Chapter

Corn for Biofuel: Status, Prospects and Implications

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Abstract

Biofuel offers an alternative energy source to meet the energy demands of a growing population of 8 billion while minimizing environmental impact. Globally, around 3000 petajoules of biofuel are produced, diversifying energy sources from conventional to renewable. Corn, rich in starch that can be converted into ethanol, is widely used in biofuel production. Corn-based biofuels are popular due to their potential to reduce greenhouse gas emissions, their biodegradability, and clean ignition, enhancing energy security. While the current state of corn as a biofuel source appears promising, increasing production requires breeding strategies like varietal crossing and cultivar selection to enhance biomass and starch content. Better agronomic practices and extension strategies are also necessary to improve yield and promote adoption among farmers. Using maize as a feedstock for biofuel production can boost the agricultural industry, create jobs in farming, processing, and transportation, and reduce reliance on foreign oil while preserving foreign exchange reserves. Technological advancements, viz., cellulosic ethanol production, have further expanded the potential use of corn for biofuels due to its abundance and convenience. However, the future of corn-based biofuels is uncertain. Therefore, ongoing innovation, exploration of alternative feedstocks, and cutting-edge technologies are necessary to overcome challenges.

Keywords: breeding approaches, climate change mitigation, energy security, ethanol, food security, starch

1. Introduction

Maize, also known as corn, since its domestication from 9000 years ago, is one of the most important cereal crops globally, serving as a staple food for millions of people and a valuable feedstock for livestock [1]. Corn (dry grain) is annually cultivated on a projected 206 Mha of land worldwide, making it the second most extensively grown crop globally after wheat with a peak production and productivity of 1210 million tonnes and 5879 kg/ha, respectively [2]. Taking into consideration of area stagnation of wheat and rice, maize is set to overtake wheat in terms of acreage by 2030 [3]. Notably, the Americas, encompassing the United States, Brazil, and Argentina, are significant maize producers due to their favorable climate, extensive agricultural infrastructure, and technological advancements along with other important maize-producing regions involving China, India and South Africa, where suitable agro-climatic conditions and dedicated cultivation efforts contribute to substantial maize yields [4]. Corn production plays a diverse and critical role in global food security, economic development, and agricultural sustainability. It is widespread across the globe, with specific regions emerging as major contributors to the global supply. Trend analysis has shown that the maize production has increasing significantly thanks to upsurge in productivity (by six times from 1961 to 2021) making it a potential crop for alternative use like biofuel (**Figure 1**).

Since being necessary is the essence of the invention, the impending energy crisis has sparked curiosity about the production of biofuel. In the upcoming years, there will be a dramatic increase in the global consumption of liquid petroleum. By 2025, the energy demand is predicted to increase by more than 50% if the current trend holds [5]. Most crucially, an endless need for finite petroleum resources cannot be a long-term viable solution. Therefore, we must begin working towards carrying a switch from the non-renewable energy source of carbon to renewable vis-à-vis sustainable bio-resources prior to situations starting to slip out of our purview. In this way, the corn-to-biofuel notion can serve as a road map.

Biofuel, derived from renewable biomass sources, has emerged as an important alternative to fossil fuels by diversifying the energy sources [6] due to its potential to mitigate climate change, enhance energy security, and promote sustainable development [7]. Because vegetation assimilates CO_2 over its growth phase during the reaction of photosynthesis biofuels have been recognized as carbon-neutral energy sources [8]. In this context, biofuels, a healthier option to petroleum, are gaining popularity because they are environmentally friendly and compassionate to the environment. Utilizing these fuels may assist reduce environmental changes and the pollutants that come from automobiles. Biofuels are produced through various methods, including biomass conversion processes such as fermentation, pyrolysis, and transesterification. Biomass feedstocks can range from crops like sugarcane,

