UTILIZATION OF ORGANICS IN INDIAN AGRICULTURE: POTENTIAL, PATHWAYS AND PRACTICAL FEASIBILITY

Abstract

Concerns about the long-term sustainability of crop production have arisen due to recent observations of stagnant and/or declining yields. The intensive cultivation of high-yielding crop hybrids/varieties and imbalanced fertilizer use as a result of the green revolution have led to a decline in soil fertility and overall system sustainability in India [1]. In light of the negative impacts of chemical fertilizers and their rising costs, there is growing interest in the use of organic fertilizers as an alternative nutrient source for sustainable agriculture production [2]. Incorporating crop residues (CR) and other organic nutrient sources into agricultural soils has been found to benefit soil health and quality. The nutrient values of composts can be further enhanced by including low-grade rock phosphate (RP) and waste mica, along with the application of Aspergillus awamori [3] during the process of composting. Biochar, a carbon-rich byproduct obtained through the pyrolysis of CR and press mud (a byproduct from sugar factories), can also be served as an effective organic nutrient source [4]. On the other hand, liquid organic manures like panchagavya and beejamruth hold the potential for promoting plant growth in agricultural applications [5]. To ensure long-term soil fertility and productivity management, it is crucial to utilize organic sources of nutrients to partially replace the nutrient requirements of crops. This highlights the importance of recycling various organic materials as nutrient sources. Furthermore, community-level composting initiatives and extensive research on low-cost organic nutrient sources at local, regional, and national levels should be explored to address this need.

Keywords: Sustainability, organics, chemical fertilizer, soil health, recycling

Authors

Pooja Tamuk
Soil Science and Agricultural Chemistry
ICAR-IARI, New Delhi.
tamukpooja09@gmail.com

Mohankumar K T
Soil Science and Agricultural Chemistry
ICAR-IARI, New Delhi.
mohanpoothrimani@gmail.com

T. Giri Shashank Reddy
Soil Science and Agricultural Chemistry
ICAR-IARI, New Delhi.
girishashank75@gmail.com

I. INTRODUCTION

The utilization of organics in Indian agriculture has gained significant attention and importance in recent years. Organic farming involves the use of natural and eco-friendly practices to cultivate crops and raise livestock, focusing on sustainability, and soil health, and reducing the reliance on synthetic inputs. According to the Food and Agriculture Organization (FAO), organic agriculture relies on managing ecosystems rather than relying on external inputs such as synthetic fertilizers and pesticides [6]. Traditional agriculture that heavily relies on chemicals and intensive input has been successful in increasing crop yields and addressing global food security concerns since the 1960s, known as the green revolution. However, the excessive and unbalanced use of chemical pesticides and fertilizers has had negative impacts on the environment and human health [1]. As a result, there has been a growing demand for agricultural products that are free from chemical-based methods and follow organic practices. Over the past decade, the demand for organic products has been increasing at a rate of 16% per year [7]. This trend can be attributed to several factors, including the escalating costs of chemical inputs like fertilizers and pesticides, the rising preference for non-genetically modified foods, and increasing demands for organic foods worldwide due to health and environmental benefits. Farmers are increasingly being drawn towards adopting organic and environmentally-friendly agricultural methods. Organic fertilizers, such as compost, vermicompost, and green manure, enhance soil fertility and provide essential nutrients to crops. It encourages crop diversification, which helps in maintaining soil health and prevents pest and disease outbreaks through biological pest control while promoting the efficient use of natural resources.

