Annals of Natural Sciences
(Peer-Reviewed/Referred International Journal)
Vol. 4(3), Sept. 2018:57-67
Journal's URL: http://www.crsdindia.com/ans.html
Email: crsdindia@gmail.com

e-ISSN: 2455-667X
Annals of Natural Sciences

ORIGINAL ARTICLE

Sustainable Agriculture Practices for Enhancing Biodiversity and Productivity: A Review of Organic Farming Systems

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ABSTRACT

As a result of the increasing issues surrounding the destruction of biodiversity (living things), degradation of land (the soil can't grow crops anymore) and the pollution caused by conventional farming methods, there has been increasing world-wide attention on implementing sustainable agriculture methods. Many traditional farming systems use large amounts of manufactured fertilizer, chemicals (including herbicides) and mono-culture; each of these factors has detrimental effects on biodiversity (the variety of living plant and animal species) and the ecological balance (balance between all living things in an ecosystem). Conversely, Organic farming is an alternative sustainable system of agriculture that is based on developing an ecological process of conserving biodiversity and minimizing the use of manufactured chemicals. Organic farmers encourage the use of diverse farming techniques such as using multiple crops from year to year (crop rotation), providing biological pest control, adding compost to the soil to support soil health, and designing ecosystems that support the natural conditions needed for plant growth (agroecology). Numerous studies indicate that organic farming systems support greater biodiversity in agricultural landscapes by providing suitable habitats and reducing chemical inputs. There is a great deal of evidence available through meta-analysis indicating that organic farms support about 33% more species of living organisms as a result of using fewer pesticides on the farm as well as having greater habitat diversity. The ecosystem services provided by organic farming systems, such as providing pollination services, controlling insect pests naturally, and cycling nutrients through the soil, also contribute to making organic farming methods more sustainable. Through increasing organic matter, diversifying microorganisms, and increasing nutrient cycling within soil, organic agriculture is improving soil health. These three aspects will improve the long-term ability for farms to produce food and improve the resilience of farms to climate change. Organic agriculture has also recently been shown through research to be profitable as well as environmentally sustainable. The primary focus of this literature is on the ecological benefits of organic farming systems and on the preservation and enhancement of soil health and agricultural productivity associated with adopting organic farming practices. The research cited concludes that organic farming is a significant element of an integrated, sustainable agriculture approach that recognizes that agricultural systems must balance food production with the conservation of air, land, water and other natural resources.

Keywords-*Sustainable agriculture, organic farming, biodiversity conservation, agroecology, ecosystem services, soil fertility, agricultural productivity*

Received: 10th July 2018, Revised: 17th August 2018, Accepted: 22nd August 2018

How to cite this article:
Kumar S. (2018): Sustainable Agriculture Practices for Enhancing Biodiversity and Productivity: A Review of Organic Farming Systems. Annals of Natural Sciences, Vol. 4[3]: Sept., 2018: 57-67.

INTRODUCTION

Food security and economic growth depend on agricultural production, but agricultural intensification also negatively impacts the environment. Agricultural intensification

