Soil Fertility Status of Bangladesh

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Key facts

- Although Bangladesh is a small country, it has a wide variety of soils.
- The fertility status of Bangladesh soils is extremely variable.
- Most of the soils are depleted and in urgent need of replenishment with manures and fertilizer if projected crop production target is to be obtained.
- It is estimated that more than 100 kg nutrients ha^{-1} $year^{-1}$ are mining out from the soil system.

Nutrient mining in Bangladesh

Certain transformations have taken place in Bangladesh Agriculture in the past with an effect on nutrient flows and balances. In a very simplified manner, one can present this transformation in 3 stages, viz.: from a natural system (1) to a low input agricultural (2) and eventually highly on external inputs relying agricultural system (3).

- Under **Natural System** the **uptake = natural supply of nutrients**. In some areas Shifting cultivation or slash and burn practices may take place (e.g. "jhum" cultivation in Bangladesh). In that system, provided the regeneration periods are long enough, the small amount of nutrients removed with crop yield can be sustained by the buffer capacity in the natural vegetation / humus / soil organic matter complex.
- With the **introduction of agriculture** nutrients are exported to the household, with removed crop and livestock produce (**uptake > natural supply**). The exported nutrients need to be supplemented through external organic inputs (manure, crop residues).
- With increased population the demand for agricultural products also increases. A **highly intensive farming system** will develop. More nutrients are exported through crop and livestock produce, even crop residues are taken from the field for fodder or fuel. The **negative balance** between naturally available nutrients and nutrients removed needs to be supplemented by external inputs, especially mineral fertilizers.

Fertility status of the different agroecological zones of Bangladesh

1. Old Himalayan Piedmont Plain

Strongly acidic in topsoil and moderately acidic in subsoils. Organic matter contents are relatively higher than in other floodplain areas. The natural fertility of the soil, except the coarse textured, is moderate but well sustained. Soil fertility problems include rapid leaching of N, K, S, Ca, Mg and B.

2. Active Tista Floodplain

Moderately acidic throughout, organic matter content is low and CEC is medium. Soil fertility level is low to medium.

3. Tista Meander Floodplain

Moderately acidic throughout, low in organic matter content on the higher land, but moderate in the lower parts. Fertility level, in general, is low to medium but the status of K and CEC is medium in most of the places.

4. Karatoya-Bangali Floodplain

Moderately acidic throughout. Organic matter content is low in ridges and moderate in basins. General fertility is medium.

5. Low Atrai Basin

Acidic; organic matter, moderate CEC and fertility status of soils.

6. Lower Punarbhaba Floodplain

Acidic; organic matter status is medium to high with high CEC. General fertility level is medium with high K status.

7. Active Brahmaputra-Jamuna Floodplain

Slightly alkaline; organic matter status is low and fertility status is low to medium. Nitrogen and P are, in general limiting whereas K, S and Zn status is reasonable.

8. Young Brahmaputra and Jamuna

Floodplain Neutral to slightly acidic; organic matter content is low in ridges and moderate in basins. Soils are deficient in N, P and S but the status of K and Zn is reasonable.

9. Old Brahmaputra Floodplain

Topsoils moderately acidic while subsoils are neutral. Organic matter content low in ridges and moderate in basins. General fertility level is low. Phosphorus and cation exchange capacity (CEC) is medium and K status is low in highlands and medium in lowlands.

10. Active Ganges Floodplain

Mildly alkaline; organic matter content low. General fertility level is medium with high CEC but deficient in N and available P and Zn.

11. High Ganges River Floodplain

Slightly alkaline; organic matter content in the brown ridge soils is low but higher in the dark grey soils. General fertility level is low although CEC is medium.

12. Low Ganges River Floodplain

Neutral to slightly alkaline; organic matter low in ridges and moderate in the basins. General fertility level is medium with high CEC and K status.

13. Ganges Tidal Floodplain

Most topsoils are acidic and subsoils are neutral to mildly alkaline. General fertility level is high with medium to high organic matter and very high CEC. Limitations are due to high exchangeable Na and low Ca/Mg ratio.

14. Gopalganj-Khulna Beels

Potentially strongly acidic; organic matter content is medium to high. Low in P status. Fertility level is medium.

