**Role of Integrated Nutrient Management in Sustainable Agriculture**

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**ABSTRACT**

 Green farming proved that fertilizers had been created magic and boosts yield of cereal crops (wheat and Rice). It change the way of farming. From long ago till now farmers are total depends on fertilizers and they forget the sustainable practice of farming. Due to the high alert state of increase in population, loss of soil fertility and cultivable land scarcity, urgently call to change in agronomic practices which could bring a significant effect on crop production and productivity. Integrated nutrient management (INM) nothing but the using different sources of plant nutrients combined to check nutrient depletion, maintain soil health, and crop productivity. Today’s objective of agriculture is to increasing crop production and productivity with qulity produce without damaging soil health. To overcome the issues several researchers put forth that integrated use of inorganic fertilizers, organic fertilizers, green manure, and bio-fertilizers is found effective. INM is found profitable in terms of monetary return than only use inorganic and environmental safety by reducing the dependence on inorganic chemical fertilizers. The continues use of excess fertilizer leads to damage soil health and adversely affect on environment. This issue calls to focus on Integrated Nutrient Management. INM helps to improving the soil fertility, it increase the activity of soil microorganisms and improves the soil physical, chemical and biological properties. The balanced combination of inorganic and organic fertilizer leads to improve crop productivity, optimizing crop yield, maximizing profitability and ultimately making the agriculture sustainable. INM is one of the good agricultural practices in order to maintain soil health, nutrient balance and to make the agriculture and environment more sustainable, sustain soil productivity and improve crop productivity through balanced use of synthetic fertilizers with organic fertilizer.

**Keywords:** Integrated nutrient Management, crop nutrition, nutrient management, soil health

**INTRODUCTION**

 Increasing population leads to increase demand for food and meet demand of food farmers are focused on imbalance or only use of synthetic fertilizers as they have mindset excess use of chemical leads to increase production, which cause deterioration of the soil health, it led to damage natural resources and it cause making it difficult to meet the global demand for quality food. In such developing situation complete food demand by only organic way is big task. To get around this problem, farmers have hunt to overusing specific inputs like chemical fertilizers and pesticides, which have already begun to harm the ecosystem. During the initial days of fertilizer usage, the impact of crop fertilization with inorganic fertilizers has been prominent in world agriculture ([Hossain and Singh, 2000](https://www.frontiersin.org/articles/10.3389/fsufs.2023.1173258/full%22%20%5Cl%20%22ref36)). Due to the alarming state of world population and scarcity of land, crop production and productivity should be increased in order to meet the objective zero hunger. The most important factor for increment of crop production is soil fertility management. For increasing the soil fertility, there will be high pressure for the farmers to use chemical fertilizers resulting more financial investment leading to the increase in cost of production. The integration of high yielding varieties (HYV) and chemical fertilizers increase the agricultural production and productivity, this approach fails in long run. The soil analysis from many sites clearly shows that the unbalanced use of chemical fertilizer over a long period leads to deficiency of several other micronutrients.

 All the above issued divert the mind towards integrated nutrient management. INM refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through management of all the sources of organic, inorganic and biological components in an integrated manner. Efficient use of all the nutrient sources including organic sources, recyclable wastes, mineral fertilizers and bio-fertilizers should therefore be promoted through integrated nutrient management (Roy et al., 2006). The aim of Integrated Nutrient Management (INM) is to integrate the use of natural and man-made soil nutrients to increase crop productivity and preserve soil productivity for future generations (FAO, 1995). Balanced supply of fertilizers is needed to promote the plant growth, improve the crop yields and enhance the soil fertility. The key component of the INM goal is to reach the most effective and homogeneous combination that could lead to good management and be an effective target of the fertilizers, sufficient and balanced use of their quantity and quality, and be straightforwardly up taken by plants for higher yield without jeopardizing soil native nutrients or polluting the environment. It is ultimately viable to achieve such a target through the wise application of integrated nutrient management (INM) approach, which is known as a balanced mixture of organic, inorganic, and bioorganic microorganisms in combinations in different practices (Janssen,1993).

