

Modernization of Agriculture and Impact on Environment

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ABSTRACT

In the early 1950s many developing countries lacked indigenous research and technology capability. In their desperate attempts to modernize traditional agriculture they selectively borrowed technology and strategies of development from the West. Green revolution technology produced some impressive results in food production but also increased poverty and caused deterioration of the environment. It is easier to be critical than to find universal solutions to solve complex problems of development in diverse agro-climatic and socio-political systems. This review examines the external mega forces, namely international agricultural centers, trade, bilateral aid, and international organizations affecting modernization of agriculture in developing countries, and provides a balanced critique on positive and negative impacts of modernization in these countries. General trends of social and environmental impacts are briefly summarized. New approaches undertaken by international centers and by some developing countries to overcome social and environmental impacts of modern agriculture are reviewed. Mechanisms to generate appropriate agricultural technology development and management of delivery services are suggested to achieve integrated socio-economic welfare of the people and sustainable environment.

KEYWORDS: *impact, modernization, agriculture, people, food, environment*

INTRODUCTION

Modern agriculture is an evolving approach to agricultural innovations and farming practices that help farmers increase efficiency and reduce the number of natural resources like water, land, and energy necessary to meet the world's food, fuel, and fiber needs. The agribusiness, intensive farming,

organic farming, and sustainable agriculture are other names of modern agriculture.[1] As we know that modern agriculture improved our affordability of food, increases the food supply, ensured the food safety, increases sustainability, and also produces more biofuels.

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But at the same time, it also leads to environmental problems because it is based on high input–high output technique using hybrid seeds of high-yielding variety and abundant irrigation water, fertilizers, and pesticides. The impacts of modern agriculture on the Environment are discussed below:

Soil Erosion

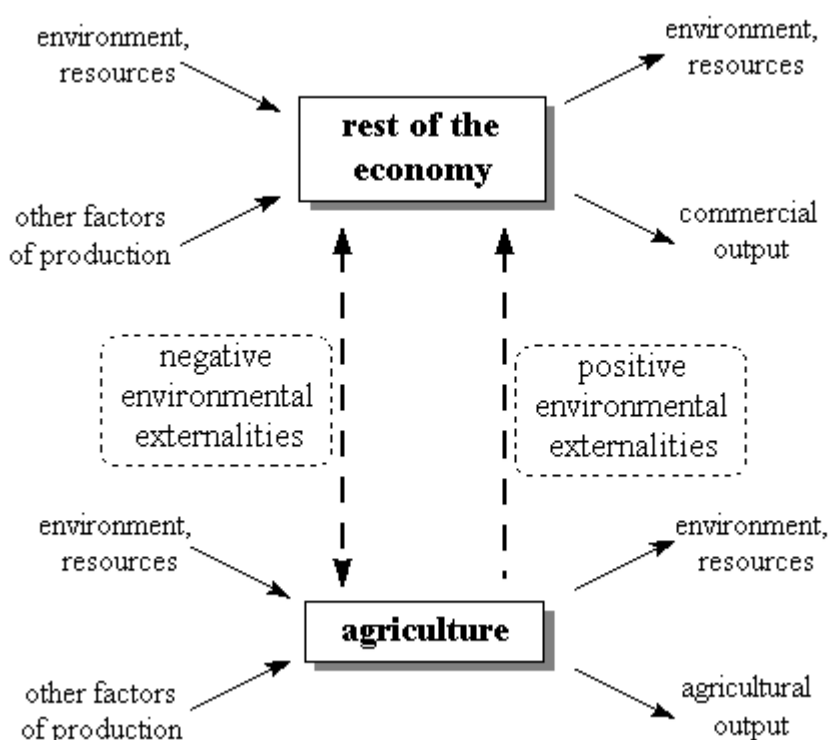
The top fertile soil of the farmland is removed due to the excessive water supply. This leads to the loss of nutrient-rich soil that hampered productivity. It also causes global warming because the silt of water bodies induces the release of soil carbon from the particulate organic material.

Contamination of groundwater

The groundwater is one of the important sources of water for irrigation. [2,3] From agricultural fields, nitrogenous fertilizers leach into the soil and finally contaminate groundwater. When the nitrate level of groundwater exceeds 25 mg/l, they can cause a serious health hazard known as “Blue Baby Syndrome”, which affects mostly infants even leading to their death.