15. Arial Beel

Moderately acidic; organic matter content generally exceeds two per cent. High CEC and general fertility level is medium to high.

16. Middle Meghna River Floodplain

Topsoils are strongly acidic and subsoils slightly acidic to slightly alkaline. General fertility level is medium with low N and organic matter.

17. Lower Meghna River Floodplain

Topsoils are moderately acidic and subsoils are neutral. General fertility level is medium to high with low to medium organic matter.

18. Young Meghna Estuarine Floodplain

Mildly alkaline. General fertility is medium but low in N and organic matter. Sulphur status is moderate to high.

19. Old Meghna Estuarine Floodplain

Topsoils are moderately acidic, but subsoils are neutral. General fertility level is medium. Potassium status is low in uplands and low to moderate in lowlands.

20. Eastern Surma-Kushiyara Floodplain

Strongly acidic to neutral. Organic matter content is moderate. CEC and Zn level are high, other essential nutrients medium.

21. Sylhet Basin

Mainly acidic; organic matter content is moderate. Fertility level is medium to high with low P and high Zn content.

22. Northern and Eastern Piedmont Plain

Slightly acidic to strongly acidic. General fertility level is low to medium.

23. Chittagong Coastal Plain

Moderately acidic. Organic matter content is low to moderate. General fertility level of the soils is medium, but N and K are limiting. Status of S is high.

24. St Martin's Coral Island

Neutral; general fertility level is low.

25. Level Barind Tract

Slightly acidic to acidic; organic matter status is very low. Most of the available nutrients are limiting.

26. High Barind Tract

Acidic to strongly acidic; low organic matter status. General fertility status is low. Zinc level is medium to high.

27. North Eastern Barind Tract

Strongly acidic; low organic matter. General fertility level is poor with high Zn status.

28. Madhupur Tract

Strongly acidic with low organic matter status. Low fertility level. Soils are mainly phosphate fixing and low in K, S and Ca.

29. Northern and Eastern Hills

Acidic; low organic matter. General fertility level is low.

30. Akhaura Terrace

Strongly acidic with low organic matter. General fertility is low.

Present status of different major nutrients in Bangladesh soil

Nitrogen

- Nitrogen is generally considered as the key nutrient in Bangladesh agriculture because of its low supply in the soils.
- Most of the agricultural soils are critically deficient in this nutrient. The main reasons are:
  Intense decomposition of organic matter
  Rapid removal of mineralized products under high leaching conditions and crop removal

Phosphorus

- In Bangladesh agriculture, phosphorus is the second most important nutrient element limiting successful crop production.
- In acidic terrace and brown hill soils, iron and aluminum oxides at low pH largely fix phosphorus, while in calcareous soils fixation occurs by calcium and magnesium carbonates.
- The net result of fixation is a decrease in the immediate availability of native and applied P.
- In medium to heavy textured soils, the available P contents up to 10 mg kg^{-1} are interpreted as low, 11-22 mg kg^{-1} as medium and 23-65 mg kg^{-1} as optimum for upland crops.
- The critical level of P by the Olsen method, which is extensively used for rice soils, has been considered as 10 mg kg^{-1} in Bangladesh.
- Significant yield responses to applied P have been recorded in pulses and leguminous oilseed crops like mungbean, chickpea and groundnut.

Potassium

- Potassium is the third major plant nutrient recently identified as deficient in most Bangladesh soils.
- Wide-spread deficiency of potassium is prevalent tubers, root crops, sugarcane, fruit, fibre crops and cereals.
- Alluvial soils are richer than terraces and brown hill soils.
- Critical levels:
  Low:-0.09-0.18 meq/100 g soils
  Medium:-0.18-0.27 meq/100 g soils
  Optimum:-0.27-0.36 meq/100 g soils

Sulphur

- S-deficiency in wetland rice was first detected in 1977 at the Bangladesh Rice Research Institute farm and on nearby farmers' fields.
- In Bangladesh agriculture sulphur has been identified as the fourth major nutrient limiting crop production since early eighties.
- Since then sulphur deficiency in Bangladesh soils is becoming wide-spread and acute.
- The use of high amount of fertilizer, cultivation of high yielding varieties, increasing cropping intensities and limited application of organic manure have all contributed to the intensification of the S deficiency problem in the soils.
- The problem is more severe in wetland rice than in upland crops because the anaerobic soil conditions in which wetland rice is grown reduces sulphates making S unavailable to plants.
- Among the upland crops, oilseeds are most affected by S deficiency problems. Oilseed crops are highly responsive to added S in most Bangladesh soils.
- Beneficial effects of sulphur fertilization have been reported on mungbean, blackgram and chickpea.
- The critical level of S for Bangladesh soils has been determined as 10 mg kg^{-1}1soil.

