Agronomic Means to combat the declining soil fertility under intensive and intensive cultivation

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The fertility status of Bangladesh soil is declining mainly due to excessive nutrient mining and depletion of soil organic matter.

The causes for the depletion of soil organic matter is happening due to following activities:

- Intensive and continuous rice-rice culture (i.e. choosing cropping patterns)
- Replacement of local varieties of rice by modern ones
- Decreasing jute cultivation area
- Increasing adoption of power tillers in recent years
- Use of dung and organic wastes as biomass fuel
- Erosion of top soil by farming activities
- Imbalance use of chemical fertilizer use

The declining fertility can be addressed through the integrated approach of organic, bio and chemical fertilizers along with cultural manipulation of cropping systems and building sustainable ecosystems to hold up fertility and productivity of the soils. The agronomic management that cab be used to fight against the declining fertility of soil are discussed below.

1. Resource Recycling

In Bangladesh organic waste is scarce for incorporation in the soil due to high demand of biomass for fuel. However, experimental evidences indicate that waste materials produced in the household if maintained properly can contribute to considerable extent to overcome the deficiency of organic matter and nutrients.

1.1. The sue of compost and farmyard manure

A considerable volume of waste materials and farm yard manure are produced in the household. But there is a lack of preservation process. In the rural area, due to unplanned management of waste materials produced in the household creating unhygienic condition and environmental hazard around the homestead. With the view to utilizing household waste, FSES tried to improve composting method. Farmers' practices were monitored how much organic waste they accumulated in year and other three methods (viz. dumping, open pit and pit with polythene sheet) of composting were practised at farmers houses in the Kazirshimal FSES site. Thirty six sampled farm (small, medium and large; 12 from each category) were involved in the study. The average farm size and cultivated land of sampled farms were 1.60 and 1.32 ha, respectively. The amount of compost produced was 3.45, 4.63, 7.67 and 10.40 t year^{-1} from farmers' practices, dumping, open pit and pit with polythene sheet method. The polythene sheet method performed best (10.40 t compost year^{-1}) which contained compost dry matter of 7.04 t year^{-1}. By manipulating polythene method 7.87 t compost may be used to one hectare of land. This will be the major source of recycling the organic matter in soil.

1.2. The Use of bio-fertilizer (Azotobacter) in rice

Inoculation of *Azotobacter* is one of means to sustain soil fertility status in soil. In a study it was observed that organic matter status declined in post-harvest soil than in the initial one, although the rate of declination was very minimum in the *Azotobacter* inoculated plots compared to the control. It was seen that the depletion rate of organic matter content decreased upto 13.91% due to Azotobacter inoculation.

1.3. The use of Rhizobium in pulse crop

Rhizobium bacteria play an important role in biological N_2- fixation. It is useful to increase or maintain soil organic matter in the soil.

1.4. The use of Cyanobacteria on soil organic matter

Cyanobacteria might be one of potions to improve sol organic matter of the soil. The soil organic matter increased due to application of cyanobacterial isolates. He found that *Cytonema* increased the soil organic matter which was about 19.01% over control. Many other reports also available in favor of *Cynobacteria* as a contributor of soil organic matter.

1.5. The use of biomass and green manure crop

Green manure can raise soil fertility. Green manuring crop are one of the effective manures for soil improvement. Green manuring crops historically were used for plant nutrition and as organic matter for increasing soil fertility, especially in lower fertile soils. However, its used is limited at farmers' level due to several constraints. The main constraint to expand the technology is intensive cropping. There is a conflict between green manure crops and agricultural crops for space and time. In an intensive cropping sequence, farmer do not set apart 6-8 week exclusively for growing a green manuring crop with no direct benefit. In this situation, if green manuring crop could be fitted into the turnaround period or inter cropped or relay crop without any adverse effect on yield of main crop, it may help the farmers to grow for increasing organic matter status of the soil and productivity of the subsequent crop.

Biomass production from a unit land area, over a period of one year should have to be increased. A number of options may be adopted for this purpose. For example, inclusion of a *Sesbania* crop in the cropping pattern(s) for a period of 50 days could yield 36 t green biomass under moderate productivity level (equivalent to 9 t DM) and this may be sufficient to maintain the current OM status of soil. This practice would not only raise the OM status of soil rather the overall biomass production in the system would be increased. It has been seen in the traditional cropping pattern, Fallow- Aman rice-Boro rice (Aman) rice yield 6.46 t ha^{-1}, Boro rice yield 6.66 t ha^{-1}, total biomass 13.12 t ha^{-1}), incorporation of *Sesbania rostrata* either growing during fallow period (Aman rice yield 7.60 t ha^{-1}, Boro rice yield 7.86 t ha^{-1}, total biomass 15.46 t ha^{-1}), or as relay with Boro and Aman rice (Aman rice yield 7.41 t ha^{-1}, Boro rice yield 6.92 t ha^{-1}, total biomass 14.33 t ha^{-1}) could improve the total biomass production as well as increase the rice yields.