Water-logging and salinity

The salinity of the soil is one of the reasons of low productivity just because of the improper management of farm drainage. In this situation, the roots of plants do not get enough air to respiration then it leads to low crop yield as well as low mechanical strength.[4,5]



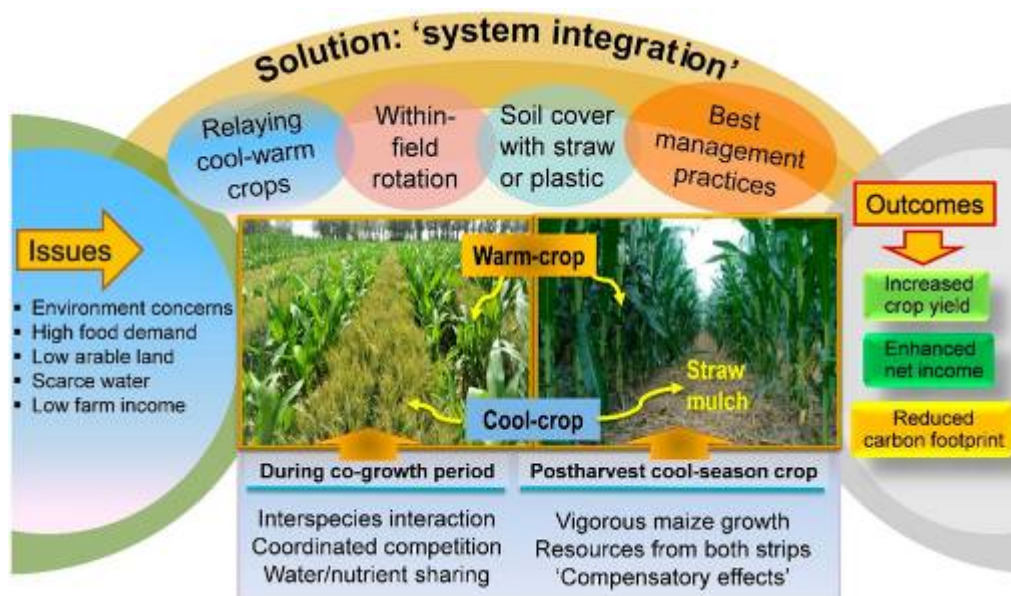
Eutrophication

It refers to the addition of artificial or non-artificial substances such as nitrates and phosphate, through fertilizers or sewage, to a freshwater system. It leads to an increase in the primary productivity of the water body or the 'bloom' of phytoplankton.

Excessive use of fertilizers that consists of nitrogen and phosphorus leads to over nourishment of the lakes/water bodies and gives rise to the phenomenon of eutrophication (EU = more, trophication= nutrition).[6,7]

Excessive use of Pesticide

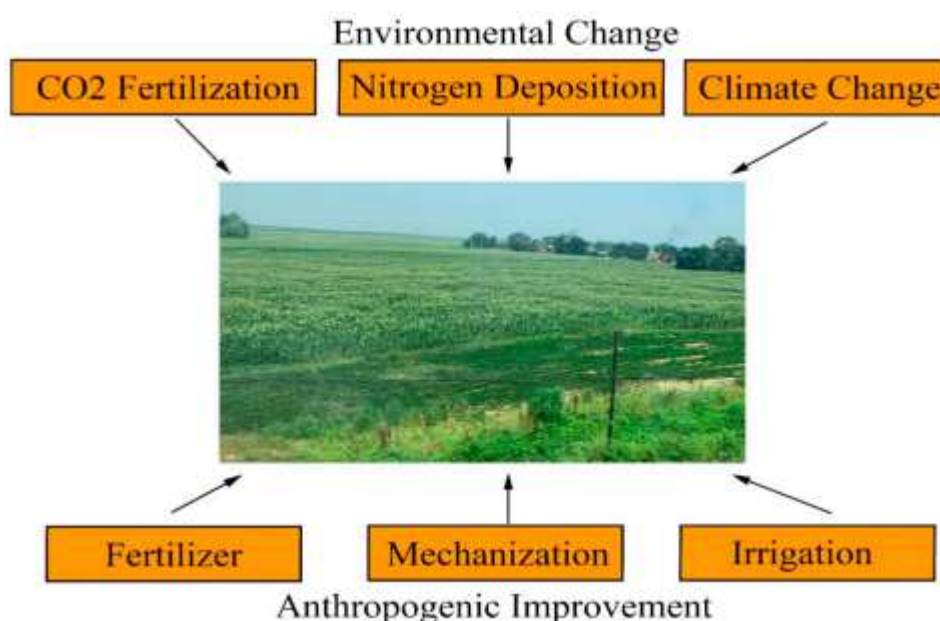
There are many pesticides that are used for destroying pests and boosting crop production. Earlier arsenic, sulfur, lead, and mercury was used to kill pests. For Example- Dichloro Diphenyl Trichloroethane (DDT) content pesticides were used, but unfortunately, it also targeted the beneficial pests. Most importantly, many pesticides are non-biodegradable, which also linked to the food chains which are harmful to the human being.



