



The Future of Innovative Agriculture: Bioeconomy and Sustainable Agriculture

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ABSTRACT

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Innovative farming techniques are essential for food security and sustainable farming practices. Innovative agricultural approaches utilize modern technologies and the latest inventions, as well as traditional agricultural practices. The main purpose of this study is to address the relationship between sustainable agriculture and bioeconomy and to examine innovative approaches that are expected to have a significant impact on the agricultural sector in the near future. The study was carried out in compilation format. Bioeconomy is an economic model or methodology based on the economic evaluation of biological resources and processes. Abiotic resources such as microbes, vegetation, animals, and biodiversity are all included in this strategy. On the other hand, sustainable agriculture, which aims to protect natural resources and take into account ecosystem benefits while maintaining food production, is an agricultural paradigm. The primary goals of bioeconomy and sustainable agriculture are economic evaluation, efficient use of natural resources and reduction of environmental impacts. Considered from these perspectives, it can be said that both concepts have common purposes and are closely related. It is possible to say that with the increasing use of sustainable agricultural methods and bioeconomy, the agricultural sector can move towards a more environmentally friendly, efficiently managed and sustainable structure in the future.

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Introduction

The world's population is growing swiftly. This rise means a greater requirement for nourishment. In order to feed the growing population, productivity in agriculture needs to increase. According to Fróna et al. (2019), a significant rise in agricultural output is necessary to keep up with the country's current rate of population growth. It is also commonly known that agriculture contributes to a number of environmental problems, such as water shortages, soil pollution, and climate change. As such, food safety is also at risk. Food safety is crucial to ensuring that everyone on Earth has access to a suitable and balanced diet. Consequently, agricultural output needs to increase in order to fulfill the demands for nutrition and food security (Miraglia et al., 2009).

Innovative agricultural techniques are essential to food security and sustainable farming practices. In addition to traditional farming practices, innovative agricultural approaches make use of modern technologies and cutting-edge inventions. These tactics aim to promote productive, sustainable, and environmentally friendly farming practices (Klerkx et al., 2009). Nowadays, the bioeconomy and sustainable agriculture serve as the pillars of these innovative approaches.

A "bioeconomy" is a way of using biological systems and resources to improve both the economics and society. The use of biotechnology, the creation of biobased goods, and the incorporation of renewable resources into production systems are examples of agricultural activities guided by the concepts of the bioeconomy. The main component of this approach is the development of scientific, technological, and economic breakthroughs regarding the use of biological resources. As the value of products and services obtained from biological sources increases in the agriculture sector, the concept of the "bioeconomy" is becoming more and more important (Bugge et al., 2019). Additionally, a greater understanding of the significance of sustainable agriculture has resulted from this process. On the other hand, sustainable agriculture is a method of production intended to guarantee that agricultural yield satisfies the needs of future generations. Adopting a fair and reasonable agricultural production strategy, preventing environmental harm, and protecting and conserving natural resources are the cornerstones of sustainable agricultural systems (Purvis and Smith, 2013).

Efficient and sustainable resource utilization is the aim of both sustainable agriculture and the bioeconomy. The goal behind the bioeconomy is to increase the economic worth of biological resources and use them for various industrial and agricultural purposes. On the other hand, sustainable agriculture aims to protect biodiversity, maintain the health of the soil, utilize natural resources in an eco-friendly way, and ensure that food is available for future generations. Here, the bioeconomy and sustainable agriculture go hand in hand (Fritsche & Rösch, 2020). While the bioeconomy promotes the effective and profitable use of biological resources in the agricultural sector, the principles of sustainable agriculture are in line with important objectives such as the preservation of natural resources and the improvement of soil health. Therefore, a comprehensive evaluation of sustainable agriculture methods and the bioeconomy indicates that they can significantly influence food production in the future in a sustainable and efficient manner. Given this, the study aims to illustrate the relationship between sustainable agriculture and the bioeconomy and explore innovative techniques that are expected to have a significant impact on the agricultural sector in the near future.

Bioeconomy

The Concept of Bioeconomy

Bioeconomy may be defined as all economic activities derived mainly from scientific and research activities focused on biotechnology. In other words, bioeconomy is understanding the mechanisms and processes at the genetic and molecular level and applying the same to create and develop industrial processes. Bioeconomy is commonly used by regional development agencies, international organizations, and biotechnology companies. It is a domain closely linked to the evolution of the biotechnology industry. The evolution of the biotechnology industry and its application to the agriculture, health, chemistry or energy industries can be given as an example of bioeconomic activities (Richardson et al., 2012).