II. POTENTIAL ROLE OF ORGANICS IN INDIAN AGRICULTURE

The negative impacts of chemical fertilizers, coupled with escalating prices, have led to growing interest in the use of organic fertilizers as a source of nutrients [2]. The use of manure holds great promise for higher productivity levels and also against the emergence of multiple nutrient deficiencies and deterioration of soil health [8]. There is a great potential for utilizing organic wastes as manure and soil conditioner, as it can increase the content of nutrients in a form available for the plant, enhancing the rate of mineralization in soil and developing an efficient method for composting [9]. The organic waste like crop residue can be converted to FYM or compost and its nutrient content can be further enriched by the incorporation of low-grade rock phosphate (RP) and waste mica along with *Aspergillus awamori* [3]. The nonavailability of nutrients at affordable prices has rekindled the global interest in organic residue recycling practices like composting, enriched compost, etc., [3]. However, a major portion of it is burnt resulting in the harmful environmental implication through the global addition of CO_2 [10] due to the shortage of human labour, the high cost of removing the crop residue from the field, and mechanized harvesting of crops [11]. The bio-decomposer namely Pusa Decomposer a liquid mixture potentially containing *Aspergillus nidulans*, *Aspergillus awamori*, *Phanerochaete chryosporium,* and *Trichoderma viride*, was developed by The Indian Council of Agricultural Research (ICAR)-Indian Agricultural Research Institute (IARI) to encourage farmers to avoid stubble burning and go for conservation agriculture. It helps maintain crop residues in the field after harvest to stabilize soil fertility. Therefore, recycling of crop residues-both, directly and indirectly, provides principal benefits like improving the water storage capacity of soils, enrichment with organic matter, and nutrient recycling [10]. Research studies have shown that the return of crop

residues improved the tilth and fertility of the soil, crop productivity, reduce wind and water erosion, and prevented nutrient losses by run-off and leaching [12]. Therefore, the incorporation of crop residues (CR) and other organic sources of nutrients in agricultural soils have been reported to benefit soil health. Retention or incorporation of CR enhances soil carbon and the availability of essential nutrients to the crop. Crop residues can be used as an effective replacement for inorganic potassium (K) fertilizers as more than 90% K content reserved in crop straw can be released during the first 30 days of decomposition [13]. Crop residue supplies all major nutrients (N, P, K, Ca, Mg, S) and micronutrients (Fe, Mn, Cu, and Zn) and helps to improve soil fertility and biological activity necessary for plant growth [14]. Sewage sludge is an effective organic fertilizer causing increments in the biomass of many crops [15]. However, its long-term use can cause heavy metal accumulation in the soil.

Liquid organic manures are based on Indigenous Technical Knowledge (ITK) is an organic product that has the potential to play the role of promoting growth and providing immunity in plant systems [5]. The Panchagavya, Jeevamruth, and Beejamruth are eco-friendly organic preparations made from cow products, and these liquid organic solutions are prepared from cow dung, urine, milk, curd, ghee, legume flour, and jaggary [16]. Biochar also offers a significant, multidimensional opportunity to transform large-scale agricultural waste streams from financial and environmental liability to valuable assets by the conversion of crop residue biomass into biochar and using the char as a soil amendment rather than directly using the crop residues as biochar being concentrated during pyrolysis contains a higher amount of nutrients [17]. Pressmud like other organic manures has great potential to supply nutrients in addition to its favorable effects on the soil as it is a very effective soil ameliorant [4]. The slaughtered house waste could serve as a valuable and environmentally friendly fertilizer [18]. Castor meal was also often used as an organic fertilizer for plant nutrition [19]. Experiments carried out in pots revealed that the yield of tomatoes and critical nutritional parameters showed a significant increase upon the application of biowaste from the tobacco industry [20].

III. PATHWAYS INVOLVED IN THE UTILIZATION OF ORGANICS IN AGRICULTURE

The utilization of organics in agriculture involves several pathways and practices. Organic farming relies on the use of natural fertilizers, such as compost, vermicompost, and farmyard manure [21], [22]. These fertilizers are derived from organic sources like animal waste, crop residues, and green manure. They provide essential nutrients to plants while improving soil health and fertility. In the absence of external inputs such as pesticides, crop rotation, and intercropping help break pest and disease cycles, improve soil health, and enhance nutrient availability while, simultaneously growing two or more crops in the same field, promoting biodiversity and maximizing land use efficiency. Introduction of natural predators, parasitoids, or beneficial insects as biological control methods to manage pests' populations and diseases [23]. Additionally, use of trap crops, companion planting, and physical barriers to minimize pest damage without relying on chemical pesticides. For organic weed management, various strategies are employed to control weeds without synthetic herbicides. These include mechanical methods like hand weeding, mulching with organic materials, cover cropping, and crop rotation to suppress weed growth and competition. As organic agriculture prioritizes soil health and conservation, various practices could be adopted for soil Conservation like conservation tillage, contour plowing, terracing,

