International Journal of Interdisciplinary Cultural Studies
ISSN: 2327-008X (Print), ISSN: 2327-2554 (Online)
Volume 19, Issue 1, 2024
https://cgscopus.com/index.php/journals

Environmental Change Enhancing Combined Approach of Organic and Conventional Farming for Sustainable Productivity

(Author)
Dr Nandita Singh, Assistant Professor, Department of Geography
(Shri Varshney P.G. College, Aligarh)
(Corresponding Authors)
Dr Harendra Kumar Gaur, Assistant Professor, Department of Zoology
(Shri Varshney P.G. College, Aligarh)

Abstract

Organic agriculture is often perceived as more sustainable than conventional farming. We review the literature on this topic from a global perspective. In terms of environmental and climate change effects, organic farming is less polluting than conventional farming when measured per unit of land but not when measured per unit of output. Organic farming, which currently accounts for only 1% of global agricultural land, is lower yielding on average. Due to higher knowledge requirements, observed yield gaps might further increase if a larger number of farmers would switch to organic practices. Widespread upscaling of organic agriculture would cause additional loss of natural habitats and also entail output price increases, making food less affordable for poor consumers in developing countries. Organic farming is not the paradigm for sustainable agriculture and food security, but smart combinations of organic and conventional methods could contribute toward sustainable productivity increases in global agriculture.

Keywords:- climate change, technology adoption, organic food, nutrition and health effects, environmental effects,

NTRODUCTION

Organic food is increasing in popularity. The growing demand is mainly attributable to consumer concerns about negative implications of conventional agriculture for human health and the environment. Especially in developed countries, most consumers consider organic food to be safer and healthier than conventionally produced food (Funk & Kennedy 2016). Rich-country consumers often also perceive organic farming to be better for the environment, climate protection, and animal welfare (Seufert et al. 2017). In Europe in particular, organic farming has such a positive public image that it is commonly touted as the paradigm for sustainable agriculture (Mercati 2016). A representative survey carried out in Germany showed that approximately 50% of the population considers wider adoption of organic agriculture as an important strategy to fight global hunger (Klümper et al. 2013). The same survey revealed that agrochemicals and genetically modified organisms (GMOs) are often perceived as major threats to food security. In developing countries, the awareness of organic agriculture is still lower, but European perceptions and food preferences are also starting to gain ground, especially among better-off urban consumers (Greenpeace 2015, Probst et al. 2012).

In the academic literature, the views are more nuanced, but the conclusions about the role of organic agriculture for global sustainable development differ widely. Some consider organic agriculture as inefficient and mainly driven by ideology (Connor &Mínguez 2012, Lotter 2015, Trewavas 2001). Others see great potential in organic farming to feed the world in an environmentally friendly way (Badgley et al. 2007, Reganold&Wachter 2016).

Over the last several decades, green revolution technologies, including high-yielding crop varieties and complementary inputs such as synthetic fertilizers, pesticides, and irrigation water, have contributed substantially to productivity growth in agriculture and improvements in global food security (Evenson&Gollin 2003, Qaim 2017). Nevertheless, approximately 800 million people are still chronically undernourished, most of them living in Asia and Africa (FAO 2017). Over the next few decades, the demand for food will increase further due to population and income growth. In addition, plant-based products are increasingly being used as renewable resources. To keep up with this rising demand, it is estimated that global agricultural production will have to increase by at least 60% and possibly up to 100% until 2050 (Godfray et al. 2010, Hertel 2015). This is a major challenge because land, water, and other natural resources are becoming increasingly scarce. Furthermore, the input-intensive agricultural production systems observed in many parts of the world are responsible for—or at least contribute to—major environmental problems, such as land degradation, biodiversity loss, water pollution, and climate change (Foley et al. 2011). Increasing production while reducing the environmental footprint will require profound changes in food and agricultural systems and the types of technologies used. But is organic agriculture the solution? This question is addressed here by reviewing the extensive literature on various aspects of certified organic farming, including economic, social, environmental, and health effects.

PRINCIPLES AND ADOPTION OF ORGANIC AGRICULTURE

Historical Background

The idea of organic agriculture evolved in the early twentieth century in the context of urbanization and the increasing use of agrochemical inputs in farming. The organic movement started in German- and English-speaking countries and was influenced by different groups that promoted rural traditions and the use of biological (instead of synthetic) fertilizers (Vogt 2007). For several decades, the organic movement remained very small, but it has gained popularity since the 1970s with rising public concerns about health and environmental effects of industrialized farming (Lockeretz 2007). In the following decades, governments in several rich countries started to subsidize the organic sector. As a result, the market share of certified organic products increased. In the European Union and the United States, policy measures to support organic farming include governmental regulations and standards, direct subsidies to organic producers, research funding, and sponsorship of communication instruments such as promotion campaigns and organic labeling. The rationale for government interventions is to reward organic farmers for their superior environmental performance and compensate for related increases in production costs or decreases in yield (Stolze&Lampkin 2009). More recently, policy support has also facilitated the adoption of organic standards in developing countries. Domestic governments and western development agencies have launched a number of projects to link smallholder farmers to organic export markets.