Interest in bioeconomy has led to the preparation of numerous definitions of the term. The definition of bioeconomy is significant. As the formulation of policies, programs, and economic development strategies directly underpins the approach and components of the definition (Maciejczak, 2013). Relevant definitions emphasize different technological, economic or social aspects and priorities and refer to different development conditions and concepts such as sustainable or innovative development (De Jong et al., 2010).

Economic activities related to the research, development, production, trade and consumption of plants, animals, microorganisms and all other living things are defined as bioeconomy collectively. In a scientific sense, bioeconomy aims to provide economic gain by producing surplus values from living things with new methods such as biotechnology. The objective of this gain is to improve health, increase yield and quality in agriculture and industry, and sustainable improvement in the environment.

Bioeconomy can be perceived differently by entities not only in the countries concerned but also in different sectors of the economy. Despite these differences, it is common for bioeconomy development to be supported by

government policy and purpose-appointed institutions (De Jong et al., 2010). The European Commission defines bioeconomy as the production of renewable biological resources and the conversion of these resources and waste streams into value-added products such as food, feed, bio-based products and bioenergy. Bioeconomy can also be defined as the economy in which the basic components of production are based on biological and renewable resources. Bioeconomy uses biomass obtained from renewable biological plant or animal products processed in a mechanical, biomechanical, thermal or chemical way in the production process (McCormick and Kautto, 2013).

A broad and rapidly growing field known as the “bioeconomy” uses biological resources—such as organisms, biotechnologies, and bioproducts—into economic operations. The agricultural, forestry, and fishing industries are some of the sectors of the economy that produce the biological products used. New products are being used increasingly frequently, particularly in the manufacturing, pharmaceutical, and energy production industries (Pfau et al., 2014). The term “bioeconomy” refers to the commercially feasible exploitation of biological resources from the land and the sea, waste recycling, and associated manufacturing processes (Adamowicz, 2017). The production of biomass, which is used as a new source of food, feed, energy, and products, is the main goal of the bioeconomy. Biotechnology, a variety of chemical technologies, and physical processes are essential for transforming biomass into ever-more complex products (Pfau et al., 2014).

Essential Principles of Bioeconomy

The word “bioeconomy” describes a methodology that prioritizes the sustainable use of natural resources and the cost-effective evaluation of biological systems. This strategy gains relevance from its simultaneous consideration of environmental sustainability, economic advancement, and social wellbeing. The core principles of the bioeconomy promote the effective and efficient use of biological resources in order to maintain the natural equilibrium while simultaneously meeting human needs (Muscat et al., 2021).

The foundations of the bioeconomy are the conservation of ecosystems’ long-term health and the sustainable use of natural resources. This strategy aims to consider the needs of future generations as well as the needs of the current generation. Reducing adverse environmental effects while boosting resource efficiency is the aim of bioeconomic practices. The sustainability tenet of the bioeconomy encourages recycling waste and sourcing natural resources from renewable sources (Leitão, 2016). In the forestry and agricultural sectors, this can be achieved by using strategies like efficient resource management and ecological farming practices. The development of renewable energy sources, including the use of biofuels, is another aspect of this concept. The concept of sustainability also encompasses social and economic sustainability. This approach ensures that the utilization of natural resources is lucrative while also addressing issues such as protecting workers’ rights, promoting social justice, and supporting local economies (Aguilar et al., 2019).

Another fundamental principle of the bioeconomy is to preserve and increase biodiversity. Another fundamental principle of the bioeconomy is to preserve and increase biodiversity. Biodiversity, as well as the diversity of natural resources, is the preservation of the many roles of different biological species in ecosystems. This theory encompasses a variety of strategies to promote biodiversity protection and diversification in sectors like forestry, agriculture, and the marine industry. This concept encompasses a variety of techniques to promote biodiversity conservation and diversification in sectors like forestry, agriculture, and the marine industry. The preservation of the variety of natural resources and the diverse functions that different biological organisms perform in ecosystems is known as biodiversity. This concept includes a number of strategies to support the preservation of genetic resources and diversity in sectors such as forestry, agriculture, and the marine industry (Hall et al., 2012). As per this theory, it is imperative to carry out bioeconomic activities such as agriculture, forestry, aquaculture, and others without posing any threat to natural ecosystems. Agroecological methods are one way that the biodiversity principle is applied in agriculture to protect natural ecosystems, increase soil fertility, and maintain biodiversity. (Gogoi et al., 2020). The notion of biodiversity also encompasses the conservation and application of genetic resources. In agriculture, preserving and utilizing regional and customary variants is essential to preserving genetic variety and transferring it to next generations. The concept of biodiversity encompasses the preservation of biological heritage, animal habitats, and indigenous species and their ecosystems (Karaca and İnce, 2019).

