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Different Green Technologies for Organic Food Production

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Abstract

Agriculture is one of the major contributors to environmental degradation today; the production, transportation, and consumption of food are all very carbon-intensive and use significant amounts of fossil fuels, which end up in our atmosphere and accelerate global warming. With population growth and rising living standards, it is more important than ever to focus on the best green agricultural technologies available. Renewable energy, zero tillage, biotechnology, organic farming, vertical farming, irrigation, integrated pest management, drones, fleet management, and digital sensors are some of the green technologies and approaches that are helping to make farming more environmentally sustainable. Because organic farming/food production is a green technology, using numerous additional green technologies within organic farming is good for sustainability. The global market for organic food has increased quickly in recent years, owing primarily to consumer awareness of quality and safety. Green technology can increase organic food yield by using strategies that are socially equitable, economically realistic, ecologically complete, and environmentally sustainable. Although the green technology business is still in its infancy, it has attracted a large amount of investor interest as a result of growing awareness about the effects of climate change and natural resource depletion. Organic food products are produced on a big scale in industrialized countries utilizing various green technologies, but this is not the case in many rising countries such as India. With the growing concern about organic food production, sufficient technology must be implemented to assure improved production. Considering the extent and relevance of organic food production, the purpose of this article is to examine information on various green technologies that can be used in organic farming and how they can aid in sustainable development.

Keywords: Climate Change, Green technology, Organic Food, Sustainable Development.

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Introduction

Agriculture is responsible for approximately 13–15 percent of global greenhouse gas emissions. It emits a lot of greenhouse gases despite having only approximately 4% of global GDP. Under business-as-usual conditions, agricultural greenhouse gas emissions are expected to climb by over 40% by 2030. Climate change has the potential to diminish total agricultural productivity in many developing countries by up to 50% over the next few decades. At the same time, the world's population is expected to nearly quadruple, thereby causing tensions between food supply and demand. Green growth in agriculture is achieved by boosting low-carbon production and carbon sequestration capacities, as well as a transition to practices that take into account regional environmental capability. What is required is a low-carbon life cycle that includes not just production but also distribution, processing, and consumption. Green agriculture can be defined as agriculture that strives towards green growth, albeit the word is not generally used. There are a few green concept words that are more widely used in agriculture. One such word is "sustainable agriculture."It incorporates the three sustainable development goals of environmental preservation, economic profitability, and social equality. Organic farming, low external input agriculture, agro-ecological and bio-dynamic production systems, integrated livestock and crop farming systems, and conservation tillage are all examples of sustainable agriculture. Organic food is generally plants or animal-based produce grown in a way that avoids or reduces the use of chemical fertilisers, growth regulators, pesticides, and growth enhancers. Organic food is agricultural food that has not been treated with chemical fertilizers, herbicides, pesticides, or other synthetic chemical compounds during production, processing, or storage. When it comes to organic foods, most consumers look for features such as recyclable, environmentally friendly, phosphate-free, and ozone friendly.

Organic food production and consumption have increased globally in recent years, owing primarily to consumer perceptions of quality and safety. Environmental concerns are also contributing to rising demand for organic food products. The consumer of organic food is less price-sensitive and more concerned about quality. Consumer attitudes about organic food have shifted as a result of health concerns. Conventional agriculture systems may offer opportunities for short-term profit, but they are neither long-term viable nor ensure safe food. To be more specific, conventional techniques of production are scarce and, as a result, are not

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a sustainable answer for organic food production (FAO and WHO, 2007).Irrational chemical use and conventional agricultural farming methods have resulted in a slew of environmental hazards, including soil salinization, decreased groundwater levels, soil erosion, genetic erosion, decreased food quality, fertilizer pollution, and increased cultivation costs, making farmers less competitive year after year (Ram, 2003). Green Technology is the sustainable solution for this problem which boosts organic agriculture and soil fertility and results in qualitative and quantitative organic food production. Green technology is the long-term solution to this problem, since it increases organic agriculture and soil fertility, resulting in qualitative and quantitative organic food production. Green technology is an alternative that ensures less environmental deterioration, increasing farm profitability and safeguarding natural resources.

