

Integrated nutrient

management practice for rainfed crops

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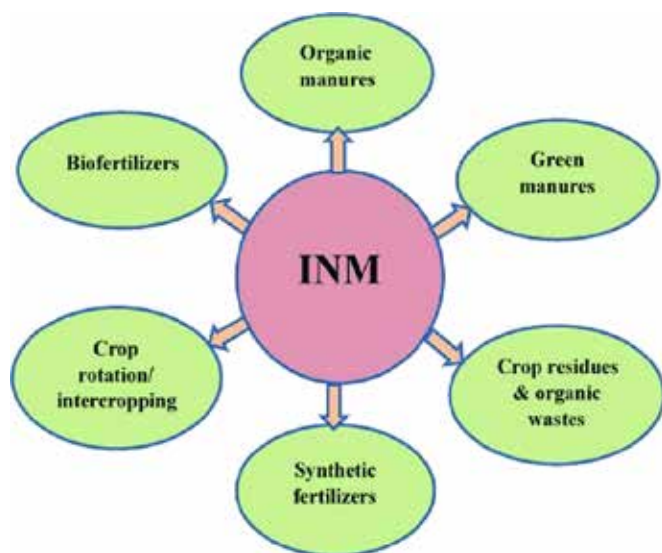
Intensive agricultural practices involving external usage of chemical fertilizers are degrading the soil health and crop productivity since post-green revolution period. Progressively affluent population and food demand is further worsening the agricultural soils for higher productivity. The total nutrient consumption at present is almost 27.29 million tonnes (MT) of N + P₂O₅ + K₂O and it is likely to increase to around 48.0 MT by 2050. Persistent decline in soil health and the quality of the environment are the major constraints coming in the way of achieving sustainability in Indian agriculture. It is therefore, pivotal to consider inclusion of organic manures, biofertilizers, crop residues, etc in cultivation to bridge the gap between nutrient added and the amount produced, thereby assuring the environmental security. Improving crop production without harming the environmental resources and mitigating climate change must be the priority in today's agriculture. Integrated nutrient management (INM) approach is an effective way to deal with low productivity and poor soils.

Keywords: Integrated nutrient management, Rainfed crops, Soil health, Soil carbon

RAINFED agriculture is complex, highly diverse and risk prone. It is characterized by low productivity, low input usage and vagaries of monsoon emanating from climate change resulting in wide variation and instability in crop yields. There is a need to enhance the productivity of rainfed areas. If managed properly, these areas have tremendous potential to contribute a larger share in food production and faster agricultural growth. The basic concept of Integrated nutrient management (INM) model is the adjustment of soil fertility and supplement of plant nutrients in an available format, optimum level in order to sustain the crop productivity and optimization of advantages of plant nutrients from all possible resources in an integrated approach. The major objectives of INM involve restoration of soil carbon content, improvement of nutrient use efficiency, soil health maintenance, minimization of chemical fertilizers and its adverse impact on the environment, ensuring increased crop productivity, and sustainable agriculture. INM is a flexible approach to reduce the use of chemical fertilizers and improve the nutrient use efficiency, sustain soil health and crop yields. Some of the suggested INM practices for major rainfed cropping

systems are presented in Table 1. The main principles in planning the integrated nutrient management strategies are:

- Adopting INM practices compatible with the local farming system, for e.g. field biological conditions (weeds, insects and diseases), soil texture, irrigation services, equipment's available and climatic conditions. In the long term, INM improves the physical, chemical and biological properties of the soil.
- Using different sources of nutrients which optimizes fertilizer input, increases the use efficiency by crops, lessens their nutrient requirements and reduces food contamination, environmental pollution and total costs.
- Applying INM practice in the root zone, where the most important processes of plant and soil occur and is a bottleneck in controlling nutrient conversions, solubility, availability and release from soil to plant roots and absorption. Fertilizers, organic manures, legumes, crop residues and biofertilizers are the main ingredients of INM.