The bioeconomy also promotes the circular economy. This concept promotes the reuse and recycling of trash. Utilizing natural resources more cost-effectively is made possible by the circular economy, which includes the production of biofuel, biodiversity-enhancing agriculture, and the composting of organic waste. In order to produce biogas, bioplastics, and compost from organic waste, the bioeconomy's circular economy concept encourages the use of biological processes. Trash production is reduced by these processes, which make it easier to recycle and reuse organic waste and promote frugal use of natural resources (Corrado and Sala, 2018). Repurposing biological resources in economic cycles is also encouraged by the circular economy idea of the bioeconomy (Tan & Lamers, 2021). Efficient utilization of natural resources is ensured by applications like utilizing agricultural waste for biofuel production or recycling forest debris for the production of wood and paper.

Innovation and technology play a major role in the bioeconomy's growth. Bioeconomic practices are always evolving and improving, which allows for a more effective and efficient use of natural resources. Innovations in fields like biotechnology, agricultural technologies, and the industrial use of biological processes enable the bioeconomic potential to grow. This strategy promotes the ongoing growth and enhancement of bioeconomic practices, according to Wei et al. (2022). The use of biological resources more effectively and efficiently is becoming increasingly achievable with the advancement of science and technology. In the pharmaceutical and

agricultural industries, for instance, improvements in genetic engineering and biotechnology have made it possible to create products and processes that are more productive. Furthermore, the idea of innovation and technology supports research and development in several bioeconomy areas (Cassman et al., 2002). Numerous industries, including agriculture, energy, health, and the environment, use research aimed at enhancing the economic potential of biological resources. Research on plant breeding, biodiversity, and the industrial use of biological processes can all be very beneficial to bioeconomic growth. Additionally, the innovation and technology principle encourages entrepreneurship and increases the competitiveness of businesses. Bringing new ideas and technological developments to market can broaden consumer base and spur economic growth. In the bioeconomic sectors, this fosters economic growth and improves job opportunities (Meyer, 2017).

In conclusion, ensuring community participation and fairness in bioeconomy endeavors is vital. This theory highlights how important it is to incorporate vast segments of society in decision-making processes linked to bioeconomic concerns and to preserve the rights of persons who will be directly damaged by those decisions. Bioeconomic policies and practices must be equally beneficial to all segments of society.

The Effects of Bioeconomy on Agricultural Production

Focused on the sustainable and economic use of biological resources, the innovative approach known as the "bioeconomy" The agricultural sector is essential to the bioeconomy because of its tight ties to natural resources. By enhancing the sustainability and effectiveness of agricultural practices, the bioeconomy has the potential to impact agriculture's future (Aguilar et al., 2019). There are various perspectives on how the bioeconomy is being applied in the agriculture sector. These can be divided into three main groups;

- Genetic innovations and plant breeding: Plant breeding is a methodical, scientific process that strives to enhance a plant's characteristics for a particular purpose. In this procedure, a variety of approaches are applied to enhance the intended characteristics, nutritional content, durability, production, and other attributes of agricultural products. In addition to traditional breeding techniques, the use of contemporary technologies like genetic engineering and biotechnology has grown in importance in plant breeding in recent years. (Małyska and Jacobi, 2018). Genetic innovations are plant modifications made feasible by technologies such as genetic engineering and biotechnology. These developments typically involve genetically modifying plants to add or eliminate desirable characteristics. The creation of more productive, pest- and disease-resistant, and ecologically friendly plants is the main objective of genetic advancements. Thanks to innovations like genetic engineering and biotechnology, the world of plant breeding has changed. The productivity of agriculture has increased due to the development of plants that are more resilient to disease and climate change (Parthasarathy, 2002).

- Sustainability & Biodiversity Preservation: Preserving the biodiversity of agro-ecosystems is a primary goal of the bioeconomy. The long-term sustainability of agricultural output depends on biodiversity preservation and sustainable resource use (Pfau et al., 2014).
- Bioenergy Production: Energy originating from biological sources is referred to as “bioenergy”. This energy, which comes from organic matter known as biomass, is one application of the bioeconomy in agriculture. Bioenergy production is the process of producing energy from plants, trees, agricultural waste, and other biological materials. This method lowers the consumption of fossil fuels and improves environmental sustainability by using renewable resources to meet energy needs. Environmental sustainability can be improved by using bioenergy in place of fossil fuels (Mohanty et al., 2022).