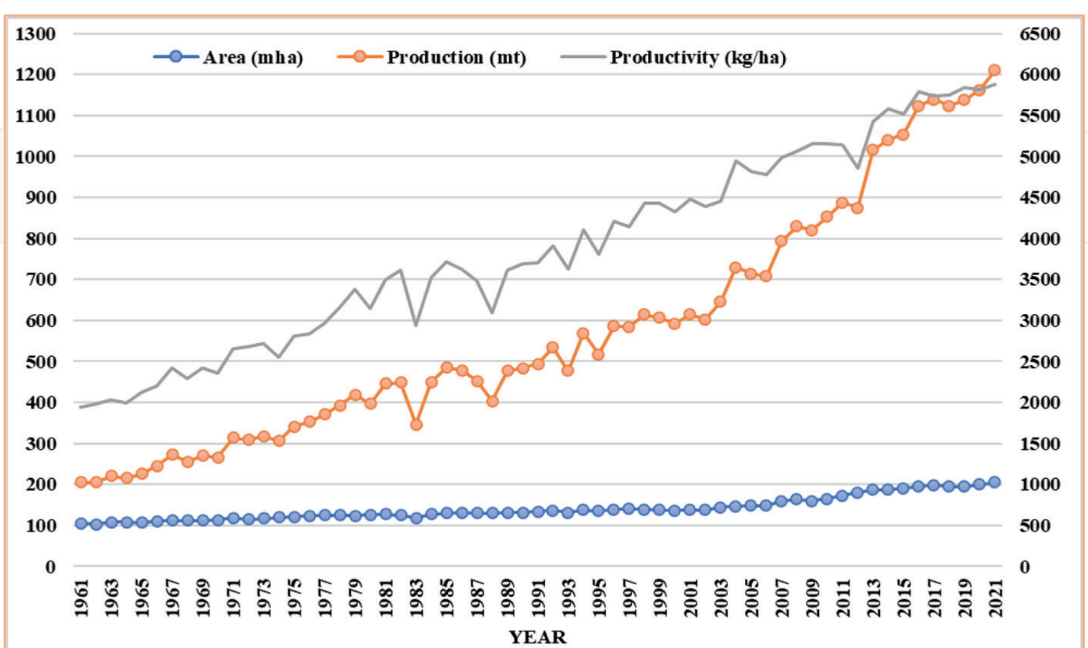

Figure 1.
Area, production, productivity trend of corn from 1961 to 2021 (data collected from http://www.fao.org/faostat).

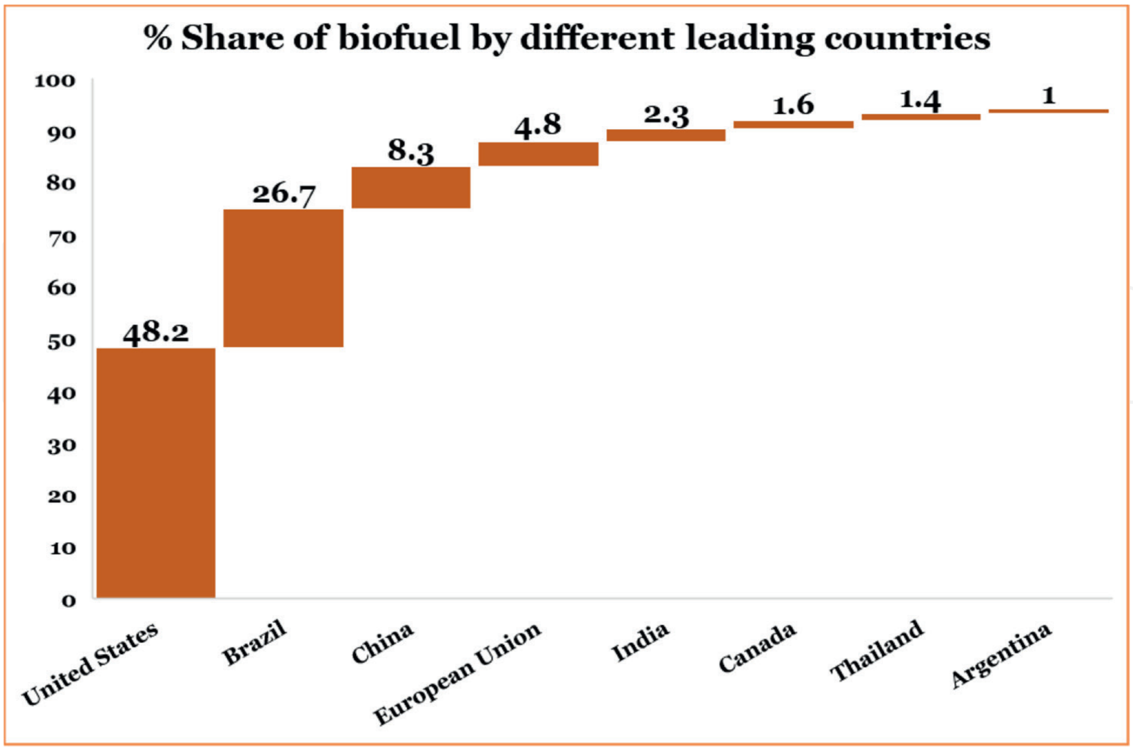

Figure 2.
Percentage share of biofuel by different leading countries (data obtained from OECD-FAO, 2021 [13]).

corn, and soybeans, to agricultural residues, forest residues, and even algae [9]. These feedstocks are transformed into liquid fuels, such as ethanol and biodiesel, or gaseous fuels like biogas. The two most prevalent kinds of biofuels employed nowadays are ethanol and biodiesel, which fall under the first generation of biofuels. Other types of biofuels include methanol, biodiesel, biogas, and Syngas. Ethanol is produced from cellulose-based feedstocks [10] such as corn, sugarcane, discarded potatoes, and others [11]. It is frequently used with petrol as an additional ingredient to raise the octane level and lower greenhouse gas emissions (GHG) [12]. With outputs totaling 1436 petajoules in 2021, the United States was the world's top manufacturer of biofuel followed by Brazil with statistics of about 840 petajoules, sharing 48.2 and 26.7%, respectively of the world total biofuel production (**Figure 2**, [13]).

