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Organic Farming and Soil Health: Evaluating Long-Term Productivity

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ABSTRACT

Organic agriculture is a holistic approach to achieving long-term agricultural productivity by focusing on soil health. This study analyzes the effects of organic farming practices—such as crop rotation, cover crops, green manures, compost use, limited tillage, and avoiding synthetic fertilizers and pesticides on soil health and long-term productivity. Soil health is assessed through physical (structure, bulk density, water-holding capacity), chemical (carbon, nitrogen, available phosphorus, pH), and biological (microbial diversity, biological activity, earthworm population) indicators. The reviewed studies clearly demonstrate that organic management enhances structural stability, water conservation, and nutrient cycling by increasing soil organic matter. Increasing the richness and biodiversity of microbial communities increases soil tolerance and resilience to environmental stresses. Organic systems may yield less than conventional systems during the initial transition period, but long-term yield stability and overall productivity have been found to be comparable. Several long-term trials also indicate that organic systems positively contribute to nutrient quality and environmental services—such as carbon storage and soil erosion reduction. Although economic benefits and productivity depend on regional conditions, soil type, climate and management skills, evidence suggests that through appropriate policy support, research investment and farmer participation, organic agriculture can play an important role in building sustainable, resilient and environmentally sensitive food systems.

Keywords: Organic Farming, Soil Health, Long-Term Productivity, Crop Rotation, Soil Organic Matter, Nutrient Cycling, Sustainable Agriculture.

1. Introduction

Agricultural productivity is crucial to feeding a growing global population and sustaining the global economy (Krauss et al., 2020). Organic farming and its attendant soil management practices such as cover cropping, compost application, and crop rotation are believed to enhance soil health and in turn ensure viable long-term agricultural productivity, even under climate-change stress. Achieving high productivity with low external inputs continues to be a challenge in organic systems, prompting research and knowledge exchange on best practices that optimise soil health and fertility while sustaining output levels. Soil health is simultaneously a principal objective of organic farming and a critical determinant of its overall productivity. The present work reviews the current understanding of how organic practices influence soil health; how soil health moderates long-term crop output; and which specific management strategies, even when widely adopted across diverse systems, demonstrate measurable effects on both soil condition and productivity. Organic farming is defined first, along with the principles and criteria guiding soil fertility enhancement in organic systems. Definitions and indicators for soil health are presented next.

2. Defining Organic Farming and Soil Health

The term organic farming describes a holistic systems approach to agriculture focused on soil health and sustainable productivity in tandem with environmental concerns. The notion of organic farming is not new, yet consensus on its definition is hard to arrive at, owing to diverse interpretations of its core precepts, such as input use. Its definition has evolved historically, and common core principles have emerged (Francis et al., 2006). A review to assess organic farming from the perspective of soil health must build an adequate foundation at the outset. Similarly, soil health is low in consensus and expansive in constituent detail. Among many determinants, easy-to-measure indicators of soil health within the organic domain are considered next.

Historical perspectives on soil fertility management also provide a useful contextual foundation for assessing variations in organic soil health metrics or indicators. The advancement of organic and conventional designs along distinct and sometimes opposite trajectories is a defining feature of soil health at both laboratory and farm scales (Krauss et al., 2020). Enhancements in organic farming have come through a wide range of practices. Crop diversification and rotation to maintain beneficial organisms and address biotic pest problems; green manure and cover crops to enhance organic matter; and reduced synthetic inputs to promote life, maintain fertility, and elevate quality have ample consideration in the organic literature. Diverse methods with established links to soil health are pursued to elucidate how practices relate to productivity within organic agriculture.

2.1. Conceptual foundations of organic agriculture

Organic agriculture originated in the early twentieth century as a response to industrial agriculture but simultaneously draws on centuries of farming practices embodying ecological principles. Growing public awareness of increasingly evident global environmental crises, combined with interest in local food production, has led to renewed consideration of organic farming worldwide.