contributes to degraded soils, reduced biodiversity, water pollution and greenhouse gases. Intensive agricultural systems use large amounts of synthetic fertilizers and pesticides, disrupting the ecological processes that support all living things (Reganold & Wachter 2016). Biodiversity is critical for maintaining stable ecosystems and for providing important benefits from ecosystems, such as pollinating plants, controlling pests, maintaining healthy soils and recycling nutrients. Agricultural intensification has significantly decreased biodiversity in farmland ecosystems by disrupting habitat complexity and increasing the amount of synthetic agricultural chemicals. Thus, organic farming systems are a sustainable alternative to traditional farming systems because they focus on protecting biodiversity and promoting ecological processes. Organic farming does not use synthetically produced agricultural chemicals; instead, it relies on using natural inputs and practicing ecological management techniques (Tiwari 2014). Several studies have reported that organic farming systems enhance biodiversity in agricultural landscapes. According to a number of meta-analyses, organic farms typically have approximately 30 - 34% more biodiversity than conventional farming operations (Tuck *et al*., 2014). Practices associated with organic farming, such as crop rotation and intercropping, biological pest control, and organic practices for managing nutrients, have been shown to improve soil health and increase ecosystem resilience. In addition to enhancing microbial populations in soil, these practices are also effective in enhancing and sustaining natural cycling of nutrients, and reducing environmental contamination (Gamage *et al*., 2017). The purpose of the present review will be to analyze the sustainable farming practices that are associated with organic farming systems, and assess their relative contributions to improving biodiversity and crop production. Research is expanding dramatically on organic farming's multiple ecological benefits and its importance in sustainable agriculture. Numerous studies have looked at biodiversity conservation, environmental sustainability, and crop production of organic compared to conventional agriculture. The findings of Tuck *et al*. (2014), who conducted a meta-analysis of 94 different studies, indicate that organic agriculture is associated with greater biodiversity than conventional systems. According to the authors, species richness is greater in organic cropping systems than it is in conventional cropping systems, with an average increase of about 30% more (compared to conventional systems). In addition to the findings of Schneider *et al*. (2014), other researchers have also reported that organic farming increases both species richness and species evenness (distributions of abundance of individual species) for many different types of organisms, including plants, insects and soil microorganisms. These studies all support the idea that organic cropping systems provide better habitat for wildlife in agricultural landscapes. Organic cropping systems also promote the development of healthier soils. The microorganisms in soils are essential for nutrient cycling and the growth of plants. Research has demonstrated that the use of certain organic farming practices (i.e., application of composts and crop rotations) increases the diversity of microorganisms in soils and improves soil productivity (Reganold & Wachter, 2016). Tscharntke, Klein, Kruess, Steffan-Dewenter, and Thies (2005) analyzed environmental benefit associated with organic farming is that it enhances many ecosystem services. Due to the reduced use of synthetic pesticides as well as increased habitat diversity for many different types of wildlife, there are typically more beneficial insects, such as pollinators and natural enemies of pests, in organic cropping systems than in conventional cropping systems. On the other hand, some studies have shown that organic crop yields can be slightly lower than conventional crop yields in some cases. However, organic farmers generally receive higher profits due to selling their products at a premium price and having lower input costs compared to conventional farmers (Reganold & Wachter, 2016). Overall, existing research suggests that organic farming systems provide important ecological benefits while supporting sustainable agricultural productivity.

Wezel *et al*. (2014) reviewed of the major concepts of sustainable agriculture (with a focus on organic farming systems) will help enable people understand the importance of

biodiversity and productivity to agriculture through a graphical representation. These concepts are also highlighted in the image with illustrations representing all of the ecological principles and management practices that contribute to sustainable agriculture systems. The pyramid above represents the three main pillars of organic agriculture: (1) the conservation of biodiversity, (2) soil health and fertility, and (3) sustainable crop productivity. These elements form the three main objectives for organic farming systems. The conservation of biodiversity is shown in the picture by the presence of birds, insects and other plant life that are typical of the many organisms found on organic farms. By using organic farming systems, farmers reduce their use of synthetic pesticides and fertilisers, thereby allowing beneficial organisms such as pollinators to thrive, natural predators to be established, and soil microbes to exist in the agricultural eco-system. A second vital component displayed in the visual representation is soil health or fertility. Composting, planting cover crops and applying organic materials help to build up soil organic matter and microbial activity. Healthy soils are critical for maintaining the cycle of nutrients, retaining water, and allowing crops to thrive. The illustration uses both earthworms and plant roots to depict how soil organisms are essential for maintaining soil structure and fertility. A third key element is cropping yield and sustainability. Organic farming systems attempt to achieve sustainability by producing crops with minimal environmental disruption and maintaining long-term viability. Organic farm yields may at times be lower than conventional farms, however, due to ecological benefits associated with improved soil health, organic farming practices can contribute to long-term agricultural sustainability. The basket of crops represented in the figure illustrates diverse agricultural production which comes from using organic farming practices. In addition to being one of the key components in these ways of farming, the graphic summary includes examples (i.e., crop rotation (long-term), crop diversification (homogenization), natural pest control (beneficial insects (e.g., lady beetles)) of organic farming methods. Crop rotation helps to enhance soil health while decreasing the potential for pests or diseases. van der Heijden, Bardgett, and van Straalen (2008) emphasized of different crops in a cropping system improves habitat variety and provides an opportunity for greater overall biodiversity. Beneficial insects (examples would be lady beetles) are able to regulate the population of pests naturally (i.e., without utilizing chemical-based pesticides). The third key component that is highlighted (visually) in the diagram is the abstaining from airborne-based synthetic chemicals such as herbicides and pesticides. Organic farmers rely on biological and ecologically based practices instead of chemical-based pesticides and synthetic fertilizers; thereby reducing the risk of contaminating the environment and preserving soil, water, and biodiversity. The Graphic Abstract also emphasizes how the application of organic farming leads to achieving resiliency in terms of climate change. Sustainable Farming Practices would contribute to agricultural systems being more resilient to climate variability; such as improving soil tilth, and being able to retain more water, increasing and encouraging an ecologically balanced soil environment.