Corn has been a major crop in the United States and many other countries around the world. In recent years, it has also become an important source of biofuel production due to its high starch content that can be converted into ethanol through different processes by fermentation [14]. The use of corn for biofuels has gained significant attention as an alternative to fossil fuels, which has the potential to reduce GHG emissions and promote energy security. However, the use of corn for biofuels has also raised concerns regarding its impact on food security, the environment, and the economy.

2. Corn biofuel: current status

2.1 Historical overview of corn for biofuels

The history of corn for biofuels is a long and complex one with its use dating back centuries, but it was only in the twentieth century that it gained significant attention as an alternative to fossil fuels. In the early 1900s, Henry Ford experimented with ethanol as a fuel for his Model T, and during World War II, the US government promoted the use of ethanol as a way to address gasoline shortages. However, the high cost of producing ethanol from corn made it economically unfeasible, and the program was discontinued after the war. Further, in the 1970s, the oil crisis sparked renewed interest in biofuels, and corn ethanol once again became a topic of discussion [14, 15]. In 1978, the US Congress passed the Energy Tax Act, which provided tax incentives for ethanol production and mandated the use of ethanol in gasoline. However, the impact of the act was limited, and ethanol production remained relatively low.

The twenty first century saw a significant increase in the use of corn for biofuels, driven by concerns over climate change and energy security. In 2005, the US government enacted the Renewable Fuel Standard, which mandated the use of biofuels, including corn ethanol, in transportation fuels [16]. The mandate has since been expanded, with the goal of reaching 36 billion gallons of biofuels by 2022. The use of corn for biofuels has had a significant impact on global markets, particularly in the US, which is the largest producer of corn ethanol [12]. The increased demand for corn as a feedstock has led to higher corn prices and raised concerns about food security. While corn ethanol has the potential to reduce (GHG) emissions and promote energy security, its production has been criticized for its potential negative impact on food security, environmental impacts, and global markets.

2.2 Current trends in corn-based biofuel production

The corn biofuel production process is complex and requires careful management to ensure that the final product is of high quality and meets regulatory requirements (**Figure 3**). With advances in technology and process optimization, the production process can be made more efficient and environmentally sustainable.

Corn-based biofuel production is a dynamic and constantly evolving industry and its production has been a budding industry over the past decade, with the United States leading the way as the world's largest producer of ethanol from corn. The increasing demand for renewable fuel sources has led to a significant increase in corn-based biofuel production, with corn ethanol being the most widely used form of biofuel in the US. One of the major trends in corn-based biofuel production is the development of new technologies that allow for more efficient and cost-effective production. This includes the use of genetically modified corn that has been specifically bred to produce higher yields of ethanol, as well as the use of more efficient production processes that reduce energy and water usage [17, 18].

The development of new markets and applications for the fuel has set new vistas for corn-based biofuel production. In addition to its use as a transportation fuel, corn ethanol is being used in a variety of industrial applications, such as solvents, cleaning agents, and as a feedstock for the production of other chemicals [19]. There is also a growing inclination towards the use of advanced biofuels, which are produced from non-food sources such as switchgrass and algae with having the potential to be more sustainable and environmentally and are turning out to be the better competitors of corn-based biofuels [20]. Despite these challenges, the corn-based biofuel industry remains a vital component of the global energy mix. With continued investment in research and development, the future of corn-biofuel production looks promising, as long as the industry continues to prioritize sustainability and responsible production practices.