Many organic farming systems are characterized by a strict prohibition of synthetic fertilizers and pesticides. Yet, organic agriculture encompasses a broad spectrum of practices, core principles underpinning its philosophy alternate with an evolving interpretation of specific applications adapted to local conditions. The Organic Agriculture Movement emerged in the early twentieth century, promoting farm systems based on natural processes to support abundant and nutritious food production. Institutionalization in various countries led to the emergence of diverse standards intended to inform farmers, legislators, consumers, and other stakeholders. Although specifications have differed, most retain a focus on soil health, encompassing nutrient cycling, organic matter enrichment, and attraction to biotic diversity. Organic standards have also sought to delineate organic practices from conventional farming without prescribing detailed implementation methods for fertilizer or pest management.

2.2. Indicators of soil health in organic systems

Soil health in organic systems can be assessed through physical, chemical, and biological indicators. Physical metrics include bulk density, water-holding capacity, infiltration rate, and tilth. Chemical indicators encompass pH, electrical conductivity, nutrient availability and capacity, and heavy-metal concentrations. Biological measures comprise microbial biomass, respiration, enzymatic activity, nematode and earthworm populations, and various chemical compounds that reflect soil quality (Doran, J. W., 2002). Monitoring these indicators also allows for an understanding of how soil management practices affect individual sites over time, paying particular attention to organic matter levels in soil.

2.3. Historical perspectives on soil fertility management

In temperate regions, main sociodemographic events, including intensification of agriculture, regional depopulation and urban concentration, along with prolonged drought periods, dramatically affected farming and soil fertility strategies. Monoculture of barley, formerly a traditional crop in mixture with legumes, replaced barley–legume and maize–legume rotations. Cropping systems became more étérologically oriented to satisfy rising demand for animal feed, yet this induced negative soil changes that largely countered positive fertility effects. Repeated posters elucidated historical soil-fertility management in diverse environments. The case of Les Oluges (Lleida Co., Spain) depicted a Mediterranean agroecosystem undergoing crop-systems changes between renovation of land 1860, availability of synthetic fertilizers 1959, and intensification 1999 (Díez Sanjuán et al., 2019). Terracing and fallow improved water availability and nutrient recirculation, indicating sustainability of fertilizing resource. Energy analyses revealed 1999 management unsustainable above or below ground despite high productivity. Integrated management characteristic of organic systems permits regulation of water, retention of nutrients, energy efficiency and long-term sustainability.

Since ancient times, proper nutrient recirculation has been essential for agricultural sustainability. Historical accounts, plot archeological studies, management schemes of medieval monasteries and old farm records exemplified land-use systems in relation to soil fertility and sustainability (Krauss et al., 2020).

3. Mechanisms Linking Organic Practices to Soil Health

Organic farming enhances soil health by improving soil organic matter dynamics, increasing soil biodiversity and the range of functional groups, and providing nutrient cycling tailored to crop demand. Although systems may exhibit similar health metrics, organic practices encourage different trajectories and development stages. Changes typically become detectable after a decade, and organic systems maintain greater soil health during and following the transition from conventional management.

Organic matter dynamics, including the stock of organic carbon, drive other attributes associated with soil health. Organic amendments, such as animal manure, cover crop residues, and other plant and animal materials, constitute the primary mechanism through which organic management boosts organic matter content. These amendments foster not only soil carbon accumulation but also, notably, increases in soil nitrogen. Humification of organic inputs generates stable organic matter such as humus, which contributes to soil structure by promoting aggregate formation. The multiple pathways through which organic inputs increase soil carbon and nitrogen encourage the development of diverse communities of soil microbial, faunal, and other taxa (Romano, 2014). Healthy soils support microbial populations capable of degrading organic residues and can withstand periodic disturbances, factors that correlate with aggregates and macroaggregates. Stable aggregates also reduce erodibility and enhance soil–water relations, buffering moisture availability during drought and runoff during high-intensity precipitation.

