SUSTAINABLE PRODUCTION OF NUTRI CEREALS UNDER RAINFED CONDICTION

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INTRODUCTION

Small millets (Sree Anna) are a group of small grained cereals having nutritionally rich grains. They are staple crops in the semi-arid tropics and largely found in low rainfall receiving areas, and consequently assume larger position in sustainable agriculture and nutritional security in the drylands. The minor or small millets comprise finger millet, little millet, kodo millet, barnyard millet, foxtail millet, proso millet and brown top millet in the order of decreasing acreage. Presently these crops are receiving renewed attention owing to their short duration, and distinctive capacity to yield even under poor and marginal soils where other crops usually fail to produce any economic yield. They offer better crops under drylands especially in tribal agriculture contributing to food, fodder and nutritional security. Because of superior nutritional qualities, the millets are now called as nutri-cereals.

Production of Small millets

Small millets are majorly grown as rain-fed crops and often associated with monsoon dependent cropping systems. They respond very well to irrigation, fertilizers and other crop management inputs. Inorganic and organic means of nutrients in small millets would increase yield, yet this was not regularly practiced earlier as these crops were grown wherever other crops fail due to all production constraints. The biotic constraints like diseases and pests are not much of concern compared to other crops. Hence, the grain yield is significant with use of minimal energy components in relation to the more traditional crops. Millets can also be grown as early post monsoon and early winter crops. Millets can also be raised as rabi crops in areas receiving north-east monsoon and in black soils drawing on residual moisture and dew precipitation.

Role of Nutrients in Small Millet Cultivation

Without proper nutrient management, continuous production of crops depletes nutrient reserves in the soil. Increased productivity of agricultural produce removes large amounts of essential nutrients from soil. Nutrient management should be realistic, attractive and environmentally friendly. Integrated Nutrient Management (INM) is a system that helps to restore and sustain crop productivity, and also assists in checking the emerging micro-nutrient deficiencies. INM helps to maintain productivity, profitability and quality of crop produce and soil. It is found that the effect of biofertilizer along with organic and inorganic source of nutrients in combination was successful in different types of soils. Biofertilizer help in supplementing chemical fertilizer for meeting the integrated nutrient demand of crops and thus helps in sustaining the soil productivity and improves fertilizer-use efficiency. Integrated use of fertilizers along with organics enhanced the productivity of millet-based cropping systems. Several studies in millets clearly indicated that the INM practices are fairly

more effective and widely used in millet crops.

Role of Organic Carbon in Rainfed Ecosystems

The soil organic matter plays significant role in maintaining soil health through its effects on microbial community, soil physical structure, nutrient cycling and soil water storage. Soil organic matter maintenance in an agro-ecosystem majorly depends on the balance between biomass C inputs, their quality and C loss from decomposition, leaching and erosion. Site-specific nutrient management (SSNM) is an approach which optimizes the supply of soil nutrients over space and time to match crop requirements which aids in enhancing crop productivity, fertilizer use efficiency and climate change mitigation. The integrated nutrient management (INM) / integrated plant nutrient system (IPNS) envisaging maintenance or adjustment of soil fertility and of plant nutrient supply to an optimum level for sustaining the desired crop productivity through optimization of benefits from all possible resources of plant nutrient in an integrated manner could prove to be the most effectual and viable option towards enhancing soil health in rainfed regions. Crop residues are good sources of plant nutrients and are important components for the stability of agricultural ecosystems. Huge crop residue is field- burned in rainfed drylands including rice, cotton, pigeon pea, castor, chillies, turmeric and other crops besides huge amounts of vegetable and fruit biomass is not being recycled towards nutrient supply systems. Any amount of organic manure addition to fields adds considerable amounts of plant nutrients besides enriching soil carbon stocks. About 25% of nitrogen (N) and phosphorus (P), 50% of sulphur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources. Crop residue contributes to soil organic matter and increases nutrient, water retention, microbial and macro-invertebrate activity.

