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CONCEPT: INTEGRATED NUTRIENT MANAGEMENT

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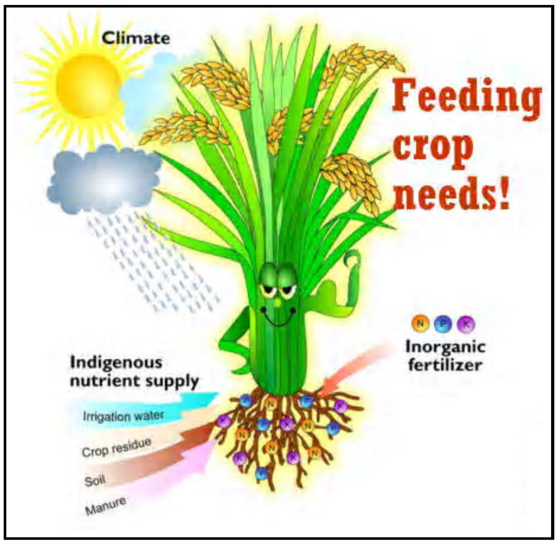
In achieving self sufficiency in food production in India, fertilizers have played key role and about 40 per cent increase in food production is credited to it. Modern agriculture largely depends on the use of high cost inputs such as chemical fertilizers, pesticides, herbicides, improved seeds, assured irrigation, scientific management and labour saving but energy intensive farm machinery. The application of such high input technologies increased the production but there is growing concern over the adverse effects of the inputs on soil productivity and environmental quality. When population pressure was low, mono-cropping was a rule, however with increase population various multiple cropping system have become popular.



The basic concept underlying Integrated Nutrient Management (INM) is the maintenance or adjustment of soil fertility/ productivity and of optimum plant nutrient supply for sustaining the desired level of crop productivity through optimization of the benefits from all possible sources of plant nutrients including locally available ones in an integrated manner while ensuring environmental quality. In practical term, a system of crop nutrition in which plant nutrient needs are met through a pre-planned integrated use of mineral fertilizers; organic manures/fertilizers (eg. green manures, recyclable wastes, crop residues, FYM etc.); and bio fertilizers. The appropriate combination of different sources of nutrients varies according to the system of land use and ecological, social and economic conditions at the local level. The term integrated nutrient management (INM) is also used synonymously with IPNSS and INSS.

Objectives of INM:

– To provide an ideal nutrition system for various soil plant situations.

– To build up an optimum combination of various nutrient sources for nutrient supply.

– To develop local manorial resources and increase their contribution towards nutrient supply.

– To ensure efficient use of nutrient resources.

– To avoid over exploitation of natural resources to maintain long term soil fertility and to prevent soil degradation.

– To maintain ecology.

Need of INM:

– Pollution hazards of chemical fertilizers: Continuous use of high levels of fertilizers over a prolonged period is posing a great threat to soil as well as environmental quality.

– Higher price of chemical fertilizers: The cost of production of chemical fertilizers has increased tremendously with the rise in prices of raw material and energy.

– Dramatic increase in fertilizer consumption: The gap between demand and supply of fertilizers is expected to reach 9-10 million tonnes by 2010. Therefore, there is an urgent need to harness and put to use all the available sources of plant nutrients to reduce the extent of soil mining and maintain soil productivity.

– Sustainability: Recycling of waste materials is the need of the hour to sustain environmental quality.

– Low fertilizer use efficiency: of urea 30-40 % in rice and 60-70 % in other upland crops whereas phosphorus use efficiency varying in between 15-20 %. Similarly, other nutrients have low use efficiency.

– Greater import cost of such high value fertilizers is causing a serious strain on the foreign exchange reserves of the country.

– Ever increasing population stress on higher food grain production and necessitated High Yielding Varieties which needs more nutrients to give their better response. HYV has shown declining trend with only use of chemical fertilizers due to micronutrient deficiencies and reduced use of organic manures.