Main ingredients of Integrated nutrient management (INM)

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Fertilizers: Fertilizers continue to be the most important ingredient of INM. The dependence on fertilizers has been increasing constantly because of the need to supply large amounts of nutrients in intensive cropping with high productivity. Domestic fertilizer production is inadequate to meet the requirements and the situation is not likely to improve in the near future. On the other hand, constraints like global price hike of fertilizers and raw materials would not permit the fertilizer import in large quantities leading to a big gap between supply and consumption. While organics and biofertilizers are expected to bridge a part of this gap, efficient use of fertilizers in narrowing the nutrient supply gap also needs greater emphasis. Utilization of fertilizer nutrients by the crops varies from 30–50% in case of N, 15–20% in case of P and less than 5% in case of micronutrients. Thus, a substantial amount of applied nutrients is lost through various pathways. The priority should be on enhancing nutrient use

efficiency, improving soil health, reducing input costs and minimizing the cost of crop production.

Organic manures: Organic manures like urban compost, farm yard manure (FYM), crop residues, human excreta, city refuse, rural compost, sewage-sludge, press mud and other agro-industrial wastes have large nutrient potential. Compost and FYM have traditionally been the most important manures for maintaining soil fertility and ensuring yield stability. Other potential organic sources of nutrients such as non-edible oil cakes and wastes from food processing industry also exist. There are several industrial by-products and municipal wastes with fair nutrient potential. Although, these nutrient carriers have not been properly evaluated to establish their fertilizer equivalents. There is a need to integrate these sources depending on their availability in different crops and cropping systems.

Legumes: Legumes have a long-standing history of being soil fertility restorers due to their ability to obtain N from the atmosphere in symbiosis with *Rhizobia*. Legumes could provide an important ingredient of INM when grown for grain or fodder in a cropping system, or when introduced for green manuring. Legumes grown as green manure, forage or grain crops improved the productivity of all cropping systems and rejuvenated the soil fertility.

Crop residues: Crop residues have several competitive uses and may not be always available as an ingredient of INM. There are large amounts of residues of crops like potato, sugarcane, vegetables, etc which are practically wasted in most cases. Although, cereal crop residues are valuable cattle feed, these could be used to supplement the fertilizers wherever available in excess of local needs. Stubbles left in the field in traditional harvesting methods range from 0.45–1.5 tonnes/ha in case of different crops. Stubbles of coarse cereals like sorghum, maize, pearl millet etc which are normally collected and burnt during land preparation cause significant loss of plant nutrients.

Table 1. Suggested INM practices for major rainfed production systems

State	Location	Crop	Suggested integrated nutrient management practices
Jharkhand	AICRPDA Centre, Chianki	Upland rice	50% N through organic source + 50% N through the inorganic source
Rajasthan	AICRPDA Centre, Arjia	Maize	-15 kg of N through FYM + 10 kg of N through subabul leaves before sowing and 30 kg of P_2O_5 /ha, 25 kg of N/ha at 30–45 DAS through 50% recommended urea through organic (FYM/compost) and remaining 50% through inorganic fertilizer and 30 kg of P_2O_5 /ha. -Seed treatment with <i>Azotobacter</i> and <i>PSB</i> or microbial consortia along with recommended dose of fertilizers. -Two sprays of 0.5% $ZnSO_4 \cdot 7H_2O$ at 40–45 DAS and 60–65 DAS (1 kg $ZnSO_4 \cdot 7H_2O$ + 0.5 kg lime mixed in 200 litres of water or two sprays of soluble NPK (19:19:19) @2% knee high and grain filling stage.
Gujarat	AICRPDA Centre, Rajkot	Groundnut	Vermicompost @1 tonnes/ha or castor cake @500 kg/ha and 6.25:12.5, N:P kg/ha through inorganic sources.
Madhya Pradesh	AICRPDA Centre, Indore	Soybean	6 tonnes FYM/ha + 75% of the recommended nutrients through fertilizers; seed inoculation with <i>Rhizobium</i> / <i>Azotobacter</i> and <i>PSB</i>
Maharashtra	AICRPDA Centre, Akola	Cotton	FYM @5–10 tonnes/ha or Glyricidia 2.55.0 tonnes/ha + 50% N + 100% P and K through inorganics + biofertilizer (<i>Azotobacter</i>) 25 g/kg seed
Uttar Pradesh	AICRPDA Centre, Agra	Pearlmillet	50% recommended dose of N (30 kg/ha) through organic + 50% of the recommended dose of N (30 kg/ha) through inorganic + 40 kg P_2O_5