Biodiversity influences organic matter decomposition, accumulation, and turnover, along with nutrient mineralization rates and two general nutrient cycling patterns. Detritivore, predator, and fungal communities dominate the decomposition and accumulation of organic matter inputs, often responding positively to the diversity of the same inputs. When nutrient acquisition rates are closely synchronized with crop demand, nutrient uptake increases, crop growth accelerates, and yields may rise. Organic farming emphasizes an abundance of pulses and root – and rhizoid – biomass crops, cover crops, and well-timed manure and compost applications at all growth stages, with diverse planting patterns that permit repeated access to and turnovers of livestock manure. Distant connections to cities enable on-farm supply and local close-circuit pollution. Management constraints arise, however, in sub-tropical humid zones suspected of allocating substantial production to biofuels. Roundups, rice-fallows, poldering, more support from both governmental and urban resource networks, and other measures are thus under consideration.

3.1. Organic matter dynamics and soil structure

The organic carbon stock and the structure of agricultural soils are closely interlinked. During the evolution of organic agriculture, the humus quality of the soil was routinely identified as a primary indicator of fertility. The organic material derived from either plant or animal sources, like green manures or compost, is now generally viewed as a key element in the management of soil organic matter (Loaiza Puerta et al., 2018). The contribution of organic carbon to soil structure is found over both short and long timescales. Past studies clearly indicate that generally applicable thresholds have still not been established for a quantitative assessment of soil structure quality in terms of dry bulk density, total porosity, average pore diameter, proportion of micropores, or the energies necessary to form and to break aggregates.

Practices of conservation tillage increase the amount of soil organic carbon stored in the topsoil while enhancing the stability of soil structures. As a consequence, sustainability remains a key issue in the management of trials and in understanding the consequences of organic practices on soil structures. With regard to the application of compost and the maintenance of diverse crop rotations, additional mechanical soil tillage had the most pronounced impact on soil structures after long-term set-aside. The introduction of integrated crop–livestock systems combined with savings in the mechanical environment was also found to improve soil structures. The improvement of highly degraded soils for organic farming remains a challenge.

3.2. Biodiversity and microbial community functioning

Under both organic and conventional management, soil functions depend on microbial community composition and activity (Kuzmicz, 2018). Therefore, stabilizing a rich and diverse microbial community and ensuring its ability to perform key functions are essential to promote soil health. Diversity of microorganisms and functional groups is closely associated with soil properties, environmental conditions, land use systems, and management interventions. The functions performed by microbial communities are constrained by the community composition, and selectively enriched groups can enhance, suppress, or facilitate the performance of certain functions in soils amenable to microbial growth promotion. This is particularly relevant when communities must contend with additional stresses imposed by environmental change or anthropogenic disturbance. In essence, sustaining a rich microbial biodiversity is vital for maintaining soil health and resilience under both organic and conventional systems. Agricultural management practices promoting such a biodiversity help to avoid unintentional community enrichments that could limit other key soil functions.

Soil health has been defined from both physical–chemical and biological perspectives, and diverse indicators have been proposed to measure it (Mas-Carrió et al., 2018). Desirable organic practices for sustaining healthy agroecosystems include, among others, avoiding synthetic pesticide and fertilizer application, maintaining adequate levels of organic matter, and promoting crop rotations. Such practices are expected to facilitate soil productivity. However, soil health indicators are still lacking under organic management, making it hard to sustain comparisons with conventional systems throughout the long term. Long-lasting experiments on organic–conventional contrasting soil health are scarce, and what little evidence exists indicates that important differences are likely to persist from the start.

3.3. Nutrient cycling and mineralization rates

Fertilizer usage in agriculture is governed by rules derived from the circulation of nutrients in the soil–plant–atmosphere system. The optimal nutrient application rate depends upon the crop type, its respective yield target, soil characteristics, and climate conditions. A significant fraction of the applied fertilizers is returned to the soil in plant residues after harvest, and whether as crop residues, farmyard manure, green manuring, or composting, the input of nutrients in organic farming follows the overall principles of fertilizer application (Wani et al., 1994). The major distinction of organic farming arises from the time frame between application and harvest. Hence, the nutrient cycling and mineralization rates in organic farming must synchronise with the time of crop demand (Bhat et al., 2017).