– Drawback of sole use of organic manure and chemical fertilizers: The use of organic manure alone suffers from the drawback of low content of plant nutrients

Table 1 : Soil fertility status of Indian soils

Nutrients	Soil fertility status
Nitrogen	Low in 228 districts, medium in 118, high in 18 districts
Phosphorus	Low in 170 districts, medium in 184, high in 17 districts
Potassium	Low in 47 districts, medium in 192, high in 122 districts
Magnesium	Kerala, other southern states, very acid soils
Sulphur	Deficiencies scattered in 100-120 districts
Zinc	50% of 150,000 soils analyzed found deficient
Iron	On upland calcareous soils for rice, groundnut, sugarcane
Boron	Parts of Bihar, Karnataka, West Bengal

and its slow nutrient release characteristics. On the other hand, the use of chemical fertilizers alone generally provides only one nutrient needed by the plant.

– The plant nutrient deficiency of Indian soils is increasing (Table 1).

Importance of INM:

Integrated plant nutrient management has now assumed great importance firstly, because of the present negative nutrient balance (10 million tonnes per year) and secondly, neither the chemical fertilizers alone nor the organic sources exclusively can achieve the production sustainability of soils as well as crops under highly intensive cropping systems. The interactive advantages of combined use of organics and inorganics have been well documented. The IPNSS helps in restoring and sustaining soil fertility and crop productivity. It also helps in arresting the emerging deficiency of nutrient other than N, P and K, favourably, optimizing the physical, chemical and biological environment of soils and bringing economy and efficiency in fertilizers. In the intensive agriculture, importance of integrated management of nutrient resources is being magnified because of inadequate and unbalanced use of fertilizers causing negative nutrient balance, depletion of soil fertility and decline in the fertilizer use efficiency.

Components of INM:

– Soil resources
– Organic resources
– Bio-nutrient resources, and
– Mineral fertilizers

Limitations of INM:

– Availability of FYM is limited and its application is labour consuming.

