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REVIEW ARTICLE

Importance of Soil Health and Water Management in Agriculture

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ABSTRACT

Sustainable agriculture and food production are based on the fertility and health of the soil. Maintaining and improving soil quality is essential as the world's population continues to rise, putting more pressure on agricultural fields. In order to optimize yields, industrialized agriculture has mostly relied on synthetic fertilizers and pesticides. However, these methods have a negative impact on the environment and human health, which is leading many farmers to switch to organic methods that focus on long-term soil vitality. In addition to sequestering carbon, improving nutrient and water efficiency, decreasing erosion and runoff, and fostering biodiversity both above and below the soil surface, organic amendments and regenerative approaches hold great potential for creating healthy, rich soils. The growing worldwide water scarcity situation, which has a significant impact on agriculture, particularly in nations like India, highlights the need for water conservation in agriculture. Due to declining water supplies, which are made worse by climate change, agriculture, the world's biggest user of water, confronts serious difficulties. Hence, this study discussed the importance of soil health and water management in agriculture.

Key words: Irrigation, Soil, Sustainability, Management

INTRODUCTION

Chemical, physical, and biological aspects of soil quality all work together to support plant health and soil productivity. Organic matter content and biological activity, and diversity are two important measures of soil quality (Gaskell, 2021). Retaining nutrients and moisture, combining particles into stable aggregates, promoting soil biota, facilitating gas exchange, and providing plant-available nutrients upon decomposition are just a few of the many advantageous functions of soil organic matter (Biswas, 2025a). Through the breakdown of organic matter, nutrient mobilization and retention, soil aggregation, and disease suppression, a variety and quantity of soil organisms, such as mycorrhizal fungi and nutrient-cycling bacteria, also support soil health (Wezel *et al*., 2014). Both short-term and long-term soil quality are impacted by management choices such as organic amendments, cover crops, compost and compost tea treatments, reduced tillage, and plant diversity.

India is ranked 13th out of 17 "extremely water stressed" nations in the world by the World Resources Institute, indicating a serious mismatch between water availability and demand (Singh *et al*., 2022). Conflicts over water supplies are frequently the result of this scarcity, which is not limited to rural areas. Water shortage in agriculture results in lower crop yields, which has an impact on livelihoods and food security, especially in rural economies (Chen *et al*., 2018). Food security is seriously threatened by water scarcity, which can reduce agricultural production by 10–30%, according to the Food and Agriculture Organization (FAO). More than 80% of India's

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freshwater consumption comes from agriculture, which plays a crucial part in the country's water usage. This percentage is far higher than the global average of 70%. However, this also suggests that there is a lot of possibility for water saving in agriculture. Water waste can be significantly decreased using efficient irrigation techniques, such as switching from conventional flood irrigation to micro-irrigation methods like drip and sprinkler systems. Through micro-irrigation, the Pradhan Mantri Krishi Sinchayee Yojana of the Indian government seeks to improve water efficiency at the farm level. Water conservation efforts can also be strengthened by implementing water-smart agricultural techniques, including crop rotation, rainwater gathering, and the use of drought-resistant crop varieties.

Table 1: Key indicators of soil health (Burger *et al*., 2005)

Physical	Chemical	Biological
Bulk density	Soil pH	Respiration of soil
Porosity	Soil enzyme activities	Microbial biomass carbon and nitrogen
Void ratio	Soil organic matter	Mycorrhizal colonization
Soil structure and texture	Available nutrients like N, P, and K	Soil microbial community
Water holding capacity	Cation exchange capacity	Potentially mineralizable nitrogen

Table 2: Traditional water management practices in India (Murthy *et al*., 2022; Das, 2025)

Practice	Description
Baoli/Bawdi	Stepwells for water storage, also cultural and social sites
Kuhls	Gravity-based diversion channels for irrigation in mountains
Jhalara	Man-made tank for rainwater harvesting
Khadin	Rainwater harvesting using long earthen embankments
Surangam	Horizontal tunnels for groundwater collection
Pat	Bamboo drip irrigation for crops like pepper
Eri	Man-made lakes or reservoirs for water storage, irrigation

MATERIALS AND METHODS

Increasing soil organic matter is a primary goal and result of using organic soil health techniques (Burger *et al*., 2005). Plant compost, animal manures, leftovers, and other Carbon-based soil fertilizer microorganisms and wildlife while increasing moisture and the ability to bind and retain nutrients (Biswas, 2025b). Given the growing expense of inorganic fertilizer and environmental effects, maximizing and maintaining organic matter in the soil provides farmers with natural fertility originating from the cycle of organic nutrients rather than expensive external inputs with significant integrated energy expenses (Gaskell and Smith, 2007). Raising the carbon content of soil not only increases output but also reduces Carbon sequestration in response to climate change and decreased emissions of nitrous oxide (Behera *et al*., 2025; Biswas, 2025a).

Water resources in agriculture face more difficulties as a result of climate change. It modifies precipitation patterns, causing erratic and unpredictable rainfall, which exacerbates problems with water scarcity (Amiraly *et al*., 2004).

RESULTS AND DISCUSSION

Animal dung and compost have long been utilized as organic amendments, offering microbial communities, organic matter, and a slow-release source of nutrients. Nitrogen and phosphorus can be strategically supplied by more concentrated organic amendments, such as bone, blood, and feather meal (Altieri and Nicholls, 2003). Crop rotations that allow land to rest in pasture or cover crops provide renewable organic matter. Reducing carbon losses and stabilizing soil aggregates are two benefits of little tillage (Mbuthia *et al*., 2015). Nutrient cycling is supported when crops and animals are integrated. When combined, these organic methods seek to use natural biological processes to maintain fertility by feeding soils more than plants (Table 1).

Climate change is predicted to affect both the quantity and quality of water resources in India by causing temporal and spatial fluctuations in water availability. For example, global warming is causing the Himalayan glaciers, which are an important source of India's river systems, to recede. This has an impact on the flow of key rivers like the Ganges and the Indus, which are vital to India's agriculture (Roy and Majumder *et al*., 2020). In order to maintain sustainability, these changes necessitate the use of adaptable agricultural water management techniques (Singh *et al*., 2025; Biswas, 2025b) (Table 2).

CONCLUSION

Soil food is the source of soil biological fertility. The intricate network of living things dwelling in the soil is for all or a portion of their life. These organisms engage in dynamic interactions to cycle nutrients, support the structure of the soil, and plant health through mutually beneficial partnerships with roots. Mycorrhizal relationships between plants, soil fungi, and roots help plants absorb nutrients and water in return for carbohydrates derived from photosynthesis. Fixation of nitrogen was done by legume-associated rhizobium bacteria. Roots biologically produce atmospheric nitrogen accessible to plants. To lessen the effects of climate change on agricultural water resources, it is essential to incorporate climate-resilient agricultural practices, such as modifying sowing dates, using water-saving irrigation techniques, and utilizing climate-smart agricultural technologies.

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