Principles of Organic Agriculture

Today, more than 100 countries publicly support organic standards (Seufert et al. 2017). Additionally, several private organic standards exist. Governmental and private standards are typically based on the standards developed by the International Federation of Organic Agriculture Movements (IFOAM) (http://www.ifoam.bio/en). Hence, most organic standards are similar, even though they can differ in specific details.

Organic standards cover different areas such as crop production, animal husbandry, wildlife collection, beekeeping, aquaculture, and processing, among others. The standards involve activities that are prohibited or restricted and other activities that are required or recommended . The cornerstones of organic production systems are balanced crop rotations with legumes, recycling of nutrients (e.g., through mixed farming), and the use of organic fertilizers. Use of synthetic fertilizers and chemical pesticides is prohibited. In livestock production, the animals must be fed with organic fodder, preferably from the same farm, and provided with sufficient space and access to outdoor areas.

Compliance with organic standards is verified on an annual basis through farm inspections undertaken by accredited certification agents (Seufert et al. 2017). For this purpose, records on all farming activities must be kept. In developed countries, certification of individual farms is commonplace. In developing countries, certification is often group based, especially in the small farm sector. Group certification reduces the costs for individual farmers as well as the transaction costs for certifiers and buyers (Jena et al. 2012, Meemken et al. 2017b).

Several studies have analyzed factors that influence farmers' decisions to switch from conventional to organic practices in developed and developing countries. Access to government subsidies for organic farming tends to play an important role (Brenes-Munoz et al. 2016). However, government subsidies can also add to policy risk, which may reduce adoption under certain conditions (Kuminoff&Wossink 2010). In addition to policy risk, organic farming may be associated with higher production risk, because certain risk-reducing inputs are not allowed (Serra et al. 2008). For instance, chemical pesticides help to reduce pest damage but are prohibited in organic agriculture. Indeed, studies showed that adopters of organic practices tend to be more risk loving than nonadopting farmers (Kallas et al. 2010, Serra et al. 2008). Other important adoption determinants include access to information and to high-value certified markets in which buyers are willing to pay significant price premiums for organic products (Läpple 2010, Wollni&Andersson 2014). Especially in the small farm sector of developing countries, adoption of organic standards crucially depends on development initiatives to provide training and marketing support to farmers (Bolwig et al. 2009).

International Journal of Interdisciplinary Cultural Studies
ISSN: 2327-008X (Print), ISSN: 2327-2554 (Online)
Volume 19, Issue 1, 2024
https://cgscopus.com/index.php/journals

In line with the increase in the global organic land area, sales of organic products have also increased. Since 2000, global organic retail sales have quadrupled, reaching US$82 billion in 2015. Demand for organic products is concentrated in North America and Europe (Figure 2*c*). In Europe, the largest organic markets in terms of total retail sales are Germany and France. However, in terms of per capita expenditures on organic products, the leading countries are Switzerland, Denmark, and Sweden (Willer&Lernoud 2017). In most developing countries, demand for organic products is negligible, although increasing in certain high-income segments of the population. Poor people can hardly afford organic products due to significantly higher prices. On average, organic products are priced 50% above conventional products, reflecting higher costs in production, processing, and distribution (Seufert et al. 2017). Price differences between organic and conventional tend to be more pronounced for animal products than for fruits, vegetables, and processed foods (Carlson &Jaenicke 2016).

YIELD EFFECTS

Estimated Yield Gaps

When evaluating the potential of organic agriculture to contribute to sustainable development, a central question concerns the yields obtained in comparison to conventional farming. Estimating yield effects of organic practices is not easy, as confounding factors have to be controlled for. For instance, when organic farmers obtain lower yields, this may be due to the organic practices, but it is also possible that the farmers are less talented or operate in less-favorable environments than their conventional colleagues. In the latter case, organic farmers would have lower yields anyway, even when applying the same technology, so the yield gap of organic farming practices would be overestimated. On the other hand, it is also possible that organic farmers are systematically more talented than their conventional counterparts, which would lead to underestimated yield gaps when simply comparing observed organic with conventional yields. Surprisingly little research has tried to control for such selection bias in estimating yield effects of organic farming based on observational data.