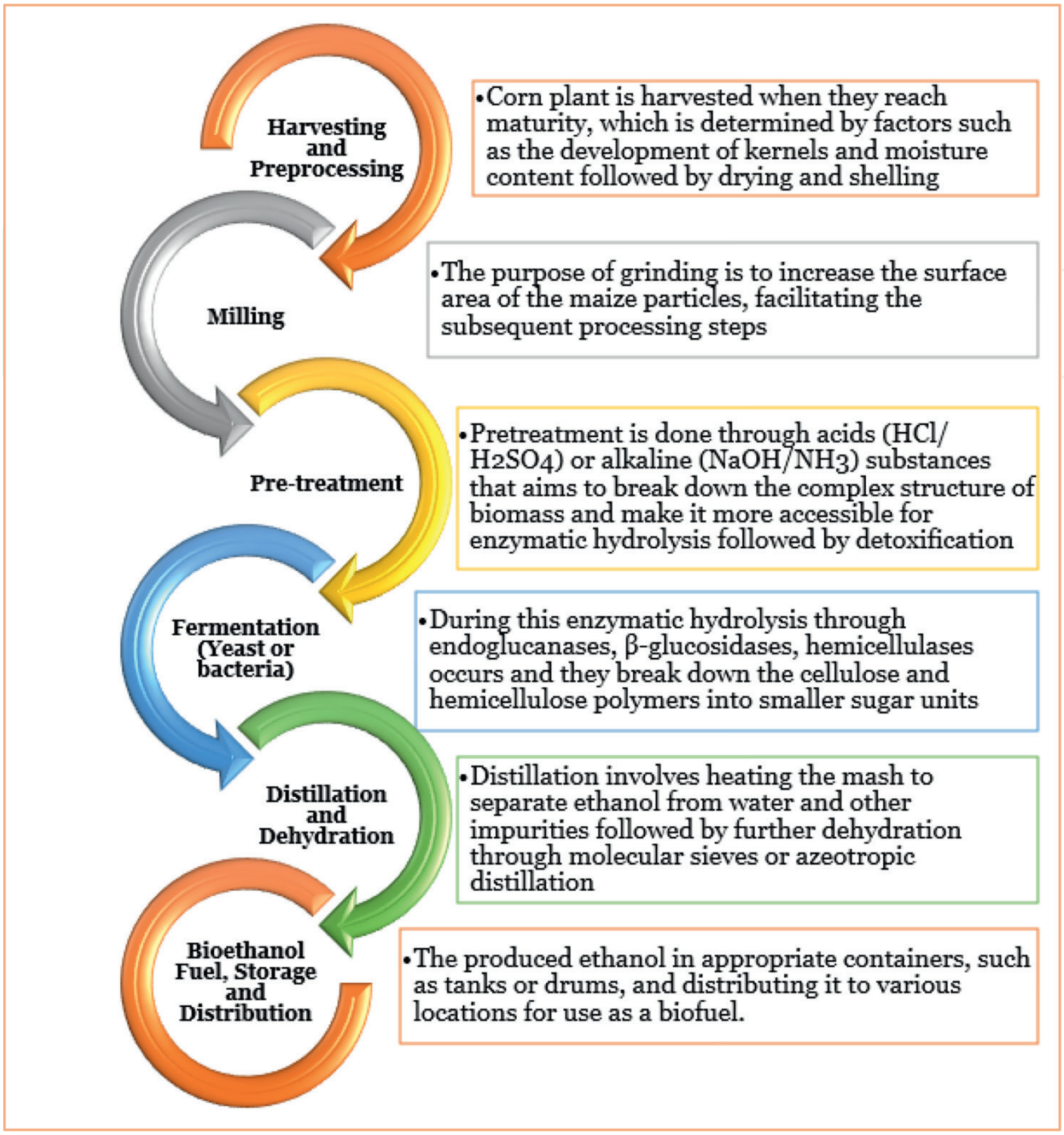

Figure 3.
Steps by step production processes of corn biofuel.

2.3 Production processes and technologies

Corn-based biofuel production processes and technologies are constantly evolving and become progressively popular as a substitute to fossil fuels, due to their renewable and ecologically friendly properties. With this growing demand, there has been a significant increase in research and development efforts aimed at improving corn-based biofuel production processes and technologies. One of the primary technological advances in corn-based biofuel production has been the use of genetically modified (GM) corn that allows for higher yields of ethanol, as the corn has been bred to yield higher amounts of sugars or its relative compounds that can be converted into ethanol. Additionally, new technologies are being developed to enable more efficient conversion of the corn sugars into ethanol, with the aim of reducing production costs and increasing efficiency [21].

Furthermore, there has been an increasing focus on improving the byproducts of corn-based biofuel production. For instance, distillers' grains, which are the leftover byproducts of ethanol production, are being utilized as an animal feed supplement. This not only reduces waste but also provides a source of revenue for biofuel producers [22]. Another futuristic trend is the development of more sustainable and environmentally friendly methods in corn-based biofuel production processes like the use of dry-grind processing, which requires less energy and water than traditional wet-milling methods [23]. Additionally, more sustainable sources of energy are being used to power biofuel production facilities, such as wind and solar power.

3. Prospects of the corn biofuel

Corn-based biofuel offers promising prospects as a renewable energy source. In addition, ongoing plant breeding research, technological advances, and extension approaches and agronomic measures are needed to improve the efficiency and environmental impact of corn-based biofuel production.

3.1 Breeding prospects of corn for biofuel

Breeding corn for biofuel production has been an important research area in recent years. The aim of corn breeding for biofuel is to develop corn varieties that have improved yield and quality traits that can enhance the efficiency of the biofuel production process [24]. It involves the crossing desirable parent plants to produce offspring that have the desired traits with proper evaluation of their performance. The different breeding aspects of corn for biofuel is illustrated below in **Table 1**.

Several breeding techniques can be employed to intensify the generation of biofuel from maize. Here are a few typical methods [26–28]:

3.1.1 Traditional breeding

In traditional breeding, several maize types are crossed to produce hybrids with the appropriate properties for the generation of biofuels. With the use of this technique, breeders can combine advantageous traits like high biomass output, higher sugar or starch content, disease resistance, and stress tolerance.

