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An Analysis of Vertical Farming and Organic Farming

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ABSTRACT: ***The main elements driving the direction and development of agricultural research include advances in science and technology, as well as worldwide urbanization. Food preferences have shifted as per capita wealth in emerging countries has increased, as have vocational shifts and global connections. These developments, along with rising population, represent a challenge to agriculture's ability to provide more and better food. Agriculture's production can be increased by using traditional farming methods, however this has a limit. The environmental danger posed by reliance on chemical fertilizers and pesticides for productivity and pest control, respectively, is a significant restriction impacting worldwide food supply. These patterns indicate that new agricultural innovations will be required in the near future, and that these technologies should be incorporated into mainstream agriculture. Vertical farming and organic farming are two study topics that are being pursued in order to overcome these limitations. Vertical farming involves stacking farms vertically to maximize output on limited plots of land. Furthermore, this method is ideally adapted for the constantly increasing global urban population since food supply needs can be fulfilled from inside cities, lowering transportation costs and minimizing the environmental damage caused by fuels in the process. Organic farming, on the other hand, is founded on principles of reducing chemical inputs in agriculture and is therefore environmentally beneficial. As a result, these methods may be used to boost output and productivity in order to satisfy rising food demand.***

KEYWORDS: ***Agriculture, Crop, Food, Organic Farming, Vertical Farming.***

1. INTRODUCTION

Today's most difficult challenge for agricultural sciences is to guarantee a constant and sufficient supply of food for a developing human civilization. Urban areas across the globe have seen significant population expansion, which has coincided with changes in eating patterns and increased worries about food safety. Food quality refers to the food's optimal levels of nutrients as well as the least amount of chemical (pesticides/fertilizers) residues utilized in the crop's development. Agriculture is also tasked with redressing environmental imbalances caused by the indiscriminate/injudicious use of pesticides in agriculture. In addition to these concerns, increased demand for fuel crops is required to support rapidly expanding economies. According to UN population projections, the global population may reach 9.15 billion by 2050, implying a 2.25 percent annual growth in population over the following forty years1 and therefore a potentially enormous market for food grains, with food production needing to be quadrupled to satisfy this demand[1].

It is estimated that feeding the world's population by 2050 would need a 70% increase in global food output, with food production in poorer nations doubling. 2 The job is hampered by environmental stress (climate change) and a scarcity of water and land resources. Though scientific and information technology advancements have resulted in a more comfortable world with worldwide connections, they have also resulted in changes in farming methods. In recent

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years, crop production and productivity have increased in tandem with fertilizer and pesticide consumption. While this trend is more noticeable in developed and industrial countries, developing countries such as China have made their presence felt with a nearly two-fold increase in cereal yield since 1961. Farmers in poor nations are unable to transition to contemporary intensive agriculture3 techniques owing to a lack of financial resources and technical expertise, and therefore stay isolated from global connections[2].

Long-distance food commerce, dietary shifts, and the growth of food-based retail sectors are all indications that globalization has had an impact on food systems throughout the globe. At the same time, these developments have raised concerns about environmental issues, since excessive chemical usage in agriculture is not ideal for environmental, biodiversity, or soil quality maintenance. As a result, changes in agricultural systems have been aided by increased global commerce and easy access to chemicals and technology. Organic agriculture, vertical farming, and intensive agriculture have all been popular in recent years as a way to meet the needs of a growing global population while also addressing environmental concerns. Vertical farming will aid in fulfilling the fast increasing urban population's food and other needs. Organic farming, on the other hand, will contribute to greater environmental harmony and agricultural anthropogenic activities[3].

1.1 Vertical farming:

Professor Despommier came up with the idea of vertical farming, and the farm utilizes traditional farming techniques like hydroponics and aeroponics to generate higher yields quicker. Vertical farming may be described as a method of commercial farming in which plants, animals, fungi, and other living forms are intentionally stacked vertically above each other for food, fuel, fiber, or other goods or services. Vertical farming is a kind of large-scale agriculture that takes place in high-rise buildings in cities. The idea envisions the growth of fruits, vegetables, medicinal plants, fuel-producing plants, and other plant products in cities, as well as their direct sale inside cities, decreasing transit costs and maximizing the use of land and water resources. Vertical farming is a step forward from green houses in that it includes harnessing resources in vertical arrays and can meet food supply needs using megacity resources. There are three kinds of vertical farming[4]:

- Gilbert Ellis Bailey coined the term "vertical farming" in his 1915 book "Vertical Farming." He spoke about the futuristic idea of vertical farming. He popularized the idea of subterranean vertical farming, which is now used throughout the Netherlands.
- Vertical farming is done in the open air or in mixed-use skyscrapers for temperature control and consumption in the second category. This is a form of sustainable farming for personal or communal use that may or may not be commercial. A modified version of this idea includes growing crops on the outside of skyscrapers to supply them with ambient light.
- The third category includes plant and animal production in skyscrapers as part of a closed system for large-scale agriculture. These systems are being tested in different places (Singapore, Canada, London).
- A vertical farm of 9300 m2 (about the size of a city block) with 30 storeys should supply 2000 kcal of nourishment each day to approximately 15,000 people.

