

A Nutrient Decision Support System Software for Irrigated Rice

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The Nutrient Decision Support System (NuDSS) for irrigated rice is part of an initiative by the Irrigated Rice Research Consortium to provide decision support on site-specific nutrient management (SSNM) in the irrigated lowlands. The software, consistent with earlier publications on SSNM, includes a handbook and practical guide.

In irrigated rice, SSNM is a plant-based approach for estimating fertilizer nitrogen (N), phosphorus (P), and potassium (K) requirements. Key principles include: identification of a suitable yield target considering the yield potential; estimation of indigenous nutrient supplies using a nutrient omission approach (nutrient-limited yield); estimation of nutrient requirements based on an expected yield gain; dynamic field-specific application of fertilizer N during the growing season, including the use of a leaf color chart (LCC); and selection of P_2O_5 and K_2O rates sufficient to overcome deficiencies and avoid soil nutrient depletion. The SSNM concept has been developed and successfully tested in key irrigated rice domains of Asia and further evolved into strategies for wider-scale delivery (Fairhurst and Witt 2002; Dobermann et al., 2004; Buresh et al., 2005). SSNM in intensive rice farming is now promoted in about 20 locations in tropical and sub-tropical Asia.

This article presents the general framework for the development of SSNM recommendations and associated modules for decision support in the NuDSS software. The software adds value to existing print materials on SSNM by combining various models into one user-friendly package to assist in development of improved fertilizer strategies that aim at effective fertilizer use, high and sustainable yields, and increased farmer profit. It was developed recognizing the need for decision aids providing assistance in complex mathematical calculations that would be difficult to perform otherwise.

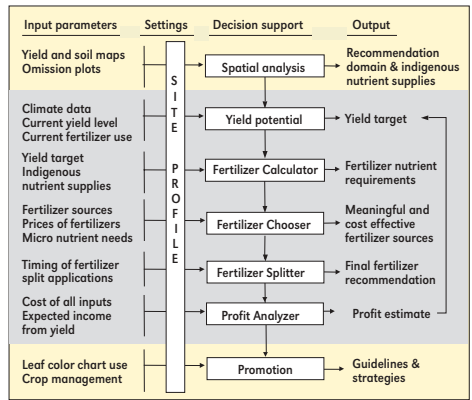
Based on the general framework for decision support depicted in **Figure 1**, the development of improved fertilizer recommendations may include five major steps with the following outputs.

Estimate recommendation domains and indigenous nutrient supplies. Larger areas are divided into smaller recommendation domains, which determine the required number of nutrient omission plots used to obtain average N, P, and K-limited yields (estimates of indigenous nutrient supplies) valid for the domain (Dobermann et al., 2003).

Select a yield target. Season-specific yield targets are set to be about 10% greater than currently achieved in farmer fields, but not more than 80 to 85% of the yield potential (Fairhurst and Witt, 2002).

Calculate fertilizer nutrient requirements. Calculations are based on expected fertilizer nutrient requirements of 40 to 50 kg N, 20 kg P_2O_5 , and 30 kg K_2O /ton required yield increase. Requirements for P

Figure 1. Flow chart of the NuDSS for irrigated rice. The gray area portrays the software modules available in the NuDSS software.



and K are adjusted using an input-output balance to prevent soil nutrient depletion due to removal with grain and straw (Fairhurst and Witt, 2002).

Select meaningful fertilizer material. Fertilizer rates of elemental nutrients (kg/ha) are expressed in nutrient sources per local area unit to facilitate wider-scale promotion.

Obtain profit estimate. The existing practice is compared with the newly developed alternative nutrient management strategy to estimate expected profit increase (ex-ante analysis). Fertilizer strategies are adjusted depending on the outcome of the economic analysis.

Simple guidelines and strategies for promotion. Where farmer fertilizer use is inadequate, it may be most effective and economic to develop, evaluate, and locally adapt improved fertilizer recommendations through farmer participation and then promote new guidelines in suitably large areas including guidelines for further adjustments. The NuDSS software aims to facilitate this process.

The NuDSS Software

NuDSS is a generic decision support system for irrigated rice capturing the most important cropping conditions in tropical and sub-tropical Asia. The underlying principles of plant nutrition are valid for all modern, high-yielding rice varieties with a harvest index of about 0.50 kg/kg. Crop- and site-specific conditions are specified in a general settings menu, including guidelines for local adaptation when conditions divert from the standard situations. The software has a built-in database for information such as default values for fertilizer sources, nutrient concentrations, and prices. NuDSS provides the option for printing user-customized reports and includes four major modules that correspond with the steps of the decision support framework (Figure 1).

Using NuDSS involves the following basic steps.

Settings. Select or add a Country Profile. Enter conversion factors for local currency, weight, area, and application units. Select or add available inorganic and organic fertilizer sources including cost and nutrient concentrations of each source. In the Crop Profile, select the cropping system and agronomic efficiencies.

Fertilizer Calculator. Specify or calculate the yield potential using the model developed by Sheehy et al. (2004). Calculate fertilizer requirements by specifying yield target, indigenous nutrient supply (N, P, and K-limited yield), and inputs of straw or other organic nutrient sources. Enter values for the farmers' fertilizer practice for comparison. The data entry mask of the Fertilizer Calculator is shown in Figure 2.

Fertilizer Chooser. Select all or specific fertilizer sources of interest. Or enter minimum amounts of a fertilizer source that must be applied. Run a solver routine to identify the least costly combination of selected fertilizer sources that matches the target recommendation rates. Evaluate different options with fertilizer sources.



Figure 2. The NuDSS software module for calculating fertilizer N, P₂O₅, and K₂O rates.

Fertilizer Splitter. Define or select a pre-defined splitting pattern for application suitable for the specific cropping season. Choose the fertilizer source that will provide needed nutrients.

Profit Analyzer. Enter paddy farm gate price, and costs for fertilizer, materials, labor, and other costs. View results of the gross margin analysis, distribution of cost centers, and the differences in costs and net profit between farmers' practice and the improved practice (SSNM).

The primary target audiences of NuDSS are intermediary technology transfer agents, i.e. extension staff, members of cooperatives or NGOs, and private sector agronomists engaged in the development and validation of fertilizer strategies tailored to local conditions and farmers' needs. Integrating agronomic and economic aspects of nutrient management make NuDSS a powerful tool in teaching and research.

The software, a tutorial, and background information on the principles of site-specific nutrient management are available free of charge for download at the websites of the Southeast Asia Program of PPI/PPIC-IPI >www.seap.sg< and the International Rice Research Institute (IRRI) ><http://www.irri.org/science/software><. **BC**

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Acknowledgments
The research was supported by IRRI, the Swiss Agency for Development and Cooperation (SDC), the International Fertilizer Industry Association (IFA), PPI/PPIC, and the International Potash Institute (IPI).

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