Tilman, Balzer, Hill, and Befort (2011) examined, the graphical summary's lower half discusses the advantages, limitations, and potential for growth of organic farming. Some of the major advantages are enhanced biodiversity, greater soil fertility, and less pollution of the planet's environment. A number of limitations to widespread adoption of organic farming arise out of yield variability, expensively attaining certified production status, and limited consumer access to organic products. The outlook for organic farming practices is dependent on sustainable farming practices, the policy support for these kinds of operations, and the role of organic farming in providing food security for people around the globe. In summary, the Summary illustrates that organic farming systems use ecological principles in conjunction with agricultural production methods, thus providing sustainability and biodiversity through their farming systems.

MATERIALS AND METHODS

This study is based on a systematic review of scientific literature related to organic farming and sustainable agriculture.

Data Analysis:

Information was compiled on:
biodiversity indicators
crop productivity
soil health parameters
ecosystem services in organic farming systems.

RESULTS AND DISCUSSION

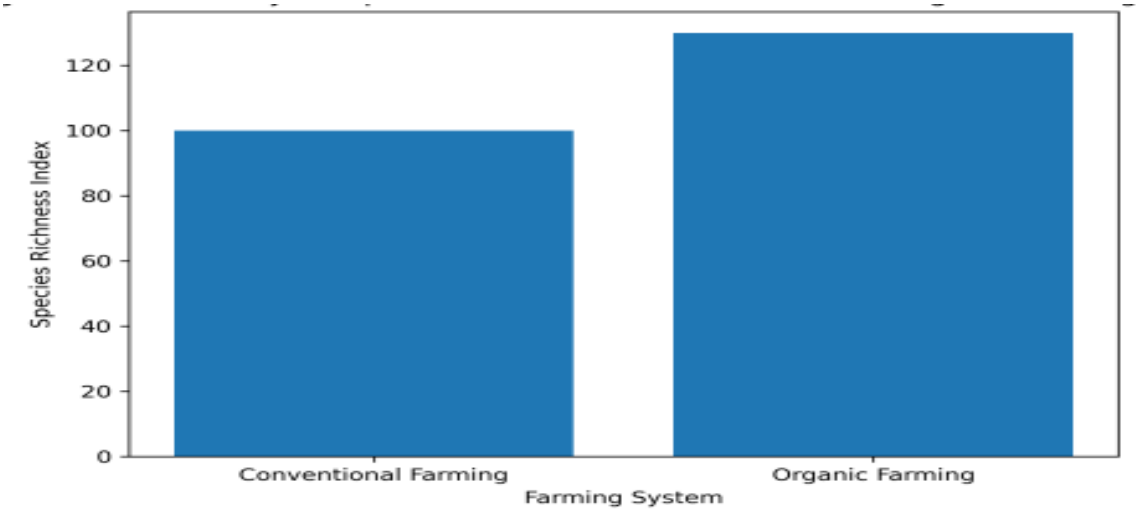

Figure 1: Comparison of biodiversity levels between conventional and organic farming systems showing higher species richness in organic agricultural landscapes.