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1.2 Advantages of vertical farming:

- *Increase in production and availability in crops:*

This agricultural technique ensures crop output throughout the year, regardless of weather conditions. According to the 2010 edition of "The Encyclopedia of Earth," A 30-story structure with a 5-acre base can provide agricultural yields equal to 2,400 acres (971.2 hectares) of conventional horizontal farming. When expressed as a ratio, 1 high-rise farm equals 480 conventional horizontal farms[5].

- *Production of organic crops:*

Vertical farming will make it easier to grow organic crops on a big scale. Additionally, use of this technology will aid in the decrease of chemical pesticide usage.

- *Conservation and recycling of natural resources:*

Hydroponics and aeroponics are two vertical farming technologies that use much less water than traditional agriculture. As a result, it aids in the conservation and recycling of water resources. Furthermore, composted and recycled municipal sewage waste may be utilized in vertical farming, further assisting in resource recycling[6].

- *Environment friendly:*

Vertical farming reduces reliance on land resources and aids forest regeneration. Furthermore, since fewer equipments are used, CO2 emissions will be reduced, aiding in environmental conservation.

- *Sustainable urban growth:*

Vertical farming, along with other technologies and a holistic strategy, will enable cities to absorb the anticipated population increase while remaining food self-sufficient. Traditional farming, on the other hand, will continue since many crops are not suitable for indoor cultivation.

1.3 Key issues challenging the adoption of vertical farming are:

- Due to varying weather conditions in various parts of the globe, uniform methods for vertical farming are impossible to implement.
- There aren't enough crop types suited for vertical farming. This issue requires urgent attention from researchers, since implementation of this method will be challenging in the absence of appropriate kinds.
- In urban communities, there is a lack of information and skills needed for agricultural operations[7].

1.4 Organic farming:

Organic farming, also known as ecological agriculture or biodynamic agriculture, is in tune with nature, meaning that the agricultural methods used in organic farming do not damage the environment. Organic farming is seen as a viable option to chemical-based farming because of

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its environmentally benign character, especially in a situation where excessive use of chemical-based fertilizers and pesticides has generated worries about ecotoxicity and health risks. Nutrient management in organic agriculture is focused on agronomic techniques such as crop rotations, soil fertility building via nitrogen, and nutrient recycling utilizing organic materials such as crop leftovers and farmyard manure, as well as a reduction in the use of chemical fertilizers. In organic farming, insect populations are controlled via the use of resistant crops, crop rotation, increased predators for natural pest management, and increased genetic variety, as well as careful use of water resources and animal husbandry[8].

According to the current FiBL-IFOAM (International Federation of Organic Agriculture Movements) study, data on organic agriculture is available from 164 countries, and 37.5 million hectares of land are farmed organically globally, including those in the process of conversion. According to the statistics, there was a 0.5 percent increase in organically cultivable area in 2012, and approximately 1.9 million farmers practice organic farming. Organic agriculture necessitates substantial changes in agricultural methods, such as reduced use of synthetic fertilizers and pesticides, increased use of organic materials, manpower, farm equipment, cultural practices (e.g., crop rotation), and a greater understanding of biological processes. These developments will need farmer training in organic agriculture as well as increased knowledge of current trends. Organic agricultural production techniques are diverse and dependent on factors such as the local environment. Synthetic fertilizers and pesticides are discouraged in organic farming. Organic materials and crop rotation are used to provide nutrition and disease control.

1.5 Advantages of organic farming:

- *Sustainability:*

Long- and medium-term effects of agricultural operations on the agro-ecosystem are taken into account in organic agriculture. To avoid soil sterility or insect issues, food production is complemented with the development of an ecological equilibrium[9].

- *Ecological services:*

Organic agriculture's effect on natural resources promotes agro-ecosystem interactions as well as environmental factors. Soil formation and conditioning, soil stability, waste recycling, carbon sequestration, nutrients cycling, predation, pollination, and habitats are among the ecological services obtained.

- *Biodiversity:*

Organic farming contributes to environmental protection and, as a result, biodiversity. The absence of chemical pesticides aids in the preservation and recolonization of beneficial species in the region, such as natural flora and animals. In recent years, the number of research on organic farming and biodiversity has risen dramatically. Organic farming generates greater biodiversity than other agricultural methods, according to a new research based on a meta-analysis of 766 scholarly articles.

