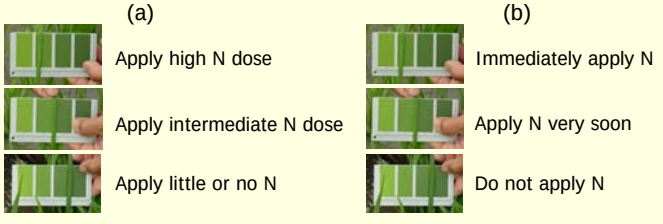


Fig.1. Using the LCC to either (a) adjust the dose of fertilizer N applied at predetermined key growth stages or (b) determine application timing of fertilizer N (Witt et al 2007).

See the SSNM web site (www.irri.org/irrc/ssnm) for details.

Optimizing P and K use efficiency

Matching crop need for P

1. Estimate requirement for fertilizer P based on yield target and P-limited yield (Table 2).
2. Apply all fertilizer P to young rice within 14 days after transplanting (DAT) or 21 days after sowing (DAS).

Matching crop need for K

1. Estimate requirement for fertilizer K based on yield target and K-limited yield (Table 3).
2. Typically apply fertilizer K twice with about 50% before 14 DAT or 21 DAS and 50% at early panicle initiation.

Table 2. Recommended P_2O_5 rates according to yield targets and P-limited yield (Witt et al 2007).

Yield target (t ha^{-1}) →	4	5	6	7	8
P-limited yield (t ha^{-1}) ↓	Fertilizer P_2O_5 (kg ha^{-1})				
3	20	40	60		
4	15	25	40	60	
5	0	20	30	40	60
6	0	0	25	35	45
7	0	0	0	30	40
8	0	0	0	0	35

Table 3. Recommended K_2O rates at medium straw input according to yield targets and K-limited yield (Witt et al 2007).

Yield target (t ha^{-1}) →	4	5	6	7	8
K-limited yield (t ha^{-1}) ↓	Fertilizer K_2O (kg ha^{-1})				
3	30	60	90		
4	0	35	65	95	
5	0	20	50	80	110
6	0	0	35	65	95
7	0	0	0	50	80
8	0	0	0	0	65

Reference

Witt C, Buresh RJ, Peng S, Balasubramanian V, Dobermann A. 2007. Nutrient management. pp 1-45. In Fairhurst T et al. (eds.) Rice: A practical guide to nutrient management. Los Baños (Philippines) and Singapore: International Rice Research Institute, International Plant Nutrition Institute, and International Potash Institute.

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