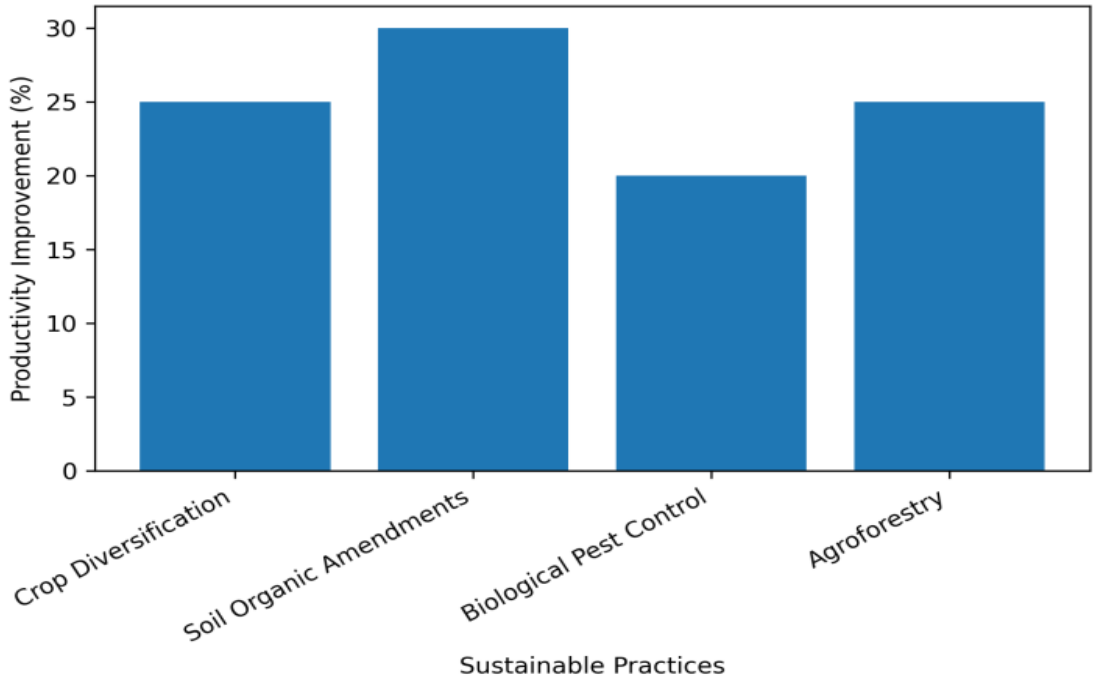

Figure 2: Contribution of sustainable agricultural practices such as crop diversification, soil organic amendments, biological pest control, and agroforestry to agricultural productivity.

Table 1: Comparison of Organic and Conventional Farming Systems

Parameter	Organic Farming	Conventional Farming
Fertilizer source	Compost, manure	Synthetic fertilizers
Pest management	Biological control	Chemical pesticides
Soil health	High organic matter	Soil degradation risk
Biodiversity	High	Low

Table 2: Major Sustainable Practices in Organic Farming

Practice	Ecological Benefit
Crop rotation	Improved soil fertility
Compost application	Enhanced soil microbial diversity
Biological pest control	Reduced pesticide dependence
Agroforestry	Habitat for beneficial organisms

The findings from this review emphasize the significance of organic farming systems for fostering biodiversity conservation, as well as cultivating agricultural productivity in a sustainable manner. Organic farming operations make use of significantly less synthetic inputs, and they promote ecological processes that further enhance the delivery of ecosystem services.

As illustrated above, organic farming systems illustrate a large influence on increasing biodiversity while establishing agricultural sustainability for future generations. Badgley *et al*. (2007) analyzed, conventional farming systems have been associated with decreasing biodiversity and degrading ecosystems resulting from the intensification of agricultural practices (Reganold & Wachter, 2016; Tuck *et al*., 2014). Conventional agriculture typically relies on monoculture cropping and large amounts of synthetic fertilizers and pesticides, whereas organic farming systems rely on ecological processes and biodiversity-based management practices to promote environmental stability and ecosystem sustainability (Pfiffner, 2011; Gonthier *et al*., 2014).