4. Long-Term Productivity in Organic Systems

Long-term field experiments from the Rodale Institute research farm in Pennsylvania show that organic systems can achieve yields comparable to those in conventional systems, even without the application of synthetic fertilizers. Compared to conventional plots that received yearly applications of mineral N, however, organic yields were notably lower. Conventional systems relying on high inputs of biocontrols, fungicides, and soil amendments to offset the limiting effects of crop rotations on soil quality and crop yields produced similar long-term average grain yields to organic systems that received no external inputs, despite higher yearly variability. Grain yield variability is often indicative of an ecosystem's underlying resilience to biotic and abiotic stressors (Romano, 2014). The accumulation of low yields (as indicated by decreased average yield levels of nearby conventional systems) in well-managed organic systems is significantly below that of conventional ones, demonstrating greater biotic and abiotic resilience under organic systems, comparable lifetime economic returns, but greater cumulative yearly financial investment. In summary, while conventional management has sustained crop productivity over the longer set of assessments using a high-input system relying on expensive inputs to mitigation stresses, organic practices have provided greater resistance to individual stresses and greater resilience overall.

4.1. Yield trends under organic management

The yields of crops grown under organic management exhibit a temporal pattern distinct from those of conventionally grown crops. Conventional systems tend to stabilize at a yield plateau after 5 to 10 years, while organic systems follow a gradual build-up, characterized by substantial variability due to the diversity of materials and approaches used in organic systems (Kniss et al., 2016). Some growers have experienced higher yields for many years, even while employing practices that conventionally-minded researchers would have predicted would lead to a gradual decline. After longer periods of experimentation, however, organic systems inevitably catch up. During the transitional period, organic systems frequently yield less than conventional ones, leading to pessimistic portrayals of organic productivity. Such depictions overlook important distinctions between strategies, standards, and objectives found within each paradigm (Romano, 2014).

4.2. Resilience to abiotic and biotic stressors

In comparison with conventional practices, organic farm management systems generally allow core processes maintaining soil health to persist longer during periods of stress (Krauss et al., 2020). Non-destructive 'natural drainage' after rainfall leads to more stable aggregate turnover, mitigating run-off losses of precious nutrients. Regenerative options such as contouring or political-farming reservist approaches may appear attractive, but draw land from production and nullify return of nutrients back to soil, unless required over a very short time-scale. Such extensive unneeded practices are non-conforming with precautionary principles of Organic farming which demand that returns of nutrients to the land must enable farm operations and England to fulfil international-product-guidelines.

4.3. Yield quality and nutritional outcomes

Organic farming can influence not only the quantity of produce but also its inherent quality and nutritional characteristics. Organic systems typically yield produce with higher mineral content (Romano, 2014). Results from a long-term trial (with nearly 30 annual assessments) indicate consistent differences in the mineral content of crops grown in organic versus conventional systems: crops under organic management contained reliably greater concentrations of essential mineral elements, such as calcium, magnesium, nitrogen, phosphorus, potassium, and zinc. Enhanced levels of potassium, phosphorus, calcium, and nitrogen are widely perceived to bolster the nutritional benefits of organically produced crops and are even thought to increase the capacity of plants to cope with adverse conditions. The higher levels of such minerals could be attributed to enriched biological activity and improved physical conditions of the soil, which may improve nutrient availability and uptake (Krauss et al., 2020). Organic farming significantly influences not only the crop quantity but also the inherent quality and nutritional characteristics of the produce. Enhanced mineral concentration in organically produced crops is a critical sign of yield quality. An extended and well-monitored trial at the Rodale Institute in the U.S. consistently shows that crops under organic management contain reliably greater concentrations of essential minerals such as calcium, magnesium, nitrogen, phosphorus, potassium, and zinc compared to those in conventional systems. The enhanced quantities of potassium, phosphorus, calcium, and nitrogen in organic crops are widely acknowledged to confer important nutritional advantages and are even believed to bolster the plants' ability to withstand adverse environmental conditions. These higher mineral levels may reflect improved biological activity and soil physical conditions in organic systems that facilitate enhanced nutrient availability and uptake.

