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DIVERGENT WAY OF SUSTAINING SOIL HEALTH THROUGH ORGANIC FARMING – A REVIEW

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ABSTRACT

Healthy soils are essential for resilient crop production with positive contributions to soil water retention. Soil health is dependent on a combination of biological, chemical and physical properties. Conventional farming practices actively deplete soil quality which can be enhanced by incorporating cover crops, animal manure and/ or compost in to the soil, all of which increase the amount of soil organic carbon (SOC). Sustained soil health can be achieved by moving back to the era of natural farming or organic way of agriculture. Recent meta-analyses with global coverage show that organic crop yields are on average 80%, 66–95% or 81% of conventional yields. Organic agriculture refrains from using synthetic fertilizers and pesticides while organic farming discussion starts with the question that how to meet the nutrient requirement of crops through organic manures to maintain crop and soil health. There is need for the standardization of suitable organic source for the specific crop and hunting good market for earning good profit from the produce. Management of soil health is challenge for maintaining crop & cropping system productivity under organic production systems. Thus, maintaining soil health is essential to human health, ecosystem functions and nature conservancy. So that soil health is more pertinent as global issue now than ever before for advancing food and nutritional security in sustained way.

Key words *: Soil health, sustainable, organic farming, compost, vermicompost.*

Soil health is connected with human health and nutritional security. The soil–human health nexus has also been recognized ever since the dawn of civilization (Brevik and Sauer, 2015). Quantity, quality, and dynamics/turnover of SOC are critical to soil health and its threshold level in the root zone is 1.5–2.0%. (Lal, 2014). Organic agriculture is a production system that avoids or largely excludes the use of synthetic compound fertilizers, pesticides, growth-regulators and livestock-feed additives, and thus offers some solutions to the problems currently besetting the agricultural sector of industrialized or green revolution countries. The objectives of environmental, social and economic sustainability are the basics of organic farming (Stockdale, 2001). In the last 15 years, organic agriculture has grown rapidly and today it is being practiced in 178 countries of the world on 97.7 million hectares area constituting 1.2 % of the global agriculture land while in India is only 5.7 million hectare). In 2016, the countries with the largest organic markets were the United States (38.9 billion euros), Germany (9.7 billion euros), and France (6.7 billion euros). The largest single market was the United States (47 percent of the global market), followed by the European Union (30.7 billion euros, 37 percent), and China (5.9 billion euros, 6 percent) (Willer et. al., 2018).

Growing awareness regarding health benefits of organic food consumption, rising per capita spending on organic food products and increasing health concerns due to growing number of chemical poisoning cases are expected to drive global organic food market in the coming years. To supplement this demand, farmers have taken to organic farming for getting price premiums which resulted in around 37.5 million hectare land across the globe under organic farming. India can take advantage of the growing opportunities in organic agriculture by making use of its varied agro-climatic conditions and traditional organic resources and farming practices (Mahale, 2002).

Concept of Soil Health Management

Healthy soil is the foundation for profitable, productive, and environmentally sounds agricultural systems. Soil is a critical resource—the way in which it is managed can improve or degrade the quality of that resource. A healthy soil provides many functions that support plant growth, including nutrient cycling, biological control of plant pests, and regulation of water and air supply. These functions are influenced by the interrelated physical, chemical, and biological properties of soil, many of which are sensitive to soil management practices. There is worldwide agreement within organic standards that organic farming systems should maintain or increase soil fertility on a long-term basis. Conversion from a conventional fertiliser regime to an organic soil building process firstly involves eliminating the use of artificial chemicals in the farming system. Organic matter content, microbial activity and general soil health are taken as measures of soil fertility. An analysis of organic farming systems in Europe (Stolze *et al.,* 2000) has found that organic farming increased the microbial activity by 30-100% and microbial biomass by 20-30%.

Principles of Sustaining Soil Health

The principle of health aims that organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible. Important facts under principle of health are as follows :

Health of individuals and communities cannot be separated from the health of ecosystems.

Health is the wholeness and integrity of living systems through the maintenance of physical, mental, social and ecological well-being.

Immunity, resilience and regeneration are key characteristics of health.

Sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings.

Organic agriculture is intended to produce high quality and nutritious food that contributes to preventive health care and well-being.

In view of these, it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Organic farming's basic tenet is the creation of a healthy and fertile soil on which rest of the farm agro-ecosystem is built. The concepts of the Living Soil and the Law of Return are fundamental principles of organic agriculture. The 'aliveness' or dynamic nature of soil is intrinsic to organic agriculture. Organic proponents often equate the quality of soil with the level of health of plants and animals, and in-turn humans, living on that soil.

Soil Health Management Phases

Organic conversion is not just about replacing a high-input chemical system with a no-input system. The organic soil, building process goes through three critical stages viz., the adjustment phase, the comfort phase and the maintenance phase.

(i) Adjustment phase : The adjustment phase is the first critical stage during the organic conversion process that involves developing a system that reduces the crop's reliance on artificial chemicals and increasing biological activity by providing optimal soil conditions. The length of this preliminary soil building process will largely depend on the soils' pre-existing condition. The challenge for the organic farmer is to implement a cost-effective strategy which encourages and builds biological processes within the soil whilst still maintaining optimal plant nutrition.

(ii) Comfort phase : The comfort phase coincides with an increase in biological activity and a corresponding release of previously 'locked-up' or unavailable nutrients. Organic farmers should take care that over fertilisation does not occur during the comfort phase. This is more likely to occur in intensive organic systems where applications of compost and green manuring are common practice. Organic farmers are encouraged to regularly monitor soil nutrient levels. Soil and plant tissue-testing enables nutrient requirements to be tracked thus avoiding 'over feeding' the soil system.

(iii) Maintenance phase : Research has indicated that some organic systems have, over a longer period of time, undergone a decline in soil nutrient reserves (Small *et al,* 1994; Penfold, *et.al,* 1995). This could be attributed to long term drawing down of nutrients during harvesting of crop or livestock products and through natural processes such as leaching. Nutrient budgeting by reconciling inputs and outputs to the soil system and correlating with regular soil tests and crop performance can help organic producers track the performance of the soil nutrient cycle.

Impact of Organic Farming on Soil Health (Kondvilkar, 2019)

(A) Impact on Physical Properties of soil

The physical properties of soil denote structure, texture, bulk density, porosity, water-holding capacity etc. and positive effects of organic farming on soil physical properties viz. soil structure, water holding capacity, soil aeration and soil temperature are well-reported viz., organic management can improve soil structure, organic matter content, and porosity in soil.

Crop rotation is directly and indirectly influences the physical structure of the soil.

Mulching of soil surface with organic materials renders the soil soft, pulverized, and humid that ultimately creates a congenial environment for beneficial microbes to maintain bulk density and porosity in the soil.

Organic farming adds more organic matter to the soil and presence of this organic matter in soil increases its moisture retention capacity.

(B) Impact on Chemical Properties of Soil

Application of different organic inputs like FYM, vermicompost, green manuring etc. ensures both the sustainability of soil organic carbon and supply of nutrients to the plants. Application of good quality FYM improves the total nitrogen, and organic matter in the soil, which is "an important substrate of cationic exchange and the warehouse of most of the available nitrogen, phosphorus, and sulphur; the main energy source for microorganisms; and is a key determinant of soil structure".

Significant differences and higher values of soil organic carbon, carbon stocks, and carbon sequestration rate were observed in organically managed plots compared to non-organic plots. It is undoubtedly an important controlling factor for C:N