and erosion control measures to prevent soil erosion, maintain soil structure, and preserve soil moisture. Organic farming promotes efficient water use through techniques like drip irrigation, rainwater harvesting, and moisture conservation methods. These practices help reduce water wastage and improve water availability for crops. Composting of organic materials like press mud with rock phosphate and *Aspergillus awamori, is* used efficiently as a source of P-fertilizer [4], [24], [25]. Bio-intervention of waste mica with *Bacillus mucilaginosus* could be used efficiently as a source of K-fertilizer for sustaining crop production and maintaining soil potassium [26]. Another possible means of improving the effectiveness of waste mica is through composting technology along with low-grade RP [3].

Organic certification and maintenance of standards are very important to ensure its authenticity and quality [27]. Certification bodies establish standards and guidelines for organic farming practices, including the use of organic inputs, pest and disease management, and environmental sustainability. Organic agriculture integrates livestock and crop production systems. This closed-loop system minimizes external inputs and enhances nutrient cycling. The utilization of organics in agriculture is supported by the development of organic markets and value chains. Organic produce is marketed through specialized channels, including organic food stores, farmers' markets, and direct-to-consumer sales. Consumer awareness and demand for organic products drive the growth of these markets. These pathways collectively contribute to the utilization of organics in agriculture, promoting sustainable practices, environmental stewardship, and the production of high-quality organic food.

IV. PRACTICAL FEASIBILITY ASSOCIATED WITH THE UTILIZATION OF ORGANICS IN AGRICULTURE

Utilizing organic methods in Indian agriculture brings numerous advantages, including enhanced soil health, decreased chemical contamination, increased biodiversity, and greater market value for organic produce [28]. However, there are challenges to overcome, such as limited awareness, the availability of organic inputs, and the transition from conventional to organic farming. Additionally, the question arises whether large-scale organic farming can meet India's food demands since it typically yields lower crop productivity compared to conventional methods that rely on synthetic inputs [29]. Organic manure alone cannot replace fertilizers due to slower nutrient release and its constraint in transportation due to its bulkiness [1]. Therefore, it is crucial to explore the relationship between organic farming and agricultural sustainability.

To address this concern, several factors should be considered like improving organic farming techniques and adopting innovative practices that can enhance productivity. This includes optimizing organic fertilizers, implementing efficient irrigation methods, and adopting crop varieties suitable for organic systems [21]. Availability of appropriate seeders and finding alternative uses for crop residues are important considerations. Incorporating straw into the soil and using a pusa decomposer can manage paddy straw effectively. Promoting crop diversification and integrated farming approaches can further increase overall food production. Furthermore, supportive policies and infrastructure are crucial for the growth of organic farming. Ensuring the availability of organic inputs, providing credit and insurance access to organic farmers, establishing certification standards, and developing marketing channels for organic produce are vital steps [27]. The certification and conversion

cultivated area under organic farming reached 2.66 million ha by March 2021 [27], while around 0.73 m ha is brought under the Participatory Guarantee System (PGS). The increasing rejection of conventionally grown produce by health-conscious individuals and their willingness to pay higher prices for organic products create opportunities for farmers.

V. CONCLUSION

Although the potential of organic farming to provide high-quality and environmentally friendly food is recognized, the challenge of meeting India's food requirements through organic farming alone is a subject of discussion. However, with appropriate strategies, technological advancements, and policy support, it is possible to improve organic farming productivity and gradually increase its contribution to fulfilling India's food needs. Sustained efforts from research institutes, developmental organizations, progressive farmers, input dealers, processors, and other stakeholders are warranted for better adoption of organic farming in Indian scenarios.