One of the most well-known sustainable methods of agricultural production, organic farming is an excellent way to enhance biodiversity while still producing food. Zehnder *et al*. (2007) examined, the concern over the negative impacts of conventional agriculture (including environmental degradation, reduction in soil fertility, and loss of biodiversity) has led to increased global interest in promoting organic agricultural systems. The many studies that have been conducted around the world have demonstrated that organic farming helps to promote ecological balance by reducing chemical inputs, creating more diverse cropping systems, and developing improved soil management practices that increase the number of species represented in a given area. These factors create a more hospitable environment for numerous forms of life within those fields, including but not limited to, soil microbes, insects of all types, birds and all other types of wildlife that contribute to the functioning of ecosystems and long-term sustainability of agriculture. A major ecological benefit of organic farming is its ability to increase the number of organisms within an ecosystem. The majority of the published comparative studies between organic and conventional farming systems indicate that organic farms have higher numbers of species present in comparison to conventional farming systems. Synthetic fertilizers and pesticides are generally avoided by organic farms, which promotes the development of beneficial species such as pollinators, predators, and decomposers. According to a meta-analysis performed by Bengtsson, Ahnström & Weibull (2005) of multiple studies done on agricultural practices, organic farming had approximately 30% more species richness than conventional farming systems. Hole *et al*. (2005) further illustrate that organic practices in agriculture create better habitat conditions and less chemical disturbance for birds, plants, insects and soil-dwelling organisms compared with conventional agricultural practices; thus, organic farming represents a significant contributor to the conservation of biodiversity in the agricultural

landscape. In addition to promoting biodiversity, another key benefit of organic farming is enhancing the health of soil and the stability of ecosystems through the maintenance of soil health. Soil contributes to agricultural sustainability through its ability to conduct nutrient cycling; retain water; and support plant growth. Organic food production methods promote the improvement of the fertility of the soil through practices such as the application of compost, the growing of cover crops, crop rotatation, and the application of farmyard manure. Such agricultural practices will improve the amount of organic material in the soil, improve the structure of the soil, and improve the activity of microbes. According to Gomiero *et al*. (2011) organic farming provides enhanced biological activity in the soil and enhanced nutrient cycling than does conventional agriculture. As organic food production systems create increased diversity of microorganisms and activity, they will also create greater resilience of and productivity from the soil, over the long term. Soil organic matter plays an important role in creating sustainable agricultural systems because it provides soil with a greater capacity to retain moisture and reduces erosion. The aggregate stability of organic soils will contribute to preventing the degradation of these soils, which will improve the sustainability of the agricultural production system. Furthermore, improved soil structure will allow roots to better penetrate the soil and uptake nutrients more efficiently. As such, organic farming methods will contribute to both the long-term fertility of soils and sustainable agricultural production systems while relying less on synthetic chemical inputs. Crop diversity is another salient characteristic of organic agricultural systems that enhances the ecological sustainability of agricultural ecosystems. Organic farms typically implement a variety of cropping systems, including crop rotation, intercropping, and mixed farming methods. By using these types of systems, the likelihood of a pest outbreak is reduced, and the resilience of the agricultural ecosystem will be enhanced. Diverse cropping systems will also provide habitat for beneficial insects and natural enemies of pests, thereby helping to maintain an ecological balance. Agroecological diversification is critical to enhancing ecosystem services, and Altieri (2004) provides compelling evidence that these types of practices will enhance agricultural production system sustainability. Crop rotation is an integral part of organic agriculture because it provides a way to sustain the fertility of soils and reduce pest and disease pressure on crops. When crops with different nutrient requirements are rotated, they help to prevent nutrient depletion, while increasing the availability of nutrients to crops grown in that rotation. When legumes are used in crop rotations, they improve the fertility of soil by fixing atmospheric nitrogen into organic forms, benefiting future crops grown in that same soil. Moreover, because crop rotation includes the growing of different crops that are not host plants for the same pests, it interrupts the life cycle of pest insects and reduces the need for chemical pesticide applications. Such environmental-based or ecological approaches to pest management enhance the sustainability of agriculture and provide protection to the environment. Organic farmers also provide valuable ecosystem services, including pollination, natural pest control, and nutrient cycling to crops. Pollinators such as bees and butterflies are critical components of crop production, as they assist in fertilizing many of the fruit and vegetable crops produced, and thereby provide the necessary conditions for continuing production of these types of crops. Conventional agricultural practices often contribute to the decline of pollinator populations in the environment by using pesticide in their production systems and destroying natural habitats. However, organic farms provide safe habitats for pollinators and provide food sources for these beneficial creatures. Research has demonstrated a significant difference between the diversity and abundance of pollinators between organic farms and conventional farms (Hole *et al*. 2005). The more diverse and abundant the population of pollinators, the greater the increases in crop yields and the productivity of agriculture.

