

Site Specific Nutrient Management: The Soil Manager

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SUMMARY

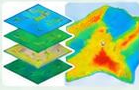
Site-Specific Nutrient Management (SSNM) is a scientific, field-specific approach that synchronizes nutrient supply with crop demand, soil fertility and yield targets. By integrating soil testing, STCR, LCC, SPAD, GIS, remote sensing and decision-support tools such as Nutrient Expert and Rice Crop Manager, SSNM enables balanced and timely fertilizer application. Compared with conventional practices, it improves nutrient-use efficiency, crop productivity and fertilizer profitability while minimizing nutrient losses and environmental impacts. Integrating these technologies with Agriculture Department extension services, KVKs, soil-testing laboratories and digital advisory platforms can strengthen farmer awareness and access to customized recommendations, promoting economically viable and environmentally sustainable nutrient management.

INTRODUCTION

Site-Specific Nutrient Management (SSNM) is a dynamic and field-specific approach to nutrient management that synchronizes the supply of nutrients with crop demand, while accounting for indigenous soil nutrient supply, crop yield requirements and nutrient-use efficiency, thereby improving productivity and minimizing nutrient losses.

Tools and Approaches in Site-Specific Nutrient Management (SSNM)

Site-Specific Nutrient Management (SSNM) uses a range of tools and approaches to assess soil and crop conditions, identify variability and provide field-specific nutrient recommendations for better productivity and sustainability.

Tool/Approach	What it does	Main purpose in SSNM
 Soil testing	Measures available nutrients such as N, P and K, along with pH, EC and other soil properties.	Determines the indigenous nutrient-supplying capacity of the soil and helps adjust fertilizer requirements.
 STCR	Uses soil-test values, crop nutrient requirements and experimentally developed fertilizer-response equations to calculate fertilizer doses for a specified yield target.	Provides a scientifically calculated crop- and soil-specific fertilizer recommendation.
 Leaf Colour Chart (LCC)	A simple plastic chart with different shades of green used to compare rice leaf colour with standard colour strips.	Helps decide when nitrogen fertilizer is required, thereby avoiding unnecessary N application.
 SPAD chlorophyll meter	Measures leaf greenness/ chlorophyll content electronically and provides a numerical SPAD value.	Used to monitor plant N status and guide N application according to crop demand.
 GIS	Integrates and maps spatial information such as soil fertility, yield and field characteristics.	Identifies spatial variability within fields and supports site-specific nutrient recommendations.
 Remote sensing	Uses satellite, drone or other sensor data to detect crop vigour, vegetation indices and spatial variation.	Helps identify nutrient stress and variability in crop growth over large areas.
 Nutrient Expert (NE®)	A decision-support software developed to generate fertilizer recommendations using information on crop, soil, previous management, yield potential and fertilizer practices.	Provides field-specific N, P and K recommendations, particularly where detailed soil testing is unavailable.
 Rice Crop Manager (RCM)	A web/mobile-based decision-support system developed specifically for rice that generates recommendations based on farmer and field information, crop establishment, variety, yield target and nutrient management.	Provides field- and season-specific recommendations for fertilizer rate, timing and management in rice.

Site-Specific Nutrient Management (SSNM) was developed during the 1990s through research led by Achim Dobermann, Roland J. Buresh, Christian Witt and other scientists at the International Rice Research Institute (IRRI), in collaboration with national agricultural research organizations across Asia. The approach was developed in response to substantial variation among rice fields in indigenous nutrient-supplying capacity, crop nutrient demand and farmers' management practices. Dobermann and White (1998) developed the SSNM framework to manage spatial variability in indigenous N, P and K supply, seasonal variation in crop N demand, and changes in soil nutrient supply resulting from nutrient balances. Subsequently, Dobermann and his coworkers (2002) evaluated and refined SSNM across intensive rice systems in Asia, establishing it as a field-specific approach for optimizing the amount, timing and balance of fertilizer nutrients according to crop requirements and indigenous nutrient supply.

Why SSNM?

