

Effect of Integrated Nutrient Management on performance of Rice-Wheat cropping system and Soil Health

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<https://doi.org/10.5281/zenodo.10039767>

Abstract

Soil fertility and nutrient management is one of the key factors of crop production, which directly affects the crop yield and quality. The rice-wheat cropping system (RW) is the predominant cropping system of Indo-Gangatic plains of India. After the introduction of green revolution, the yield and productivity of rice and wheat increased tremendously with the introduction of high yielding varieties and the adoption of improved management practices but higher application rates of inputs to meet the food demands of increasing population led to the serious problem of depletion of soil health which is further causing a threat to the sustainability of RW cropping system. The major causes of the decline in productivity of continuous RW cropping system are inherently low fertility status, appearance of multiple nutrient deficiencies, and imbalanced use of synthetic fertilizers, groundwater depletion, soil salinisation and inadequate system diversity. So, improvement in soil health and quality for sustained agricultural production is very vital for food and nutritional security of India and it can be possible through integrated nutrient management i.e., integrated use of synthetic and organic manures which not only sustains the crop yield and increases the soil fertility in long term, but also enhances the nutrient use efficiency. Therefore, to maintain the soil sustainability and increase RW productivity in long term, a balanced and integrated use of organic and inorganic fertilizer is the best option.

Key words: Integrated nutrient management, organic manures, soil health, synthetic fertilizers, wheat

Introduction

Rice and wheat are the two major staple crops of India which contribute more than 70% to the total cereal production in the country, and provide food and nutritional security. According to Katyal, Sharma, and Gangua (1998) the rice and wheat (RW) system covers an area of about 23% of rice and 40% of wheat, and both crops together contribute 85% of the total cereal production. According to Singh and Sidhu (2014) it was observed that in the mid-1960s, Green Revolution technologies led to the emergence of RW as the major production system covering an area of 10 million hectares spread over the Indo-Gangatic Plains of India. It was found that about one-third of the total cereals of India are produced in this region. However, during the last few years the production as well as productivity



of rice-wheat (RW) cropping system has become more or less stagnant. The study of Sharma and Subehia, (2003) revealed that the main factor for low system productivity is inadequate and imbalanced fertilizer use to these nutrient exhaustive crops which has consequently declined the soil fertility. To sustain higher crop yields as well as maintaining soil health integrated nutrient management (INM) is one of the most important components of the agricultural production system. The study conducted by Thind *et al.* (2016) showed that Indian agriculture is facing different types of problem for decreasing crop production and deterioration of soil fertility and increasing cost of production today. Stagnation or decline in productivity of RW system is a result of inefficient nutrient management. Fertilizers play a crucial role in enhancing the production and productivity of any crop, but imbalanced use of synthetic fertilizers adversely affects the production potential and soil health. One way to cut down on their consumption would be to recycle the organic waste that is already accessible nearby, such farmyard manure, vermicompost, green manure, crop residue, sewage sludge etc along with bio-fertilizers which can be a valuable and inexpensive source of plant nutrients. However, the use of organic manures alone might not meet the crop requirement in adequate amount and suitable proportion due to presence of relatively low levels of nutrients in organic source of fertilizers. Therefore, in order to make the soil well supplied with all the plant nutrients in unavailable to available form, it is necessary to use organic manures along with inorganic fertilizers to obtain optimum yields. INM has been considered as one of the most suitable options for sustaining soil health as well as crop productivity (Kumar *et al.* 2021). Various studies revealed that judicious use of organic manures along with chemical fertilizers enhances soil physical, chemical and biological properties and also enhances crop productivity.

Concept of Integrated Nutrient Management

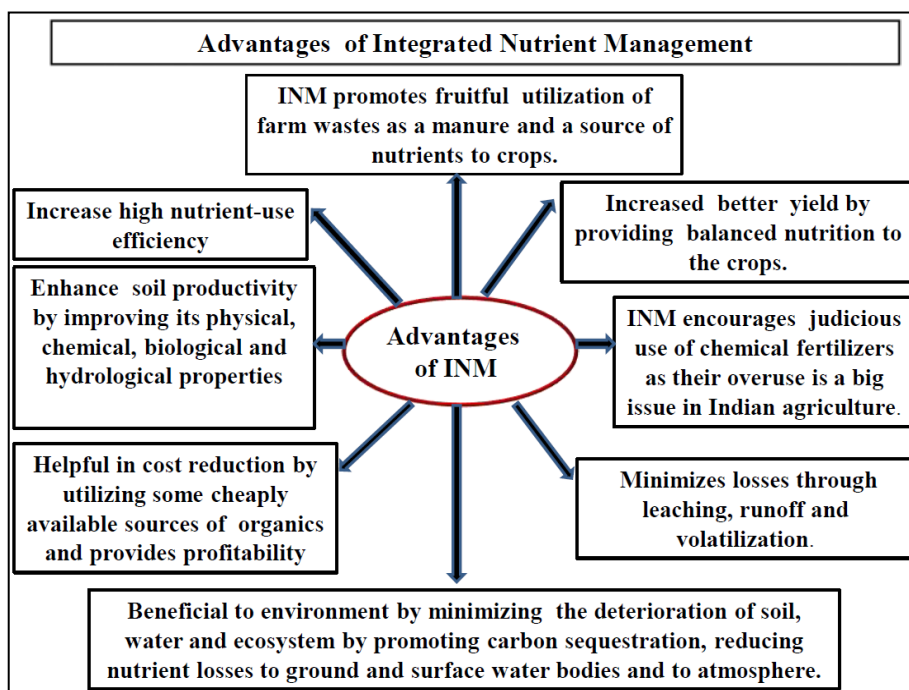
Integrated Nutrient Management (INM) refers to combining old and modern methods of nutrient management into ecologically sound and economically optimal farming system that uses the benefits from all possible sources of organic, inorganic and biological components/substances in a judicious and integrated manner (Janssen, 1993). It optimizes all aspects of nutrient cycling including N, P, K and other macro and micronutrient inputs and outputs, with the aim of synchronizing nutrient demand by the crop and its release in the environment. Under INM practices, the losses through leaching, runoff, volatilization, emissions and immobilization are minimized, while high nutrient-use efficiency is achieved (Zhang *et al.*, 2012).