The relative significance of farming has dropped steadily since the beginning of industrialization, and in 2006 – for the first time in history – the services sector overtook agriculture as the economic sector employing the most people worldwide. But we forget that if we need food to survive then we need agriculture.[8,9]

Discussion

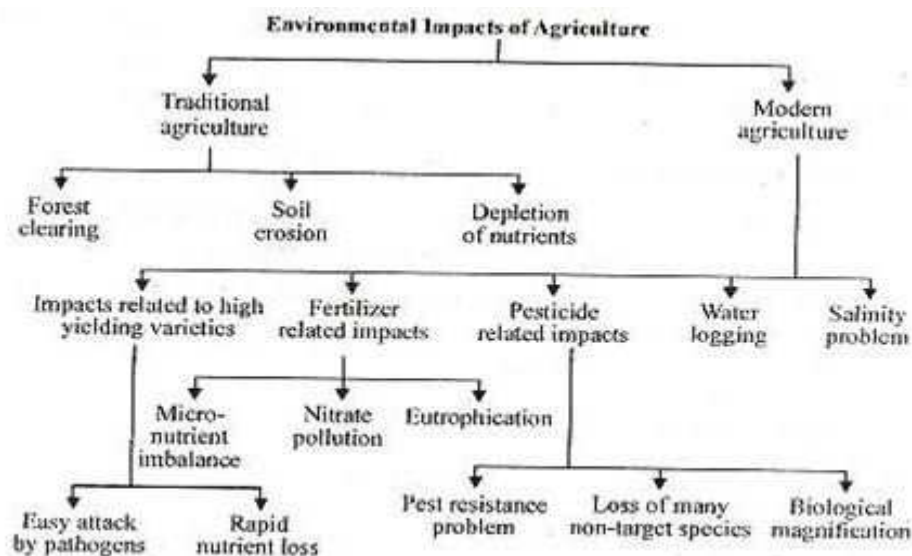
Agricultural methods have intensified continuously ever since the Industrial Revolution, and even more so since the “green revolution” in the middle decades of the 20th century. At each stage, innovations in farming techniques brought about huge increases in crop yields by area of arable land. This tremendous rise in food production has sustained a global population that has quadrupled in size over the span of one century. As the human population continues to grow, so too has the amount of space dedicated to feeding it. According to World Bank figures, in 2016, more than 700 million hectares (1.7 billion acres) were devoted to growing corn, wheat, rice, and other staple cereal grains—nearly half of all cultivated land on the planet. In the coming decades, however, meeting the demand for accelerated agricultural productivity is likely to be far more difficult than it has been so far. The reasons for this have to do with ecological factors. Global climate change is destabilizing many of the natural processes that make modern agriculture possible. Yet modern agriculture itself is also partly responsible for the crisis in sustainability. Many of the techniques and modifications on which farmers rely to boost output also harm the environment. Below are brief descriptions of three ways intensive agriculture threatens the precarious balance of nonagricultural ecosystems.[10,11]



Irrigation

Worldwide, agriculture accounts for 70 percent of human freshwater consumption. A great deal of this water is redirected onto cropland through irrigation schemes of varying kinds. Experts predict that to keep a growing population fed, water extraction may increase an additional 15 percent or more by 2050. Irrigation supports the

large harvest yields that such a large population demands. Many of the world's most productive agricultural regions, from California's Central Valley to Southern Europe's arid Mediterranean basin, have become economically dependent on heavy irrigation.