Because of the bioeconomy’s diverse uses, the agriculture sector has a lot of potential for a sustainable future. However, the effects of these activities as well as their social, environmental, and economic elements must be closely monitored. Understanding how bioeconomic activities—such as bioenergy production, agricultural biotechnology, and biodiversity protection and management—have impacted and will continue to impact the agricultural sector is crucial (Priefer et al., 2017). This is a synopsis of the bioeconomy’s implementation in the agriculture industry.

- Efficiency: Agricultural productivity efficiency can be increased by utilizing the bioeconomy. Combining more productive agricultural processes with more resilient plant varieties increases agricultural output (Zilberman et al., 2013).
- Environmental Sustainability: Environmental sustainability in the agriculture sector can be significantly impacted by the core idea of the bioeconomy, sustenance. By using the bioeconomy, one can reduce soil erosion, increase water efficiency, and reduce the need for chemical pesticides and fertilizers (Pfau et al., 2014).
- Economic Development and Social Welfare: Utilizing bioeconomy in the agriculture sector can boost social welfare and economic growth. Policies focused on the bioeconomy and innovative agriculture technology can decrease income inequality and boost employment in rural areas (Refsgaard et al., 2021).

Sustainable Agriculture

Sustainability

It is derived from the Latin word “sustinere” (Rigby and Cáceres, 2001), which means sustainability, continuity or preservation of its existence, which includes being supported for a long time, and in the simplest sense, it can sustain the existence of something (Meadowcroft, 1997). The concept of sustainability first came to the fore in 1977 in Dennis Pirages’ book titled *Sustainable Society*. The concept was later included in Dennis Hayes’ book titled *First Steps Towards a Sustainable Society -Repairs, Reuse, Recovery* published in 1978. However, the concept gained a central position in the environmental movement with the

report titled *Our Common Future* prepared by the United Nations World Commission on Environment and Development established in 1983 and published in 1987 (Tekeli, 2001). It is seen that the concept has been in widespread use in recent years and has been used in almost every field.

The concept of sustainability has a qualitative feature and characterizes the concept it is used together. For instance, the consideration of the concept of sustainability together with the concept of development characterizes the concept of development and emphasizes that development should have certain characteristics. Therefore, when the meaning of the concept of sustainability differs, it adds different characteristics to the concepts it is used together. These qualifications are sometimes in the form of the continuity of the desired situations and conditions, sometimes definite and serious limitations in the use of non-renewable resources, or the frugal and repeated use of renewable resources, and sometimes the protection of the assets required by social, economic and environmental systems at least at the required level (Bozlağan, 2002).

Sustainable Agriculture

Agriculture is one of the first economic activities of human beings and is the sector where the interaction between nature and human is most intense. Humanity has been fulfilling its fundamental needs, such as food and clothing, through soil cultivation and the production of animal products. As agricultural activities have expanded, reliance on soil has intensified, accelerating the transition to societal living. Initially, the relationships between individuals, society, and the environment were straightforward; however, technological advancements, globalization, evolving societal desires, and the intensification of processes have complicated these relationships (Latham, 1997). Consequently, agricultural activities, originally serving basic functions like sustenance, have evolved to encompass roles such as financing industrialization, environmental protection, participation in international trade, and enhancing rural livelihoods and welfare. Presently, agriculture constitutes a holistic and multifaceted entity, encompassing biological, economic, environmental, social, and political dimensions. Therefore, assessing the agricultural sector necessitates consideration of these dimensions. These dimensions can be classified as bio-physical environment, socio-political environment and economic-technological environment (Yunlong and Smit, 1994:300).

This multidimensionality of the agricultural sector and a number of problems caused by modern agricultural practices necessitate the investigation of new approaches based on evaluating these dimensions together and minimizing or eliminating the negative effects of modern agricultural practices. One of these new approaches is sustainable agricultural practices (Cairol, 2009). Although it is stated that the view of sustainable agriculture dates back to ancient times, an important reference point is the definition of sustainable development in the Our Common Future report. Because the definition of sustainable development emphasizes meeting the needs of the poor and the basic need of these segments is manifested in the direction of nutrition, it shows that the idea of sustainable

development naturally includes the idea of sustainable agriculture (Mebratu, 1998).