Advantages of INM

The number of advantages that INM practices can bring to farmers and the environmental benefits are remarkable. Some of the advantages are given in Fig. 4.



Figure 1: Advantages of Integrated Nutrient Management



Source: Hasanain *et al.* (2020)

Objectives of INM

The objectives behind INM are to reach the eco-friendly practice through combination of organic and inorganic fertilizers for: - Decreasing the vast use of chemical fertilizers by making a balance between fertilizer inputs and crop nutrient requirement. Improving the level of yield and maintaining the soil fertility. Maximizing the profitability, reducing the environmental pollution etc.

Principles of INM

Maximizing their input by obtaining nutrients from all available sources. Maximizing the use of soil nutrients is INM's overarching goal in order to increase crop productivity and resource usage effectiveness. INM demands the fertilizer application volume and timing to be in accordance with the crop nutrient requirements in order to achieve maximum yields and enhance nutrient-use efficiency. This is done by spatially and temporally matching the soil nutrient supply with crop demand. Lowering N losses and increasing crop output.

Components of INM

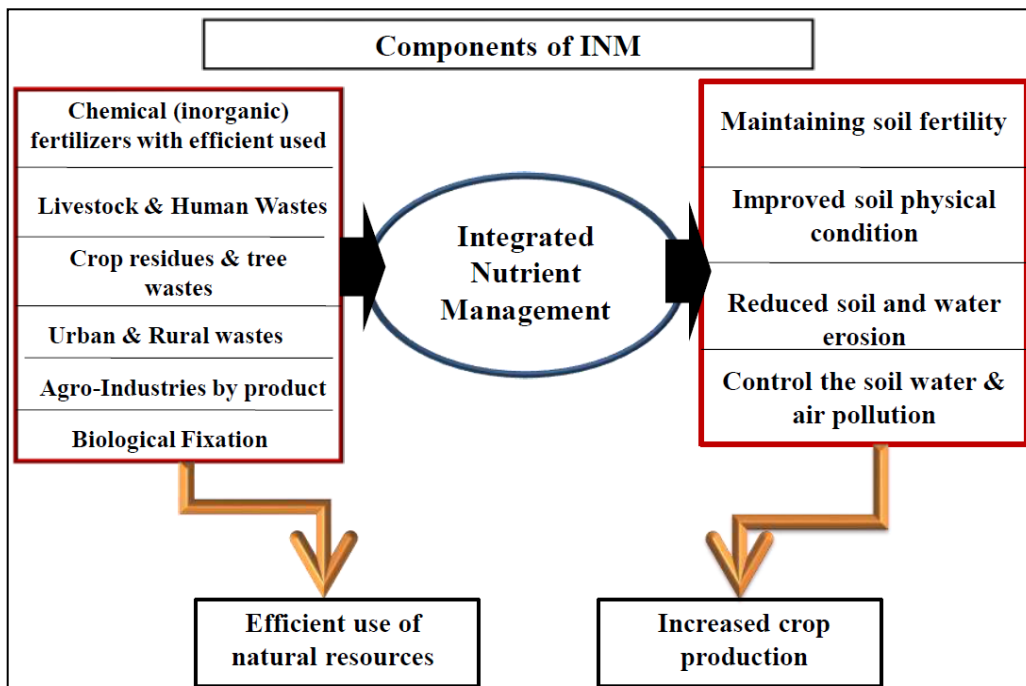
Major components of integrated nutrient management are: -

Including crops that improve soil fertility, such as green manures and legumes. Recycling of crop residues. Use of organic manures like FYM, compost, vermicompost, poultry manure etc.



Utilization of biological agent. Balanced application of fertilizer nutrients in accordance with crop needs and desired yields.

Figure 2: Components of INM and their role in soil productivity



Source: Hasanain *et al.* (2020)

Recent progress in INM technology

With the successful adaptation of INM in India, it has contributed significantly in enhancing crop yield ranging from 8 to 150% in comparison with conventional practice. It has also increased water use efficiency and water-holding capacity in a rice–wheat system (Sharma *et al.*, 2001). The economic return to farmers by adaptation of INM is definitely positive as suggested by Sarwar *et al.* (2021). Results of Singh and Saini (2021) and Bharali *et al.* (2017)) indicate that INM has the potential to improve organic carbon, soil enzymes activities, microbial biomass carbon and bacterial populations. These changes in turn enlarge the nutrient pool of available N, P and K for plants' growth.

Conclusion

In the current agricultural scenario, improving crop output without compromising soil health depends on the application of balanced nutrients. Therefore, from environmental concern, there is need to supplement a part of chemical fertilizers with locally available organics and it can only be possible through integrated use of organic and inorganic fertilizers. Cultivation of crops based on INM system

by the application of organic manures with recommended dose of synthetic fertilizers not only increased yield of crop and maintains soil fertility but also generate higher net return to the farmers.

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