Green technology in agriculture is said to be sustainable when it produces high-quality organic food from a high-quality environment while preserving its landscapes, habitats, and species, so maintaining a high-quality existence for humans. Environmental deterioration in the context of development should be considered for the sustainable growth of organic agriculture in emerging countries. Not only should resource usage be considered in terms of sustainability, but so should resource conservation (Kates and Thomas, 2005). This paper discusses many green technologies and planned studies involving their application in the production of organic food and sustainable development.

Environmental benefits and adaptation potential of organic agriculture

Objectives	Means	Impacts
• Alternative to industrial production inputs (mineral fertilizers and agro chemicals) to decrease pollution • *In situ* conservation and development of agro-biodiversity • Landscaping • Soil fertility	• Improvement of natural resources processes and environmental services (soil formation, predation) • Farm diversification (polycropping, agroforestry and integrated crop/livestock) and use of local varieties and breeds • Creation of micro-habitats (hedges), permanent vegetative cover and wildlife corridors • Nutrient management (rotations, corralling, cover crops and manuring)	• Reliance on local resources and independence from volatile prices of agriculture inputs (mineral fertilizers) that accompany fossil fuel hikes • Risk splitting (pests and diseases), enhanced use of nutrient and energy flows, resilience to climate variability and savings on capital-intensive seeds and breeds • Enhanced ecosystem balance (pest prevention), protection of wild biodiversity and better resistance to wind and heat waves • Increased yields, enhanced soil water retention/drainage (better response to droughts and floods), decreased irrigation needs and avoided land degradation

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Green Technology and Sustainable Development

There is no universally agreed-upon definition of green technology. The word refers to technology that has the potential to considerably improve environmental performance when compared to other technologies. It is associated with the phrase "environmentally sound technology." It covers a wide range of scientific disciplines, including energy, atmospheric science, agriculture, material science, and hydrology. Green technology encompasses not just specific technologies, but also systems, which include know-how, methods, commodities and services, and equipment, as well as organizational and managerial processes. Many green technologies strive to minimize carbon dioxide and other greenhouse gas emissions in order to avert climate change.

Green Technology for Sustainable Development In order to reap the benefits of green technology, it must be successfully linked to the country's overall development goals and implemented to tackle socioeconomic problems. Green Technology can make a significant contribution to the long-term development of agriculture if these considerations are taken into account. Organic agricultural techniques in industrialized countries, when paired with Green Technology, produce higher yields than conventional approaches in underdeveloped countries, paving the way for agricultural development that is sustainable (Ghadiyali and Kayasth, 2012). Sustainable agriculture is a method of producing crops or livestock in an environmentally sustainable manner while causing no harm to the farm. It also avoids having a negative impact on water supplies, soil, biodiversity, or other natural resources in the surrounding area. As a result, this type of agricultural practise not only helps to conserve and protect soil, water, and climate, but it also ensures the enhancement of agro-biodiversity while meeting food and livelihood needs (Satish et al., 2012). Because it is based on ecological cycles, organic agriculture is a good farming system that develops a notion for achieving indelible sustainability in agriculture. This system keeps a fixed resource base, preventing over-exploitation of renewable resources and depletion of non-renewable resources. As a result, green technology has the ability to adequately compensate farmers for producing high-quality, safe organic food. Sustainable agriculture can be implemented with three important aims in mind: economic equality, environmental health, and social and economic profitability. Thus, by making the best use of its resources and recognizing these three major aims, green technology in agriculture contributes to the achievement of the goal

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of sustainable development (Deshmukh, 2014).

Green Technologies That Can Be Used In Organic Farming

Many people mistakenly believe that organic farming entails completely avoiding technology, however new green technology is being integrated into organic agricultural operations on a daily basis. The list is as follows;

1). Renewable Energy

Because most agricultural machinery works on fossil fuels, which emit greenhouse gases into the atmosphere and are a primary driver of climate change, renewable energy is one of the frontiers for green tech adoption. This environmental damage can be reduced by employing clean (renewable) energy, which is why sustainable agriculture is so important. Renewable energy and agriculture are a fantastic match since these natural resources can be gathered indefinitely, providing farmers with a steady stream of revenue.