Nevertheless, numerous studies have tried to estimate yield effects of organic farming, often using data from trials on experimental stations. Experimental data help to avoid bias through confounding factors but have their own problems in terms of external validity (see below). Available studies show a wide range of results, depending on the particular context. In some situations, organic yields were found to be higher than conventional yields, whereas in other situations they were considerably lower.

More recently, a few review papers have tried to synthesize the evidence. A first attempt in this direction was a study by Badgley et al. (2007). The authors used results from various sources to conclude that organic agriculture had 33% higher average crop yields than conventional agriculture at the global level. In developed countries, organic yields were 9% lower than conventional yields, but in developing countries, the authors claimed that organic practices would increase crop yields by 74% (Badgley et al. 2007). However, this study was heavily

COMMON GROUND

International Journal of Interdisciplinary Cultural Studies
ISSN: 2327-008X (Print), ISSN: 2327-2554 (Online)
Volume 19, Issue 1, 2024
https://cgscopus.com/index.php/journals

criticized on various grounds (Cassman 2007, Connor 2008, Goulding&Trewavas 2009). Many of the studies included in the review by Badgley et al. (2007) did not meet minimum scientific standards in terms of experimental design (Cassman 2007). Other relevant studies were simply ignored (Goulding&Trewavas 2009). For developing countries, Badgley et al. (2007) mostly compared yields of crops that had received high levels of organic nutrients as the organic version with crops that had received very little or no fertilizer as the conventional version (Connor 2008). Hence, despite being highly cited, the results of Badgley et al. (2007) are not reliable and meaningful.

Three scientifically more rigorous meta-analyses of organic-conventional crop yield comparisons were published in the last few years (de Ponti et al. 2012, Ponisio et al. 2015, Seufert et al. 2012). Results of these analyses are summarized in Table 2. Across all crops, mean yield gaps of organic agriculture are in the magnitude of 19–25%. Considerable differences can be observed across different crop species, with legumes and fruits showing smaller yield gaps than cereals and root and tuber crops. There is some evidence that the yield gap increases as conventional yields increase (de Ponti et al. 2012). Under best management practices for both systems, yield gaps do not seem to differ significantly between developed and developing countries (Ponisio et al. 2015). However, in all three meta-analyses, observations from developing countries are heavily underrepresented (Seufert&Ramankutty 2017), so statements about geographic differences of yield gaps need to be interpreted with caution. Longer-term research was recently started to improve knowledge about the productivity effects of organic farming in developing countries (Forster et al. 2013).

One relevant issue when comparing yield levels between organic and conventional agriculture is the time period that the original studies cover. It is sometimes assumed that yields would decline shortly after conversion to organic practices but would then recover after a while due to gradually improving soil conditions in organic farming. However, the evidence to support this assumption is weak. While some studies report organic yield increases over time, others find no changes or even decreasing yields in longer-term studies (de Ponti et al. 2012, Mäder et al. 2002).

Explaining Yield Gaps

Apart from sunlight and favorable temperatures, plants need a range of different nutrients to grow well, especially nitrogen, phosphorus, potassium, and several micronutrients. In addition, soil texture and composition, water availability, and problems due to pests and diseases matter. Almost all of these parameters may differ between organic and conventional practices; hence, it is not surprising that yield levels differ as well. As mentioned, organic standards prohibit the use of synthetic fertilizers. Although all the required nutrients can, in principle, also be provided through organic fertilizers, nutrient management is more difficult in organic production systems (Niggli 2015).

Organic systems are often found to be limited in nitrogen and phosphorus (Berry et al. 2002, Oehl et al. 2002). The release of plant-available nitrogen from organic sources is slow and can often not keep up with the nitrogen demand during peak crop growth periods (Seufert et al. 2012). The amount of phosphorus provided in organic systems is also sometimes insufficient to replenish the quantities lost due to harvest (Oehl et al. 2002). In general, providing the right mixture of nutrients to optimally support plant growth is more complicated in organic systems because the nutrient ratio of organic inputs can only be influenced to a very limited degree (Seufert&Ramankutty 2017).

Nutrient limitations are an important factor to explain the observed yield gaps in organic agriculture. Against this background, lower-than-average yield gaps observed for legumes and fruits are plausible. Legumes can fix atmospheric nitrogen and are hence less dependent than other crops on externally added nitrogen. Fruits grow on trees that have longer growing seasons and extensive root systems and are hence better able to absorb nutrients in synchrony with crop demand (Seufert et al. 2012).