1.6 Principles of Organic Farming:

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- To draw upon local resources and to work as much as possible within a closed system
- To try to preserve the long-term fertility of soil
- To avoid all forms of pollution resulting from different types of agricultural techniques
- To produce food products in sufficient quantity and of high nutritional quality
- To cut down use of fossil energy in agricultural practice
- To allow agricultural workers' to build up their potentialities as human beings and earn a living through their work
- To provide such conditions of life to livestock that fulfill their physiological needs.

1.7 Environmental Benefits of Organic Farming:

Organic farming safeguards the environment against the negative impacts of synthetic inputs, such as pesticides, fertilizers, and hormones. Fertilizers and pesticides discharge harmful toxins into the land and water. Some pesticides may damage the environment, or they can be poisonous and hazardous to human health when used directly. Because the toxic effects of pesticides are often more severe in children than in adults, children are at a higher risk of direct exposure than adults. Agriculture without pesticides and artificial fertilizers may provide results in a variety of circumstances, but the yields would be lower than in conventional farming. As a result, agricultural techniques and fertilizer usage will be required to produce the enormous quantity of food consumed across the globe. Organic agriculture almost always promotes more biodiversity and has a positive environmental effect per unit of land. It doesn't have a significant beneficial effect per unit of output. Organic grains and milk, for example, emit more greenhouse gas per unit of product than their conventionally produced equivalents. Organic olives and cattle, on the other hand, have fewer emissions in the vast majority of instances. Organic foods, on the overall, need less energy input but more land than conventional foods. Due to less soil changes and chemical applications, organic farming systems offer more biodiversity than conventional farming systems, according to studies[10].

Agro-biodiversity, also known as agricultural biodiversity, is a subset of biodiversity that includes all forms of life that are directly related to agriculture and may live in both fields and crossroads. Ecologists argue about whether increasing on-farm variation and a diverse overlaying collection of species enhance agricultural biodiversity at the farm level. Crop resilience and ecological stability are boosted as a result. Crop biodiversity, or the cultivation of a large variety of crops on a single farm, is a component of agricultural biodiversity, and it results in differences in soil fauna, pests, predators, and weeds. More importantly, crop biodiversity has been linked to increased agricultural production via pest management and soil replenishment, resulting in increased farm revenue consistency and security. The absence of pesticides and herbicides improves population density and biodiversity fitness. Weed species attract beneficial insects, which in turn increase forage on weed pests and soil quality. Because of the high number of bacterial organisms generated by natural fertilizers, soil-bound organisms typically reap a variety of advantages, including a lower intake of pesticides and herbicides. Organic farming reduces the risk of low yield to a large degree because it increases biodiversity.

2. DISCUSSION

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Agriculture's current main goals are to achieve food sufficiency while also conserving the environment. Limiting land and water resources, as well as environmental health deterioration owing to excessive use of chemicals for nutrition and pest control in agriculture, are obstacles to attaining this goal. Anthropogenic efforts for development have exacerbated environmental deterioration and accelerated the pace of climate change. Climate change has prompted global attempts to mitigate its impacts on the planet in general and agriculture in particular. These measures should be supplemented by agricultural production method improvements as well as scientific application of indigenous knowledge, which has been shown to be more sustainable. The two distinct agricultural methods described above can be easily incorporated into the existing agricultural system and implemented on a worldwide basis. Vertical farming, a relatively new idea in agriculture, has a lot of promise, given the shrinking agricultural land resources as a result of widespread urbanization and rising per capita income in emerging countries. Though a novel idea for a developing country, the approach has tremendous potential and can effectively fulfill the challenge in terms of quantity, quality, and diversity. Organic farming, on the other hand, is a well-known idea in agriculture, but it still needs further research and integration of scientific knowledge before it can be incorporated into mainstream agriculture to meet rising demand. These two methods, each with its own set of principles, are potential paths for global agriculture that need further study and incorporation into the mainstream for a better environment and a well-fed world.

3. CONCLUSION

Agriculture is seeing new developments as a result of changing demographic patterns and technology advances. To fulfill the increasing needs of contemporary agriculture, these new technologies must be utilized wisely. To fulfill the increasing expectations and requirements of humanity, vertical farming and organic farming may be embraced as viable alternatives to traditional agriculture. Furthermore, barriers to adoption of such techniques should be addressed, and appropriate links between researchers and farmers should be established. Vertical farming and organic farming are two study topics that are being pursued in order to overcome these limitations. Vertical farming involves stacking farms vertically to maximize output on limited plots of land. Furthermore, this method is ideally adapted for the constantly increasing global urban population since food supply needs can be fulfilled from inside cities, lowering transportation costs and minimizing the environmental damage caused by fuels in the process.

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