There are various definitions in the literature on sustainable agriculture. According to one of these definitions, sustainable agriculture is efficient food production without consuming the resources of the world and without polluting the environment. In other words, it is agriculture that allows the basic principles of nature in shaping agricultural crop and livestock breeding systems that can provide their own continuation like nature. In addition, it has social values such as revitalizing the countryside, providing farmers with a rich life and healthy food for everyone (Pugliese, 2001). According to another definition, sustainable agriculture refers to environmental health, economic profitability, and social and economic equality (IFAS, 2008).

For most people, sustainable agriculture means agriculture that will ensure the conservation of natural resources, protect the environment indefinitely, increase the trust and health of the community, and ensure profitable and adequate food production for all people working in agriculture. The concept also includes goals such as social justice and protecting animal welfare. Sustainable agriculture arises as an alternative to both traditional and modern agricultural practices, characterized by highly specialized approaches heavily reliant on synthetic and other non-agricultural inputs. The fundamental principles underlying this perspective are twofold: firstly, that the resources necessary for agricultural production are finite, and secondly, that achieving sustainable development to the desired degree is unattainable if it disrupts the natural equilibrium (Turhan, 2005).

Compared to other sectors, the agricultural sector causes severe negativities in terms of its environmental effects. Food demand, which is the basic need of the increasing world population, is met by the agricultural sector. 38% of the land in the world is used for agricultural activities. The world population is expected to reach 9.6 billion by 2050. This indicates that people will need a world three times bigger than today's production and consumption habits (UNDP Turkey). While food and other products are obtained through agricultural activities, especially for nutrition, which is the basic need of human beings, greenhouse gas emissions, biodiversity loss, chemical pollution and soil degradation are experienced as a result of these activities. Embracing sustainable agricultural systems presents the most promising avenue to mitigate these losses and safeguard future food and ecosystem security (Reganold & Wachter, 2016). Prioritizing the establishment of a sustainable food system entails building a foundation in economics, social equity, and environmental stewardship. This approach ensures meeting the nutritional needs and securing food for all individuals today while also ensuring food security for future generations.

According to a report published by the Business World and Sustainable Development Association (SKD Turkey) in 2018, it is projected that by 2030, the global population will approach 8.5 billion, with Turkey's population nearing 90 million. Consequently, fewer farmers will be tasked with producing approximately 50% more agricultural output than today to meet the nutritional needs of the future population (Üner, 2021). Production techniques that

protect and preserve the environment and society should be used to ensure food safety. In order to achieve this, it is necessary to reduce dependence on fossil fuels, turn to renewable energy, develop practices and waste management activities to protect biodiversity and water resources. It is also important to optimize the use of pesticides and fertilizers to maintain soil fertility.

The objective is to manage natural resources in a way that will benefit in the future with sustainable agriculture, which requires the existence of a balanced relationship between agriculture and the environment (Eryılmaz and Kılıç, 2018). Sustainable agriculture aims to bring solutions to the problems arising from industrial agriculture and is based on the facts that the world's resources for agricultural production are not unlimited, the natural balance should not be disturbed and continuous economic development should be ensured (Turhan, 2005). The significance of food security and combating poverty for developing countries proves the necessity of sustainable agriculture (Zezza and Tasciotti, 2010). While in developed countries this concept refers to issues such as increasing environmental quality, reducing environmental impacts that harm human health, supporting small and domestic enterprises and preventing desertification in rural areas (Ghorbani et al., 2010).

Sustainable Agricultural Practices

Genetically modified seeds affecting human health are used in food production processes; foods are exposed to additives, hormones, pesticides, pesticide chemicals and chemical fertilizers during the crop cultivation phase; irradiation is performed in order to ensure that product quality is maintained for a long time during the processing phase (Thomson, 2003). Foods produced by being exposed to all these processes threaten human health. Drugs and hormones used in the production process disrupt the structure of the soil, reduce biodiversity, disrupt the balance of nutrients, cause environmental damage such as soil salinization and barrenness. Sustainable agriculture fosters a sustainable way of life for both producers and consumers, socially and economically. It achieves this by enhancing soil productivity, while simultaneously promoting the long-term conservation of natural resources and minimizing environmental harm through the utilization of advanced technologies. It is very important to ensure the balance between these three components (Adanacioğlu, Saner, & Ağır, 2018).

Sustainable agricultural practices are divided into organic agriculture and good agriculture. With these practices, it is ensured that products with increased food quality are produced with the protection and development of natural resources, protection of the environment and production processes suitable for health conditions (Eryılmaz, Kılıç and Boz, 2019).