In terms of water availability and use, organic systems tend to have an advantage because soils managed with organic methods show better water-holding capacity and higher rates of water infiltration. This is also one reason why organic systems are often said to be more resilient and have higher yield stability, even under drought conditions (Gomiero et al. 2011, Niggli 2015). On the other hand, organic systems are sometimes more susceptible to pest outbreaks, which can lead to yield losses and higher yield variability (Seufert&Ramankutty 2017). The ban of chemical pesticides and GMOs in organic agriculture limits the tools available to farmers for effectively controlling weeds, insect pests, and plant diseases. Hence, in high pest pressure environments, and where pests and diseases that are difficult to control with biological methods are found, yield gaps of organic agriculture are higher than in low pest pressure environments.

External Validity of Estimated Yield Gaps

Most of the data that rigorously compare crop yields in organic and conventional agriculture stem from experimental trials carried out on research stations. Experimental yields are often higher than those in real-world agriculture because farmers are not always able to fully replicate recommended management practices. If yield differences between experimental stations and farmers' fields would be the same for organic and conventional agriculture, yield comparisons between the two systems would not be systematically biased. However, there is increasing evidence that yield differences between experimental stations and farmers' fields are larger for organic than for conventional practices (Kravchenko et al. 2017). The reason is that organic farming is more knowledge intensive, and yields depend more on timely management interventions (Seufert et al. 2012, Taheri et al. 2017). Hence, while the reported yield differences between organic and conventional agriculture may be true under experimental conditions, they may possibly underestimate the yield gaps that occur in real-world farming situations.

International Journal of Interdisciplinary Cultural Studies
ISSN: 2327-008X (Print), ISSN: 2327-2554 (Online)
Volume 19, Issue 1, 2024
https://cgscopus.com/index.php/journals

To test the external validity of results obtained from studies on experimental stations, Kniss et al. (2016) compared data from a large number of commercial farms in the United States. For cereals, they found yields on organic farms to be approximately 20% lower than on conventional farms, which is similar to the yield gaps reported in the meta-analyses (Table 2). However, for certain vegetables, Knisset al. (2016) reported yield gaps of 50% and more, which is significantly higher than what the meta-analyses reported. Under practical conditions in some parts of Europe, Pimentel et al. (2005) reported organic cereal yields to be 50% lower than conventional yields. These results should not be extrapolated, as unbiased evidence about organic yield effects under real-world conditions is limited (Kravchenko et al. 2017, Leifeld 2016). In any case, given the higher knowledge requirements for successful organic farming, it is likely that the average yield gaps would rise if an increasing number of farmers would adopt organic practices.

Another interesting question is how yield gaps between organic and conventional agriculture may further develop in the long run, when factoring in technological change. Available studies do not provide a clear answer to this question (Seufert&Ramankutty 2017). As mentioned, yield gaps tend to increase with increasing conventional yields. In addition, over the coming decades yield gaps may potentially widen due to slower plant genetic improvements in organic farming. Organic standards ban the use of GMOs and genome editing techniques, which have significant potential to further increase crop yields and yield stability (Qaim 2016). On the other hand, organic agriculture has received limited research until now (Niggli 2015); increasing the research efforts could possibly contribute to reducing the research gaps over time.

NUTRITION AND HEALTH EFFECTS OF ORGANIC FOODS

Consumers often perceive organic foods to be more nutritious and healthier than conventional foods (Seufert et al. 2017). In principle, this could be due to lower contamination of organic foods with unhealthy components or higher contents of nutritionally desirable ingredients. A large body of literature has analyzed whether there are indeed significant differences between organic and conventional foods in terms of chemical composition.

Several systematic reviews suggest that organic food contains lower levels of chemical pesticide residues (Barański et al. 2014, Dangour et al. 2010, Huber et al. 2011). Whether this difference is relevant for human health depends on the types and quantities of pesticides used in conventional farming. In developed countries, where pesticide regulations are relatively strict, differences in risk for exceeding maximum allowed limits are generally negligible (Magkos et al. 2006, Smith-Spangler et al. 2012). In terms of other unhealthy components, some reviews conclude that organic foods contain lower concentrations of nitrate and cadmium (Barański et al. 2014, Huber et al. 2011). No significant difference was found in terms of fungal or bacterial contamination in most studies, although some suggest higher microbial concentrations in certain organic products such as fruits (Mditshwa et al. 2017).

