Indian Journal of Fertilisers **18** (11) : 1046-1047, November, 2022

Nutrient Management Strategies in Rainfed Agro-ecosystems of India

Frank Notes

Arvind Chaudhary

Rainfed agro-ecosystem, relying entirely on rainfall for water, occupies a prominent place in Indian agriculture. Spread over 52% of the net cropped area, rainfed agriculture contributes 40% to India's total food production. Rainfed areas account for 89% of millets production, 88% of soybean, 65% of pigeon pea and chickpea, 73% of cotton, 69% of oilseeds, 50% of maize, and 40% of rice production. As major producers of millets, pulses and oilseeds, these areas are likely to make country's future both food and nutrition secure, because productivity in the Green Revolution regions has more or less saturated/plateaued. Although the average per hectare food-grain productivity of rainfed crops has doubled (increased from 0.6 t in the nineteen eighties to 1.2 t at present) during last 40 years, a wide gap still exists between yields attained at the research stations and farmers' fields. Lack of irrigation facilities, improper distribution of rainfall, inadequate groundwater, shallow soil depth, poor water holding capacity, and secondary and micronutrient deficiencies are primarily responsible for these gaps.

Low yielding crop-livestock mixed farming systems practiced by the resource-poor farmers in these regions have in the past provided stability during drought years, and helped them in coping with weather aberrations, but fell short of ensuring immediate livelihood security. Mono-cropping system, comprising a long fallow period (October to June), is a rule rather than an exception. Low productivity in many arid and semi-arid rainfed agricultural systems is often due to degraded soil fertility and limited water and nutrients input, exacerbated by erratic rainfall, adverse soil conditions, poor infrastructure, and inadequate market linkages, etc.

Rainfed soils are highly prone to vagaries of climate, with rainfall being the major crop production-limiting factor. Rainfall variability, in amounts and intensities, accentuates the frequency of both droughts (early-season, mid-season and terminal) and floods, and consequentially threatens the very sustainability of food grain production in these regions. *In situ* moisture storage in soil profile and its conservation in the water harvesting structures is a must for meeting water requirements at critical growth stages of crops. Adoption of watershed technology or water conservation measures offers a means to improve land productivity and impart resilience to the system.

Mega scale land degradation, induced by both natural calamities and accelerated agricultural/industrial/urban activities, is a prime cause for poor soil health. Since soil organic matter plays a significant role in improving soil health through its beneficial effects on microbial community, soil physical structure, nutrient cycling, and soil water storage, its stabilization or improvement, is required to arrest/decelerate the soil degradation. Soil health enhancement brought about through enhanced carbon retention/sequestration is a win-win prescription to pocket higher profits and ensure livelihood security of both small and marginal farmers.

Rainfed soils are both hungry and thirsty. Nutrient management sans water management is unthinkable and we have to go in for "higher crop yields per drop of water and per fertilizer bag". Achieving water and nutrient synergy through drip fertigation, introducing nutrient responsive crop genotypes, infusing new generation of specialty and innovative fertilizers like nano fertilizers, adopting best agronomic management practices (BMPs) is essential for sustained productivity of the rainfed-dryland ecologies.

Balanced fertilization is a useful yield-enhancing, soil health building, and NUE-improving strategy. Prior assessment of soil fertility is desirable while working out the balanced fertilizer doses as the precise information about the nutrient supplying capacity of the soil along with other relevant information facilitates the computation of *right* amount of a *right* fertilizer product and its application through *right* method at the *right* time to meet the optimum nutrient requirement of a crop. Development and adoption of site-specific nutrient management (SSNM) strategies is one example of balanced application of fertilizers which takes into account and makes use of the on-farm generated nutrient sources and helps in reducing

{ National Mission for Sustainable Agriculture launched by the Government of India has a major thrust on enhancing agriculture productivity, especially in rainfed areas, through integrated farming, soil health management, and resource conservation synergy. }

the cost on purchased inputs, increasing productivity, improving nutrient use efficiency, and minimizing/ arresting the depletion of soil fertility.

