Soil Science Division

Program Area: Soil Management and Biofertilizer

Isotopes and radiation techniques will continue to have important roles in research to increase global food production. Radioisotopes (^{32}P, ^{65}Zn, ^{14}C etc.) and stable isotopes (^{15}N, ^{2}H, ^{18}O, ^{13}C etc.) are valuable tools for measuring fertilizer use efficiency and nutrient uptake, determining the fate of fertilizers and pesticides in soils, and nutrient release rates from organic amendments. Tracer techniques have proved to be highly effective for obtaining quick, precise and quantitative determinant indicators of soil and water health as well as for comparing alternative practices to improve the productivity of these two natural resources. BINA has given emphasis on (a) physico-chemical characterizations of soils for fertilizer recommendations (b) micronutrient studies in soils and crops, and (c) improvements in methods to provide soil health card services to farmers and (d) to develop various nitrogenous biofertilizer for rice (*Azotobacter* and *Azospirillum*) and pulses (*Rhizobium/Bradyrhizobium*) and phosphatic biofertilizer for all of the major crops for reducing dependence on chemical fertilizers.

Achievements:

A. Soil Management:

1. Fertilizer Recommendation Guide: Soil Science Division of BINA is actively participating for updating BARC coordinated fertilizer recommendation guide every five years by generating data on soil, crops/cropping patterns which are being used by the farmers at different regions through the extension personnel in order to increase crop production and maintaining soil quality.

2. Preparation of Upzila Mrittika Babohar Nirdeshika: Upzila Mrittika Babohar Nirdeshika of SRDI was prepared based on active participation of Soil Science Division, BINA along with NARS institute and generated data on soils of different Upazilas.

3. Soil health card services to farmers: The Institute has introduced soil health card services to farmers in Sadar, Fulpur and Muktagacha upazilas of Mymensingh and Nokhla, Sherpur districts to get maximum sustainable yield.

4. Use of sewage sludge in crop production: Application of 400 kg/ha sewage sludge produced equal yield obtained from 100 kg nitrogen/ha from urea.

5. Minimum tillage for wheat cultivation: Seeds can be sown by opening a furrow with a country plough in between two rice rows immediately before or after harvest. It reduces the turn around time between two crops and wheat can be grown with residual soil moisture, thus, reducing the cost of cultivation.

6. Wheat cultivation in saline soil: This management practice has been developed for utilization of fallow saline land for wheat cultivation. Timely planting immediately after harvest and careful management can prevent the land from quicker drying. Planting of wheat seeds should be done immediately when 'Jo' condition of land arrives.

7. Use of micronutrient for higher mungbean and mustard production: This management practice is recommended for the dark grey flood plain soils of Mymensingh and Jamalpur areas, which are deficient in several micro elements.

8. Nitrogen fertilizer management in rice cultivation: Application of half the dose of nitrogen fertilizer as urea super granule can give higher grain yield and thus reduce the cost of N-fertilizer and environmental pollution. Inclusion of legume between two cereals and incorporated into the soil reduces one third of the recommended dose of nitrogen fertilizer in the following T.aman rice.

9. Use of press mud instead of TSP: Application of decomposed press mud @ 1200 kg/ha (equivalent of 200 kg TSP) at the time of land preparation for rice and sugarcane cultivation saves money and use of P fertilizer.

10. Phosphatic fertilizer management in rice based cropping system: This practice recommends 50% of the total recommended dose of phosphatic fertilizer in an area where continuous cropping patterns are followed with Wheat -T. aus-T. aman rice. In the second crop T. aus rice, no P-fertilizer is needed, while 50% of the recommended dose of P fertilizer may be applied in the third crop.

10. Use of urea super granule to reduce nitrogenous fertilizer: Application of urea super granules 8-10 cm deep under the soil of rice field can reduce the use of costly urea fertilizer by 25%.

11. Soil fertility and land degradation assessment: Evaluation of soil characters showed site-specific decline in silt and clay particles, soil pH, organic carbon, total nitrogen, availability of phosphorus and sulphur, exchangeable cation (Ca, K and Na) contents in Old Himalayan Piedmont Plains (AEZ 1), Tista Meander Floodplain (AEZ 3), Young Brahmaputra and Jamuna Floodplain (AEZ 8), Old Brahmaputra Floodplain (AEZ 9), Ganges River Floodplain (AEZ 11-13), North-Eastern Barind Tract (AEZ 27), Madhupur Tract (AEZ 28), Meghna River and Estuarine Floodplains (AEZ 16-19), Eastern Surma Kushiara Floodplain (AEZ 20), Northern and Eastern Piedmont Plains (AEZ 22) and Chittagong Coastal Plain (AEZ 23). Soil acidification and depletion of plant nutrients were identified at these areas.

12. Reference inventory and soil erosion assessment using nuclear techniques: An average local reference ^{137}Cs inventory 946.4 Bq m^{-2} was obtained from Khagrachari. At Khagrachari ^{137}Cs, ^{210}Pb, ^{226}Ra and $^{210}Pb_{ex}$ were distributed in decreasing trend with increasing depth. Soil respiration decreased 12-34% and increase 8-53% by soil erosion and deposition respectively. Soil organic carbon, soil temperature and soil moisture is the main controlling factor of soil respiration.

13. Assessment of arsenic in soils: Clear variation of arsenic contents were identified in soils of AEZs 1, 3, 8, 9, 11-13, 27 & 28 and found no site-specific arsenic contamination except in Ganges River Floodplain areas.

14. Soil Museum: A soil museum established at BINA in which 28 soil monoliths were collected representing the important soil series belonging to different subgroups/families as USDA Soil Taxonomy System and General Soil Types of Bangladesh.