Regarding nutritionally desirable components, most reviews suggest that organic plant products contain moderately higher concentrations of secondary metabolites such as phenolics (Barański et al. 2014, Brandt et al. 2011, Smith-Spangler et al. 2012). Concerning vitamin C and carotenoids, the results are mixed (Barański et al. 2014, Hunter et al. 2011, Smith-Spangler et al. 2012). Higher levels of omega-3 fatty acids were found in organic milk and chicken (Barański et al. 2017, Huber et al. 2011, Smith-Spangler et al. 2012). On the other hand, slightly lower concentrations of proteins and amino acids were found in organic foods (Barański et al. 2014). However, it is not clear whether these differences in nutritionally desirable components between organic and conventional foods are clinically relevant (Barański et al. 2017, Dangour et al. 2010, Forman & Silverstein 2012, Smith-Spangler et al. 2012).

Certain differences in the composition of organic and conventional foods may not be surprising, as farming practices can affect plant chemistry (Brandt et al. 2011). Lower cadmium and nitrate levels in organic plants are linked to synthetic fertilizers not being allowed in organic farming (Barański et al. 2014). Nitrogen fertilization promotes vegetative growth (associated with the formation of proteins and carbohydrates) while limiting generative growth (associated with the formation of secondary metabolites) (Huber et al. 2011). Regarding animal products, higher levels of omega-3 fatty acids are potentially linked to outdoor grazing and larger biodiversity in pastures on organic farms.

However, plant chemistry depends not only on the production system but also on weather conditions, soil type, genotype (variety), ripening stage of the product at harvest, and postharvest conditions (Brandt et al. 2011, Huber et al. 2011). For instance, cadmium levels are highly dependent on soil type and may therefore also be high in organic products (Barański et al. 2014). Furthermore, management practices within both organic and conventional systems can vary (Huber et al. 2011, Smith-Spangler et al. 2012). Organic cattle are not necessarily kept on biodiverse pastures, and conventional cattle are not always raised indoors with silage. As a result, the variation in the composition of foods can be larger within organic and conventional systems than between the two systems (Brandt et al. 2011).

Beyond the chemical composition of foods, several studies have examined possible human health effects of organic diets through observational data from consumers. A few studies suggest that the consumption of organic foods can be associated with a lower risk of allergies and eczema in infants (Alfvén et al. 2006, Kummeling et al. 2008). A cohort study carried out in France showed that regular consumption of organic food is associated with lower rates of obesity (Kesse-Guyot et al. 2013). However, a systematic review did not find differences in health outcomes (Dangour et al. 2010). Generally, it is difficult to prove causality with observational data. Organic consumers are known to make different—often healthier—food and lifestyle choices (Huber et al. 2011, Kesse-Guyot et al. 2013), which can lead to selection bias in impact evaluation. Given the limited evidence, general conclusions about health effects of organic food consumption cannot be drawn (Barański et al. 2017, Dangour et al. 2010, Forman & Silverstein 2012).

Agricultural production contributes to various environmental problems such as climate change, biodiversity loss, soil degradation, and water pollution (Foley et al. 2011). It is widely believed that organic agriculture causes fewer negative environmental externalities than conventional agriculture, which is also the main reason why many governments subsidize the organic sector. In this section, we review the evidence of the effects of organic farming on various environmental aspects.

Land-Use Efficiency

Approximately 40% of the global ice-free land is used for agricultural production (Foley et al. 2011). Continuous land-use change (e.g., deforestation) is associated with various environmental problems, especially the loss of biodiversity and the release of soil carbon into the atmosphere. Thus, balancing food production and environmental goals will increasingly require using land and other natural resources more efficiently. Organic systems have lower land-use efficiency than conventional systems. As discussed above, organic crop yields are lower than conventional yields on average. In addition, organic crop rotations typically include crops that are not suitable for human consumption. Finally, organic animal husbandry is characterized by longer production cycles and lower animal growth rates, meaning that larger quantities of fodder and more land for fodder production are required per unit of organic meat (Treu et al. 2017).

Land-use requirements are also relevant when assessing other environmental effects of organic and conventional production systems. Therefore, environmental impacts are typically expressed per unit of land and per unit of output, where the latter tries to account for lower land-use efficiency in organic systems. Given the rising demand for food and agricultural products, measuring per unit of output seems more relevant to assess environmental impacts from a global perspective. However, even this approach probably underestimates the environmental effects that large-scale conversion to organic agriculture might have. Today, only a marginal share of the global agricultural land is certified organic. Large-scale conversion to organic would likely require bringing more natural habitats into agricultural production. Such additional land-use change would be associated with environmental costs that are not fully accounted for by simply expressing per unit of output (Leifeld 2016).

