

ICAR-Research Complex for Eastern Region, Patna

No-3: Integrated Nutrient Management: A Pathway to Sustainable Agriculture

In recent years, Indian agriculture has been standing at a crossroads. On one hand, the demand for food production continues to grow, while on the other, the very foundation of agriculture *i.e* Soil health is steadily deteriorating. Recognizing this challenge, the nationwide *Khet Bachao Abhiyan* implemented during 1st to 30 June 2026 is rapidly gaining momentum as a key strategy to restore soil health and ensure long-term agricultural sustainability. This has attracted renewed attention to balanced nutrient management, placing Integrated Nutrient Management (INM) at the center of sustainable farming strategies. INM is gradually emerging not just as a nuttiest recommendation, but as a necessity that improves productivity, reduces input costs, and ensures long-term sustainability.

The Changing Face of Indian Agriculture

India's agricultural success story, particularly after the Green Revolution, is well known. The introduction of high-yielding varieties (HYVs) and increased use of chemical fertilizers significantly boosted food production. However, over time, this input-intensive approach has revealed its limitations. Excessive dependence on nitrogenous fertilizers like urea, coupled with the neglect of phosphorus (including excessive DAP uea), potassium, and micronutrients, has created serious imbalances in the soil fertility. Today, many farmers are witnessing declining crop response despite applying higher doses of fertilizers. This phenomenon, often referred to as declining factor productivity, reflects the deteriorating health of soils.

The situation is further worsened by:

- Continuous cropping without nutrient replenishment
- Burning of crop residues
- Declining organic matter content
- Limited use of organic and biological inputs

As a result, soils are losing their natural fertility, structure, and biological activity.

Fertilizer Use Pattern: A Cause for Concern

Recent data highlights the growing imbalance in fertilizer use across the country. While the ideal N:P:K ratio is 4:2:1, it has widened significantly to 9.8:3.7:1, indicating excessive nitrogen application. At the same time, India's dependence on imported fertilizers continues to rise. The total nutrient consumption has reached nearly 32.93 million metric tonnes, reflecting both increased demand and growing pressure on external resources. Global price volatility and geopolitical tensions have further added to the uncertainty, directly affecting farmers through rising input costs.

Integrated Nutrient Management

INM is a holistic approach that promotes the judicious combination of chemical fertilizers, organic manures, biofertilizers, and improved agronomic practices. The core principle of INM is simple **"Feed the soil to feed the plant."** Instead of relying solely on chemical fertilizers, INM focuses on maintaining soil fertility and ensuring efficient nutrient use over the long term. When followed effectively, chemical fertilizer requirement can be reduced gradually (25% or more) over the years.

Key Components of INM

1. Balanced Use of Chemical Fertilizers

Chemical fertilizers (say Urea, DAP, MOP etc.) remain essential for meeting immediate nutrient demand. However, it should be applied as per soil testing report (Soil Health Cards) and scientific recommendations. Site-Specific Nutrient Management (SSNM) ensures precise application, reduces nutrient losses and improves fertilizer efficiency.

2. Organic manures

Organic manures play a vital role in improving soil health and sustainability. They are two types bulky (FYM, Compost etc) and concentrated (Oil cakes, bone meal etc). These inputs enhances soil organic carbon, improve water retention, and support beneficial microorganisms.

Table 1: Nutrient Composition of Common Organic Sources

Source	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Farmyard Manure	0.45–0.80	0.20–0.40	0.50–0.70
Vermicompost	1.50–2.50	1.20–1.80	1.50–2.40
Poultry Manure	1.50–3.00	0.40–0.70	1.00–1.40
Mustard Cake	5.20	1.80	1.20
Neem Cake	5.20	1.00	1.40

3. Green Manuring

Green manure crop fix the atmospheric nitrogen and enrich the soil by adding biomass and nitrogen on decomposition. Green manure crops like dhaincha is incorporated when crop is around 45 days and produced optimum tender biomass. These crops improve soil fertility naturally and reduce fertilizer requirements.

Table 2: Contribution of Green Manure Crops

Crop	Biomass (q/ha)	Nitrogen Added (kg/ha)
Sunnhemp	152	84
Dhaincha	144	77
Cowpea	108	56
Berseem	111	60

4. Biofertilizers

Biofertilizers (N or P biofertilizer) are beneficial microorganisms which enhances nutrient availability to crops and improve soil health.

Table 3: Role of Biofertilizers

Biofertilizer	Nutrient Contribution (kg N/ha)	Yield increase (%)
Rhizobium (Legumes)	25–35	10–30%
Azotobacter/Azosprillum (cereals and vegetables)	20–25	10–20%
Azolla (low land rice)	40–60	10–20%
PSB (all crops)	10–20	10–30%

5. Crop Residue Recycling

Crop residues are often seen as waste, but they are actually valuable nutrient sources. One tonne crop residues can supply 3–15 kg nitrogen, 2–7 kg phosphorus, and 3–20 kg potassium, reducing the need for external inputs and improves soil organic matter and microbial activity.

6. Agro-Industrial by-products

Industrial by-products and mined minerals serve as highly effective soil conditioners to reclaim problematic soils across India, such as using gypsum or phosphogypsum to treat alkaline soils, and lime, dolomite, or basic slag to neutralize acid soils. Furthermore, materials like rock phosphate and glauconite provide cost-effective, sustainable alternatives for supplying essential Phosphorus and Potassium. This strategic application improves overall soil structure and nutrient availability while significantly reducing reliance on expensive, imported chemical fertilizers.

7. Agronomic practices

Agronomic practices such as crop rotation, crop diversification, inclusion of legumes, mixed cropping, conservation agriculture and efficient water and nutrient management promotes soil health. Leguminous crops in cropping system naturally fix atmospheric nitrogen, contributing 40–90 kg nitrogen per hectare and enriching soil fertility.

INM Impact on Crop Productivity

Decades of long-term fertilizer experiments across various agro-ecological zones in India prove that substituting 25% to 50% of chemical fertilizers with organic and bio-nutrient sources yields either equal or even superior harvests compared to utilizing 100% chemical fertilizers alone. This clearly demonstrates that INM improves yields compared to sole chemical fertilizer use.

Table 4: Yield Improvement under INM

Cropping System	INM Strategy	Yield Increase
Rice–Wheat	75% NPK + FYM	12–18%
Maize–Soybean	50% NPK + Compost	15–22%
Sugarcane	NPK + Crop Residue Recycling	10–15%
Cotton–Pulses	NPK + Green Manure	18–25%

These improvements occur due to better soil structure, enhanced nutrient availability, and improved water retention.

Benefits INM for Farmers and Environment

- Improves soil fertility and productivity
- Enhances nutrient use efficiency
- Stabilizes crop yields
- Improves crop quality
- Reduces environmental pollution
- Increases resilience to climate change

The Government initiatives

Government initiatives such as the Soil Health Card Scheme and training through Krishi Vigyan Kendras are helping farmers adopt INM practices. However, wider adoption requires:

- Strong extension services
- Farmer awareness and training
- Promotion of on-farm organic inputs
- Increased use of quality biofertilizers
- Digital advisory support

Conclusion

The widespread adoption of INM will lead to a more resilient, profitable, and environmentally sustainable agricultural system.

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