Seshania rostrata could be relayed with boro/aus rice and this may be sued as green manure for succeeding transplant aman rice seedling or cutting of *Seshania rostrata* could be planted/transplanted before panicle initiation of boro/aus rice. As relay crop with boro and aus rice, 25-35 and 15-20 t ha^{-1} green biomass of *Seshania rostrata*, respectively could be obtained without hampering the yield of rice.

Mungbean is a easy decomposable crop. It can be relayed with aus rice. Accommodating summer mungbean crop with aus rice (relayed 40 days after sowing of aus rice) produced 10-16 t ha^{-1} fresh biomass by least hampering the rice yield which may used as green manure to raise the organic matter status of the soil.

The use of other green manuring crops like sunhemp, grasspea, blackgram etc. may be used to increase biomass production and incorporation into the soil.

1.6. The used of dual culture of Azolla with rice

Dual culture of *Azolla* in wetland rice is a unique technology to produce green biomass for incorporation as green manure. It can be practiced in boro or T. aman season in our country. Inoculation of 0.1-0.2 kg m^{-2} *Azolla* inoculum after 7-10 days of transplanting can produced and incorporated two layers of *Azolla* biomass during one rice season. Each layer of *Azolla* produced 10 t ha^{-1} fresh biomass which may supplement 30 kg N ha^{-1} i.e. incorporation of two layers of *Azolla* supplement 60 kg N ha^{-1}. It is reported that the incorporation of 2 layers of *Azolla* increased percent

organic matter upto 2.77% in post-harvest rice soil in comparison to initial soil whereas it was decreased (−0.37%) in control.

2. Enhancement of aforestration programme including cropland agroforestry

Ever increasing population pressure not only demands for more per capita biomass but it has already shown negative impact on biomass production. The major causes are i) reduction in land for cropping and cropping activities, ii) decrease in homestead area/homestead destruction, iii) reduction in community forest are, iv) intensive crop culture, v) elimination of jute from cropping, and vi) decrease in cattle population. The reduction of biomass fuel creating conflict with soil organic matter. To overcome this situation intensification of aforestration programme including crop land forestry is necessary.

3. The use of nightsoil, urban garbase, animal excreta, sewage, etc.

The municipal and the rural wastes such as nightsoil, urban garbage, animal excreta, sewage, sludge and plant residues can be used as organic manure directly or just treated through a simple anaerobic process. The use as organic fertilizer is the best way to dispose of these wastes. Nightsoil management and treatment are the good way to prevent and eliminate disease, and supply a good organic fertilizer. The process should be introduced to produce organic manure, treatment of nightsoil to get safe fertilizer, sludge fertilizer, sewage irrigation and biogas residue as fertilizer.

4. Reduced tillage practice

Reduced or conservation tillage is a form of low input agriculture, in that it requires a lower input of energy and labour, and minimizes disturbance to the soil. No-tillage leaves organic materials undisturbed and stratified in the topsoil. However, whether reduced tillage gives good results partly depends on the soil type. It is not suited to poorly drained soils. The advantages and disadvantages of reduced tillage or no-tillage should be examined according to the particular local situation.

5. Integrated nutrient management

The integration of inorganic, organic and bio nutrient sources leads to not only increase in food grains production with concomitant nutrient balances but also results in the build-up of soil fertility. Results of field experiments showed a significant response of different crops/cropping patterns to added nutrients from both inorganic and inorganic sources. The yield levels of modern varieties of rice, wheat, jute, mustard, potato and sugarcane were remarkably increased by two to three fold more than the national average due to integrated nutrient management. The different cropping patterns gave higher yields due to integrated management of inorganic fertilizers and cowdung/organic manures with appropriate management practices. It was also seen that the yield of wheat and rice had positive response due to the application of chemical fertilizers and organic manure.

6. Integrated farming

Integrated farming may be one of the approach to increase productivity of the farms and to combat soil fertility. There is a possibility to achieve better utilization of available resources for obtaining maximum returns by integration cropping, dairy, poultry, fisheries, agrofoerstry and homestead production systems. By way of recycling the waste/uneconomic products of one component over the other, the cost of production of the economic yield of other component is very much reduced thus leading to increased net income of farm as a whole. It shows that under present farm resources and environment in Bangladesh, there is an excellent scope for the improvement of productivity, food and nutrition, and overall welfare of the farmers through diversification of enterprises, mobilization of resources and intensification of farm activities.

7. Soil nutrient balance

Since fertilizers are not being applied at balance rates by farmers they create a deleterious effect on soil productivity. Soil fertility is degraded overtime and after growing each crop (especially cereals) in terms of nutrients and organic matter. On the other hand, in the deficiency of one essential, the excessive application of others nutrients leads to make the soil deficient. It is evident that only N

application created negative balance of P, while negative balance of K was observed in all the treatments irrespective of whether K was applied or not. Balanced use of NPKS fertilizer also increases the productivity of cropping pattern as a whole.

8. Soil management strategy

Soil properties have changed as a result of intensive cropping, monoculture, increasing wetland and heavy use of agrochemicals. Loss of soil quality can result from the mismanagement of soil resources, in the absence of information on how to manage it properly. A soil management strategy for sustainable agriculture must be based on maintaining soil quality on the long term basis.