5. Management Practices with Evidence on Soil Health and Productivity

The environmental performance of both organic and conventional agriculture is tied to farming practices. In organic systems, longer crop rotations, cover crops, and compost applications are positively correlated with soil health, but fewer studies document links between these practices and productivity. Crop rotation breaks disease cycles and positively influences yield. Various metrics assess the effect of long-term organic management on soil health indicators and productivity. Performance data indicate that organic systems fare comparably to conventional ones while delivering substantial benefits for soil, the environment, and human health (Romano, 2014).

Diversity-rich rotations featuring break crops remain an effective tool for combating soil-borne pests and diseases in continuous cereal systems, while saturating successive cereal sequences with low-competitiveness cover crops mitigates elevated weed pressure stemming from intensified monoculture. Similarly, with mechanical weeding, weed-crop relationships are altered sufficiently to allow legume intermediate crops to vault over competitors in both continuous and near-continuous rotations.

5.1. Crop rotation and diversification

Crop rotation is an agricultural management practice aimed at improving soils and increasing crop productivity. The long-sequence rice-wheat crop rotation prevalent in Asia, covering approximately 18 million hectares, has been extensively studied (Polat, 2018). In the continental United States, a major cropping system in the Midwest consists of corn-soybean. Even a slight loss of soil health in a continuous cropping system, such as continuous corn, results in economically significant reductions in corn yield. Crop rotation has been defined as growth of at least two different crops in the same field in a preplanned succession. In terms of agronomic practices, crop rotation refers to planning the sequence of various crops to be planted on a specific field. Agronomic practices that follow within-season and after-season crop diversification in the crop rotation cycle are varietal, fertilization, herbicide, insecticide, and fungicide practices. Sequence effects are the carry-over influence of the previous crop on subsequent crop growth, yield, and quality. Break crops within a rotation cycle can enhance soil moisture availability and nutrient input to following upland crops by improving soil structure, and nurturing unfavorable soil-bound pathogens and pests.

5.2. Green manures, cover crops, and compost applications

Winter cover crops increased nitrogen availability and efficient use during eight years of intensive organic vegetable production (White et al., 2022). This is the first study on the long-term effects of compost and cover crops on soil nitrogen balances and crop performance in high-value vegetable systems in California. Results suggest that nitrogen balances could be improved with minimal impact on yields by reducing compost additions and using non-leguminous cover crops annually. Soil nitrogen stocks declined by about 50% from year 0 to year 1 due to intensive tillage, fertilization, and residue inputs. Nitrogen inputs at regional typical rates were used inefficiently, with only 13 to 23% exported in harvested vegetables, and a large portion of fertilizer nitrogen remaining unmineralized after harvest. Much nitrogen taken up by crops was returned to the soil as residues. Without winter cover crops, nitrogen losses through leaching are higher; cover cropping can reduce these losses. Compost contributed significantly to nitrogen surpluses but had little effect on crop nitrogen uptake and yields, with added compost nitrogen only slightly increasing crop N uptake.

5.3. Reduced or avoided synthetic inputs and pest management

Reduced and avoided applications of synthetic inputs can have positive indirect effects on soil health. Organic farming enhances pest control through increased plant diversity in time and space, material diversification, and crop rotations alongside economic diversification (Krauss et al., 2020). This diversification decreases reliance on pesticides and directly improves soil health. Furthermore, integrated pest management aided by organic principles improves soil health. Generally, soil health has a solid correlation with food-web structure, particularly with mesofauna.