A) Solar Energy: - Solar energy, which is derived directly from the Sun, is the most basic source of energy. The photovoltaic cell, which converts sunlight directly into electricity, is a rapidly expanding alternative energy. Battery charging, lighting, water pumping, refrigeration, communication, and small motors are all powered by solar electric systems. In comparison to conventional fuel, solar photovoltaic has applicability as a green agricultural energy source for pumping water, which solves a number of issues. For example, it has no fuel and maintenance costs and does not contaminate the environment (Mekhilef *et al*., 2013).Solar water pumping systems have significant promise in places like India, which receives a lot of solar radiation. Also included are village street illumination, rural house lighting, and pest treatment (BCSE, 2004) With the development of new technology, there is a likelihood that solar energy applications may expand, improving the efficiency of solar cells while lowering their cost. This form of green technology is the ideal substitute for improving the standard of living of rural communities by providing biofertilizers and organic foods, as well as cooking and lighting (Chel and Kaushik, 2010)

B) Biomass Trees, vegetables, and animal waste are the best sources of biomass energy, making them ideal for organic agriculture. Through procedures such as gasification, agricultural residues and wastes are transformed to electric and thermal energy, which is subsequently employed in efficient power generation cycles. When biomass develops a biorefinery and biogas combination, it creates new goods and strengthens the organic

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agricultural sector. The emission of greenhouse gases can be reduced by substituting biomass for fossil fuels. As a result, biomass has the potential to increase organic agricultural earnings while also conserving finite resources (Ravindranath et al., 2004)

C) Biorefineries are technologies for extracting energy and other valuable products from biomass resources. Processing corn into various products such as corn syrup and ethanol, as well as changing trees into wood products, heat, and power, are some of the most important tasks performed in biorefineries. Biorefineries produce a variety of useable products such as fuel, high protein animal feed, gluten, and energy from fully renewable organic agricultural resources.They also play an essential role in reducing transportation-related greenhouse gas emissions, both through their operations and the renewable ethanol they produce for transportation fuels. In the long run, these environmentally friendly and sustainable energy sources will assist the enormous rural population in meeting their energy needs, which will lead to organic food production indirectly (Elmekawy et al., 2013)

D) Biofuel: - Bio-ethanol and bio-diesel have proven to be viable energy sources in the future. In India, 0.8 million kiloliters of ethanol may be produced if all available sugarcane molasses is used, which can satisfy 9 percent of the country's current petroleum needs. As a result, researchers are developing a variety of innovative technologies to manufacture enhanced biofuels from wood biomass, agricultural, and forest wastes (Aradhey and Wright, 2011)

E) Geothermal Energy: - This method generates heat or power using energy from the earth's crust. The heated geothermal fluid is pumped to the surface from subsurface reservoirs. The received heat energy is subsequently transformed to electricity or used directly in heating applications. Heating buildings, warming water for fish farming, pasteurising milk, nurturing plants in greenhouses, and dehydrating onions and garlic are all examples of when geothermal fluids are used. Low-to-medium temperature resources (between 21°C and 149°C) are generally selected since they are more plentiful and widespread than high-temperature resources.Therefore, geothermal initiatives are a dependable resource for organic food production (Dickson and Fenelli, 2013)

F) Biogas and Organic fertilizers: - This environmentally friendly method converts biological agricultural waste into fuel and fertiliser. Anaerobic digestion transforms organic waste into biogas and residue. Biogas is a well-known, environmentally friendly renewable

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energy source that can be used for lighting, cooking, or regulating a greenhouse's temperature for optimal vegetable growth, with the by-product being used for organic farmland food production (Dhussa, 2004).The residue is the result of the mineralization process and can be utilised to increase crop output and soil fertility since it is nutrient-rich and has a high penetration capacity into the soil. It is thought to be a good substitute for chemical fertilisers and beneficial to organic crops because it reduces up to 80% of odours from the feedstock.