Crop residues to the extent of 500 Mt per annum are generated in India. These are good sources of plant nutrients and increase the soil carbon stocks. About 25% of N and P, 50% of S, and 75% of K taken up by the cereal crops are retained in crop residues, making them the valuable nutrient sources. Unfortunately, about 80 Mt of crop residues are burnt as a part of clearing the field for planting/sowing the next crop, which adds to the air pollution besides causing loss of plant nutrients. Rainfed agro-ecosystems offer an option of on-farm generation of organic matter, which could help in meeting a part of the nutrient requirements of crop.

Adoption of integrated farming systems involving different components *viz*. crop, livestock, poultry, fisheries, etc. is a powerful tool and holds the key for ensuring income, employment, and livelihood and nutritional security of the farmers residing in rain-dependent regions. Introduction of legumes into crop sequences provides multiple benefits in terms of fixing the atmospheric nitrogen, adding to the soil high-quality organic matter, facilitating soil nutrients' circulation and water retention, and economizing on the amount of mineral fertilizer applications.

Biofertilizers contain living microorganisms which when applied to seeds, plant surfaces, or soil, colonize the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host plant. Most of food legumes (pulses) such as chickpea, pigeon pea, mung bean, black gram, lentil, etc. grown extensively in the rainfed drylands enrich nitrogen fertility for the succeeding crops(s). However, for improving efficiency of biofertilizers, addition of organic manures is essential. Biological nitrogen fixation (BNF) has been used world-over in the rainfed agroecologies for partially meeting the external N requirements of crops. In India, the use of biofertilizers/bioinoculants has been expanded to partially supplement the P, K and Zn needs of crops.

Integrated nutrient management (INM) is the combined application of chemical fertilizers and organic manures including biofertilizers for sustained crop production. It is a holistic approach aimed at maintenance of soil fertility and the supply of plant nutrients in adequate amounts. In the current situation of escalating cost of mineral fertilizers, curtailing their use through amalgamation of other nutrient sources offers a viable solution to enhancing productivity, restoring soil health, and increasing net profits of resource-poor farmers residing in the rainfed regions. INM needs to be promoted as an essential component of production technologies through awareness creation, demonstration, and training. Upscaling of INM technology involving researchers, extension workers and creating linkage with line departments and in convergence with central and state government programmes is the need of hour.

Doubling the nitrogen use efficiency (NUE) from current 30% to 60% continues to be a goal across the different agroecosystems. Under conditions of limited and uncertain water availability, NUE enhancement is possible only through large scale adoption of foliar application of water soluble fertilizers, nano fertilizers, biostimulants, and plant protection chemicals through drones (wherever possible). New and efficient plant growth promoting agri-inputs like seaweed extract-based biostimulants, organically chelated products, amino acid-based products, besides 100% water soluble fertilizers and nano fertilizers for foliar and fertigation have brought a paradigm shift in the principles of crop nutrition and enhancing crop productivity with minimum environment footprints.

National Mission for Sustainable Agriculture (NMSA) launched by the Government of India has a major thrust on enhancing agriculture productivity, especially in rainfed areas, through integrated farming, soil health management, and resource conservation synergy. Through promotion of location-specific integrated farming systems; soil and moisture conservation measures; comprehensive soil health management and mainstreaming rainfed technologies will make farm sector more productive, sustainable, remunerative, and climate resilient in the rainfed areas.

This special issue of Indian Journal of Fertilisers is being brought out to commemorate the International Conference on 'Reimagining Rainfed Agro-ecosystems: Challenges and Opportunities' to be organized at ICAR- CRIDA Hyderabad during 22-24 December, 2022. It consists of eight papers on 'Emerging Strategies for Efficient Nutrient Management in Rainfed Agro-ecosystems'. We hope that all those concerned with Indian agriculture including scientists, policymakers, input suppliers, extension personnel and farmers will find the content of the special issue relevant and useful. ■