REFERENCES

[1] N.C. Mahajan, R.K. Naresh, M.S. Chandra, P.K. Kanaujiya, M.P. Singh, A. Kumar, and K. Lokeshwar, “Can organic manures replace chemical fertilizers to enhance nitrogen and water use efficiencies of rice-wheat systems? A review,” J. Pharm. Innov., Vol. 10, no. 7, pp. 1133-1142, 2021.

[2] K.B. Meena, M.S. Alam, H. Singh, M.A. Bhatt, A.K. Singh, A.K. Mishra and T. Thomas, “Influence of farmyard manure and fertilizers on soil properties and yield and nutrient uptake of wheat,” Int. J. Chem. Stud., vol. 6, no. 3, pp. 386–390, 2018.

[3] M. D. Meena, and D. R. Biswas, “Residual effect of rock phosphate and waste mica enriched compost on yield and nutrient uptake by soybean,” Legume. Res., vol. 36, no. 5, pp. 406 - 413, 2013.

[4] S. Kumar, R.S. Meena, D. Jinger, H.S. Jatav, and T. Banjara, “Use of pressmud compost for improving crop productivity and soil health,” Int. J. Chem. Stud., vol. 5, no. 2, pp. 384–389, 2017.

[5] P. K. Upadhyay, A. Sen, S. S. Rathore, and B. Kumar, “Scientific validation of indigenous organic formulation-panchagavya for sustaining rice productivity and residual effect in rice-lentil system under hot semi-arid eco-region of middle Indo-Gangetic plains," Indian J. Tradit. Knowl., vol. 18, no. 1, pp. 104-113, 2019.

[6] J.T. Willer, C. Meier, and B. Schlatter,” The world of organic agriculture: statistics & emerging trends 2021,” 2021.

[7] J. Aschemann-Witzel, G. Ares, J. Thøgersen, and E. Monteleone, “A sense of sustainability? – How sensory consumer science can contribute to the sustainable development of the food sector,” Trends Food Sci. Technol., vol. 90, pp. 180–186, Aug. 01, 2019.

[8] A. Iqbal, L. He, I. Ali, S. Ullah, A. Khan, K. Akhtar, S. Wei, S. Zhao, J. Zhang, and L. Jiang, “Manure combined with chemical fertilizer increases rice productivity by improving soil health, post-anthesis biomass yield, and nitrogen metabolism,” PLoS One, vol. 15, no. 10, Oct. 2020.

[9] K. Lamessa, “Integrated Nutrient Management for Food Security and Environmental Quality,” Food sci. qual. manag., vol. 56, pp. 32-41, 2016.

[10] M. I. Abdurrahman, S. Chaki, and G. Saini, “Stubble burning: Effects on health & environment, regulations and management practices,” Environ. Advan., vol. 2, Dec. 01, 2020.

[11] National Policy for Management of Crop Residues (NPMCR) “Incorporation in soil and Mulching Baling/ Binder for domestic/industrial as fuel Government of India Ministry of Agriculture Department of Agriculture & Cooperation (Natural Resource Management Division),” Krishi Bhawan, New Delhi, 2014.

[12] S. G. Choudhury, S. Srivastava, R. Singh, S.K. Chaudhari, D.K. Sharma, S.K. Singh and D. Sarkar,“Tillage and residue management effects on soil aggregation, organic carbon dynamics and yield attribute in rice-wheat cropping system under reclaimed sodic soil,” Soil Tillage Res., vol. 136, pp. 76–83, Mar. 2014.

[13] N. Sui, C. Yu. et al., “Comparative effects of crop residue incorporation and inorganic potassium fertilisation on apparent potassium balance and soil potassium pools under a wheat-cotton system,” Soil Res., vol. 55, no. 8, pp. 723–734, 2017.