3.1.2 Marker-assisted selection (MAS)

Marker-assisted selection is a method of breeding that makes use of molecular markers connected to particular qualities of interest. Breeders can selectively breed maize varieties with those markers, expediting the development of desired features, by discovering genetic markers linked to traits related to the generation of biofuels, such as high sugar or starch content [28].

3.1.3 Genomic selection

Genetic information about a person is used to predict that person's performance. Breeders can determine the genetic potential of various individuals for features linked to biofuels by studying the full genome of maize plants. The choice of parent lines for crosses can be influenced by this knowledge, improving the output of biofuel in succeeding generations [29].

Different aspects for breeding	Descriptions
Increased biomass yield	Breeding for corn varieties with higher biomass production, considering traits such as harvest index, stover yield, and overall plant growth.
Enhanced sugar/starch content	Starch is the main component of corn grain, and it is the primary substrate for biofuel production and high starch content in corn can lead to higher ethanol yields, which can make the biofuel production process more cost-effective. Thus, breeding programs aim to develop corn varieties that have higher starch content [5].
Reduced lignin content	Breeding for a lower level of lignin, a compound found in the stalks and leaves of corn plants, can improve the efficiency of the biofuel production process.
Improved conversion efficiency	Breeding for corn varieties with traits that enhance the efficiency of conversion processes, such as increased enzymatic digestibility and higher ethanol yield [25].
Increased oil content	Corn varieties Selection with higher oil content, suitable for biodiesel production, by focusing on oil accumulation and favorable fatty acid profiles [26].
Drought tolerance	Breeding for corn varieties with improved drought tolerance, enabling sustained biomass production under water-limited conditions.
Disease and pest resistance	Incorporating genetic resistance to common corn diseases and pests, reducing yield losses, and ensuring healthier maize crops for biofuel production.

Table 1.
Different aspects of corn breeding for biofuel production.

3.1.4 Genetic engineering

To improve features relevant to biofuel production in maize, certain genes can be inserted using genetic engineering techniques. For instance, genes that boost stress resistance or lower lignin content can be introduced into the genomes of maize plants. Breeders can introduce unique features that might not be present in the maize gene pool thanks to the exact alterations made possible by genetic engineering.

3.1.5 Doubled haploid (DH) method

Homozygous plants with all of their genes present in a single plant are created using the DH method and this strategy can hasten the creation of pure breeding lines with desired features for biofuels. The use of DH technology shortens the breeding process and enables the selection of superior lines based on characteristics including disease resistance, sugar content, and biomass production [26].

3.1.6 High-throughput phenotyping

To quickly and precisely evaluate a variety of plant features, high-throughput phenotyping uses automated methods. Breeders can choose and create better varieties by identifying individuals with superior biofuel-related features using high-throughput phenotyping systems to analyze vast populations of maize plants [27].

3.1.7 Multi-trait selection

Because the generation of biofuels is so complex, it's crucial to take several features into account at once. For which, breeders can apply multi-trait selection techniques that take into account traits like disease resistance, stress tolerance, and nutrient utilization efficiency in addition to biomass output and sugar or starch content. It guarantees a thorough improvement in maize varieties for the production of biofuels.

It's also imperative to note that various breeding techniques are frequently combined and integrated to increase their efficacy. The choice of breeding strategy is also influenced by the resources that are available, the breeding objectives, and the regulatory factors.

3.2 Potential prospects for promoting the adoption of corn as a biofuel crop among farmers

As the biofuel crops provide economic opportunities, environmental sustainability and promotes climate resilience as well as diversified agricultural systems. It is a need of an hour to promote the biofuel crops among farmers. Growing corn as a biofuel crop offers vast opportunities for farmers in income diversification, access to stable markets, value-added production, improved soil health, adoption of conservation practices, government support, and contribution to energy independence [30]. Therefore, it makes corn an important and feasible option for farmers interested in sustainable and economically viable agriculture. The potential prospects for promoting the adoption of corn as a biofuel crop among farmers are as follows.

3.2.1 Educational and skill Upgradation programs

The international conference on research and educational opportunities in biofuel crop production highlighted the importance of education and skill development in bio-fuel crop production to harness the opportunities of entrepreneurship, processing and value addition in the biofuel supply chains among the farmers for income diversification with alternative energy resources [30].

3.2.2 Incentives

Luring the stakeholders with financial incentives such as tax credits, grants, and subsidies to who grow corn for biofuel could be an immediate way but sensitizing the growers to cut down ecological and social cost of production will an ultimate aim for the policy makers to enhance the production as it was achieved in microalgae biofuel production [31].

3.2.3 Advancing market

The marketing sphere of biofuel can be innovatively invented as biofuel shares the potential interaction with food market which is responsible for price hike of food products. Contrary, biofuel production can be serves as potent solution for the food waste and play important role in low carbon economy. These possibilities can be utilized by manufacturers and distributors to develop markets for corn-based biofuels, which can increase demand and provide farmers with a stable market for their crops.