Organic Agriculture: It is stated that the word organic was first used to describe the ecological agricultural system in Lord W. Northbourn's work titled *Look to the Land* published in 1940 (Bulut, 2018). In this book, it is seen that a production process different from traditional agriculture is meant by using the chapter title 'Organic vs. Traditional Agriculture'.

Organic agriculture is a sustainable agricultural system focused on human and environment, based on the protection of ecological diversity. Organic agriculture “is a sustainable form of agriculture for the production, processing, labeling, control, certification and marketing of plant and animal products through organic inputs and appropriate agricultural techniques that are allowed to be used in order to protect the environment” (Demiryürek and Bozoğlu, 2007). All stages of this process should be carried out according to nationally and internationally valid rules and compliance with these standards should be checked and certified by independent organizations.

Since 1991, the European Union (EU) has been enforcing legislation governing organic agriculture, and it has mandated that countries exporting organic products to EU nations comply with its own organic agriculture regulations. According to the United Nations Food and Agriculture Organization (FAO, 2021), organic agriculture is defined as “a holistic production system that promotes biological diversity and the health of the agricultural ecosystem, and where the production and marketing stages of agricultural production are traceable, sustainable and have practices that will benefit development in the rural region by adapting to regional conditions”.

Organic agriculture, as one of the sustainable agricultural practices, has been defined by the International Federation of Ecological Agricultural Movements (IFOAM) (2008) as a system based on policies that are based on the fair relationship between health, ecology, environment and society, and the needs and technological innovations of society and nature, established to maintain soil, ecosystem and human health. Organic farming achieves environmental benefit, fair relations and improving the quality of life of all interested parties through innovations and contributions of science. Organic agriculture first started in Europe and the United States and became widespread with the increasing demand of consumers (Eryılmaz, Demiryürek and Emir, 2014).

According to Demiryürek (2011), the main elements of organic agriculture are to prohibit or reduce the use of chemicals such as pesticides, fertilizers, growth regulators, hormones in maximum amounts, not to cause biological and mechanical damages with production techniques, and to protect consumer health and soil fertility. Organic agriculture has a transparent, traceable process, and production and products are controlled and certified by independent organizations. Organic food production has a human and environment-oriented production approach that does not disrupt the ecological balance by using a small amount of agricultural input (Ustaahmetoğlu and Toklu, 2015).

Good Agriculture: All workflows related to good agricultural practices, planning, development, marketing of agricultural production, recording of all activities, and delivering products to end users in the food supply chain in a controlled manner have been planned. While doing all these, we can express it as an environmentally friendly agricultural form that meets hygiene standards, has a product-recording system and is widely accepted all over the world (İçel, 2007).

Good agriculture is a human and environmentally friendly production system aimed at restoring the natural balance that is deteriorated and lost as a result of wrong practices in nature. The synthetic pesticides that lead to this

degradation foresee the limitation and control of hormones and artificial chemical fertilizers. In addition, they are certified production systems that aim to use animal manure, green fertilizers and all waste organic compost instead of these drugs (Er and Başalma, 2013). The constant increase in the world’s population has accordingly increased the need for food. It has started to use mechanization and technology at a high level in order to obtain more efficiency from the unit area according to the supply-demand balance. These agricultural moves, which gained popularity under the name of agricultural innovation and green revolution, soon led producers to use chemical spraying unconsciously and uncontrollably as conventional agriculture. Accordingly, there have been changes in organic and inorganic substances in the soil. It became evident that the organisms inhabiting the ecological environment could no longer endure excessive and uncontrolled human interference with nature, leading to some adverse consequences. In addition, excessive chemical use has created serious health threats for individuals who consume related products as well as disrupting the soil structure and environmental order. This practice has been explained by FAO (Food and Agriculture Organization) as “the procedures to be applied to make the agricultural production system socially livable, economically profitable and efficient, protecting human health, and attaching importance to animal health and welfare and the environment” (FAO, 2021).