Energy Use and Greenhouse Gas Emissions

Approximately 25% of the anthropogenic greenhouse gas (GHG) emissions are attributable to food production (Edenhofer et al. 2014). Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions accrue during the combustion of fossil fuels (e.g., for the production of mineral fertilizer and the use of agricultural machinery), soil chemical processes, and animal digestion, among others (Gomiero et al. 2011). Energy use and GHG emissions from agriculture are typically evaluated through life cycle assessments until a product leaves the farm (Meier et al. 2015, Smith et al. 2015).

The evidence suggests that organic agriculture uses less energy per unit of land, and to a lesser extent, also per unit of output than conventional agriculture (Table 3). This difference is mainly attributable to the nonuse of synthetic fertilizers and pesticides in organic systems. Fuel use for agricultural operations is similar across systems. However, for certain crops (especially vegetables) more fuel is sometimes required in organic production, when repeated mechanical or thermal weed control becomes necessary (Lynch et al. 2011, Scialabba& Müller-Lindenlauf 2010, Smith et al. 2015). This may also lead to higher overall energy use in organic systems in certain situations (Lee et al. 2015).

Concerning GHG emissions, most studies conclude that organic farming has lower impacts when expressed per unit of land but not when expressed per unit of output (Table 3). Generally, organic systems are characterized by lower nitrogen inputs, and thus lower N_2O emission potential. However, balancing nutrient supply and plant demand is typically more challenging in organic systems; oversupply of nitrogen from organic fertilizer may also lead to significant N_2O emissions, while undersupply leads to lower yields (Clark &Tilman 2017, Lynch et al. 2011, Skinner et al. 2014). In crop production, soil carbon stocks and sequestration rates were found to be significantly higher in organic than in conventional systems (Gattinger et al. 2012, Lori et al. 2017). In livestock production, less intensive organic husbandry systems lead to larger quantities of manure per unit of meat, and thus higher methane and N_2O emissions (Treu et al. 2017). Overall, the evidence does not support the widely held notion that organic agriculture is more climate friendly than conventional agriculture (WBA 2016).

Nutrient Leaching and Water Quality

Nutrient leaching is a problem, especially in regions with intensive agriculture, as it causes eutrophication of water bodies and marine ecosystems (Halberg 2012). Nitrate (NO_3^-) leaching under organic management was found to be lower per unit of land but not per unit of output (Table 3). The overall eutrophication potential per unit of output, measured in terms of phosphate (PO_4) equivalents, and the acidification potential, measured in terms of sulfur dioxide (SO_2) equivalents, were even found to be higher in organic systems (Clark &Tilman 2017). Nonuse of synthetic fertilizers is generally associated with lower leaching potential (Lori et al. 2017, Niggli 2015), but again, avoiding mismatches between nutrient supply and plant demand can be challenging in organic systems, potentially leading to greater nutrient losses (Gomiero et al. 2011, Halberg 2012, Tuomisto et al. 2012).

Concerning pesticides, as synthetic pesticides are banned in organic farming, the risk of pesticide pollution of water bodies is lower (Reganold&Wachter 2016). However, certain nonsynthetic pesticides, which are used in organic farming, can also have negative effects for aquatic life. For instance, in organic horticultural production copper-based solutions are widely used to control fungal diseases (Niggli 2015).

International Journal of Interdisciplinary Cultural Studies
ISSN: 2327-008X (Print), ISSN: 2327-2554 (Online)
Volume 19, Issue 1, 2024
https://cgscopus.com/index.php/journals

Soil Quality

Millions of hectares of previously fertile land have become unsuitable for agricultural production because of soil degradation (e.g., erosion), often as a result of mismanagement (Halberg 2012). Organic practices such as the application of organic matter (e.g., green or animal manure) and longer and more diverse crop rotations with cover and catch crops can help to reduce soil erosion and fertility decline (Lori et al. 2017, Niggli 2015). Meta-analyses and results from long-term field trials confirm that organically managed fields have higher contents of organic matter and larger and more active soil microbial communities (Table 3), both key indicators of soil quality.

Biodiversity

Agricultural intensification and homogenization of landscapes have significantly contributed to biodiversity loss (Bengtsson et al. 2005, Halberg 2012). There is large agreement that organic farms are more biodiverse (Hole et al. 2005, Mäder et al. 2002, Pimentel et al. 2005, Schneider et al. 2014, Tuck et al. 2014), which is due to lower pesticide use, longer crop rotations, and more seminatural landscape elements (e.g., hedges) (Niggli 2015). Meta-analyses suggest that species richness (number of species) and species evenness (relative abundance of different species) are both significantly higher on organic farms than on conventional farms (Table 3). Large differences were found when high-intensity conventional systems were taken as the reference (Bengtsson et al. 2005, Tuck et al. 2014). However, the biodiversity benefits diminish with increasing intensity of organic production systems (Gabriel et al. 2013). Disagreement exists whether the benefits of organic farming also diminish with increasing scale (Bengtsson et al. 2005, Schneider et al. 2014, Tuck et al. 2014).