Site-Specific Nutrient Management (SSNM) is needed because nutrient-supplying capacity and crop nutrient requirements vary considerably among fields and across seasons, whereas blanket fertilizer recommendations often apply the same rates irrespective of this variability. SSNM helps synchronize nutrient supply with crop demand, improving the efficiency of applied N, P and K, maintaining soil fertility and reducing unnecessary nutrient losses. In extensive on-farm research across 179 rice sites in Asia, Dobermann and his coworkers (2002) reported that SSNM increased grain yield by an average of 7 % compared with farmers' fertilizer practices, while N-use efficiency increased by 30- 40 %. The approach also improved nutrient uptake and profitability, demonstrating its potential to increase rice productivity while using fertilizers more efficiently.

Site-Specific Nutrient Management involves field-specific nutrient recommendations based on soil fertility, crop demand and field variability. Major approaches include soil-test-based and STCR methods, which use soil nutrient status and yield targets; crop- and plant-based approaches, which synchronize fertilizer application with crop demand using tools such as LCC and SPAD; GIS and remote-sensing approaches, which identify spatial variability for precise nutrient application; and decision-support tools such as Nutrient Expert (NE®) and Rice Crop Manager (RCM). An integrated SSNM approach combines these methods to optimize the rate, source, timing and method of nutrient application, thereby improving nutrient-use efficiency and crop productivity.

How it differs from conventional fertilizer practice?

Site-Specific Nutrient Management (SSNM) differs from conventional fertilizer practice mainly in its field-specific and demand-based approach. In conventional fertilizer management, farmers often follow blanket or locally recommended fertilizer schedules, applying fertilizers according to general crop recommendations, previous experience or traditional practices rather than field-specific soil and crop requirements. Common practices include applying basal N, P and K at planting or transplanting and subsequently top-dressing nitrogen at fixed growth stages. However, several shortcomings may occur, such as imbalanced application of N, P and K, excessive or insufficient fertilizer use, incorrect timing and method of application, repeated use of the same fertilizer dose irrespective of soil fertility, and limited use of soil-test information.

In rice, excessive nitrogen application can also increase nutrient losses through volatilization, leaching and runoff, whereas inadequate P or K application may limit yield and reduce nutrient-use efficiency. These limitations highlight the need for site-specific and demand-based nutrient management such as SSNM (FAO, 2017). In contrast, SSNM considers soil nutrient-supplying capacity, crop demand, yield targets and field variability to determine the appropriate nutrient source, rate, timing and method of application. Thus, SSNM aims to improve nutrient-use efficiency, crop productivity and fertilizer profitability while minimizing nutrient losses and environmental impacts.

How it is useful to Farmers?

The integration of soil testing, STCR, LCC, SPAD, GIS, remote sensing, Nutrient Expert (NE®) and Rice Crop Manager (RCM) with the Agriculture Department can provide farmers with a practical digital and field-based fertilizer advisory system. Soil testing laboratories can provide information on soil fertility, while STCR can convert soil-test results into crop- and yield-target-based fertilizer recommendations. LCC and SPAD can help extension personnel guide farmers on the timing and need for nitrogen application based on crop N status. GIS and remote sensing can identify spatial variability in soil fertility and crop growth and help Agriculture Department officials prepare location-specific advisories. NE® and RCM can further convert information on soil, crop, variety, previous crop and management practices into field-specific fertilizer recommendations. By integrating these tools through soil-testing laboratories, Krishi Vigyan Kendras (KVKs), Agricultural Extension Centres, mobile

applications and farmer training programmes, the Agriculture Department can deliver timely, location-specific fertilizer advice, promote balanced nutrient use, reduce unnecessary fertilizer application and improve nutrient-use efficiency, productivity and farm profitability.

CONCLUSION

SSNM provides a scientific, field-specific and demand-based approach to improve fertilizer management in rice and other crops. By integrating soil testing, STCR, LCC, SPAD, GIS, remote sensing and decision-support tools such as NE® and RCM, nutrient application can be better synchronized with soil and crop requirements. This approach can improve nutrient-use efficiency, crop productivity and fertilizer profitability while reducing nutrient losses and environmental impacts. Effective integration with Agriculture Department extension services, KVKs and digital advisory platforms can make SSNM more accessible to farmers. Thus, SSNM offers a practical pathway towards balanced, efficient and sustainable nutrient management in modern agriculture.

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