

# Status of Biofuels Usage in Ethiopia and their Implications on the Environment: A Systematic Review

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## Abstract

*This paper examines the current status of biofuels usage in Ethiopia and the implications of their adoption on the environment. Biofuels, derived from renewable biomass sources, have gained attention as an alternative to fossil fuels, aiming to reduce greenhouse gas emissions and promote energy security. Firstly, the paper introduces the concept of biofuels and their potential benefits in mitigating climate change and enhancing energy sustainability. It discusses the different types of biofuels, including bioethanol and biodiesel, and their production processes, highlighting their renewable nature and potential to reduce carbon emissions. The paper examines the current policies, regulations, and incentives in place to promote biofuel production and consumption, emphasizing the government's commitment to utilizing biofuels as part of its energy diversification strategy. Furthermore, the paper assesses the environmental implications of biofuels usage in Ethiopia. It examines the impact of biofuel production on land use, deforestation, and biodiversity, considering the potential conflicts between biofuel feedstock production and food security. The paper further discusses the technological advancements, research, and development efforts in biofuels production and utilization in Ethiopia. Finally, the paper concludes by providing insights into the future prospects and recommendations for biofuels usage in Ethiopia. It emphasizes the importance of comprehensive and integrated approaches that consider environmental, social, and economic factors in biofuel development and implementation. The paper underscores the need for further research, stakeholder engagement, and policy adjustments to ensure the sustainable and responsible utilization of biofuels in Ethiopia. In summary, this seminar paper provides a comprehensive analysis of the status of biofuels usage in Ethiopia and their implications on the environment.*

**Keywords:** Bioenergy, Environment, Renewable Energy, Soil Degradation.

## 1. Introduction

### 1.1. Definition of Biofuels and their Importance in Energy Production

According to biofuel is any fuel made from organic materials or their processing and conversion derivatives, moreover biofuels are materials that can be converted into liquid fuels for use in heating or transportation [1]. According to agricultural products such as starchy and cereal crops like sugarcane, corn, beets, wheat, and sorghum are used to make bioethanol in addition to oil- or tree-seeds such as rapeseed, sunflower, soya, palm, coconut, or jatropha are used to make biodiesel [2,3]. According to any fuel which can be solid, gaseous, or liquid as well as is derived from biomass, mostly of agricultural origin, is commonly referred to as a biofuel and biofuel is a combustible fuel made from newly generated biomass as opposed to old biomass, which is the source of petroleum products. The term "biofuel" typically refers to liquid fuels that are used in addition to or

in instead of petroleum-based liquid fuel. Although the terms "bioenergy" and "biofuel" have been used interchangeably, the phrase "bioenergy" is more frequently used to refer to any energy source made from recently created biomass, including food, fiber, wood, grasses, crop residues, even industrial and municipal trash[4,5]. Nevertheless, the two most popular biofuel kinds are biodiesel and ethanol.

As clean and renewable fuels that can be used in any direct-injection engine without having to modify the current technology, biodiesel products have the potential to be reliable replacements for fossil fuels. The term "bioethanol" (also known as "ethyl alcohol," "grain alcohol," "CH<sub>3</sub>-CH<sub>2</sub>-OH," or "ETOH") refers to a liquid biofuel that can be made using a variety of biomass feedstock's and conversion processes. Because bioethanol is an oxygenated alternative fuel that is made from renewable bio-based resources, it has the potential to lower particle emissions

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from compression-ignition engines Using starches, sugars, and cellulosic biomass, bioethanol is a renewable alcohol based fuel that may be created [6].

According to the widespread attention that biofuels are receiving now has a number of underlying reasons. It is asserted that biofuels offer a "triple solution" to the issues of poverty, climate change, and energy security [7]. Biofuels are better to other petroleum fuels that are harmful since they arguably emit fewer greenhouse gases They also offer a replacement for fossil fuels, whose prices are rising quickly, and they facilitate the creation of rural jobs on the production side. Additionally, biofuels increase energy security, lowers reliance on imported oil, and boosts domestic supplies.

The fastest growing sector in terms of greenhouse gas (GHG) emissions has been the transportation industry As 96.3% of all transportation fuels in 2018 fossil fuels are extensively reliant on in this industry and 15% of the world's pollution is caused by transport, 23% of all CO<sub>2</sub> emissions connected to energy come from GHGs Biofuels are widely considered to be potential alternative transportation fuels that can help reduce reliance on petroleum based fuels and combat climate change. Although, diversifying energy sources, reducing reliance on imported fossil fuels, and lowering greenhouse gas (GHG) emissions are only a few of the benefits of producing biofuels, according to [8-10].

New technologies for exploiting biomass for biofuels have been developed in tandem with rising fossil fuel prices, which could lead to the development of successful biofuels industries in underdeveloped nations The desire to produce biofuels has increased, and they are now receiving a lot of attention as the ideal fossil fuel replacement, particularly in the transportation and power generating sectors Consequently, as a result of their due to their environmental recognition and the extent of their benefits, biodiesel and ethanol are regarded as suitable substitutes for traditional diesel and gasoline fuels.