Chemical residues (pesticides) in products will show their harmful effects in a short time and may be a precursor to more serious problems in the long term. The excess of pesticides developed with technology should not only be evaluated with the amount of production, but also with biological diversity and animal health (Guru et al., 2015). It should not be overlooked that infectious and epidemic diseases transmitted from other living creatures in nature to humans are also important. Since all agricultural inputs are organic inputs, the organic one should be preferred in the physical preservatives of the fertilizers that feed the soil obtained by organic and natural methods that protect against pests (Ali et al., 2019). However, the increase in food demands with the increasing world population has made it difficult for organic farming practices to offer more products and services at affordable prices to the market in this process. In essence, the challenges posed by environmental and geographical factors in implementing organic agricultural practices, coupled with the lower yield of agricultural products per unit area and the challenges in protecting the resulting products, have prompted producers to revert to conventional agricultural practices. Aligned with these developments, the adoption of good agricultural practices has underscored the necessity of using pesticides in soil and products in quantities that do not pose harm to human, animal, environmental, and subterranean resources, supplemented by organic fertilizers for support (Lotter, 2003). In this way, the amount of product obtained from the unit area is expected to be more than organic agriculture practices. It is expected that the consumer will turn to Good Agricultural Practice products in a way that the possibility of harming the nature is minimized. In addition, inspecting and controlling each stage of Good Agricultural Practice products and keeping these certification procedures in places where consumers can

easily see and examine will also increase the demand of consumers for Good Agricultural Practice products. If we focus on the type of cultivation in general; it is expressed as a system in which the product is watered as much as it needs, the necessary measures are taken to prevent disease and pest contamination, but if it occurs, the necessary dose is struggled, and the needs of the soil and plant are determined and fertilized (Baweja et al., 2020).

Good agricultural practices need to be reliable and healthy to protect both products and consumers. There are special methods and standards used to achieve this. Good agricultural practices were established by the European supermarket chains (Eurep) and their important suppliers towards the end of the 1990s. The main purpose here is to collect the demands of various suppliers as a whole and to help farmers and suppliers. The guidelines published in Hazard Analysis and Critical Control Points (HACCP) developed using the standard are managed according to the United Nations Food and Agriculture Organization and ISO Guide 65 for certification schemes (Eurocert, 2021). Within the scope of good agricultural practices, it is aimed to issue certificates in three headings as plant products (fruit, vegetables and ornamental plants, etc.), livestock (cattle, sheep and poultry, etc.), and aquaculture products (fish, molluscs, etc.) (Eurocert, 2021). In other words, the objectives of good agricultural practices argue that agricultural production systems should be applied without harming the environment in a way that is both economically profitable and efficient and protects human and animal health against various risks and dangers while making them socially livable.

Benefits of Sustainable Agriculture

Sustainable agriculture is an agricultural method that provides many environmental, economic and social benefits. This approach aims to increase the well-being of societies and leave a better world for future generations while protecting natural resources (Hosseini et al., 2011).

From an ecological point of view, sustainable agriculture promotes the efficient use of natural resources. Preventing overuse of chemical fertilizers and pesticides helps maintain soil fertility and reduce erosion. In addition to organic agricultural methods, habitats are offered to safeguard biodiversity and lessen adverse impacts. Long-term, this improves the condition of the soil and the water resources (Jhariya et al., 2021).

From an economic standpoint, sustainable agriculture boosts farmers' incomes and supports local economies. Sustainable agriculture, in contrast to conventional farming practices, has lower input costs and longer-term production stability. Furthermore, organic agricultural goods frequently fetch higher prices on the market, giving farmers financial advantages. Moreover, this type of agriculture boosts employment and helps rural areas flourish economically (Reyhan & Reyhan, 2017).

Community health and well-being are improved socially through sustainable agriculture. In order to address health issues like obesity, local food systems are encouraged to provide fresh and nutritious food to a wider audience. Yet, local communities and small farmers are better able to secure their own food security when agricultural techniques are sustainable. Both local autonomy and food sovereignty are strengthened by this.

Sustainability over the long run is one of the main advantages of sustainable agriculture. For future generations, a better environment is guaranteed by the balanced use and preservation of natural resources. Consequently, agriculture may be sustained over the long run while preserving the standard of living in communities (Smith et al., 2022).

Thus, sustainable agriculture has advantages for the environment, the economy, and society at large. It enhances community well-being, protects natural resources, boosts farmer incomes, and leaves a healthier environment for coming generations. Thus, it is critical to promote and encourage sustainable agriculture in order to raise the standard of living for both the current and future generations.

Integration of Bioeconomy and Sustainable Agriculture

Food, energy, and industrial raw materials are in greater demand today due to the growing global population. But we're starting to doubt conventional patterns of production and consumption due to dwindling natural resources and environmental issues. Important ideas that seek to preserve ecosystem services and promote environmental sustainability through more resource efficiency are the bioeconomy and sustainable agriculture (Sillanpää et al., 2017).