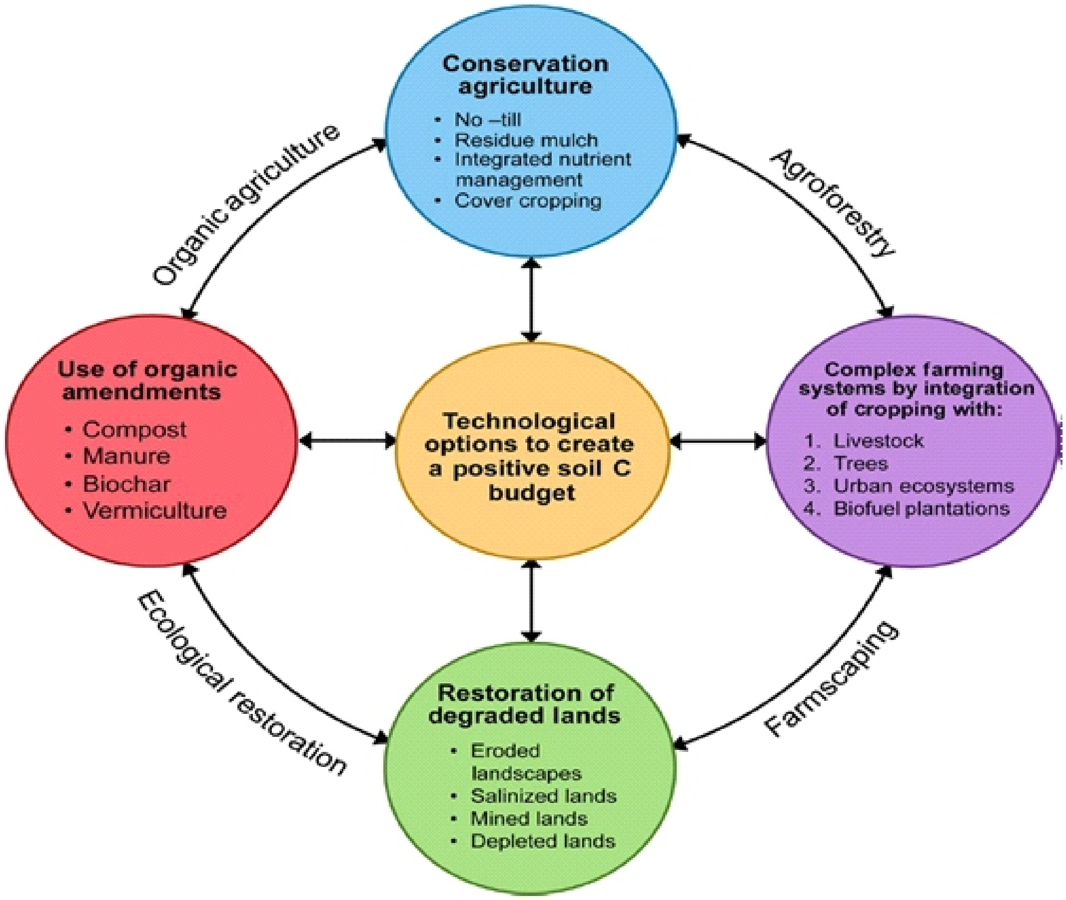

Fig.-1 : Technological options to manage soil health.

ratio, total and available N, N mineralization, soil moisture, microbial activity, and soil texture.

Strikingly, several studies have reported that organically amended soil holds more available N than the soil receiving inorganic fertilization, mainly due to relatively slow and constant mineralization rates, ultimately decreasing nitrogen leaching. Organic acids and humus fraction of decomposing matter are more efficient in releasing phosphorus and reducing its fixation in soil. Nutrient supply through organic sources also ensures micronutrient availability to the plant.

(C) Impact of Organic Inputs on Biological Properties of Soil

These biological properties are very important while assessing soil. Soil micro-organisms are the living part of soil organic matter present in the soil. The microbial biomass and microbial activities in the soil are crucial to sustaining the productivity of the soil. For ensuring the consistent release of nutrients to the plants, there is a need to have a balanced ratio of microbial biomass and activity in the soil.

Organic farming is reported to have enhanced both microbial biomass and microbial activity by 20-30% and 30-100%, respectively. The microbial activity leads to increased competition, parasitism and predation in the rhizosphere, it collectively reduces the chances of plant disease infestation.

Application of quality organic inputs enhances the microbial population in the soil. Organic fertilizer application improved dry nodule weight, photosynthetic rates, N_2 fixation, and N accumulation as well as N concentration in several crops.

Several composts like vermicompost, farmyard manure etc. are generally used for nutrient management in organic farming, which ultimately promotes the beneficial macro and microflora in the soil. Application of organic inputs like human urine, sewage sludge, municipal waste, deep litter, cattle slurry, cattle manure etc. ensures higher soil microbial biomass.