The ability to use chemical-free methods to keep pests away from one's food source benefits the ecosystem. Organic farms generally have more good bugs (lady bugs, lacewings, and parasitic wasps) than conventional farms, and therefore organic farming

promotes more biological control of pests than does traditional farming. By supporting natural enemies of pests and decreasing the use of chemical pesticides, organic farming keeps the earth in balance by helping to maintain ecological balance and reducing the number of crop pests. The ecological advantages of organic agriculture do not negate controversy regarding its yields compared to those of conventional agricultural systems. According to a review by Seufert *et al*., organic systems have lower yields (on average 19 to 25% less) than do conventional systems (Seufert *et al*., 2012). There is much variability in the yield gap based on both the magnitude and the type of crop grown, as well as environmental conditions and management practices used, and under certain circumstances (such as developing nations and fields that are less input-dependent), organic farmers can achieve comparable yields to conventional farmers.

Organic farming systems are generally expected to produce higher crop yields, as well as provide stability when crops are grown under stress from drought or degrading soils. These benefits stem from organic farming's ability to improve soil organic matter and its ability to hold water, which can help buffer crops during unpredictable climactic changes. Although organic farming may produce slightly less yield than conventional farming (Reganold & Wachter, 2016), it provides substantial environmental benefits such as decreased pollution, improved soil health, and increased biodiversity.

All these benefits aid with the long-term sustainability of agricultural systems.

In addition to having environmental benefits, there is also the economic sustainability of organic farming systems. Organic food products generally receive a premium price in the marketplace as consumers typically purchase these products because they are perceived to be healthier and more environmentally friendly. The greater market price can compensate farmers for their potentially lower yield; this provides an economic incentive for them to adopt more sustainable agricultural practices. Organic farming also reduces the use of synthetic fertilizers and pesticides, thus allowing for greater profitability in the long term. Organic farming also serves to mitigate climate change through reduced greenhouse gases and enhanced carbon sequestration. Organic farming systems have greater soil organic matter, which allows them to retain carbon in the soil, thereby reducing the levels of carbon dioxide in the atmosphere. Organic farming requires less fossil energy because organic farms do not use synthetic fertilizers or pesticides. According to Pimentel *et al*. (2005), organic systems typically need less energy than conventional systems, therefore organic farms can be considered more environmentally friendly than conventional systems. There are several barriers to the adoption of organic farms. A significant barrier for farmers is their technical knowledge and ability to manage organically. Farmers need to plan carefully, improve the health of their soil, learn new methods of farming, and put those new methods into practice when changing from a conventional farm to an organic farm. Farmers may have temporary decreases in yield during the conversion of their farm, but those yields will return to normal once the soil returns to a health state and has a good balance of biology.

Some organic inputs can also create challenges for farmers who want to convert to organic. Farmers in many developing countries may have limited or no access to compost, biofertilizers, and/or biocontrol pesticides. In addition, the certification process can be complicated and expensive. Smallholder farmers may not want to go through the expense and the red tape of certification even if there are environmental benefits to using organic farming methods.

Consumer demand for organic produce is at an all-time high; however, organic financial investment has created barriers for some groups of people. The financial opportunity to invest in organic produce is not equally available everywhere.

Developing sustainable agriculture that encourages farmers to convert their operations to organic farming will require integration and expansion of organics markets utilizing distribution channels to create supply chain efficiencies.

The governments of various countries have made investments to advance organic agriculture through financial assistance programs, educational resources, research

funding, and market development strategies. In addition, several countries have created national guidelines and certifications for organic agriculture, providing consumers with additional confidence in the products being sold.

