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Sustainable Wheat Production through Site-Specific Nutrient Management

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The green revolution, a well-known agricultural shift, greatly increased South Asia's production of food grains. However, the agricultural industry is worn out as a result of unsustainable crop and nutrient management techniques. Crop yields stalled, factor productivity fell precipitously, and marginal farm incomes decreased in the late 1980s, creating major risks to food security, agricultural sustainability, soil health, and rural economies in the developing countries. Farmers have been forced to use more fertiliser during the past 20 years due to worries about poor soil health, decreased output, and low nutrient-use efficiency. By adjusting fertiliser inputs to crop requirements, site-specific nutrient management (SSNM) aims to improve nutrient-use efficiency. Accurate mapping and data analysis are made possible by technologies such as GIS, GPS, and remote sensing, which help make well-informed judgments on the application of nutrients based on spatial variability. India's adoption of SSNM is hindered by issues including data scarcity, insufficient technical capacity, and budgetary constraints. Building capacity, enhancing data systems, funding, streamlining regulations, bolstering extension services, farmer-to-farmer education, and governmental support are all ways to overcome challenges. SSNM implementation promotes sustainability, reduces waste, improves fertiliser use efficiency, and reduces environmental risks. To increase the efficacy of SSNM, more studies should concentrate on nutrient dynamics, soil health, and improved recommendations. SSNM provides a route to effective and ecologically responsible agricultural nutrient management.

Keywords: Crop modelling, Nutrient use efficiency, Productivity, SSNM, Sustainability

Introduction

In agricultural systems, effective nutrient management is essential to attaining sustainable food production and environmental preservation. The difficulty of feeding the world's expanding population, which is expected to reach 9.7 billion people by 2050, calls for the use of the best nutrient management techniques. India's consumption of fertiliser has increased dramatically over the last forty years, contributing significantly to the nation's ability to produce its own food grains. About 30–50% of the total crop production is attributed to nutrients. Site-specific nutrient management (SSNM) has become a viable strategy to address these issues and work toward higher production and productivity. The dynamic, field-specific management of nutrients during a certain cropping season to optimise the supply and demand of nutrients in accordance with their variations in cycling via soil-plant systems is known as site-specific nutrient management (SSNM). The implementation of site-specific nutrient management (SSNM) has become a viable strategy to solve these issues and aim for higher production and productivity. The dynamic, field-specific management of nutrients during a certain cropping season to maximise the supply and demand of nutrients in accordance with their variations in cycling via soil-plant systems is known as site-specific nutrient

management, or SSNM. Nutrient management guidelines have been produced for nearly all farmed crops based on extensive research conducted over the last 50 years. The produced guidelines specify the quantity of various nutrients needed on a hectare basis, as well as when they should be applied. These general guidelines, which mainly ignored the variation in the intrinsic fertility of the soil and other edaphic features, led to an excessive use of nutrients in certain areas while underapplying them in others. This resulted in wastage of fertilisers and low NUE.

Site-Specific Nutrient Management (SSNM)

Site-Specific Nutrient Management (SSNM) is a scientific method of managing fertiliser that applies nutrients based on the unique requirements of a given crop and area rather than adhering to standard guidelines. To get desired yields, it is dependent on balancing the soil's ability to supply nutrients with crop nutrient demand. SSNM determines the appropriate source, rate, time, and technique of fertiliser application by taking into account variables such as soil fertility state, crop growth stage, yield objective, and environmental circumstances. This method lowers fertiliser losses to the environment, boosts crop productivity and profitability, and enhances nutrient usage efficiency. SSNM encourages sustainable soil fertility management and balanced fertilisation through the use of instruments like soil tests, leaf colour charts, and decision-support systems.