 No single source of plant nutrients, such as chemical fertilizers, organic manures, crop residues, and bio-fertilizers, can meet the entire nutrient need of a crop in today’s intensive agriculture systems ([Mahajan and Gupta, 2009](https://www.frontiersin.org/articles/10.3389/fsufs.2023.1173258/full%22%20%5Cl%20%22ref56)). Findings of various studies ([Selim and Al-Owied, 2017](https://www.frontiersin.org/articles/10.3389/fsufs.2023.1173258/full%22%20%5Cl%20%22ref89); [Selim, 2018](https://www.frontiersin.org/articles/10.3389/fsufs.2023.1173258/full%22%20%5Cl%20%22ref88)) suggest integrated nutrient management (INM) is a tool that can offer good options and economic choices to supply macro and micronutrients of plants and also contribute to reducing the dependence on externally purchased chemical fertilizers besides protecting soil health. Physical properties related to soil structure, are greatly influenced by adding organic manures ([Das et al., 2014](https://www.frontiersin.org/articles/10.3389/fsufs.2023.1173258/full#ref20)). INM reduce the burden on synthetic fertilizer and it reduction and balanced use of fertilizer save the cost of production.

**What is Integrated Nutrient Management**

 The integrated nutrient management (INM) is an approach that seeks to increase agricultural production and safeguard the environment for future generations. The basic concept of integrated nutrient management (INM) or integrated plant nutrition management (IPNM) is the maintenance of soil health and plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all the possible sources. It involves a proper combination of chemical fertilizers, organic manures, green manures, crop residues, N 2-fixing crops (like pulses such as green gram, black gram, etc. and oilseeds such as soybean, groundnut, etc.), crop rotations and bio-fertilizers suitable to the system of land use and ecological, social and economic condition

**Component of INM:**

 **Integrated Nutrient Management**

**Crop Rotation Bio-fertilizer Organic Green Synthetic Fertilizers**

 **Manure Manuring**

**Crop Rotation**

Crop rotation is the practice of growing different crops sequentially on the same piece of land to improve soil health, optimize nutrients in the soil, and reduce pest and weed pressure.

**Advantage:**

* Increase Soil fertility
* Reduce pest, disease and weed pressure on field
* Increase crop yield and reduce the risk of crop failure
* Improved nutrient uptake by plant
* Efficient use of natural resources

**Bio-fertilizers:**

* These are biologically active inputs and contain one or more types of beneficial micro-

 organisms such as bacteria, algae or fungi.

* Every micro-organism has a specific capability and function. There are broadly seven

 types of bio-fertilizers.

**1) Blue-green algae:**

* Blue-green algae or cyanobacteria are free-living nitrogen-fixing photosynthetic algae

 that are found in wet and marshy conditions.

* Blue-green algae are so named for their colour but they may also be purple, brown or red.
* They are easily prepared on the farm but can be used only for rice cultivation when the

 field is flooded and do not survive in acidic soils.

**2) Azolla:**

* Azolla is a free-floating water fern that fixes nitrogen in association with a specific

 species of cyanobacteria.

* Azolla is a renewable bio-fertilizer and can be mass-produced on the farm like blue-green

algae. It is a good source of nitrogen and on decomposition, a source of various micronutrients as well.

* Its ability to multiply fast means it can stifle and control weeds in (flooded) rice fields.
* Azolla is also used as a green manure and a high-quality feed for cattle and poultry.

**3) Phosphate-breaking micro-organisms:**

* These are a group of bacteria and fungi e.g. VAM capable of breaking down insoluble

 phosphates to make them available to crops.

* Their importance lies in the fact that barely one third of phosphorous in the soil is

 actually available to the crop as the rest is insoluble.

**Care should be taken while using Bio-fertilizer**

* They require sufficient organic matter in the soil to be of any great benefit.
* Bio-fertilizers produced by commercial units is the issue of using micro-organisms native

 to another area or region.

**Organic Manures**

Organic manures are resulting from the animal and plant residues that contain lesser amount of plant nutrients in complex form and therefore they are applied in large quantities. When the organic manures decompose by the activity of microorganisms, the nutrients within it are released for the plant uptake. Application of organic manures in soil not only for the supply of plant nutrients but also it maintains the soil health. It is a very good alternative to the inorganic fertilizers since farmers are not able to buy the fertilizers because of their higher prices at present. There are different types of organic manures namely farmyard manure (FYM), compost, Vermicompost, poultry manures, pig manure, oil cake etc.