Table 2. Application of biofertilizers in some important rainfed crops

Location	Crops/cropping systems	Fertilizer (kg/ha)			Biofertilizer
		N	P ₂ O ₅	K ₂ O	
Jhansi	Cluster bean	15	60	0	Inoculation with <i>Rhizobium</i>
	Sorghum + <i>Dolichos</i>	60	20	0	
Agra	Barley	60	30	0	Use of FYM + <i>Azotobacter</i>
Ranchi	Soybean	20	80	40	Inoculation with <i>Rhizobium</i>
	Groundnut	25	50	20	Inoculation with <i>Rhizobium</i>
	Pulses	20	40	0	Inoculation with <i>Rhizobium</i>
Dantiwada	Green gram	0	20	0	Inoculation with <i>Rhizobium</i>

Biofertilizers: Biofertilizers are the materials containing living or latent cells of agriculturally beneficial microorganisms that play an important role in improving soil fertility and crop productivity due to their capacity to fix atmospheric N, solubilize/mobilize P and decompose farm waste resulting in the release of plant nutrients. The extent of benefits from these microorganisms depends on their number and efficiency, which however, is governed by the soil and environmental factors (Table 2).

Integrated nutrient management in relation to macro and micronutrients

Generally, most of the major studies regarding the effect of application of macronutrients (NPK) are mainly focussed on testing the rate of application, timing of application and varietal responses. However, the effect of micronutrient application is focussed on yield and quality traits, it may also include methods of application suitable for treating the problems of micronutrient deficiency. Most of the studies suggest that application of the recommended dose of inorganic fertilizers is more important than being neglected in order to maintain the economic yield, especially in low fertile soils. Above all, imbalanced and continuous use of inorganic fertilizers may result in micronutrient deficiencies, which become major constraints for productivity and sustainability of soil health. Therefore, INM becomes one of the most principal practices, which can replace the traditional methods, decreasing the nutrient losses and their harmful effects on the environment, while maintaining higher crop yield and more profits. Considerable

attention to the success of INM is related to the selection of a combination of practices, which can provide plants with different nutrient sources in adequate amount at intervals agreeable with the plant requirements and also which plays a vital role in improving the nutrient use efficiency and can achieve higher yields. Also, INM practices may be the best way for harmonizing the utilized totality of the farm wastes that can be used as plant nutrients. Although, the combination of organic fertilizers with inorganics is considered as a stock of nutrients which can continuously supply the current crop with their requirements, they can also be considered as a scheme which has greater residual effect on subsequent crops than sole application of inorganic fertilizers, due to slow release of nutrients over time and its added value in soil organic matter content.

The role of the soil microorganisms is very important in controlling nutrient conversions, their solubility, availability, release from the soil root zone to plant roots, absorption and raising nutrient use efficiency, which can be achieved by adopting INM practices. They could also be related to decreased loss of nutrients through leaching, runoff, volatilization, emissions, and immobilization which results from increase in the soil organic matter content and improvement in soil physical and chemical properties.

Concept of INM started in late 1980s, importantly to solve the issues related to micronutrient deficiencies and deterioration of soil health. Balanced fertilization in INM approach is nothing but the application of nutrient sources in the right proportion with suitable methods specific to crop and agro-climatic situation leading to soil



Groundnut in FYM @10 tonnes/ha +100% recommended dose of fertilizer with crop rotation (Groundnut-Finger millet)



Finger millet in FYM @10 tonnes/ha +100% recommended dose of fertilizer with crop rotation (Groundnut-Finger millet)

health building and enhanced nutrient use efficiency. Organic manures play a significant role in INM package and they increase soil organic carbon (SOC) which proliferates the microbial activity in soil, help retain soil moisture longer and reduce the leaching of plant nutrients besides imparting drought tolerance during dry spells. Various sources of soil organic amendments are accessible to growers as on-farm materials, viz. crop residue, weed biomass, green manures, compost, animal bedding material, semi-waste and also off-farm wastages, viz. municipal biosolids, poultry manure, coir pith, biochar, tank silt etc.