G) Wind Energy: - Wind technologies are used in organic agriculture because they supply mechanical power for pumping and treating drinking water, irrigation, telecommunications, houses, schools, and clinics, as well as augmenting larger power plants (BCSE, 2004). Wind turbines used to pump water for irrigation can boost agricultural growth while emitting no carbon dioxide. As modest wind constructions assist in the generation of power, it serves the objective of avoiding the costly installation of transmission wires. Wind energy can also be used to generate greenhouse gases in an environmentally benign manner via power producing systems.Wind energy is becoming more popular throughout Asia. India and China have done an excellent job of constructing this infrastructure. India's overall wind power capacity is estimated to be 45,000 MW (MNRE, 2008). This technology can be considered a viable option for supplying sustainable energy services for organic food production (Omer, 2012)

2) Integrated Pest Management

Integrated Pest Management (IPM) is an eco-friendly pest management strategy that includes biological, mechanical, and cultural pest management, as well as the need-based use of chemical pesticides with a favourable use of bio-pesticides, bio-control agents, and indigenous alternative potential. The primary goal of Integrated Pest Management is to maximise the yield of organic food while minimising costs, as well as to raise awareness among farmers about beneficial and harmful insect pests and diseases and how to manage them, as well as to reduce environmental pollution in the air, water, and soil caused by pesticides (Ghadiyali and Kayasth, 2012)

3) Information and Communication

Soil testing, crop cultivation, water management, biofertilizer management, and insect management all benefit from information and communication. It is also helpful in the transportation, sale, and storage of organic food goods. The primary goal of this technology is to improve product quality management and homogeneity; achieve labour savings; and

reduce the loss of nutrients and pesticides in conjunction with other potentially ecologically damaging items.The possibility of getting more from precision farming inside the significantly advanced agriculture has been discovered through optimization of the entire production system, contributing to farmers' revenues and savings. This method decreases the health risks associated with indoor air pollution as well as the costs associated with the purchase of commercial fossil fuels.

4) Drones

Everyone has noticed the rising fascination and preoccupation with drones. They have shown to be extremely beneficial in the agricultural industry as a green technology for increasing sustainability and aiding in the fight against climate change. Drones increase precision farming by eliminating the need for guesswork and assisting farmers in being more efficient, and hence more sustainable, in their labour. It has a wide range of applications in the farming industry. Drones are ideal for obtaining aerial imagery and inspecting crops because of their large array of sensors and cameras. They can also be used to manage livestock, spray crops, and map irrigation systems. Drones are quickly becoming a common smart farming tool, and their prices are expected to continue to fall as their usage grows.

5) Irrigation Monitoring

Irrigation is the act of providing water to crops, and it is an important aspect of the agricultural process. Without enough water, the crop would not produce a healthy yield. You can, however, ensure that you are using the water supply as wisely and efficiently as possible with the right technology. The less water a farmer consumes, the more environmentally friendly his or her activity becomes. The Earth's water supply is finite, which means we only have so much, and conserving water is critical for environmental health. Wireless and remote monitoring technologies are now available, allowing farmers to gain greater control over their operations and make more informed decisions about water usage and distribution. This is especially useful on large farms with a lot of acreage to manage.

6) Fleet Management Technology

When it comes to making agriculture more sustainable, looking at cars is critical because they contribute significantly to the amount of fossil fuels produced by the industry. Fleet management is a green technology that has improved in recent years thanks to advances in GPS technology. These sophisticated devices can provide specific information such as fuel

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use, engine speed, and upcoming maintenance.Ultimately, this technology can be utilised to ensure that the equipment is utilised as efficiently as feasible. Farmers will save money while also reducing their carbon footprint. Because of the cost, this type of technology is not yet available to everyone, but it is becoming more commonplace, and new farmers are learning about it all the time.

7) Farming Robots

Farm robots do not have to be of the flying form; they can also function on the ground. Many new companies are springing up to build robots that will not only help farming become more efficient, but will also have a lower environmental impact. The small robot firm is an excellent example of how robotics and artificial intelligence may be used to enhance the environment.Their robots can be used on farms for a number of tasks, including sowing seeds and applying biofertilizers in a targeted manner rather than spraying widely from a tractor. Because they do not need to transport a human passenger, they are much lighter than other farm machines and do not compact the soil as much. Soil compaction is a serious issue in farming, resulting in soil runoff, contaminated rivers, and flooding.