Technological Options to Manage Soil Health

Sustainable management of Soil Organic Carbon (SOC) is critical to enhancing and managing soil health. Thus, management of soil health involves management of SOC pool. The SOC pool can be enhanced by technological options that create a positive carbon budget (Fig.-1). Important among these are conservation agriculture (CA), integrated, and diverse cropping/farming systems, use of organic amendments and those options that restore soil/ecosystem functions.

Research into the sustainability of organic farming systems in India has been limited. The research has tended to focus on comparative studies in extensive cropping and livestock systems. These systems are characterised by their low use of external inputs. FYM, vermicompost, neem cake, poultry manure, phosphate rock, lime, legume rotations, incorporation of green manures and crop wastes and the application of microbial preparations are used for building soil fertility (Sharma *et. al.,* 2015).

Challenges in Sustainable Soil Health under Organic Production Systems

Maintaining soil health while accommodating the increasing productivity is a continued and growing challenge of organic production system for agricultural scientists and farmers in India and elsewhere.

Management of soil organic carbon (SOC) and its dynamics are key determinants of soil health. However, the SOC content in most cultivated soils of India is less than 5 g/kg soil compared with 15 to 20 g/kg soil in uncultivated virgin soils. Besides, the subtropical environment that aggravates SOC losses in the sub-continent, intensive tillage, removal/ burning of crop residues and mining of soil nutrients under intensive cropping systems contribute significantly to such SOC losses. Other crop management practices that could have enhanced SOC content, such as field application of FYM and other organic manure or green manuring are limited among smallholder farmers due to low availability of organic manures and proper management conditions.

Adoption of efficient organic nutrient management practices through the support of innovative approaches and tools (Nutrient Expert decision system, Green Seeker sensors, remote sensing, GIS) and techniques would be critical to empower the extension system to generate and deploy recommendations that are farm-specific in accordance to soil health cards and match the resource endowment of the organic practitioners.

Nutrient weak farming systems are prevalent (Resource cycling is weak).

Eco-management practices as a base of cropping or farming systems are missing.

Market led integrated organic farming systems or trade-off based economic integrated organic farming systems are still an issue at micro-level. Since availability of organic inputs and manure is a big constraint for supplementing nutrient needs of crop.

On-line data bank of organic growers, their soil resources, input & output flow and real time changes in beneficial microflora & fauna need to be established.

Standardization of local inputs (manures, bio-pesticides, biodynamic manures, liquid bio-sprays) with quality parameters and operational guidelines is lacking.

Nutrient management schedule for mitigating nutrient deficiency in standing crops is not known to farmers.

Number of organic production methods, viz., Biodynamic, *Rishi Krishi*, *Panchgavya* and *Homafarming* are need to be practiced by farmers.

Development of techniques to enhance the nutritive value of composts through incorporation of various organic wastes, rock phosphate, dolomite, lime, cakes, bio-fertilizers, cow pit pat, ash, fish meal acceptable in organic production system.

There is need of continuous monitoring of soil health with respect to physico-chemical and biological soil properties and monitoring of ground water environment and flora and fauna on conventional and Jaivik farms.

CONCLUSIONS

Through organic farming, provision of good quality food is possible without affecting soil health and environment on sustainable basis. There is need for the standardization of suitable organic source for the specific crop and hunting good market for earning good profit from the produce. The area under organic farming is increasing world over. Management of soil health is challenge for maintaining crop & cropping system productivity under organic production systems. Maintaining soil health organically relies on nurturing the soils biological and mineral processes. Incorporation of green manures and legumes in the cropping rotation, applications of compost, mineral rock dusts and organic fertilisers, livestock grazing, combined with appropriate tillage are some of the techniques used by organic farmers to meet this objective. Hayne (1940) stated that, “if we feed the soil, it will feed us,” and that “only productive soil can support a prosperous people.” Thus, maintaining soil health is essential to human health, ecosystem functions and nature conservancy. Soil health is more pertinent to global issues now than ever before. Its management is essential to advancing food and nutritional security.

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