A Layout of Environmental Impacts of Agriculture

Researchers and farmers alike are becoming increasingly aware of the consequences of this large-scale diversion of freshwater. One of the most obvious consequences is the depletion of aquifers, river systems, and downstream ground water. However, there are a number of other negative effects related to irrigation. Areas drenched by irrigation can become waterlogged, creating soil conditions that poison plant roots through anaerobic decomposition. Where water has been diverted, soils can accrue too much salt, also harming plant growth. Irrigation causes increases in water evaporation, impacting both surface air temperature and pressure as well as atmospheric moisture conditions. Recent studies have confirmed that cropland irrigation can influence rainfall patterns not only over the irrigated area but even thousands of miles away. Irrigation has also been connected to the erosion of coastlines and other kinds of long-term ecological and habitat destruction.[12,13]

Livestock Grazing

A huge amount of agricultural territory is used primarily as pasture for cattle and other livestock. In the western United States, counting both federally managed and privately owned grazing lands, hundreds of millions of acres are set aside for this purpose—more than for any other type of land use. Agricultural livestock are responsible for a large proportion of global greenhouse gas emissions, most notably methane. In addition, overgrazing is a major problem regarding environmental sustainability.

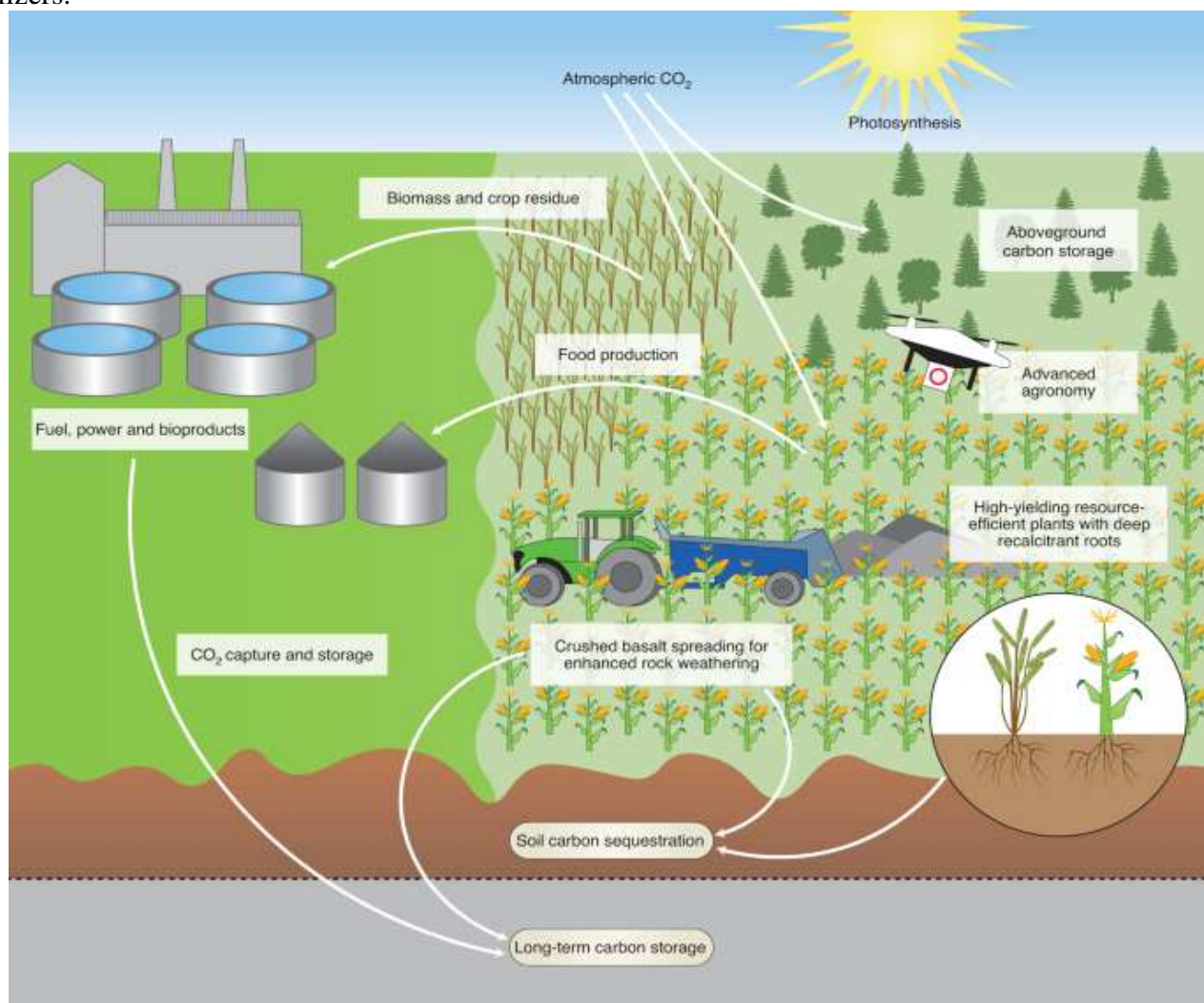


Indoor farming market during COVID-19

In some places, stretches of forage land are consumed so extensively that grasses are unable to regenerate. The root systems of native vegetation can be damaged so much that the species die off. Near streambeds and in other riparian areas where cattle concentrate, the combination of overgrazing and fecal wastes can contaminate or compromise water sources. Cattle and other large grazing animals can even damage soil by trampling on it. Bare, compacted land can bring about soil erosion and destruction of topsoil quality due to the runoff of nutrients. These and other impacts can destabilize a variety of fragile ecosystems and wildlife habitats.[14,15]

Chemical Fertilizer

Synthetic fertilizers containing nitrogen and phosphorus have been at the heart of the intensified farming from World War II to the present day. Modern agriculture has become heavily dependent on these chemical inputs, which have increased the number of people the world's farms can feed. They are particularly effective in the growing of corn, wheat, and rice, and are largely responsible for the explosive growth of cereal cultivation in recent decades. China, with its rapidly growing population, has become the world's leading producer of nitrogen fertilizers.