Organic agriculture has the potential to offer viable solutions for sustainable development through the integration of all ecological, social, and economic components of sustainability. Organic agriculture supports and enhances the following: increased biodiversity, improved soil health, added ecosystem functions and increased environmental protection by addressing environmental pollution. Collectively, the above-mentioned functions and ecosystem services contribute towards the overall sustainability and resilience of agricultural ecosystems. While the challenges of productivity, certification, and market access remain with organic agriculture, continued investments in research and policy will assist in increasing the effectiveness of organic production systems.

To sum up, research indicates that organic farming methods result in a number of environmental benefits, thus providing an essential element to sustainable agriculture. By promoting biodiversity preservation, improving soil health, and managing pests naturally (i.e., through ecological principles), organic methods demonstrate a promising avenue toward long-term sustainability. As increasing global pressures regarding degradation of the environment and the security of food supplies continue to mount, the potential for organic agriculture to serve as a viable and environmentally appropriate method for promoting sustainable agricultural systems will likely increase.

The most commonly cited example of the ecological benefit provided by organic agricultural systems is their ability to enhance biodiversity across multiple trophic levels. In particular, many studies have documented the higher levels of biodiversity supported by organic farming systems when compared to those supported by traditional farming systems (Tuck *et al*., 2014; Pfiffner, 2011). Research conducted by Tuck *et al*., 2014, shows that organic farms have about 30-34% more species (diversity) than conventional farms when aggregating data from over 90 studies. Organisms found on organic farms with higher biodiversity consist of plants, insects, birds, soil fungi, and arthropods (Tuck, 2014; Gonthier, 2014). The gain in organic biodiversity is mainly due to lower use of chemical pesticides and more habitat diversity on organic farms. By eliminating pests in addition to beneficial organisms (e.g., pollinators, natural pest predators), chemically based pesticides are commonly used in conventional agriculture (Reganold and Wachter, 2016). Organic farmers can rely on ecologically sustainable pest management strategies using biological pest control methods without using chemical pesticides (Montañez & Amarillo-Suárez, 2014). Pollinators are an important group of organisms that benefit from using organic farming methods. The provision of pollination is one of the most important ecosystem services provided by earth. Pollination plays a crucial role in improving the productivity of many fruit and vegetable crops. Researchers have demonstrated that organic farming systems generally have greater abundance and diversity of pollinators than do conventional farming systems, primarily due to increased floral diversity and decreased exposure to pesticides (Gonthier *et al*., 2014; Pfiffner, 2011). Increasing numbers of pollinators can increase the effectiveness of crop pollination and increase the production of food (Tuck *et al*., 2014). Organic farming systems also support a greater number of naturally occurring pest enemies that can attack pests (for example, predatory beetles, spiders and parasitic insects) than conventional farming systems will support. Natural enemy organisms are instrumental in controlling insect pest populations through biological control mechanisms (Montañez & Amarillo-Suárez, 2014). Therefore, the presence of a diverse range of natural enemy communities can help to reduce the prevalence of insect pest outbreaks and decrease the need for chemical insecticides (Gonthier *et al*., 2014; Pfiffner, 2011). Biological pest control is an integral part of sustainable agriculture and is a primary tenet of organic farming systems. Studies indicate that organic production methods have been shown to increase the numbers of predatory insects and parasitic wasps that serve as natural enemies of insect pests (Montañez &