8) Digital Sensors

The modern technology available today can monitor every part of farming and is assisting in making the industry more sustainable with lower environmental implications. Sensors can track microclimate data, pH levels in soil, and even animal movement. These agricultural sensors are used in precision agriculture, providing data that helps farmers monitor and optimise crops, as well as react to changing environmental circumstances, such as optical sensors developed to assess clay, organic matter, and moisture content of soil. Farmers may use digital sensors to enhance crops, preserve water, reduce waste, and increase production.This green technology is getting more affordable and accessible, and it will soon be a realistic alternative for many more countries.

Different Green Practices Already In Use in Organic Farming

A) Mixed Farming:- is regarded as a relatively widespread method in organic agriculture. One of the most effective kinds of mixing is probably when crop wastes are used to sustain the animal and animal excreta is employed as biofertilizers for systems that can be obtained. This can be accomplished by developing software that can analyse sensors and allocate pesticides and fertilisers to specific areas.Precision agriculture makes use of this technology

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in the form of geographic information systems, global positioning systems, grid soil sampling, satellite data and process models, yield monitoring, artificial intelligence structures, remote sensing, and skillful systems for farmers to use information. Agriculture models such as the Agriculture Intelligence System are also beneficial to the farmer community in terms of agricultural product marketing, sales, and profitability (Ghadiyali et al., 2011)

B) Multiple Cropping and Crop Rotation:- is a type of polyculture that involves growing more than two crops on the same plot of land during the same season. It can be done in two ways: relay cropping, in which a subsequent crop is sown alongside the first one before it is harvested, and double cropping, in which the current crop is harvested first, followed by the successive one. Crop rotation, on the other hand, is the technique of growing two or more dissimilar or unrelated crops in the same land during separate seasons. The main advantage of using such systems is that they assist to preserve the quality of land, which is deteriorating due to inorganic farming.These agricultural approaches aim for a non-destructive environment while increasing organic food supply. In comparison to conventional farming, this approach provides a more harmonic relationship to the crops since the soils are of higher biological, physical, and, in certain cases, chemical quality (Deshmukh, 2014)

Conclusion

Green technology is more expensive than the technology that it is meant to replace. When compared to proven technologies, the expense of training and development can make it even more expensive. Geographic features, human resource capabilities, technology readiness, and supporting infrastructure are other considered advantages. As a result, what may be a feasible green technology in one country or location may not be in another.Acceptance and proliferation of these systems can be hampered by a slew of other impediments. Green technology's solution is to adopt green technology, however impoverished countries have been unable to use applicable technology to a large amount due to their inability to afford existing equivalents. Efforts must be made to make these technologies affordable to everyone.Efforts are now being made to boost agricultural output while limiting the depletion of already available resources beyond the point of recovery through the use of Green Technologies. Efforts to establish indigenous energy sources are critical to fostering a culture of using environmentally acceptable energy resources. To raise

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awareness, effective communication channels must be designed.It is critical to remember that small-scale wind and solar PV systems are intermittent and weather-dependent energy sources. Taking the cost element into account, these are not the most cost-effective solutions for farming households. At the community level, the utilisation of wind and PV systems is possible through technical help and concessional financing access, particularly for storage facilities such as a granary, cold storage, and so on.Electricity generated by small-scale wind and solar photovoltaic systems has been demonstrated to contribute to farmers' income and savings. This method decreases the health risks associated with indoor air pollution as well as the costs associated with the purchase of commercial fossil fuels. As a result, from the standpoint of long-term growth, an improved public investment strategy for the development of these practises is proposed.Pesticide subsidies should be eliminated, staple food production should be decoupled from pesticides, strong agreements between national and international agencies should be established, and funds previously spent on chemical use should be diverted to human resource development. These are recommendations for any government committed to integrated pest management. The main reason for the country's slow progress in organic farming is a mismatch between demand and supply of organic products, which is caused by a lack of adequate links between them. The government is assisting producers and customers in promoting their products in order to conceal this issue.Aside from simplifying the process, this may contribute to lower certification costs. Many more such concepts have been proposed or are now being pursued, necessitating longer-term public and commercial sector funding as well as effective global collaboration of scientists.

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