– Burning of crop residues (straw) instead of

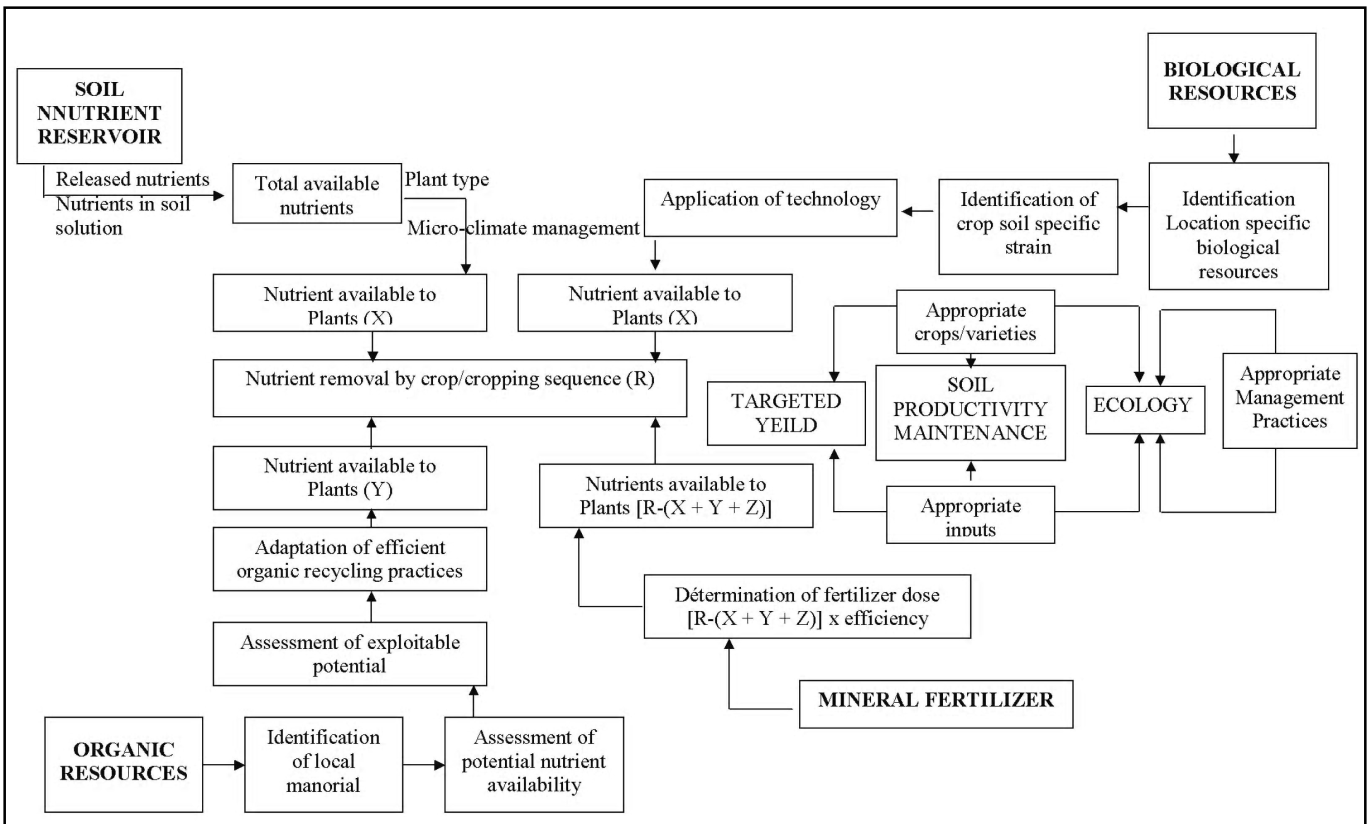


Fig. 1 : Components of integrated nutrient supply system

recycling or composting.

– Facilities to collect, store and market huge amounts of animal wastes from livestock farms are limited. Direct disposal can be harmful to the environment.

– Literature (pamphlets) on the proper use of organic manures, crop residues (straw) and bio fertilizers is not easily available.

– Rapid composting technology is still unknown to most farmers.

– Direct exposure of compost or farmyard manures to the sun, wind and rain, results in nutrient losses through leaching and volatilization.

– Lack of government support for promotion, pricing and quality control of commercial organic fertilizer.

INM in cropping system: Mono-cropping in year after year depletes rapidly the natural fertility of a given area of land due to removal of nutrients from the same depth layer of soil by crop roots. Moreover, the mono cropping (Sorghum) has also been reported to have negative allelopathic effect (Hussain and Gadoon, 1981) and autotoxicity (Batish *et al*., 2001). Therefore, cereal crop field must be rotated with other suitable crops to maximize the productivity.

Nutrient management in multiple cropping system is more efficient than in individual crop because there is a residual effects of nutrients viz. phosphatic fertilizer and organic sources of plant nutrients. Organic and inorganic sources of plant nutrients applied to preceding crop can benefit the succeeding crop to a great extent (Singh *et al*., 1998) and the system productivity may become sustainable through integrated use of organic and inorganic sources of nutrients (Singh and Yadav, 1992).

Cereal straw was found beneficial in augmenting the crop yield. Crop residues with proper technology can be exploited in crop production. Straw mulches in multi-locational trials were found effective in enhancing the productivity of many crops. The important microbial inoculants which deserve attention are Rhizobia, Azotobactor, Azolla, BGA and Phosphorous dissolving micro organisms (PSB and VAM).

Sharma and Bhardwaj (2005) reported that there would be no need to add phosphorus to the succeeding wheat crop if phosphorus enriched organics were used for maize in the previous season. They registered significant direct effect on maize grain yield with application of FYM or FYM + Eupatorium biomass (1:1) @ 10 t ha^{-1} enriched to 0.44 per cent P level through indigenous rock phosphate alongwith 25 per cent of the recommended nitrogen through urea indicating saving of 75 per cent nitrogen and 100 per cent potassium. Similarly, the highest green and dry forage yield of succeeding winter maize fodder crop has been recorded with application of 50 per cent recommended dose of fertilizer (RDF) + 10 t ha^{-1} vermicompost in preceding *kharif* rice crop which was significantly higher than respective level of RDF + 10 t/ ha FYM and statistical at par with100 per cent RDF, 75 per cent RDF + vermicompost or FYM @ 10 t ha^{-1}. This result indicated that integrated nutrient management in *Kharif* rice could produce a sizable quantity of green fodder from succeeding winter maize (Barik and Chaudhuri, 2005).