6. Comparative Performance: Organic vs Conventional Systems

Soil health represents a vital capability of agricultural systems, underpinning their long-term productivity and sustainability (Wittwer et al., 2021). Monitoring soil health across organic and conventional systems is necessary to inform management actions and shape policy directions (Kniss et al., 2016). Conventional systems frequently exhibited superior performance; however, organic systems demonstrated improved soil health over time. Organic systems struggled to match conventional productivity and profitability in many contexts, with lower realised prices insufficient to offset greater input costs. Nonetheless, these analyses often neglect the importance of ecosystem services, measuring organic systems only against food and feed production. Comprehensive consideration of productivity, profitability, and ecosystem service provision offers a more nuanced view of comparative system performance.

6.1. Soil health indicators across systems

Studies comparing soil health indicators in organic and conventional systems quantify differences in soil chemical, physical, and biological attributes between these farming systems. From agricultural intensification to UN climate change summits, soil degradation is emphasized as a concern for agriculture and society (Doran, 2002). In the last thirty years, soil health indicators have been proposed as important measures to assess the status of agrosystems. Recent studies have conducted systematic reviews of global databases containing soil health indicators from experimental trials comparing organic and conventional management systems. Organic systems are defined as having a restricted use of synthetic fertilizers and pesticides, with other specific requirements determined by certifiers, while other systems are considered conventional regardless of the practices applied.

Soil health indicators reported for long-term organic trials in the United States indicate that organic farming systems foster improvements in a set of soil health indicators. Chemical attributes such as total carbon, total nitrogen, available phosphorus, base saturation, soil pH, and residual macronutrients differ significantly between organic and conventional systems, as do the physical attributes of bulk density and aggregate stability. Soil biology indicators also exhibit contrasting conditions under long-term organic and conventional practices. Biomass, diversity, and activity evaluations associated with the soil food web indicate a greater elementary foundation of services and functions in organic soils. Organic management promotes not only an improvement of soil chemical and physical properties but also a better functioning of the biological communities that ensure soil health.

6.2. Productivity and profitability considerations

Adopting organic approaches involves long-term productivity risks and potential trade-offs with profitability. Hence, detailed cost-benefit analyses with diverse benefit and cost components assume a pivotal role. Careful consideration of long-term productivity and profitability helps farmers and agribusinesses target strategies that maintain system elasticity and recognise critical balance trade-offs (Forster et al., 2013).

Preliminary assessments show that regarded organic systems display either marginally greater average long-term gross margins, lower short-term maximum gross margins, or more elevated risk profiles. Performance indicators indicate that wider rotations enhance wheat and inline with increasing crop diversity, with no clear relationship for legumes; although rotations demonstrate broader impacts on yield stability, the nature of these effects remains enigmatic (Birnholz et al., 2018).

6.3. Environmental and ecosystem service implications

Agricultural practices affect crop production and soils can retain, lose, or sequester carbon depending on management. Conventional (CONV) and organic (ORG) systems were compared at study sites in Spain and Australia using the same multi-crop rotation, applying fertilizers equivalent to crop removal, conducting similar tillage operations, and having similar equipment. Productivity decreased from CONV to ORG, with highest yields in CONV with intensive tillage. ORG had lower yields as a result of less weed control and reduced fertilizer efficiency. Reduced tillage and ORG farming positively influenced soil quality variables, improving aggregate stability, soil biodiversity, and microbial community composition. ORG management and conservation tillage significantly reduced sediment delivery and soil erosion, with reductions up to 93%. ORG systems also showed 46–51% lower global warming potential and 80–85% reduced aquatic ecotoxicity potential per hectare. No major changes were observed in soil fertility parameters, which typically require long-term management to detect.

7. Contextual Variability and Policy Implications

The context of organic farming systems is inherently variable. This variability is reflected in local policies, integrated systems, and farming practices (Romano, 2014). Empirical results from Ontario, Canada indicate that the decision-making of organic farmers aligns with their integrated, adaptive systems focused on organic inputs and ecological practices. Decisions are informed by agricultural policies, department extension services, market signals, and standards compliance.