Based on the economic assessment of biological resources and processes, the bioeconomy is an economic model or methodology. Abiotic resources such as microbes, vegetation, animals, and biodiversity are all included in this strategy. Chemicals, materials, food, energy, medicine, and other things can all be produced and processed using them. In the past, industries like mining, energy, and industry have tended to dominate the economy. An understanding of the biological resources' economic value and the promotion of their sustainable use are made easier by the bioeconomy. Biotechnology, biofuels, sustainable agriculture, biobased materials, and biobased goods are just a few of the industries that are impacted by the bioeconomy (Wesseler and von Braun, 2017).

Aiming to preserve natural resources and take ecosystem benefits into account while maintaining food production, sustainable agriculture is an agricultural paradigm. A common characteristic of traditional agricultural practices is their high input consumption, which can result in abuse of natural resources and environmental deterioration (Günaydın, 2014). But the long-term goal of sustainable agriculture is to reduce these adverse effects and protect biodiversity, land, and water. Preserving the fertility and health of the soil is the primary objective of sustainable agriculture. In order to guarantee the sustainable use of soil, strategies including boosting organic matter, stopping erosion, and protecting soil structure are put into practice. Preventing soil erosion enhances environmental sustainability and guarantees the long-term productivity of agricultural land. Furthermore, the preservation of water resources is a priority in sustainable agriculture. To stop pollution of the water supply, water-saving irrigation techniques are employed along with a decrease in chemical pesticides and fertilizers. By preserving the equilibrium of aquatic ecosystems, these efforts safeguard the long-term health of water resources and promote environmental sustainability (Aydn Eryilmaz et al., 2019).

There are various reasons why there is a major relationship between sustainable agriculture and the bioeconomy. Through the utilization of agricultural waste and the promotion of sustainable farming practices, the bioeconomy assures the efficient use of resources. From this angle, the bioeconomy promotes more effective use of natural resources while supporting the idea of sustainability in agricultural activities. By encouraging sustainable farming methods, the bioeconomy contributes to the sustainable use of natural resources. By using fewer chemical pesticides and fertilizers, bioeconomy-based agricultural practices preserve biodiversity and the health of the soil. Long-term productivity and increased soil fertility are two benefits of sustainable farming practices like organic farming (Duque-Acevedo et al., 2020). Moreover, through encouraging the use of agricultural waste, the bioeconomy advances the economical use of resources. Agricultural wastes can be used in many ways, such as the generation of compost through biodegradation or biomass energy. They can also be used as animal feed. By ensuring that waste is recycled, this minimizes environmental effects and stops resource waste. Therefore, by promoting the effective use of natural resources, the relationship between the bioeconomy and sustainable agriculture improves environmental sustainability (Maraveas, 2020). By guaranteeing the implementation of sustainability principles in agricultural activities and the preservation of natural resources, the bioeconomy seeks to leave a healthier environment for future generations. The bioeconomy and sustainable agriculture work together in this situation to guarantee resource efficiency while reducing environmental effects. Sustainable agriculture's guiding principles are supported by the use of agricultural wastes in the generation of biomass energy and the biodegradation of soil nutrients (Liobikiene et al., 2019).

For the preservation of biodiversity and the delivery of ecosystem services, the connection between the bioeconomy and sustainable agriculture is crucial. In order to protect biodiversity and keep ecosystems functioning, bioeconomy techniques can complement the tenets of sustainable agriculture. For example, organic agricultural techniques reduce the usage of chemical pesticides and fertilizers, protecting water resources and improving soil fertility (Gogoi et al., 2020).

As such, the relationship between the bioeconomy and sustainable agriculture can promote the effective use of natural resources, thereby supporting environmental, economic, and social sustainability. To improve this relationship, though, the participation and cooperation of society, business, and policymakers are required. Thus, sustainable agriculture and the bioeconomy can advance jointly and contribute significantly to a more sustainable future.

Conclusion

With an emphasis on the future of creative agriculture, this paper discussed the trajectory of sustainable agriculture and the bioeconomy. According to what we learned from our interviews, combining the bioeconomy with sustainable agriculture has the power to significantly alter the agriculture industry for the betterment of society, the environment, and the economy. The primary goals of

the bioeconomy and sustainable agriculture are the economical assessment, the efficient use of natural resources, and the mitigation of environmental effects. However, in order to achieve these goals, legislators, farmers, and industry stakeholders must work closely together to develop creative solutions. The agricultural industry can move toward a more environmentally friendly, efficiently managed, and sustainable structure in the future with growing use of sustainable agriculture methods and the bioeconomy. For the sake of both current civilizations and future generations, this shift will be an essential step toward creating a healthy planet.

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