3.2.4 Demonstration trails

The exposure with benefits of growing corn as biofuel as well as provide hands-on training and support for farmers can increase the adoption of this technology among them. As study revealed the robust result in knowledge generation through pilot and demonstration plant on advancing the biofuel innovations in European Union [32].

3.2.5 Extension services

For the production of biofuel crops such as switchgrass, sweet sorghum, miscanthus, soybean, and elephant grass or from micro-algae government provide support program and assistance along with economic incentives [33].

3.2.6 Research and Development

Investment in research for identifying new varieties and efficient management techniques which can be better suited for corn as biofuel production, along with the development of more effective processing methods can foster the adoption of this magical crop as biofuel among farmers. Similar, initiatives had been taken by China for enhancing the adoption of biofuel sugarcane.

3.2.7 Farmer-to-farmer learning

To foster the adoption of biofuel corn the farmer-to-farmer learning networks must be expanded where experienced farmers can share their knowledge and experience with other farmers [34].

3.2.8 Collaborations

For the sustainable transportation of palm biofuel, an international collaboration was done between Malaysia and Colombia. Similar collaborations can with agricultural organizations such as farm bureaus and commodity groups to promote the benefits of growing corn for biofuel.

3.2.9 Social influence

Encourage farmers and stakeholders who have successfully adopted corn as a biofuel crop to serve as advocates and role models for other farmers [35].

3.2.10 Public relations and marketing

Develop public relations and marketing campaigns to raise awareness of the benefits of corn-based biofuels can encourage the farmers to adopt this.

3.3 Best practices for sustainable corn biofuel production

Corn-based biofuels have the potential to contribute significantly to sustainable energy production, provided they are produced using best practices that minimize their negative environmental, social, and economic impacts. Some of the best practices that can be adopted to ensure sustainable corn-based biofuel production (**Figure 4**) are discussed below.

3.3.1 Efficient and sustainable farming practices

It should be firmly adopted to reduce the carbon footprint of corn cultivation which can be achieved through practices such as conservation tillage, crop rotation, and precision agriculture, which help to minimize soil disturbance and reduce the use of fertilizers and pesticides [36–38].

3.3.2 Advanced biofuel production technologies

The usage of advanced biofuel production technologies such as cellulosic ethanol production and waste-to-energy conversion [39] can reduce the pressure on land resources and increase the overall efficiency of the production system.