[14] S. Sharma and S. S. Dhaliwal, "Effect of Sewage Sludge and Rice Straw Compost on Yield, Micronutrient Availability and Soil Quality under Rice–Wheat System," Commun. Soil Sci. Plant Anal., vol. 50, no. 16, pp. 1943–1954, 2019.
[15] R. Meena, S. P. Datta, D. Golui, B. S. Dwivedi, and M. C. Meena, "Long-term impact of sewage irrigation on soil properties and assessing risk in relation to transfer of metals to human food chain," Environ. Sci. Pollut. Res., vol. 23, no. 14, pp. 14269–14283, Jul. 2016.
[16] N. S. Gore and M. N. Sreenivasa, "Influence of liquid organic manures on growth, nutrient content and yield of tomato (Lycopersicon esculentum Mill.) in the sterilized soil*," Karnataka J. Agric. Sci., vol. 24, no. 2, pp.153-157, 2011.
[17] S. Ch, K. A. Gopinath, and V. Govindarajan, "Use of Biochar for Soil Health Management and Greenhouse Gas Mitigation in India: Potential and constraints Organic Farming View project Elevated Carbon Dioxide and Climate Change on Crop Plants View project," 2013.
[18] M. Roy, S. Karmakar, A. Debsarcar, P. K. Sen, and J. Mukherjee, "Application of rural slaughterhouse waste as an organic fertilizer for pot cultivation of solanaceous vegetables in India," Int. j. recycl. org. waste agric., vol. 2 no. 6, 2013.
[19] Z. S. Liu, J. M. Wu, and Y. H. Lin, "Optimum castor meal application in the cultivation of pak choi (Brassica chinensis l.) with toxicity survey for earthworms (Eisenia andrei)," Horticulturae, vol. 7, no. 10, Oct. 2021.
[20] S. Chaturvedi, D. K. Upreti, D. K. Tandon, A. Sharma, and A. Dixit, "Bio-waste from tobacco industry as tailored organic fertilizer for improving yields and nutritional values of tomato crop," J. Environ. Biol., vol. 29, pp.759–763, 2008.
[21] E.-M. Meemken and M. Qaim, "Organic Agriculture, Food Security, and the Environment," Annu. Rev. Resour. Econ., vol. 10, pp. 39–63, 2018.
[22] D. Nandan, "Organic Farming and Feasibility of Agricultural Systems," Int. J. Mod. Agric., vol. 10, no. 1, 2021.
[23] H. Abdel Farag El-Shafie, "Insect Pest Management in Organic Farming System," Multifunctionality and Impacts of Organic and Conventional Agriculture, Intech Open, 2020.
[24] D. R. Biswas and G. Narayanasamy, "Rock phosphate enriched compost: An approach to improve low-grade Indian rock phosphate," Bioresour. Technol., vol. 97, no. 18, pp. 2243–2251, Dec. 2006.
[25] S. K. Reza, S. Singh, S. C. Datta, T. J. Purakayastha, and S. K. Singh, "Phosphorus Solubilization Through Organic Acids Production in Pressmud Composted with Rockphosphate," Natl. Acad. Sci. Lett., vol. 40, no. 1, pp. 13–16, Feb. 2017.
[26] K. Rani, D.R. Biswas, R. Bhattacharyya, S. Biswas, T.K. Das, K.K. Bandyopadhyay, and K. Kaushik,"Bio-activation of waste mica through potassium solubilizing bacteria and rice residue," The Indian Journal of Agricultural Sciences, vol. 92, no. 1, pp. 75–79, Jan. 2022.
[27] APEDA, "Agricultural and Processed Food Product Export Development Authority" https://apeda.gov.in/apedawebsite/ organic/organicproducts.htm. 2021.
[28] S. Das, A. Chatterjee, and T. K. Pal, "Organic farming in India: A vision towards a healthy nation," Food Quality and Safety, vol. 4, no. 2, pp. 69–76, 2021.
[29] A. A. Reddy, I. Melts, G. Mohan, C.R. Rani, V. Pawar, V. Singh, M. Choubey, T. Vashishtha, A. Suresh, and M. Bhattarai, "Economic Impact of Organic Agriculture: Evidence from a Pan-India Survey," Sustainability (Switzerland), vol. 14, no. 22, Nov. 2022.