As mentioned, because of lower yields, large-scale conversion to organic agriculture would likely imply further loss of natural habitats. It is largely agreed that the biodiversity gains from organic production cannot offset the biodiversity loss associated with additional land-use change (Gabriel et al. 2013, Green et al. 2005, Mondelaers et al. 2009, Schneider et al. 2014). The “land sharing” versus “land sparing” debate is complex and requires site-specific solutions, which is why simplistic global prescriptions are inappropriate (Phalan et al. 2011, Tuck et al. 2014).

Summary of Environmental Effects

Overall, the environmental benefits of organic agriculture are less clear than widely believed. Often, the environmental performance of organic systems is better than that of conventional systems when compared per unit of land, but the difference vanishes when measuring per unit of output (Table 3). Consequently, organic agriculture seems to be more suitable to address local environmental problems (e.g., soil degradation) than global problems (e.g., land-use change, climate change) (Mondelaers et al. 2009).

It should be mentioned that some of the findings on environmental effects are not yet fully conclusive. Limited data are available from developing countries, so existing results may not be globally representative (Clark &Tilman 2017, Gattinger et al. 2012, Lee et al. 2015, Skinner et al. 2014). Furthermore, available studies mostly compare organic and conventional systems without controlling for confounding factors, so that observed differences cannot necessarily be interpreted as causal effects of organic standards. Finally, it needs to be stressed that large heterogeneity in environmental impacts exists within both conventional and organic systems (Bengtsson et al. 2005, Halberg 2012, Lori et al. 2017, Meier et al. 2015, Skinner et al. 2014, Treu et al. 2017). Environmentally friendly farming practices (e.g., sound management of nutrients, longer crop rotations, seminatural landscape elements) are particularly encouraged by organic standards, but they are also used by many conventional farmers (Lynch et al. 2011, Pimentel et al. 2005).

CONCLUSIONS

Many rich-country consumers consider organic foods to be healthier and organic agriculture to be more environmentally friendly than conventional farming methods. These perceived benefits are influencing food and agricultural policies. Sometimes organic farming is promoted as the paradigm for sustainable agriculture and food security. In this article, we have reviewed the available literature about the economic, social, environmental, and health effects of certified organic agriculture from a global perspective.

In terms of health effects, clear conclusions cannot be drawn. Although some studies show differences between the chemical composition of organic and conventional foods, others do not, and where differences are found, these are small and may not be clinically relevant. In terms of environmental and climate effects, organic farming is less polluting than conventional farming when the effects are measured per unit of land but not when measured per unit of output. As the demand for food and agricultural products is high and growing, expressing environmental and climate effects per unit of output seems more relevant from a global perspective.

The reason why organic farming is more environmentally friendly than conventional farming per unit of land but not per unit of output is the lower average yield obtained with organic agriculture. The bans of synthetic fertilizers, pesticides, and GMOs in organic farming make plant nutrition and pest control more difficult and often less effective. So far, organic farming accounts for only 1% of the global agricultural land. Due to the higher knowledge requirements in organic farming, currently observed yield gaps between organic and conventional methods might further increase if a larger number of farmers would switch to organic practices. This is especially true in developing countries, where smallholder farmers tend to have relatively low levels of education and limited access to agricultural training.

The yield gaps imply that more land would be required to produce the same quantity of output with organic methods. Expanding agricultural production further into natural habitats would lead to additional GHG emissions and loss in biodiversity. Depending on the context, such indirect land-use change effects could outweigh the positive environmental effects of organic farming per unit of land. Against this background, organic farming is not the paradigm for sustainable agriculture and food security. Widespread upscaling of organic production methods would also entail significant output price increases, thus making food less affordable for poor consumers in developing countries.

The conclusion that organic farming is not the global blueprint for sustainable agriculture does not mean that organic methods cannot be useful in specific situations. Under certain conditions, organic farming can be clearly positive for the environment, even when the effects are measured per unit of output. Experience shows that farmers can benefit as well when they are linked to certified markets in which consumers are able and willing to pay a significant price premium for organically produced foods. This is the case in certain high-value niches but less so in mass markets catering to lower-income population segments.