Magnesium and Calcium

- The pH values of Bangladesh soils generally range between 5.8 and 7.0.
- Thus, most of our soils have adequate Mg and Ca saturation.
- But Acid Hill soils and Old Himalayan Piedmont soils are extremely low in exchangeable Ca and Mg.
- Magnesium deficiency problems have been observed on potato, cotton, sugarcane and tea grown on these soils.
- Although Ca is also inadequate in these soils, application of TSP, SSP and gypsum to supply P and S satisfactorily meet of Ca demand of the crops.
- Critical level of Mg is 0.80 meq $100g^{-1}$, and Ca is 2.00 meq $100g^{-1}$

Zinc

- The importance of zinc in crop nutrition has received considerable attention in the recent years.
- The incidence of zinc deficiency is wide spread in most calcareous and alkaline soils.
- The problem is more acute in wetland rice culture.
- The critical level of Zn in rice plant tissue is generally considered as 20 ppm.
- Yield responses of rice to zinc fertilization have well documented indifferent soils of Bangladesh where zinc contents are below the critical level.
- Zinc sulphate is the main source of zinc used in Bangladesh agriculture

Balanced Fertilization in Bangladesh

- Balanced fertilization is the key to successful crop production and maintenance of good soil health.
- It is important to see how close nutrient addition and removal by crops match with each other.
- The farmers of Bangladesh use 215 kg nutrients (N: 149 kg, P_2O_5: 37 kg, K_2O: 22 kg and S + Zn + B + others: 7 kg) ha^{-1} $year^{-1}$, while the estimated removal is around 280 -350 kg ha^{-1}.
- From organic and natural sources about 50-70 kg nutrients are added to the soil system every year.
- Severe mining of N and K are going on in the country's soil system.
- IPNS can only provide ideal nutrition for a single crop/crops grown in a pattern.

Scenario and Future Perspectives of Soil Fertility in Bangladesh

- Bangladesh has no alternative but to maximize crop yields per unit area through intensive use of land and soil resources.

- Future soil research and development should be directed towards maximizing crop yields per unit area in intensive cropping systems as well as making the achieved yield levels sustainable through fighting intelligently against soil deterioration.
- Soil organic matter level is alarmingly low in all soil types of the country. It is generally around 1% in most and around 2% in few soils.
- Therefore, research should be carried out on organic matter build up through green manuring/organic manuring and assessment of their contribution to soil fertility and crop production in different agro ecological zones (AEZs) of the country.
- Bangladesh should continue her efforts to search effective and usable means of improving N use efficiency.
- Soil test crop response correlation studies should be strengthened and carried out following local procedure of soil test, greenhouse studies and field trials to generate reliable information for fertilizer recommendations.
- Continuous trials with various cropping patterns are essential for evaluating long term fertilization effects.
- For sustained high yields it is recommended to not only consider soil values and yield, but also to evaluate nutrient input and uptake/removal balances.
- Maximum potential yield (MPY) and maximum economic yield (MEY) research should be strengthened under the leadership of soil scientists.
- Research on salt affected soils, acid-sulphate soils, acidic soils and few other soil problems needs strengthening.
- Research should be carried out in future to develop appropriate soil and crops management practices for best possible utilization of these land resources.
- In hilly areas of Bangladesh, topographic farmers and faulty cultivation practices have been encouraging soil erosion at unusually high rates.
- The future soil research in the erosion prone areas should cover estimation of annual soil loss, and development of suitable soil and water conservation practices.
- In Bangladesh, no research in the past was directed towards degradation and pollution of soil environment through various ways and means.
- City wastes represent a potential storehouse for an immense quantity of energy and nutrients. Research may be undertaken to develop technologies for producing compost .
- Biological nitrogen fixation is another important research area where future research and development in this area should be strengthen.