Resource management in RAINFED DRYLANDS

An information kit

IIRR MYRADA

Integrated nutrient management for dryland agriculture

Need for integrated nutrient management (INM)

- Use of mineral (chemical) fertilisers is the surest and quickest way to increase crop production
- The high cost, unavailability and risks associated with fertilisers deter farmers from using them in recommended and balanced proportions
- INM is essential to maintain soil fertility and increase food production without harming the environment

Sources of nutrients for crop production

- Soil organic matter
- Soil reserves
- Biological nitrogen fixation (BNF)
- Organic manures
- Mineral fertilisers
- Precipitation and irrigation water

INM strategy

- The INM strategy includes maintenance or adjustment of soil fertility and plant nutrient supply to sustain the desired level of crop productivity
- INM is a holistic system approach focusing on the cropping system rather than on individual crop
- INM also focuses on the farming system rather than on individual field
- It does not preclude the use of mineral fertilisers
- It relies heavily on optimal use of renewable nutrient sources such as BNF and organic manures and minimal use of mineral fertilisers

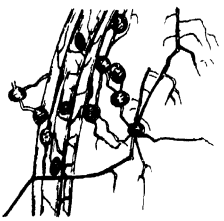
Do you know that?

- **Annual growth rate of population in India is 1.8%.**
- **Population pressure on arable land in India has doubled from 3 persons/ha in 1950 to 6 persons/ha in 1996.**
- **Plants require at least 13 elements for their growth and development.**
- **A cereal crop absorbs 35-46 kg N+P+K to produce 1 tonne of grain.**
- **A grain legume (e.g., soybean) absorbs 210 kg N+P+K to produce 1 tonne of grain.**
- **Total BNF is about 175 million tonne/year; of this, about 80% is accounted for through terrestrial fixation.**
- **Out of 17,000 legume species, only 200 are being exploited by human beings.**
- **Grain legumes fix up to 450 kg N/ha/year.**
- **All nitrogen requirements of grain legumes are not fulfilled through BNF alone.**
- **Application of 12.5 tonnes/ha farmyard manure or compost in India increases average yields of different crops by 160-200 kg/ha.**

Biological inputs for nutrient management

Biological process

- Several microorganisms in the soil decompose plant and animal residues.
- Microorganisms regulate nutrient flow in the soil by assimilating nutrients and producing soil biomass (immobilisation) and converting carbon, nitrogen, phosphorus and sulphur to mineral forms (mineralisation).
- Several groups of microorganisms are involved in important biological processes.



VAM

Beneficial microorganisms

- **Symbiotic nitrogen fixers — symbiotic partnership between bacteria (*Rhizobium/Bradyrhizobium*) and legumes contributes substantially (up to 450 kg/ha/yr) to total BNF.**
- **Non-symbiotic and associative nitrogen fixers — inoculation with bacteria (*Azotobacter and Azospirillum*) reduces N requirement of cereals or non-legume crops up to 20 kg/ha.**
- **Plant growth promoting rhizobacteria (PGPR) — these improve plant growth through hormonal effects and reduce disease severity.**
- **Phosphate solubilising microorganisms — these bacteria and fungi solubilise inorganic phosphates and make them available to plants in usable form.**
- **Vesicular-arbuscular mycorrhizae (VAM) — these help increased uptake of nutrients such as P, S, Cu, etc. and improve plant growth.**

Advantages of BNF

- **An economically-attractive and ecologically-sound process.**
- **Reduces external nitrogen inputs.**
- **Improves the quality and quantity of internal resources of nitrogen.**

BNF

- BNF is an integral part of nitrogen cycling in nature.
- *Rhizobium* inoculation is practised to ensure adequate nitrogen nutrition of legumes instead of fertiliser nitrogen.
- Efficient strains of *Rhizobium/Bradyrhizobium* supplied as inoculants are used as biofertilisers by seed or soil inoculation.

Use of biofertiliser by seed inoculation

- Different crops require different rhizobia.
- Select the right type of biofertiliser (inoculant).
- The inoculant must be fresh and within the expiry date limit.
- Use well-tested inoculants produced by reputable manufacturers.

- Users in India must insist on inoculants with ISI mark.
- Prepare inoculum slurry using a sticking agent such as jaggery, rice porridge, gum arabic, etc.
- Mix seeds with inoculum slurry by hand.
- Dry seeds on a plastic sheet kept under a shade.
- Sow seeds within 48 hours after inoculation.
- Cost of biofertilisers varies from Rs. 20 - Rs. 80 per hectare.

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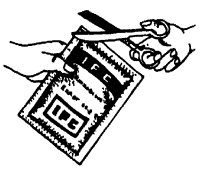

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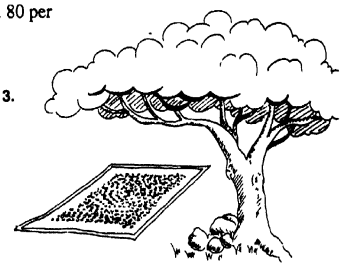

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Management practices to improve plant growth and BNF in soil

- Use high nitrogen-fixing crops/varieties.
- Practice mixed cropping and intercropping (row and strip) with legumes.
- Use appropriate tillage practices, landform treatments and nutrient amendments.

Legumes, grown in rotation or as intercrops, increase crops yields of succeeding non-legume crop by 0.5 to 3 tonnes/ha saving up to 120 kg N/ha compared to sequential cropping of non-legume crops.

Row intercropping

Strip intercropping

Advantages

- Increases biological activity in the soil.
- Reduces nitrogen losses through immobilisation.
- Improves the performance of microorganisms such as azotobacters, azosporilla, PGPR and VAM
- Improves soil fertility, soil productivity and crop productivity.

Organic inputs for nutrient management

- Addition of organic matter to the soil is essential to maintain soil fertility and productivity.
- Organic manures are of two types: **bulky** — FYM, composts (rural and town), crop residues; and **concentrated** — oilcakes, poultry manure, slaughter house waste, etc.
- FYM is the most commonly used organic manure in India, particularly for high value crops. It is prepared from animal-shed wastes and straw and contains 0.5-1.0% N, 0.05-0.07% P and 0.03-0.035% K.
- Crop residues can be recycled by composting, mulching and direct incorporation. About 240 million t yr^{-1} straw/stover is produced from rice, wheat, sorghum, pearl millet and maize.
- Based on N content, organic manures are less efficient than mineral fertilisers; however, combined use of these nutrient sources is superior than using mineral fertiliser alone.
- A combination of crop residue restitution (based on the availability), fallowing or green manuring can be used to maintain organic matter levels in the soil.

Mineral fertilisers

- India is the fourth largest fertiliser user in the world.
- Fertilisers account for less than one fourth of the nutrients absorbed by the crop.

- Use appropriate mineral fertilisers to meet the demand for necessary nutrients.
- Ensure that efficiency of applied fertilisers is optimised through adoption of suitable practices.

Fertiliser application

- Form or type — as recommended for the crop.
- Method — furrow placement and covering with soil instead of broadcasting.
- Time — Split N doses instead of one application.
- Quantity — just sufficient to meet plant demand without adversely affecting BNF.

Implementation of INM

- The knowledge available about different sources of nutrients such as BNF, organic manures and mineral fertilisers can be used to develop a suitable strategy for INM to sustain crop productivity.
- INM strategy is realistic, attractive, and environment-friendly.
- INM will enhance the efficiency of biological, organic and mineral inputs for sustaining productivity of dryland soils.

Contributor: S. P. Wani

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