Site-Specific Nutrient Management (SSNM) Approach for Fertilizer N Management

Site-specific nutrient management (SSNM) enables rice farmers to optimally supply their crops with essential nutrients. The SSNM approach aims to apply nutrients at optimal rates and times to achieve high yield and high efficiency of nutrient use by the rice crop, leading to high cash value of the harvest per unit of fertilizer invested.

With the SSNM approach, fertilizer N recommendations for rice can be developed by

1. Estimating the total fertilizer N required for rice in a typical season, and then
2. Formulating a dynamic N management to distribute fertilizer N to best match the crop's need for N.

Estimating the total fertilizer N required for rice

The total fertilizer N requirement depends on the deficit between the crop's total N need to achieve a yield target, and the N supply from naturally occurring (indigenous) sources, which include the soil, organic amendments, crop residue, manure, and irrigation water. This deficit in N that must be filled by fertilizer N is directly related to the estimated yield response to fertilizer N, which is the difference between a yield target and yield without fertilizer N—referred to as the N-limited yield.

Yield response to fertilizer N = Yield target – N-limited yield

Only a fraction of fertilizer N applied to rice is taken up by the crop. Hence, the total amount of fertilizer N required for each ton of grain yield increase depends on the efficiency of fertilizer N use by rice (AE_N), which is defined as the increase in yield per unit of fertilizer N applied. An AE_N of 18 or 20 is typically achievable with SSNM and good crop management in farmers' fields. In high-yielding seasons with favorable climate, an AE_N of 25 is often achievable with good crop management. Guidelines in estimating fertilizer N required by rice based on grain yield response to fertilizer N and the agronomic efficiency of fertilizer N use (AE_N) are shown in the table below.

Agronomic efficiency (kg grain increase kg^{-1} applied N) →	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

Formulating a dynamic N management to distribute fertilizer N

The required fertilizer N is divided into several doses during the growing season to ensure that N supply matches the crop need at critical growth stages. In the SSNM approach, fertilizers are applied using the following principles:

1. Apply only a moderate amount of fertilizer N to young rice (typically within 14 days after transplanting or 21 days after sowing),when the growth and need of the plant for supplemental N is small.
2. Reduce or eliminate this early application of fertilizer N when high-quality organic materials and composts are applied or the soil N-supplying capacity is high.
3. Dynamically manage fertilizer N to ensure sufficient N supply to the crop at the critical growth stages of mid-tillering and panicle initiation.
4. Apply fertilizer N based on the plant's need for supplemental N, as determined by leaf N status with the leaf color chart (LCC).

Using the Leaf Color Chart (LCC) for Fertilizer N Management in Rice

The leaf color chart (LCC) is a plastic, ruler-shaped strip containing four panels that range in color from yellowish green to dark green. It is an easy-to-use and inexpensive diagnostic tool for monitoring the relative greenness of a rice leaf as an indicator of the plant N status.

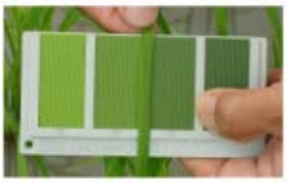
Leaf N status of rice is closely related to photosynthetic rate and biomass production, and it is a sensitive indicator of changes in crop N demand within a growing season. The LCC can be used to rapidly assess leaf N status and thereby guide the application of fertilizer N to maintain an optimal leaf N content, which can be vital for achieving high rice yield with effective N management.

The LCC is used to monitor leaf N status from tillering to panicle initiation or later, by either of two equally effective options. The decision on which option to use can be based on farmers' preferences and location-specific factors, such as frequency of visits by farmers to their fields and their knowledge of critical growth stages for N application. The fixed-time/adjustable-dose option saves time, and is thus preferred by farmers who have gainful alternative activities. The real-time option is generally preferred when farmers lack sufficient understanding of the critical stages for optimal timing of fertilizer N.

Fixed time / adjustable-dose N management option

With this option, farmers measure leaf color before applying N at active tillering and panicle initiation. If mean leaf color is intermediate between 3 and 4, apply a standard baseline dose of fertilizer N, which is a fraction of the estimated total fertilizer N required in years with average crop-growing conditions. If the mean leaf color is higher (for example ≥4), apply less fertilizer N than the baseline. If the mean leaf color is lower (for example ≤3), apply more fertilizer N than the baseline. Such adjustments in N doses at active tillering and panicle initiation ensure application of more N in fields and years with high plant demand for N, and application of less N in fields and years with low demand for N.

Apply high N dose



Apply baseline N dose

Apply little or no N

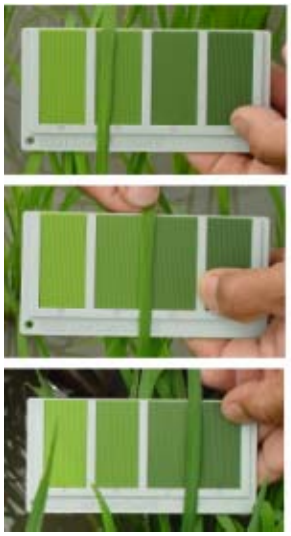
Real-time N management option

With this option, farmers monitor the rice leaf color at 7- to 10-day intervals from tillering to about 5–10 days after panicle initiation for inbred rice, and up to heading for hybrid rice and large panicle-type rice. Farmers apply fertilizer N whenever the leaves become more yellowish-green than a critical threshold value indicated on the LCC. The dose of fertilizer N

is a fraction of the estimated total fertilizer N required in years with average crop-growing conditions.

Leaf color is typically monitored a total of four to five times for inbred rice and five to six times for hybrid rice. The effective use of real-time N management requires the selection of an N dose and a critical threshold LCC color that ensure 2−3 N applications in an average yielding field or year. In fields and years with above average growth and crop N demand, rice leaves will turn yellow more rapidly, resulting in more N applications and hence more fertilizer N use. In fields and years with below average growth and crop N demand, the rice will require less N and leaves will remain greener longer, resulting in fewer N applications and less fertilizer N use.

The critical threshold value can be adjusted for cultivars and crop establishment method. Thresholds for cultivars with inherently yellowish leaves should be more yellowish green than for cultivars with inherently dark green leaves.



How to use the LCC

1. Randomly select at least 10 disease-free rice plants or hills in a field with uniform plant population.
2. Select the topmost fully expanded leaf from each hill or plant. Place the middle part of the leaf on a chart and compare the leaf color with the color panels of the LCC. Do not detach or destroy the leaf.
3. Measure the leaf color under the shade of your body (direct sunlight affects leaf color readings). If possible, the same person should take LCC readings at the same time of the day every time.
4. Determine the average LCC reading for the selected leaves.

For more information

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