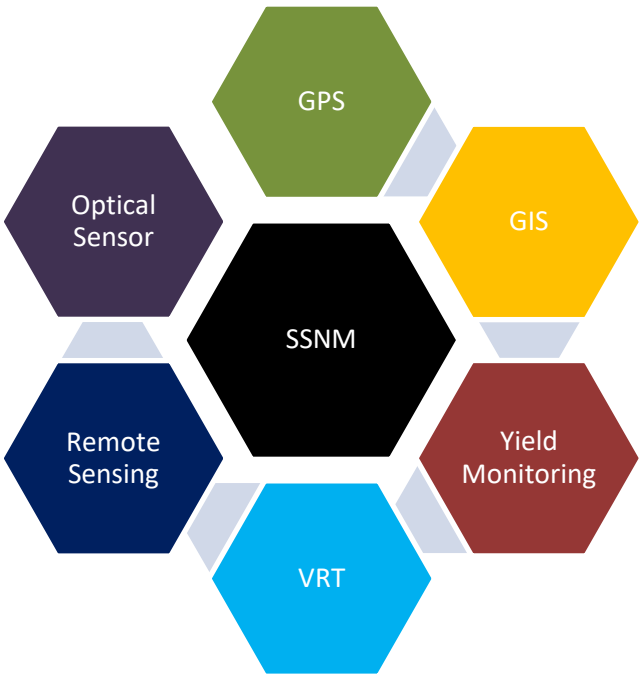

Fig.1: Site Specific Nutrient Management (SSNM)

Principles of SSNM

Site-Specific Nutrient Management (SSNM) is a term used in agricultural science to describe a method of applying fertiliser that aligns nutrient supply with crop requirements for a specific site and season. The management of nutrients, particularly N, P, and K, should be guided by SSNM principles to boost crop yields, reduce waste, and increase profitability.

The SSNM approach aims to increase farmers profit through:

- Balanced fertilisation based on crop requirements
- Plant-based estimation of nutrient supply
- Need-based nitrogen management
- Sustainable management of phosphorus (P) and potassium (K)
- Increasing profitability

Important Features of SSNM

1. Integration with other integrated crop management (ICM) techniques, such as the use of high-quality seeds, optimal plant density, integrated pest control, and effective water management.
2. Making the best use of currently available native nutrient sources, such as crop wastes and methods
3. The site and season-specific requirements of the crop are taken into consideration while applying N, P, and K fertilisers.
4. Choosing the most cost-effective mix of the available fertiliser sources.
5. Utilising the leaf colour chart guarantees that nitrogen is applied when and in the quantity required by the crop, preventing fertiliser waste.

SSNM Approaches

The indigenous nutrient supply from the soil and the crop's nutrient requirement for reaching the desired yield are the primary pillars of the relatively new nutrient recommendations approach. The SSNM recommendations could be developed based on soil-plant analysis or only plant analysis.

Impact of SSNM on Soil

Due to excessive nutrient depletion and uneven fertilizer and plant growth promoter (PGP) application, degraded soil quality is drastically lowering crop output. In India, where soil fertility is quickly decreasing as a result of an imbalance in nutrient levels, this presents a challenge to sustainable soil management. The existing indiscriminate fertilizer application methods have the potential to permanently harm the nitrogen supply system. In order to solve these issues, improved management practices (IMPs) are essential. They do this by moving away from generalised techniques and toward more complex tactics that take crop production potential and individual farm variety into account.

Components of SSNM

In crops including rice, wheat, and maize, SSNM is frequently employed to feed nutrients in accordance with crop demand at certain times and locations.

1. Evaluation of Indigenous Nutrient Supply (INS): Estimation of the nutrients that the soil naturally supplies includes:

- Indigenous Nitrogen Supply (INS)
- Indigenous Phosphorus Supply (IPS)
- Indigenous Potassium Supply (IKS)

2. Crop Nutrient Requirement: Total nutrient demand needed to achieve a target yield depends on:

- Crop species and variety
- Yield potential
- Growth duration
- Climatic conditions

3. Fertilizer Requirement Estimation: Calculation of fertiliser nutrients needed after accounting for soil nutrient supply.
4. Nutrient Use Efficiency Consideration

- Adjustment for recovery efficiency of applied nutrients.
- Important for nutrients such as nitrogen that have high losses.

5. Balanced Nutrient Application

- Proper proportion of N, P, K and secondary/micronutrients.
- Prevents nutrient imbalance and hidden deficiencies.

6. Temporal Nutrient Management

- Synchronisation of fertiliser application with crop growth stages.
- Split nitrogen application
- Basal vs. top dressing

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