Actual certifications of organic status vary by region. In the European Union, rules governing soil association compliance have persuaded informants to extensively review prescribed farming standards before integrating them into local configurations. Policies and purposes also influence operational strategies elsewhere.

7.1. Soil type, climate, and regional adaptation

Soil health and fertility management in organic agriculture rely upon specific practices incorporated into site-appropriate crop rotations. Local soil type, climate, and crop suitability strongly influence the performance of various organic fertility and management practices.

An ongoing investigation of soil health indicators and crop productivity was established in 1999 at the WVU Organic Research Farm. Performance and sustainability of an alfalfa–sorghum–winter wheat sequence with a crimson clover cover crop were compared to Kentucky bluegrass hay stockpiled for wildlife. Maintaining the approved organic certification and the accompanying strict pesticide restrictions at the KBS site dictated the practice set investigated. Considerable differences occurred in initial soil conditions. Fertility amendments were applied annually as MGA 101 or either compost, poultry litter, or biodegradable organic mulch according to the long-term organic protocol.

Within New England, organic practices generally preserved the status quo or increased soil organic matter. However, during the early years of treatment cycles, significant soil degradation occurred at several western locations. The presence of organic amendments, compost, and poultry litter positively influenced crop yield even under a longer organic transitional span. During the first half of the alfalfa–sorghum–wheat rotation cycle, the treatment with these amendments exhibited the greatest soil health composites and crop yield. Subsequently, improvement at the KBS site and the continued low-status base delineated appearance of the treatments along the entire time span. High-stress periods in the middle of the crop cycle at nine years applied pressure at all tested locations and resulted in reduced yield across 75% of the farming sites, suggesting variation also within the organically managed spectrum.

7.2. Certification, standards, and farmer decision making

Certification, standards, and farmer decision making represent a major concern in organic agriculture (Francis et al., 2005). As previously noted, the transition to organic practices generates concerns about the long-term social and environmental health of society and agriculture. Organic farming has become a multi-billion dollar industry, supported by sizable organizations, including multinational corporations. Organic farming has developed as an extensive commercial enterprise, leaving some disillusioned about the future of organic agriculture. Farmers produce a wide range of products that qualify for organic certification, and many question whether the organic methods employed increase or decrease social sustainability over the long term. Farmers base decisions on crop rotations, cover crops, composting, and pest/weed management on compliance with the current organic certification system (Templer et al., 2018).

7.3. Policy incentives and research priorities

Adoption of organic agriculture practices could be accelerated through appropriate policies and research investment. Extension outreach and case study evidence demonstrating the positive effects of organic farming on soil health could be bolstered, along with financial support for experiments. Targeted encouragement in major agricultural regions may promote wider uptake.

The currently prevalent view that nutrient management plays little role in fertility decline and that organic production entails no nutrient input sharply limits the provision of organic-specific incentives (Ingram et al., 2014). Managing soil health indicators in the longer term may yield wider benefits. Policies consistent with the promotion of carbon pathways such as cover cropping, compost application, residue retention, pest control through maintenance of soil biota, and mix-cropping should receive increased focus.

8. Conclusion

Scientific literature offers a compelling framework for assessing long-term impacts of organic farming on soil health and productivity. Organic practices consistently enrich soil health across diverse contexts. Although yield levels diverge across systems, overall productivity remains equivalent in the long term. Environmental, ecosystem service, and contextual dimensions further inform the commercial viability of organic methods, with soil indicators playing a central role in decision-making. The growing adoption of organic crop production highlights the relevance of understanding its potential benefits. Analysis across horticulture, pasture, and arable crops confirms comparable long-term productivity under organic and conventional systems. Performance differs based on rotation complexity, soil type, pre-rotation management, and climate, pointing to wide variation in site-specific outcomes. Among various farming approaches, organic practices generate broad-based gains in soil health, facilitating productivity and resilience, with important implications for scaling food systems.

Conflict of Interests

None.

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None.

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