While these chemicals have helped double the rate of food production, they have also helped bring about a gigantic increase, perhaps as high as 600 percent, of reactive nitrogen levels throughout the environment. The excess levels of nitrogen and phosphorus have caused the once-beneficial nutrients to become pollutants. Roughly half the nitrogen in synthetic fertilizers escapes from the fields where it is applied, finding its way into the soil, air, water, and rainfall. After soil bacteria convert fertilizer nitrogen into nitrates, rainstorms or irrigation systems carry these toxins into groundwater and river systems. Accumulated nitrogen and phosphorus harm terrestrial and aquatic ecosystems by loading them with too many nutrients, a process known as eutrophication.[16,17]



Nutrient pollution is a causal factor in toxic algae blooms affecting lakes in China, the United States, and elsewhere. As excessive amounts of organic matter decompose in aquatic environments, they can bring about oxygen depletion and create “dead zones” within bodies of water, where nothing can survive. Parts of the Gulf of Mexico are regularly afflicted in this manner. Nitrogen accumulation in water and on land threatens biodiversity and the health of native plant species and natural habitats. In addition, fertilizer application in soil leads to the formation and release of nitrous oxide, one of the most harmful greenhouse gases.

With the global population continuing to skyrocket, the tension will continue to grow between continued agricultural growth and the ecological health of the land upon which humans depend.

Results

The environmental impact of agriculture is the effect that different farming practices have on the ecosystems around them, and how those effects can be traced back to those practices.[18] The environmental impact of agriculture varies widely based on practices employed by farmers and by the scale of practice. Farming communities that try to reduce environmental impacts through modifying their practices will adopt sustainable agriculture practices. The negative impact of agriculture is an old issue that remains a concern even as experts design innovative means to reduce destruction and enhance eco-efficiency.[20] Though some pastoralism is environmentally positive, modern animal agriculture practices tend to be more environmentally destructive than agricultural practices focused on fruits, vegetables and other biomass. The emissions of ammonia from cattle waste continues to raise concerns over environmental pollution.[19]



When evaluating environmental impact, experts use two types of indicators: "means-based", which is based on the farmer's production methods, and "effect-based", which is the impact that farming methods have on the farming system or on emissions to the environment. An example of a means-based indicator would be the quality of groundwater, that is affected by the amount of nitrogen applied to the soil. An indicator reflecting the loss of nitrate to groundwater would be effect-based.[14] The means-based evaluation looks at farmers' practices of agriculture, and the effect-based evaluation considers the actual effects of the agricultural system. For example, the means-based analysis might look at pesticides and fertilisation methods that farmers are using, and effect-based analysis would consider how much CO₂ is being emitted or what the nitrogen content of the soil is.[14]