**Table 1. Nutrient content of different organic manures (source from Mahajan et al., 2007)**

|  |  |
| --- | --- |
| Organic Manure | Nutrient Content % |
| A. Bulk manures | N  | P2O5  | K2O |
| FYM  | 0.5  | 0.2  | 0.5 |
| Farm compost  | 0.5  | 0.15  | 0.5 |
| Poultry manure  | 3.03 | 2.63 | 1.4 |
| Vermicompost | 1 | 0.8 | 0.8 |
| B. Concentrated organic manures |
| Neem cake  | 5.22  | 1.08  | 1.48 |
| Linseed cake  | 5.56 | 1.44  | 1.28 |
| Groundnut cake  | 7.29  | 1.53  | 1.33 |
| Safflower oil cake  | 7.88  | 2.20  | 1.92 |
| Cotton oil cake  | 6.5  | 2.89  | 2.17 |
| Fish manure  | 4-9  | 3-9  | 0.3-1.5 |

**Green Manuring**

Green manures are crops grown specifically for incorporated back into the soil, either directly, or after removal and composting for building and maintaining soil fertility and structure, though they may also have other functions.

## Importance of Green Manuring

* Building soil organic matter and soil structure
* supplying nitrogen and other nutrients for a following crop
* preventing leaching of soluble nutrients from the soil
* providing ground cover to prevent damage to soil structure
* bringing crop nutrients up from lower soil profiles
* smothering weeds and preventing weed seedling growth

### Types of green manure crop

1. **Green manuring In-Situ**

 Any crop or plant (generally leguminous) grown and ploughed in situ is called green

 manuring in situ.

E.g.: Sesbania (*Sesbania speciosa*), Dhaindia (*Sesbania aculeate*), Sunhemp (*Crotolaria juncea*), Phillipesara (*Phaseolus trilobus*), Cowpea (*Vigna anguiculata*), Green gram/Mungbean (*Vigna radiata*), Black gram (*Vigna mungo*), Berseem (*Trifolium alexandrium*) etc.

1. **Green Leaf Manuring**

 Consists of gathering green biomass (tender leaves and twigs) from nearby location

 (bunds, field boundaries) and adding it to the soil.

E.g.: *Cassia auriculata*, Neem (*Azadiracta indica*), Glyricidia (*Glyricidia maculate*), *Leucaena leucocephala*, *Cassia tora*, *Tephrosia purpurea*, *Vitex nigundo*, Karanj (*Pongamia glabra*), Calotropis (*Calotropis gigantea*) etc,.

**Synthetic Fertilizers**

 Fertilizers are an important tool or key input for increased agricultural production in modern era. It is because they are the major contributors for enhancing crop production and maintaining soil productivity. Some of the advantages of chemical fertilizers include: They are easy and quick sources of plant nutrients, contain nutrients in higher and definite concentrations compared to other sources, use of balanced fertilization, however, based on soil test recommendations increases the fertilizer use efficiency and pays back to the farmer more profit per rupee invested, chemical fertilizers are less bulky in nature and can be easily transported and time and labor costs can be saved (Mahajan and Gupta, 2009)

**Goal of INM:**

* To maintain soil productivity
* To ensure productive and sustainable agriculture.
* To reduce expenditure on costs of purchased inputs by using farm manure and crop residues etc. To utilize the potential benefit of green manure, leguminous crops and bio fertilizers.
* To prevent degradation of environment
* To meet the social and economical aspiration of the farmers without harming the natural resource base of agricultural production.

**Constrain in adapting INM**

* Limited Availability and Accessibility of Inputs
* Difficulties growing green manure crops.
* Time and Labor Intensive
* Lack of knowledge and poor advisory services.
* Complex process

## CONCLUSION

##  During the last two decades, to achieve food security with declining land and other resources, INM practice is gradually being abandoned, and nutrient management is being shifted to over-reliance on chemical fertilizers. It is a well-known fact that, agriculture mainly depends on soil. The nutrient status of the soil is the main factor determining the production and productivity of the cro. Therefore, situation calling to adopt the Integrated nutrient management practice , as it holds great promise in meeting the growing nutrient demands of intensive agriculture. It can also help in maintaining production sustainability without deterioration in quality of plants environment. It play great role in sustainable agriculture , i.e. use of modern practices to meet present and future food and fiber needs without in way damaging the basic resources such as soil and water for future use. To fill the quality food in consumer basket with meet demand of food for increasing population and save the environment INM is best way to sustain by sustainable agriculture.

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