Organic Matter

In rainfed agro-ecosystems, there lies an option of on farm generation of organic matter. On farm generation of organic matter could help in meeting a part of the nutrient requirement of crop and also meet the demands towards enhancing soil quality. Farmyard manure (FYM), poultry manure (PM), etc., produced on-farm could serve as source of nutrients to augment crop growth and yield as well as contribute to soil health enrichment. Green manuring/green leaf manuring is one of the important strategies that improves soil organic carbon, adds soil nutrients, improves soil biological health, and enhances soil moisture storage as a consequence of which the crops can cope with intermittent droughts. Green leaf manuring with gliricidia aided in supplementing both macro and micronutrients. Composting is a method by which organic waste is transformed to stable humic substances through biological processes. Organic matter in the compost aids in improving soil structure and water holding capacity contributing to enhanced nutrient holding capacity. Being a rich source of nutrients, application of tank silt to soils aids in enhancing crop productivity and reduces the amount of synthetic fertilizer application.

The efficient use of biofertilizer in rainfed agroecology could be a viable approach to increase crop yield and improve soil health. The effect of added biofertilizers could be enhanced when used in conjunction with chemical fertilizers and different organic sources. Based on INM trials conducted in rainfed agroecology it was found that the conjunctive use of poultry manure with *Azotobacter*, *Azospirillum* helped in reducing the doses of inorganic fertilizers.

INM strategies

Entire phosphorus and potassium applied at sowing, whereas nitrogen is to be applied in two or three split doses depending upon moisture availability in the areas of good rainfall and moisture availability. In

areas of uncertain rainfall: 50% at sowing and the remaining 50% around 35 days after sowing is recommended. Adequate application of FYM, 7.5 to 10 tonnes per hectare help in better development of root growth.

Bio-fertilizers

Treating seeds with *Azospirillum brasilense* (N fixing bacterium) and *Aspergillus awamori* (P Solubilizing fungus) @ 25 g/kg seed is beneficial. In case seeds are to be treated with seed dressing chemicals, treat the seeds first with seed dressing chemicals and then with bio-fertilizers at the time of sowing. Procedure for inoculating seeds with bio-fertilizers 1. Bio-fertilizer culture specific to the crop is to be used @ 25g per kg of seed. 2. Sticker solution is necessary for effective seed inoculation. This can be prepared by dissolving 25 g jaggery or sugar in 250 ml water and boiling for 5 minutes. The solution thus prepared is cooled. 3. Smear the seeds well using the required quantity of sticker solution. Then add culture to the seeds and mix thoroughly so as to get a fine coating of culture on the seed. 4. The culture-coated seed is to be dried well in shade to avoid clumping of seeds. 5. Use the inoculated seeds for sowing.

Improving soil organic matter

Integrated nutrient management, addition of organic amendments *viz.,* crop and weed residues and their composting, vermicomposting, green manuring through crops, tree-based green leaf manuring, tank silt application, application of FYM, poultry manure, and sheep and goat manuring etc. treated sewage sludge, biochar and agro industries waste like baggessage, coir pith, groundnut shell, poultry manure, sheep penning, press mud, seri waste, etc, Cover crops, growing of leguminous crops, No or minimized tillage in the crop production system Incorporation of green manuring crops sunhemp, dhaincha, cluster bean, Sesbania, cowpea, green gram, etc., Mulch-cum-manuring with tree leaf (*Pongamia glabra, Azadirachta indica, Delonix regia* and *Peltophorum ferrugenum*) improve the Soil Organic Carbon (SOC), N. P. K, secondary nutrient and micronutrients. Also, it improves the soil microbial population and which in turn helps the nutrient uptake and soil health.

Conclusions

Rainfed agro-ecosystems, which hold the potential to meet a major share of the food, fuel and fibre requirement of the country's ever-increasing population, need to be made much more productive by adopting suitable soil and crop management practices. Adopting strategies which would cater to both sustaining and elevating soil health status and enhancing crop productivity levels in these regions assumes high priority. INM is a holistic approach which would enable in meeting the needs of replenishing soil, augmenting productivity levels and also enhancing livelihood security of peasants inhabiting rainfed lands. In the current situation of escalating cost of fertilizers coupled with their role as a component augmenting emission of greenhouse gases, curtailing their use through amalgamation of all other nutrient supplying sources through integrated nutrient management would serve as a viable solution to enhancing productivity, restoring soil health, increasing net profits of farmers along minimizing GHG emissions and environmental pollution.

contributes 85% of the total production of small millets. In India Karnataka, Tamil Nādu, Uttarakhand, Maharashtra and Odisha are leading finger millet producing states.