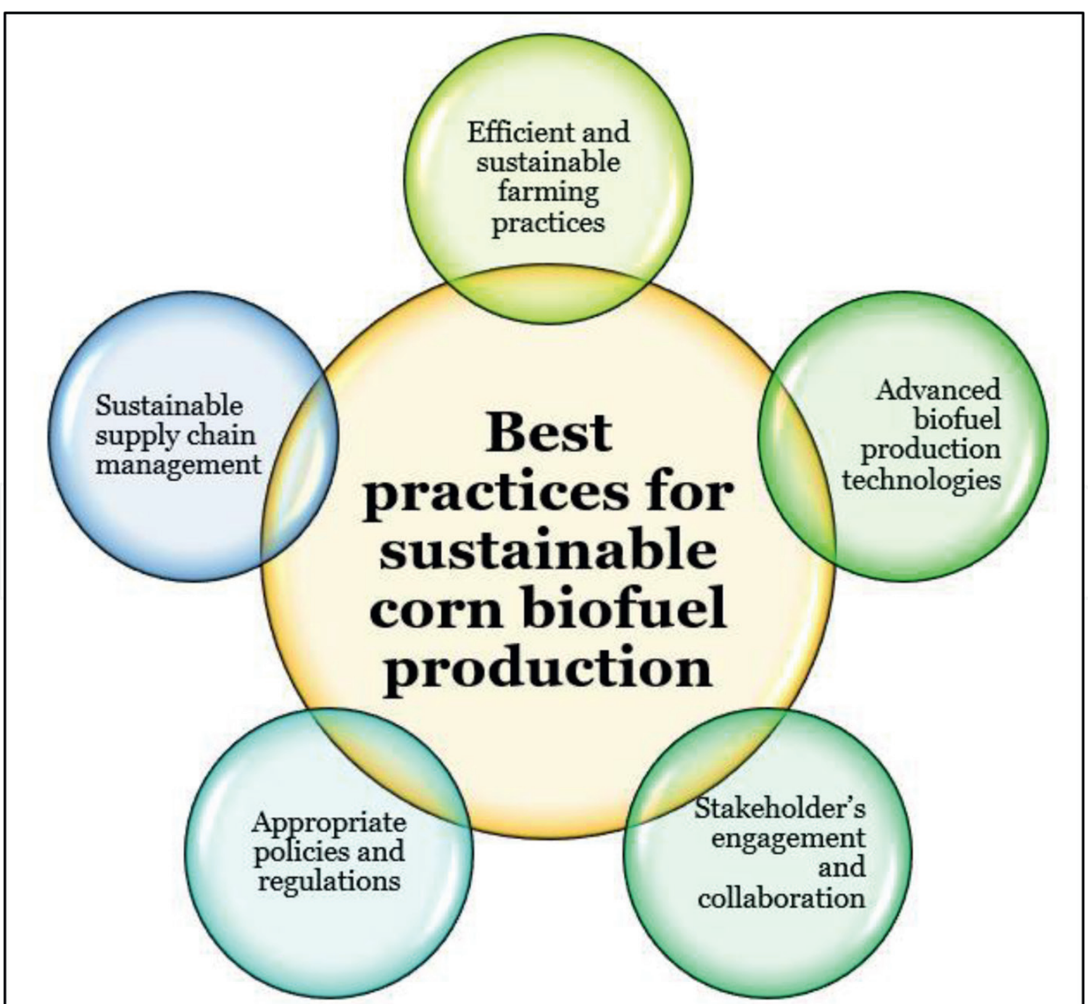

Figure 4.
Best practices for sustainable corn biofuel production.

3.3.3 Sustainable supply chain management

The implementation of sustainable supply chain management practices can ensure that corn-based biofuels are produced and transported in an environmentally and socially responsible manner [40]. This includes the use of sustainable transport modes and the implementation of social and environmental impact assessments throughout the supply chain.

3.3.4 Appropriate policies and regulations

The government policies and regulations that promote sustainable biofuel production should be put in place including incentives for sustainable farming practices, support for the development of advanced biofuel technologies, and regulations that ensure that corn-based biofuels are produced in a sustainable manner [41, 42].

3.3.5 Stakeholder's engagement and collaboration

These are quite essential for promoting sustainable corn-based biofuel production encompassing engaging with all stakeholders including farmers, industry, civil society, and government agencies to promote sustainable biofuel production practices, and to ensure that the concerns of all stakeholders are taken into account [43].

The sustainable production of biofuels requires the adoption of best practices that reduce the negative environmental, social, and economic impacts of biofuel production. By adopting these practices, corn-based biofuels can play a significant role in meeting the growing demand for sustainable energy production.

3.4 Potential benefits and drawbacks of corn-based biofuels

Corn-based biofuels are an increasingly popular alternative to fossil fuels since there are numerous potential benefits associated with the production and use of corn-based biofuels, there are also several drawbacks that must be considered. One of the main benefits of corn-based biofuels is that they can be produced domestically, reducing dependence on foreign oil [44]. Additionally, the production of biofuels creates jobs and provides new revenue streams for farmers [45]. Furthermore, biofuels have the potential to reduce GHG emissions, which can help to mitigate the impacts of climate change [46].

Despite the significant prospects, there are several drawbacks associated with its production and use. One major drawback is that they are often criticized for being less energy efficient than fossil fuels, requiring more energy to produce than they provide in return. This is due to the energy-intensive nature of the production process, which includes planting, harvesting, and processing the corn into biofuel [47]. Also, they compete with food production for land and resources, which can drive up food prices and contribute to food insecurity in developing countries [48]. Furthermore, the expansion of corn biofuel production has been linked to the destruction of natural habitats, such as forests and wetlands, which can have negative impacts on biodiversity [49]. As with any alternative energy source, it is important to carefully weigh the potential benefits and drawbacks before investing in and promoting corn-based biofuel production.

4. Implications of corn-based biofuels

The implications of corn-based biofuel are multifaceted and require careful consideration. While it offers the potential to reduce reliance on fossil fuels and mitigate climate change, there are several notable impacts to consider which are explained as follows.

4.1 Environmental implications

Corn-based biofuels have gained popularity as a renewable alternative to fossil fuels, but their environmental impacts must be carefully considered. The key environmental consideration will be as follow [50].

4.1.1 Loss of biodiversity

The key environmental concern associated with corn-based biofuels is the potential for habitat destruction and biodiversity loss through the conversion of natural habitats to agricultural land for corn production.

4.1.2 Environmental pollution

The use of fertilizers and pesticides in corn production can pollute waterways and harm aquatic ecosystems.

4.1.3 Increased water use

Corn production requires significant amounts of water, and the production of biofuels requires even more water due to the processing and conversion of the corn into fuel. This can exacerbate water scarcity in regions where water resources are already limited [51].

4.1.4 Soil degradation and erosion

The high demand for corn production can lead to intensive farming practices that strip the soil of nutrients and increase the risk of erosion. Soil erosion can contribute to land degradation, loss of agricultural productivity, and increased sedimentation in waterways.

4.1.5 Impact on climate change

While biofuels are often promoted as a way to reduce GHG emissions, the production process itself can be energy-intensive and result in emissions from fertilizer production, transportation, and processing while the life cycle analysis will be taken into consideration [52].

These impacts must be carefully considered when evaluating the viability of corn-based biofuels as a renewable energy source.

4.2 Economic implications

Corn-based biofuels can have both positive and negative economic impacts. Demand for corn as a feedstock for biofuel production can spur growth in the agricultural sector and create jobs in farming, processing, and transportation. In addition, the growth of the biofuels industry can create new employment opportunities in biofuels production and distribution [53]. Additionally, by producing biofuels domestically, countries can reduce their dependence on foreign oil and increase their energy security, while maintaining foreign exchange reserves for other development purposes in the country [41].

