Harmonizing Growth: The Art of Integrated Nutrient Management

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Introduction

Degradation of soil health is a major concern nowadays and it is due to decline in the level of organic carbon, inadequate use of chemical fertilizers and nutritional imbalance (P, K, S, Fe, Zn, Mn, Cu). These factors are responsible for the stagnation in agricultural production. The best way to prevent soil degradation is to use organic sources which reduce the loss of soil organic carbon. Incorporation of organic matter before and after the harvest of crops will maintain the soil health and improve chemical (EC, pH, buffer capacity), physical (soil structure, density, porosity) and biological properties (microbial flora and fauna) of soil, specifically in marginal soils which have low nutrient content, low availability of nutrients and very low productivity. Chemical fertilizers are quickly lost in soil due to leaching, runoff, and volatilization while organic fertilizers have a longer residual effect on subsequent crops due to slow release of nutrients in soil. Although chemical fertilizers are lost in soil, they have a greater impact on crop yield and productivity in comparison to organic fertilizers which have low impact on crop yield. As the population is increasing day by day demand for food is proportionately increasing. To resolve these concerns INM (Integrated nutrient management) plays a major role in addressing these challenges.

Integrated nutrient management (INM)

INM refers to practices of using available plant nutrients, adequate use of chemical fertilizers in conjunction with organic matter, bio-fertilizers, crop rotation, intercropping and green manures in a proportionate manner for maintaining high yields without affecting the soil health and quality. The increase in productivity is the mutual effect of these components. In addition to this it also improves soil physical, chemical and biological properties. INM is beneficial for small and marginal farmers who cannot afford synthetic fertilizers due to their high cost. It combines the traditional practices and improved economic technologies to minimize the use of chemical fertilizer while increasing nutrient efficiency and it is the most appropriate approach to maintain soil fertility, health and quality in the long term.

Concept of INM

INM is the integration of new and old technologies of nutrient management to form an optimal and ecologically sound farming system that utilizes inputs from all possible organic sources, inorganic and biological substances in an adequate and efficient manner. It enhances nutrient cycling (N, P, K and micro-nutrients) with the objective of increasing the availability of nutrients in the soil. INM primarily focuses on the reduction of nutrient loss through leaching, volatilization, immobilization and runoffs while increasing the nutrient use efficiency.

1. Loss of soil productivity is a more significant concern than loss of soil itself, though land degradation should be prevented before it occurs, instead of curing it afterward – i.e., the focus of INM should be on increasing the productivity potential of soil.
2. Plant nutrient management and soil management cannot be dealt with in isolation but should be treated as an integral part of farming systems.
3. To restore and maintain soil productivity (moisture retention, improve soil structure, increase nutrient level and erosion resistance) improved organic matter practices should be adopted.
4. The orientation, planning and implementation of INM should be bottom-up rather than top-down, with complete involvement of farmers and local people.
5. Inclusion of legumes in the cropping system to encourage nitrogen fixation and crop rotations as grain, forage or green manure.

Components of INM

Elements of INM are broadly classified into three major groups-

1. Organic manure
2. Biofertilizer
3. Inorganic fertilizers

Organic manure

Organic manure is obtained from plant, animal and human residue that contains plant nutrients in complex organic form. Organic sources such as – farm

waste, animal waste, night soil, slaughterhouse waste, poultry house waste, litter and by-products of agro-industries. These manures improve soil water holding capacity, enhance drainage in soil and increase nutrient availability.

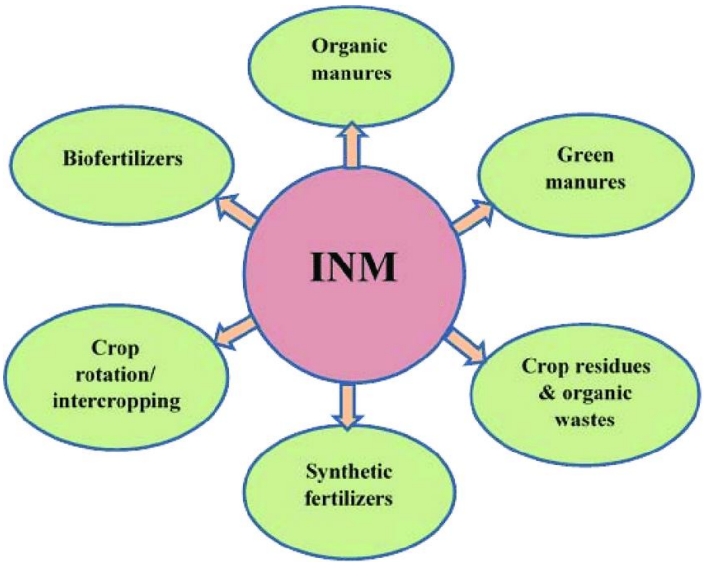

Fig. 1: Components of INM

Classification of organic manure –

1. **Bulky organic manure –**
   a) FYM – Cattle manure, Sheep manure, Poultry manure.
   b) Compost – Farm compost, Town compost.
   c) Sewage and Sludge
2. **Concentrated organic manure –**
   a) Oil cakes –
      i. Edible oil cakes – Mustard cake, Groundnut cake, Sesame cake, Linseed cake.
      ii. Nonedible cakes – Castor cake, Neem cake, Sunflower cake.
   b) Slaughter house wastes – Blood meal, Bone meal.
3. **Green manure –** Practice of growing succulent and leafy legume/non-legume, short duration crops and incorporating them into same field at flowering stage (because after that fiber content in crop increases due to which it takes more time for decomposition). Green manure crops prevent nutrient leaching, check weed growth, improves nutrient supply and enhance nitrogen fixation. Green manuring classified into –
   1. In-situ incorporation
   2. Ex-situ incorporation
      a. Leguminous plant – Sun hemp, Sesbania, Cowpea.
      b. Non- leguminous plant – Maize, Sunflower
      c. Green leaf manure – Leaf and twigs of Neem, Glyricidia.