Aquaponics

The environmental impact of agriculture involves impacts on a variety of different factors: the soil, to water, the air, animal and soil variety, people, plants, and the food itself. Agriculture contributes to a number larger of environmental issues that cause environmental degradation including: climate change, deforestation, biodiversity loss,[15] dead zones, genetic engineering, irrigation problems, pollutants, soil degradation, and waste.[16] Because of agriculture's importance to global social and environmental systems, the international community has committed to increasing sustainability of food production as part of Sustainable Development Goal 2: “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”.[17] The United Nations Environment Programme's 2021 "Making Peace with Nature" report highlighted agriculture as both a driver and an industry under threat from environmental degradation.[18]

Conclusion

Sustainable agriculture is the idea that agriculture should occur in a way such that we can continue to produce what is necessary without infringing on the ability for future generations to do the same.

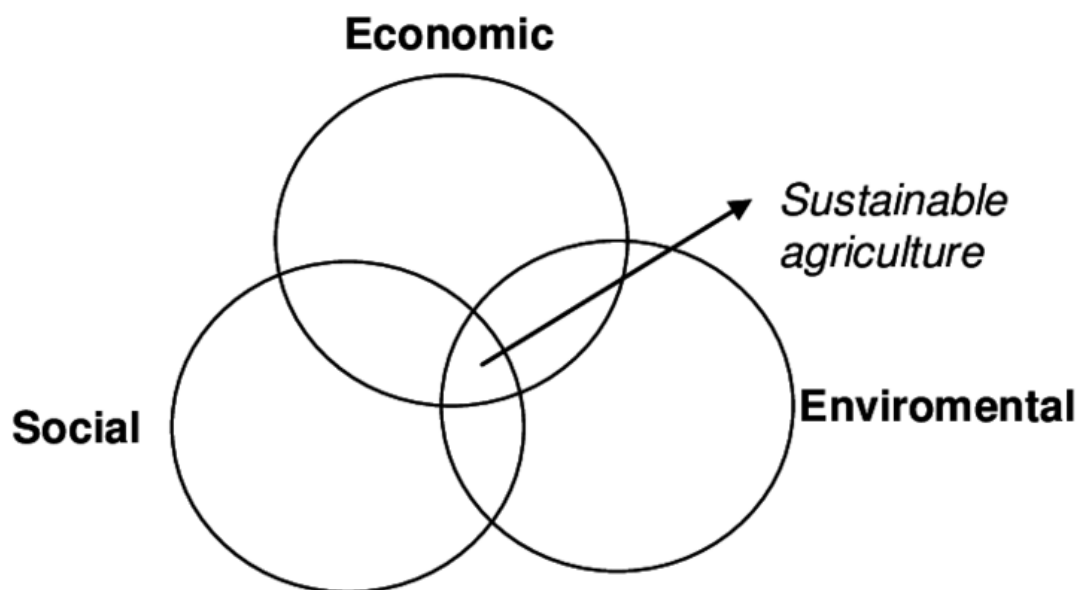


Food security

The exponential population increase in recent decades has increased the practice of agricultural land conversion to meet the demand for food which in turn has increased the effects on the environment. The global population is still increasing and will eventually stabilize, as some critics doubt that food production, due to lower yields from global warming, can support the global population.

Agriculture can have negative effects on biodiversity as well.[15] Organic farming is a multifaceted sustainable agriculture set of practices that can have a lower impact on the environment at a small scale. However, in most cases organic farming results in lower yields in terms of production per unit area.[16] Therefore, widespread

adoption of organic agriculture will require additional land to be cleared and water resources extracted to meet the same level of production.



A European meta-analysis found that organic farms tended to have higher soil organic matter content and lower nutrient losses (nitrogen leaching, nitrous oxide emissions, and ammonia emissions) per unit of field area but higher ammonia emissions, nitrogen leaching and nitrous oxide emissions per product unit.[17] It is believed by many that conventional farming systems cause less rich biodiversity than organic systems. Organic farming has shown to have on average 30% higher species richness than conventional farming. Organic systems on average also have 50% more organisms. This data has some issues because there were several results that showed a negative effect on these things when in an organic farming system.[18] The opposition to organic agriculture believes that these negatives are an issue with the organic farming system. What began as a small scale, environmentally conscious practice has now become just as industrialized as conventional agriculture. This industrialization can lead to the issues shown above such as climate change, and deforestation.[19,20]

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