15. Fertilizer recommendations for eight BINA developed crop varieties: Recommended fertilizer doses for BINA developed crop varieties as below: Binadhan-14, Binadhan-8, Binadhan-10, Binadhan-9, Binasoybean-3, Binasoybean-4, Binatil-1, Binatil-2, Binatil-3, Binamoog-8, Binasharisha-7, Binasharisha-8 & Binapatshak-1.

16. Fertilizer recommendations for some cropping patterns and areas: Recommended 15 cropping pattern based fertilizer doses in different AEZs of Bangladesh which have been incorporated in National fertilizer recommendation guide and booklet of BINA.

17. Integrated Plant Nutrition System (IPNS) and Fertilizer Use Efficiency: In rice-rice cropping pattern, incorporation of press mud, poultry manure and/or tobacco dust @ 2-3 t/ha (IPNS) before 5-7 days of boro rice transplanting recorded equal yield compared with high yield goal based fertilizers. Three-split application of nitrogen fertilizer increased nitrogen use efficiency of rice crop. Application of fertilizer @ $N_{120}P_{25}K_{50}S_{16}Zn_2B_1$ along with cowdung (5 tha^{-1}) made available K for rice crops to obtain 5.5 t ha^{-1} yield of boro rice (Binadhan 8 & 10) as well as reduced adverse effects of salinity.

18. Determined critical limit for different crops varieties: Critical limit (CL) of a nutrient refers to a value below which an economic crop response to the added nutrient is highly expected. It depends on soils, crops and extraction methods. The critical limit (ppm) of some crops for phosphorus are Wheat (Balaka)-15 (Olsen) & 12 (Bray), Mungbean (Binamoog-1)-13 (Bray), Jute (Binadeshipat-2)-15 (Olsen), Lentil (Binamosur-1)-12 (Olsen) & 10 (Bray), Chickpea (Binasola-2)-14 (Olsen), Groundnut (Binachinabadam-1&3)-12 (Olsen) & 10 (Bray), Mustard (Binasharisa-3 & 4)-11 (Olsen), Sesame (Binatil-1)-14.5 (Olsen) & 10.5 (Bray) and sulphur are Mustard (Binasharisa-3 & 4)-15 (Olsen), Rice (Binadhan-6)-12 (Birdsley & Lancaster), Sesame (Binatil-1)-18 (Birdsley & Lancaster).

19. Determined soil organic carbon stocks at different AEZs and it's sequestration using different management practices: Soil organic carbon stocks in 0–20cm depth of soil were traced 1.18±0.123, 0.71±0.043, 1.40±0.432, 0.22±0.015, 0.01±0.004, 0.11±0.008, 0.07±0.005, 0.48±0.176, 0.64±0.047 and 0.40±0.030 million tones in AEZs 11, 12, 13, 14, 15, 16, 17, 18, 19 and 20, respectively. Rice straw incorporation and mulch significantly produced more soil organic carbon (17 and 10%) over no crop residue after five crop cycles of rice. Minimum tillage also found better for carbon sequestration (0.039 t C ha^{-1} yr^{-1}) than traditional tillage. This was experimented and proved to be a highly effective.

20. Management of Potassic Fertilizer: In rice-rice cropping system, 25% potassium fertilizer can supplement due to addition of rice straw from the previous crop (left 20-25 cm straw, on dry basis 1.5-2.5 t ha^{-1} supplied 30-40 kg K) as well as reduce K mining from the soil. In Potato-Boro-T.aman rice cropping pattern 25% potassium fertilizer supplemented in second and third crop based on integrated use of organic and inorganic fertilizer application at Rangpur region. On the other hand, if the first crop of the pattern received the full dose of sulphur and zinc, the following crop T.aman rice required only 50% of the recommended dose of sulphur. The optimum dose of potassium for boro and T.aman rice were 53 and 44 kg ha^{-1} at Mymensingh (AEZ 9). The corresponding doses were 65 and 54 kg ha^{-1} at Bogra (AEZ 25).

21. Providing analytical services: Soil Science Division provides analytical services of soil, plant, water, adulterated fertilizer to farmers, students, GO/NGOs of the country.

B. Biofertilizer:

22. Lentil biofertilizer (BINA LT -18): This is a Rhizobium inoculant, for lentil cultivation which can be increased 15-40% seed yield.

23. Chickpea biofertilizer (BINA CP-2): This is an Mesorhizobium inoculant, for chickpea cultivation and it can increase 25-30% seed yield.

24. Mungbean biofertilizer (BINA MB-1): This is an Bradyrhizobium inoculant, for mungbean cultivation which can increase 18-30% seed yield.

25. Cowpea biofertilizer (BINA COP-7): This is an inoculant for cowpea cultivation. It can increase seed yield by 25-45%.

26. Groundnut biofertilizer (BINA GN-2): This inoculant for groundnut cultivation. It can increase 20-40% seed yield.

27. Soybean biofertilizer (BINA SB-4): This is one of the most promising Bradyrhizobium inocula for soybean cultivation. Farmers can obtain 75-150% more seed yield.

28. Blackgram biofertilizer (BINA BG-1): This is an inoculant for blackgram cultivation. It can increase 20-30% seed yield.

29. Dhaincha biofertilizer (BINA DC-9): This is an inoculant for dhaincha cultivation. It can increase seed yield by 25-50% of this green manuring crop.

30. Dhaincha biofertilizer (BINA DhM-3): This is an inoculant strain for dhaincha cultivation which increase biomass yield of dhaincha by 25-40%.

31. New *Rhizobium* sp. discovered: Three new bacterial species from lentil-root nodules from Bangladesh discovered i.e. ***Rhizobium bangladeshense*** (R), ***Rhizobium binae*** (R) and ***Rhizobium lentis*** (R) these are useful for lentil, peas and lathyrus cultivation.