Biofertilizers

These are the substances that contain living microorganisms and have ability to mobilize nutrients, promote plant growth and increases soil fertility. Classification of biofertilizers –

a. Nitrogen fixing biofertilizers – Rhizobium, Azospirillum, Azotobacter, Blue green algae
b. Phosphorus solubilizing bacteria – *Pseudomonas striata*, *Bacillus polymixa*, Aspergillus, Penicillium.

Inorganic fertilizer

Industrially manufactured chemical substances that contain plant nutrients and having high analytical value.

Classification of inorganic fertilizer-

a. Nitrogenous fertilizer – Ammonium sulphate, Ammonium chloride, Ammonium nitrate, Sodium nitrate, Calcium nitrate, Potassium nitrate, Urea, CAN, Anhydrous ammonia.
b. Phosphate fertilizer – SSP, DSP, TSP, DAP, MAP, Rock phosphate, Basic slag.
c. Potassic fertilizer – Potassium nitrate, Murate of potash.

Advantages

1. **Increasing soil fertility and productivity:** INM improves soil quality and production in sustainable way by increasing soil productivity and soil health. When soil is fertile, it can store, recycle and supply nutrient to plants. In addition to this soil fertility also depends on soil microorganisms (earthworm and bacteria), clay amount and type, biological and chemical properties.
2. **Environmental quality:** INM addresses environmental consideration by adjusting nutrient application according to crop need and soil conditions in order to avoid excessive applications (increases potential loss to water and atmosphere) and insufficient applications that causes degradation of soil fertility. INM is characterized by reduction in the amount of chemical fertilizer by combination of chemical and organic fertilizers. Emission of greenhouse gases (nitric oxides and nitrous) is reduced by INM practices, inadequate application of nitrogenous fertilizer increases leaching of nitrates and significant effects on soil flora and fauna biodiversity.

3. **Yield quality:** Neither chemical nor organic fertilizers can increase crop yield individually to a significant level. Due to excessive application of chemical fertilizers yield of crops has reached a plateau and with the sole application of organic fertilizers significant increment in yield is not possible. Integrated use of chemical and organic fertilizers increases the yield potential, maintains soil physical and biological properties.
4. **Nutrient availability:** Continue and imbalanced use of chemical fertilizers resulted in deficiencies of several macro and micro nutrient which become major constraints in stability, productivity and sustainability of soil health. Therefore, INM plays a major role in integration of traditional and new practices to decrease the nutrient losses, increases their availability in soil and to fully utilize the nutrient available in organic waste.
5. **Soil properties:** In addition to supply plant nutrients to soil, inorganic and organic in conjunction with biofertilizers improves the aggregate stability, soil organic carbon (SOC), moisture-retention capacity, cation-exchange capacity, bulk density and aeration. INM plays an important role in improving physio-chemical properties (water infiltration, water holding capacity and soil field capacity) which consequently improves the water use efficiency and economic use of water that leads to water conservation without impairing the crop productivity.

Constraints

Delay in adoption of new technologies is primarily due to low efficiency of agricultural extension services in rural areas. Lack of proper trainings and low literacy rate of farmers in developing countries is the major constraint for extension of nutrient management programs. Although most of the farmers did not know about rate of fertilizer application, method of application to target the satisfactory crop yield. Proper training programs in rural area about adoption of new agricultural technologies, introduction and improvement of education (formal and informal) will be a turning point in rural extension services.

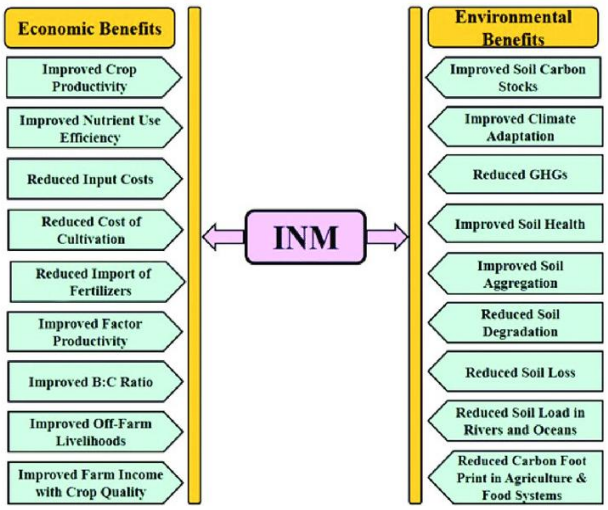

Fig. 2: Benefits of INM

Constraints faced by farmers

1. Non availability of FYM.
2. Lack of awareness about biofertilizers and green manure crops.
3. Poor and marginal soil conditions.
4. Lack of improved varieties.
5. High price of chemical fertilizers.
6. Difficulties in growing green manure crops.
7. Non availability of good quality water.

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