Amarillo-Suárez, 2014; Tuck *et al*., 2014). Organic farms support the increase of natural predators which leads to the availability of more ecological services and a higher level of sustainability. Another important ecological aspect influenced by organic farming is soil biodiversity. Soil ecosystems are made up of a wide diversity of microbial life (bacteria, fungi, earthworms) which are necessary for the cycling of nutrients and the fertility of soils (Reganold and Wachter, 2016). Organic practices like composting, crop rotation and using green manure result in the increase of soil microbial biodiversity and activity (Gonthier *et al*., 2014; Pfeiffner, 2011). Soil health is one of the most well-known benefits of organic farming. The soil organic matter has an important role in maintaining soil productivity, retaining water, and maintaining the activity of microbes (Reganold & Wachter, 2016). Organic farming systems often contain higher levels of soil organic carbon when compared to conventional farming systems, due in part, to the application of organic fertilizers (manure, compost) (Pfeiffner, 2011; Tuck *et al*., 2014). An increase in soil organic content generally leads to an improvement in soil structure and an increase in water infiltration potential. These improvements are of utmost importance to areas suffering from soil degradation and erosion (Reganold & Wachter, 2016). Improved soil structure also enhances plant root development and nutrient uptake, which can contribute to improved crop productivity (Gonthier *et al*., 2014). Another important ecological benefit of organic farming systems is their contribution to landscape-level biodiversity conservation. Organic farms often maintain field margins, hedgerows, and other semi-natural habitats that provide important resources for wildlife (Pfiffner, 2011). These habitats support a wide range of organisms including birds, pollinators, and predatory insects that contribute to ecosystem stability (Tuck *et al*., 2014). Landscape complexity plays a significant role in determining biodiversity patterns within agricultural ecosystems. Studies suggest that organic farms located within heterogeneous landscapes support higher biodiversity compared with farms located in simplified landscapes dominated by monoculture cropping systems (Gonthier *et al*., 2014; Pfiffner, 2011). Landscape heterogeneity increases habitat availability and promotes ecological connectivity among different species populations (Tuck *et al*., 2014). Organic farming practices also contribute to climate change mitigation through increased carbon sequestration in agricultural soils (Altieri, & Nicholls 2004). Soil organic matter acts as a carbon sink, storing carbon that would otherwise contribute to atmospheric greenhouse gas concentrations (Reganold & Wachter, 2016). Organic farming systems that incorporate organic amendments and cover crops can significantly increase soil carbon storage (Gonthier *et al*., 2014). Despite the numerous ecological benefits associated with organic farming, concerns have been raised regarding potential yield differences between organic and conventional farming systems. Some studies have reported that organic farming systems may produce slightly lower yields compared with conventional systems due to lower availability of synthetic fertilizers and pesticides (Reganold & Wachter, 2016). However, recent research suggests that the yield gap between organic and conventional farming systems is often smaller than previously believed. Reganold and Wachter (2016) reported that organic farming systems can achieve approximately 80–90 % of the yields obtained in conventional systems while providing significant environmental benefits. In addition, organic farming systems often provide higher economic returns due to premium prices for organic products and reduced input costs (Tuck *et al*., 2014). Economic viability is an important factor influencing the adoption of organic farming practices. Farmers are more likely to adopt sustainable agricultural practices when they are economically beneficial and supported by appropriate policy frameworks (Reganold & Wachter, 2016). Increasing consumer demand for organic food products has also contributed to the expansion of organic farming systems worldwide. Another important aspect of sustainable agriculture is the integration of agroecological principles into farming systems. Agroecology emphasizes the importance of biodiversity, ecological interactions, and ecosystem services in agricultural production systems (Gonthier *et al*., 2014). Organic farming systems align closely with agroecological

principles because they prioritize ecological processes and biodiversity conservation. Education and extension services are essential for promoting the adoption of organic farming practices among farmers. Farmers require knowledge and technical support to implement sustainable agricultural practices effectively (Pfiffner, 2011). Training programs and research initiatives can help farmers transition from conventional to organic farming systems.

CONCLUSION

The findings of this study provide abundant evidence for the benefits of using organic farming practices as a means to support biodiversity and sustainable agricultural production. Many of the ecological advantages of organic farming include an increase in biodiversity; improved health and productivity of soils; enhanced ecosystem services; and lower environmental costs or impacts (Reganold & Wachter, 2016; Tuck *et al*., 2014; Gonthier *et al*. 2014). Therefore, the incorporation of organic farming into sustainable agriculture is important and necessary, based upon the evidence presented in this review. Organic farming offers a viable approach to achieving sustainable food production while conserving biodiversity. Less chemical use, and reliance on more natural methods of production, through crop diversification and using biological controls for pests, helps to provide an ecological balance to organic farming systems. This review provides ample evidence that organic farming can enhance both biodiversity and ecosystem services within agricultural landscape. Sustainable agricultural practices, including crop rotations, composting or mulching, and agroforestry, improve soil health and extend the ecological life of agricultural ecosystems. Agricultural policy should encourage the adoption of organic farming and other sustainable practices in order to achieve a balance between agricultural production and biodiversity conservation.

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