However, the environmental footprint of agricultural production needs to be reduced for mass markets as well. This will require new technologies and production methods that conserve natural resources and make farming more resilient and less dependent on chemical inputs. Solutions have to be locally adapted, taking into account all promising areas of science. Neither conventional nor organic methods currently have perfect answers to these challenges. Sustainable production systems will likely require smart integration of both types of agriculture. Organic methods are well suited to reduce land degradation and improve soil quality, but in many situations, crop productivity and environmental efficiency could be further improved if these methods were combined with moderate levels of synthetic fertilizers and the newest insights into plant genetic improvement. Ideological barriers between supporters and opponents of organic agriculture need to be overcome to pave the way for developing and implementing more sustainable forms of farming.

There are several areas that deserve more research to further improve our understanding of the effects of organic agriculture. First, many of the available studies on yield performance and environmental effects refer to developed countries. Additional studies under typical conditions in developing countries would be very useful. Second, many of the existing studies with farm survey data have not properly controlled for selection bias. More rigorous empirical studies are needed. Third, while several studies showed that organic farming can be profitable with the existing support through subsidies and development projects, it is less clear whether organic farming could also be profitable without such external support. Fourth, the net food price effects of organic agriculture are not sufficiently understood. Although it is clear that organic foods are more expensive than conventional foods, it is less clear how much of the price markup is attributable to differences in farming practices as opposed to other factors such as scale effects, market structure, and efficiency. Finally, it would be interesting to analyze how the productivity, environmental, and profitability effects of organic farming might change through slight adjustments in the definition of what is allowed and disallowed in certified organic production.

International Journal of Interdisciplinary Cultural Studies
ISSN: 2327-008X (Print), ISSN: 2327-2554 (Online)
Volume 19, Issue 1, 2024
https://cgscopus.com/index.php/journals

Reference:-

- Ayuya OI, Gido EO, Bett HK, Lagat JK, Kahi AK, Bauer S. 2015. Effect of certified organic production systems on poverty among smallholder farmers: empirical evidence from Kenya. *World Dev*. 67: 27–37

- Bacon C. 2005. Confronting the coffee crisis: Can Fair Trade, organic, and specialty coffees reduce small-scale farmer vulnerability in northern Nicaragua? *World Dev*. 33: 497–511

- Badgley C, Moghtader J, Quintero E, Zakem E, Chappell MJ, et al. 2007. Organic agriculture and the global food supply. *Renew. Agric. Food Syst.* 22: 86–108

- Barański M, Rempelos L, Iversen PO, Leifert C. 2017. Effects of organic food consumption on human health; the jury is still out! *Food Nutr. Res*. 61: 1287333

- Barański M, Srednicka-Tober D, Volakakis N, Seal C, Sanderson R, et al. 2014. Higher antioxidant and lower cadmium concentrations and lower incidence of pesticide residues in organically grown crops: a systematic literature review and meta-analyses. *Br. J. Nutr.* 112: 794–811

- Barham BL, Weber JG. 2012. The economic sustainability of certified coffee: recent evidence from Mexico and Peru. *World Dev*. 40: 1269–79

- Becchetti L, Conzo P, Gianfreda G. 2012. Market access, organic farming and productivity: the effects of Fair Trade affiliation on Thai farmer producer groups. *Aust. J. Agric. Resour. Econ.* 56: 117–40

- Bellemare MF. 2012. As you sow, so shall you reap: the welfare impacts of contract farming. *World Dev*. 40: 1418–34

- Bengtsson J, Ahnström J, Weibull A-C. 2005. The effects of organic agriculture on biodiversity and abundance: a meta-analysis. *J. Appl. Ecol*. 42: 261–69

- Sibhatu KT, Krishna VV, Qaim M. 2015. Production diversity and dietary diversity in smallholder farm households. *PNAS* 112: 10657–62

- Skinner C, Gattinger A, Muller A, Mäder P, Fließbach A, et al. 2014. Greenhouse gas fluxes from agricultural soils under organic and non-organic management—a global meta-analysis. *Sci. Total Environ.* 468–469: 553–63

International Journal of Interdisciplinary Cultural Studies
ISSN: 2327-008X (Print), ISSN: 2327-2554 (Online)
Volume 19, Issue 1, 2024
https://cgscopus.com/index.php/journals

- Smith LG, Williams AG, Pearce BD. 2015. The energy efficiency of organic agriculture: a review. *Renew. Agric. Food Syst.* 30: 280–301

- Smith-Spangler C, Brandeau ML, Hunter GE, Bavinger JC, Pearson M, et al. 2012. Are organic foods safer or healthier than conventional alternatives? A systematic review. *Ann. Intern. Med.* 157: 348–66

- Snider A, Gutiérrez I, Sibelet N, Faure G. 2017. Small farmer cooperatives and voluntary coffee certifications: rewarding progressive farmers of engendering widespread change in Costa Rica? *Food Policy* 69: 231–42