Bag *et al*. (2004) noted that the application of 75 per cent recommended dose of NPK through inorganic fertilizers and substitution of rest 25 per cent nitrogen by pelleted form of organic manure @ 0.4 t/ha through biomax was found to have better performance in both crops (rice and rapeseed) in terms of yield and yield attributing characters. Disease infestation in rapeseed can be

Table 2 : Major source of nutrients

Component	Desire effect	Undesire effect
Fertilizer	Concentrated source of one or more plant nutrients	Deficiency of secondary and micro nutrients
Organic manure (FYM)	Source of all nutrients (in small amount). Improve soil physical and biological properties	Does not meet immediate crop demand
Legumes and green manure as rotation or intercrop	Important source of nitrogen fixed from the atmosphere. Check weed growth. Lesser diseases/pest problem	Crop competition (when grown along with crop) / miss the season. Very little of N fixed is available to the rotation crop
Crop residue	Most important source of K. Mulching may improve soil physical properties, check weed growth	Immobilization of nutrients especially N. Higher dose of fertilizer may needed. Allelopathic effects
Bio fertilizers N fixer P solubilizers	N fixation Enhanced P availability	Location specific and effect of environmental factors
Factory by products	Source of all nutrients, rich in P and S. Improve soil properties	May contain wax. Higher salt content

minimized by application of neem seed powder through Neematex @ 0.8 t/ha.

In twelve years of study, Bajpai *et al.*(2006) found that substitution of 50 per cent recommended dose of N through green manure (*Sesbania aculeata*) and 50 per cent NPK through chemical fertilizer to rice and 100 per cent recommended NPK through chemical fertilizers to wheat improved the physico-chemical properties (bulk density, infilteration rate, organic carbon and available soil N and P status) of soil.

Gawai and Pawar (2006) recorded significantly higher grain and fodder yields of sorghum with application of 75 per cent recommended dose of fertilizer (RDF) + 5 t farmyard manure (FYM) per ha + bio fertilizer (Seed inoculation with Azospirillum and phosphate solubilizing bacteria (PSB) which was on par with application of 100 per cent RDF through inorganics alone, showing 25 per cent saving of nutrients. While the residual effects of application of 5 t FYM / ha + 50 per cent RDF applied to preceding sorghum and 100 per cent RDF to succeeding chickpea resulted in significantly higher grain and straw yield of chickpea.

Conclusion:

The growing demand for more agricultural productivity and the scarcity of land resources forced the farming community for intensification of farming systems. The farmers need to be educated to realize the nutrient potential of organic manures, crop residues, composts and bio fertilizers and to make them acquainted with the optimum use of locally available organic manures and bio fertilizers. The emphasis should be on increasing the proper and balanced use of mineral fertilizers supplemented with organic manure, bio fertilizers green manure and recyclable organic wastes. The most conservative estimates show that hardly 270-300 Mt of organic manures of different kinds contributing around 4 to 6 Mt of NPK are available in the country. It is unfortunate that recycling of agricultural wastes and crop residues has not received much attention in the past. The future prospects of rational utilization of these need to be explored and technologies and policies are needed to exploit their potential. The incentives and infrastructure should be developed to tap this resource both from urban and rural areas efficiently. It should, however, be appreciated that these sources are only partial substitutes for factory-produced inorganic fertilizers and can not be expected to meet the entire need for plant nutrients for high crop yields.

Research needs:

– To asses the extent and type of damage caused to soil health and environment due to continuous use of chemical fertilizers in different agro ecological situations.

– To workout the quantity, nature and extent of locally available organic manorial resources and the extent that they could replace the chemical fertilizers.

– To evaluate the returns on sustained long term basis through combinations of organic and inorganic sources in different soil types and in different crops and cropping systems.

– To develop simple and reliable techniques to measure and monitor the dynamic inter relationships amongst nutrient management systems, production and environmental capital stocks *viz.,* soil, water etc.

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