However, there are also potential economic drawbacks to consider. Corn biofuel production can contribute to food price volatility and competition with food production for resources. The more corn used for biofuel production, the higher the price of corn as food may be, affecting food prices and food security [48]. In addition, corn-based biofuels can be expensive to produce and use compared to fossil fuels. The production process requires significant energy inputs, and the infrastructure needed to produce and distribute biofuels can be costly [47]. These costs can be passed on to consumers, which can make biofuels less competitive with fossil fuels.

4.3 Social implications

The most imperative social influence is the creation of new jobs at the biofuel processing plant, particularly in rural areas where corn is typically grown which in turn will increase the living standard of the people of those areas. The expansion of the biofuels industry can also spur economic development in these areas and lead to improved infrastructure and services of those communities [54]. In addition, it can also provide environmental benefits by improving air quality, which in turn can have a positive impact on the health of communities near biofuel production facilities [46].

Apart from this, the biofuel production may also lead to land use changes and biodiversity impacts, which can negatively affect local ecosystems and wildlife. Additionally, the benefits of corn-based biofuels may not be evenly distributed across society [49]. For example, the economic benefits may accrue primarily to large agribusinesses, while the negative impacts, such as land use change and biodiversity degradation, may disproportionately affect indigenous communities or marginalized groups. Also, the increasing demand for corn as a feedstock for biofuels may lead to changes in land use practices that impact marginalized communities, potentially leading to displacement of smallholder farmers and land tenure issues [55].

4.4 Policy implications

Corn-based biofuels have gained increasing attention in recent years as a potential solution to reducing GHG emissions and increasing energy security. However, there are several policy implications associated with the production and use of corn-based biofuels. One of the main policy implications is related to the use of government subsidies to support the production of corn-based biofuels. Many governments provide subsidies or tax incentives to encourage the production of biofuels, including corn-based ethanol [56]. However, there is ongoing debate about the effectiveness of these subsidies and their impact on food prices, the environment, and energy security. The use of corn for biofuel production can compete with the production of food crops, leading to potential food price increases and shortages in some areas. Therefore, many governments have implemented policies to limit the amount of corn that can be used for biofuel production, or to encourage the use of non-food crops or agricultural residues as feedstocks. Many governments have implemented sustainability standards and certification schemes to ensure that biofuels are produced in an environmentally and socially responsible manner [42] and in turn aim to promote the use of sustainable practices and avoid negative impacts on land use, biodiversity, and water resources.

The production and trade of biofuels can have significant economic impacts, particularly for countries that are heavily dependent on biofuel exports. Therefore, many governments have implemented trade policies and regulations to manage the international trade of biofuels and ensure fair competition [41].

Another important policy consideration is the likely impact of corn-based biofuels on environmental quality viz., air and water quality. The production and use of biofuels can lead to increased emissions of air pollutants, particularly during the cultivation and processing of feedstocks. Additionally, the production and use of biofuels can have significant water requirements, which can lead to competition with other water users and potential impacts on water quality and availability. Some studies have suggested that the life-cycle emissions of corn-based ethanol may be higher than those of gasoline, particularly when indirect land use changes are considered [57–59]. As a result, there is ongoing debate about the role of corn-based biofuels in meeting climate change goals, and the potential need for alternative biofuel feedstocks and technologies.

Hence, it is imperative to note that the policy implications of corn-based biofuels are complex and interrelated. Policies aimed at promoting the production and use of biofuels may have unintended consequences, particularly if they are not designed and implemented in a coordinated and integrated manner. Therefore, it is essential for policymakers to take a comprehensive and holistic approach to the development of biofuel policies, considering the economic, social, environmental, and technical aspects of biofuel production and use.

5. Conclusions

Corn-based biofuels have played an important role in diversifying the energy mix, reducing GHG emissions, and promoting energy security. Extensive breeding and agronomic research, as well as efforts to expand cultivation, have led to improvements in corn-based biofuel production practices, making them a viable and sustainable option. However, it is important to consider the implications of a heavy reliance on corn for biofuel production. Increased demand for corn as a feedstock can lead to higher prices and potential conflicts with food production. Therefore, it is critical to find a balance between biofuel production and food security to ensure that enough food is available for a growing world population. In addition, the study of corn for biofuels underscores the need for continued innovation and research into alternative feedstocks and advanced technologies. This approach would not only address the potential drawbacks of corn-based biofuels, but also expand the range of sustainable options available. Overall, significant progress has been made in the use of corn as a biofuel, but it is important to take a comprehensive and balanced approach that considers environmental, social, and economic factors. In this way, we can maximize the benefits of corn-based biofuels while minimizing the negative impacts and paving the way for a greener and more sustainable energy future.

Conflict of interest

The authors declare no conflict of interest.

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