Upscaling the INM practices

Convergence with various schemes: Government of India has initiated some important policies and programs for promoting the soil health management, which facilitated the farmers to improve their soil fertility status through some innovative technologies. National Mission for Sustainable Agriculture (NMSA), Soil Health Card (SHC), National Policy for Management of Crop Residue (NPMCR), National Biogas and Manure Management Programme (NBMMP) are some of the programmes.

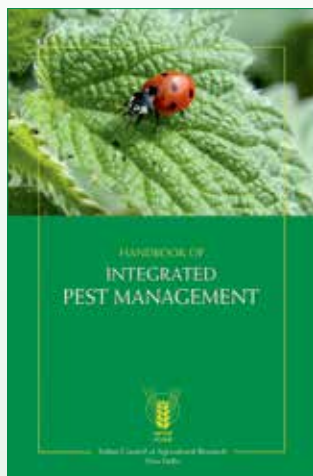
SUMMARY

Integrated nutrient management is an appropriate and eco-friendly approach in enhancing the productivity of different rainfed cropping systems. It was found that the effect of biofertilizers along with organic and inorganic sources of nutrients in combination was successful in different soil types further meeting the integrated nutrient demand for rainfed crops. Thus, INM is the realistic way to sustain the fertility and productivity of the soil and then increasing the crop productivity in different rainfed cropping systems. Best management practices pertaining to INM, viz. judicious use of chemical fertilizers, combined application of inorganic fertilizers with organic amendments, animal manures, site specific nutrient management (SSNM), introduction of legumes in monocropping, mulching, green manuring, conservation agriculture, crop residue recycling and biofertilizers, legume cover crops and location specific indigenous technical knowledge practices like sheep penning etc needs to be promoted and upscaled.

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HANDBOOK OF INTEGRATED PEST MANAGEMENT

To reverse the loss of environmental resources and also to reduce biodiversity loss, the Government of India has Integrated Pest Management (IPM) as part of the National Agricultural Policy. Integrated Pest Management emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. IPM is not new – mechanical, cultural and biological tactics were used by farmers for hundreds of years before chemical pesticides became available. Besides, there are IPM techniques that have been developed more recently and are effective in suppressing pests without adversely affecting the environment.



The task of spreading the message of IPM across is tough due to poor awareness about the subject among people in line-departments as also among the farmers. The information on integrated pest management as a whole is scattered. This *Handbook* comprehensively deals with all the aspects of integrated pest management in field crops, horticultural crops under traditional, protected systems. Information on basic strategies and tactics of different methods of management including mass production of biocontrol agents, IPM policy and pesticide registration is provided in comprehensive form.

The *Handbook of Integrated Pest Management* comprises 82 chapters which are well written in lucid language with crispy sentences by the renowned scientists. The role of IPM is elucidated with different pests like *Trichogramma*, *Bacillus thuringiensis*, *Nomuraea rileyi* etc. and agricultural crops like rice, wheat, maize, sorghum, pearl millet, pulses, soybean, rapeseed mustard, groundnut, minor-oilseed crops, sugarcane, cotton, jute and mesta, potato, vegetable crops, fruits, grapes, citrus, banana, pomegranate, coconut etc. This *Handbook* will provide information of available useful technologies to educate on how to reduce or judiciously use chemical pesticides, safeguard ourselves from chronic poisoning, save the National environment while also reducing input costs and raise farmers' income. This compilation will be useful to teachers, students, trainers, line-department personnel and policy makers.

TECHNICAL SPECIFICATIONS

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