Balanced Fertilizer Use-A Key to Sustainable Agriculture

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ABSTRACT

For India, striking a balance between high agricultural output and environmental stewardship is a critical task. Increased fertilizer use due to population pressure has led to serious soil deterioration, nitrate contamination of groundwater, and greenhouse gas emissions. The patterns in fertilizer usage in India underscore the dangers that uneven nutrient application poses to the ecosystem. It recommends Integrated Nutrient Management (INM), which blends chemical, organic, and nano fertilizers, as well as rigorous soil testing.

INTRODUCTION

Achieving a balance between high productivity and environmental responsibility requires effective fertilizer use. It has been discovered that both chemical and organic fertilizers significantly contribute to groundwater nitrate enrichment as well as ammonia and nitrogen oxide (NOx) pollution of the environment. Developing nations like India account for over 17 per cent of the world's population despite making up only 2.5 per cent of its total land area. India's population grew from 361 million in 1951 to 1441.7 million in 2023, a significant increase in population pressure that caused people to use more fertilizer because there was no more arable land (Anonymous 2024). In contemporary agriculture, balanced fertilizer use is crucial, as is integrated soil

management, which is essential for increasing crop sustainability and productivity. Sustainable agriculture aims to satisfy society's current food and textile requirements without jeopardizing the capacity of future generations to satisfy their own. India's Green Revolution has made food production self-sufficient. Although recently introduced crop types have responded well to inputs, this has required more fertilizer, which has changed the ground water table and contaminated water with phosphate and nitrate.

SUSTAINABLE AGRICULTURE

Sustainable agriculture is an integrated system of plant and animal production practices with a site-specific application that will, over time: (a) satisfy human food and fiber needs; (b) enhance environmental quality; (c) make efficient use of non-renewable resources and on-farm resources and integrate appropriate natural biological cycles and controls; (d) sustain the economic viability of farm operations; and (e) enhance the quality of life for farmers and society as a whole.

INDIA'S FERTILIZER CONSUMPTION

Although food grain production has increased to many folds India's fertilizer consumption has also increased significantly over the decades, due to increased use of fertilizers soil nutrition is lost in the process of cultivation. Since 1990, the number of inorganic fertilizers used in agriculture in Asia has nearly doubled, from 56.0 Mt to 110.5 Mt. In 2020, the area accounted for 55% of the world's agricultural usage of inorganic fertilizers. Between 1990 and 2020, the use of nitrogen fertilizers increased by 78%, phosphorus by 90%, and potassium by 254%, from 5.3 Mt to 18.9 Mt. Between 1990 and 2020, Asia's production of inorganic fertilizers increased by 138%, accounting for nearly half of the world's total in 2020. With increasing and unbalanced use of fertilizer several challenges arise such as environmental pollution, groundwater contamination, soil degradation, etc. Concerning these changes in the environment sustainable crop production becomes necessary.

CONCERNS WITH INCREASING FERTILIZER USE

SOIL DEGRADATION

Soil degradation is one of the most urgent issues brought on by over use of chemical fertilizers. 33 per cent soils are already degraded (FAO, 2021). When applied excessively, chemical fertilizers, particularly those high in nitrogen, phosphorus, and potassium (NPK), can quickly raise the acidity of the soil. The soil becomes less fertile and less able to sustain healthy plant growth as a result of this acidification, which gradually depletes vital soil nutrients and upsets the pH equilibrium. Indian farmers, especially those with tiny landholdings, may apply fertilizers without knowing the precise requirements of their soil because they frequently lack access to thorough soil testing. This exacerbates soil degradation by creating a vicious cycle of using more fertilizer to sustain yields.

GROUND WATER CONTAMINATION

Fresh groundwater habitats are seriously threatened by non-point contamination from fertilizers used in agriculture, which are frequently scattered across wide distances. High nitrate concentrations in groundwater are caused by the leaching of residual nitrate from the extensive use of chemical fertilizers in agriculture and the careless disposal of human and animal waste on land. However, soil texture, fertilizer usage patterns, their breakdown products, and the amount of organic matter in the soil all affect groundwater's susceptibility to fertilizer pollution.

NUTRIENT RUNOFF

Large amounts of nutrients are left unutilized in soil due to excessive and uneven fertilizer usage, which increases the soil's susceptibility to leaching and runoff. Despite increased fertilizer use worldwide, crops usually only recover 30 to 50 percent of the nitrogen that is supplied, which means that a significant portion is lost from the soil system. These losses accelerate eutrophication, algal blooms, and hypoxia downstream by increasing the transport of nitrate and phosphate into surface and groundwater. Nutrient imbalance (high N with insufficient P, K, or micronutrients) deteriorates soil health, lowers nutrient-use efficiency, and increases reliance for larger fertilizer inputs at the soil level. Nitrous oxide (N2O) emissions, a powerful greenhouse gas that links poor soil management to climate change, are also greatly increased by nutrient runoff from agricultural soils.

SUSTAINABLE PRACTICES FOR FERTILIZER USE

SOIL TESTING

The scientific basis for balanced fertilizer use—that is, providing nutrients in the proper kind, quantity, timing, and technique—is soil testing. Every goal of soil testing advances sustainable agricultural development and supports this idea.

INTEGRATED NUTRIENT MANAGEMENT (INM)

Integrated Nutrient Management (INM) is a farming strategy that combines organic, inorganic (chemical), and biological nutrient sources in a balanced manner to maintain soil fertility and meet crop needs sustainably, increasing productivity while protecting the environment.

COMBINED FERTILIZER USE

The agricultural chemical company Yara carried out a traditional long-term trial at Haninghof, Germany, to investigate the long-term impacts of various nutrient management techniques. In contrast to unbalanced nutrition, the effects of applying balanced mineral fertilizer and combining farmyard manure (FYM) with mineral fertilizer on indices of sustainable crop output are assessed.

CROP ROTATION AND COVER CROPPING

Reduce the demand for synthetic fertilizers by maintaining soil health and stability through crop rotation and cover crops. Additionally, by supplying nutrients directly to the root zone through irrigation, cutting waste, and encouraging ideal growth, fertigation systems can increase the effectiveness of fertilizer use.

CONCLUSION

Because it balances crop output with soil and environmental health, balanced fertilizer use is essential to sustainable agriculture. In order to minimize losses and degradation, soil test-based nutrient delivery guarantees the right nutrients, in the right amount, at the right time. Soil biological activity and nutrient utilization efficiency are improved by combining chemical fertilizers with organic manures, biofertilizers, and contemporary techniques like fertigation. These methods lower greenhouse gas emissions, fertilizer runoff, and groundwater contamination. Balanced fertilization maintains long-term crop yields and farm profitability by reestablishing soil fertility and resilience. In the end, it is a science-driven route to agriculture that is resource-efficient, climate-resilient, and ecologically conscious for coming generations.

REFERENCES

Anonymous. 2024. Agricultural statistics. Directorate of economics and statistics, Department of agriculture, Cooperation and Farmers welfare, Ministry of Agriculture, Government of India, New Delhi p 44-48

FAO. 2021. *World Food and Agriculture - Statistical Yearbook*.