According to traditional biofuel energy sources are significantly used in Ethiopia's energy sector [11]. With a share of 89% of Ethiopia's overall energy output in 2018, solid biomass is the country's main energy source. The distribution of biomass across the nation is uneven, with low biomass cover in the eastern lowlands and the northern highlands. Charcoal, crop by products, and cow dung are the main sources of the biomass-based fuels [12]. Most economic sectors in Ethiopia use biomass, which accounts for 416 TWh (terawatt hours) of the country's total primary energy consumption There are thought to be 74 million tonnes of biomass used annually in the country [13-16]. However, this has led to the country's forest resources being depleted, which in turn has caused desertification, sporadic droughts, and increasing greenhouse gas emissions. Ethiopia's disproportionate reliance on biomass fuel and the meagre amount of energy used in the country's manufacturing, utility, and commercial sectors of the economy are both stark examples of the country's energy poverty [17,18]. Ethanol can be produced in most of the integrated distilleries in the sugar factories of the country and the country has recently started to use blended bio-ethanol for city vehicle fuel consumption [19]. However, bio-ethanol can also be used for household fuel

consumption. Ethiopia's national energy policy acknowledges the need for alternative renewable energy and focuses primarily on its distribution in order to improve the nation's ability to produce energy and to lessen the exploitation of unsustainable biomass resource use [20]. Biogas, briquetted fuels, biodiesel, and bioethanol are some of the alternative renewable energy sources that have been identified [21]. Hence present paper aims at reviewing the status of biofuels usage in Ethiopia and their implications on the environment.

## 1.2 Objectives for the Review

- To provide an overview of biofuels usage in Ethiopia and their role in the country's energy mix.
- To examine the environmental implications of biofuels production and usage in Ethiopia, including land use change, water use, and greenhouse gas emissions.
- To identify opportunities and challenges for expanding biofuels production and usage in Ethiopia in a sustainable and socially responsible manner.
- To explore mitigation and adaptation strategies to address the environmental impacts of biofuels production and usage in Ethiopia.

## 1.3 Overview of the Review paper

### 1.3.1. Overview of Biofuels Usage in Ethiopia and their Role in the Country's Energy Mix

Particularly in sub-Saharan African countries like Ethiopia, biomass is regarded as the foundation of energy sources in developing nations [22]. Biomass is a renewable resource that is widely used for a variety of tasks, mostly for cooking and lighting. Biomass resources include woody biomass, crop residue, animal waste, dung, sewage, agricultural, and municipal wastes. Woody biomass includes cellulose, hemicelluloses, lignin, lipids, proteins, and simple sugars. Wood, agricultural waste, urban and industrial trash, and animal waste make up Ethiopia's biomass energy resources. According to it is anticipated that 153.4 million tons of energy can be obtained from bioenergy resources each year. According to Figure 1 the woody biomass is projected to be 73% (wood 69% and charcoal 4%), followed by animal manure (14%), and 13% by residue. The majority of rural culture relies on freely gathered woody biomass, crop byproducts, animal excrement and consumption outpaces replanting; therefore utilization is still out of balance [23].

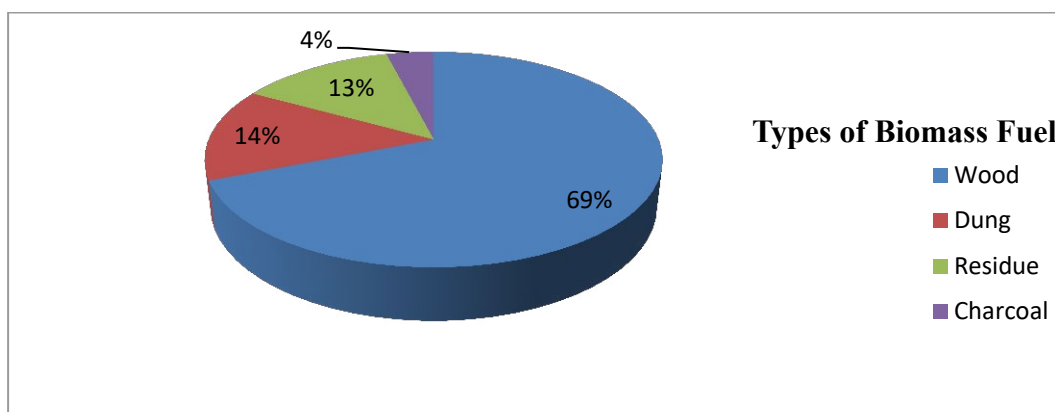
Ethiopia has a promising potential for the establishment of biofuels in Africa, which has established Africa as one of the real expansion zones for the growth of biofuel feedstock [24-26]. Up to 60 Peta-joules (PJ) equivalent to 1.7 billion liters of bio-jet fuel could be produced from sugarcane in Ethiopia [27]. About 30% of the land has been designated as being practically accessible for uses other than food-based plant growth and ecological preventions and there is about 25 x 10<sup>6</sup> hectares of accessible area with ideal environmental conditions for the creation of biofuels [28]. Only 7 x 10<sup>5</sup> hectares of land are acknowledged as appropriate for sugar cane farming. In addition, other biomasses and oil-bearing seeds, such as castor bean, jatropha, cassava, and croton are also considered for potential biofuel plantations [29].

As Ethiopia oversees a biofuel development strategy where renewable and substantially cleaner alternatives to traditional energy sources are taken into account as GTP-I and GTP-II, which are the country's national growth and transformation programmes. On its GTP, the Climate-Resilient Green Economy (CRGE) strategy was also introduced in 2011 in which strategy aims to raise the nation's economy to middle-income status by 2025 [30]. Reducing GHG emissions from transportation fuel is one of the pillars of the CRGE strategy. To do this, biodiesel, largely made from jatropha, and bioethanol, primarily made from sugarcane molasses, are produced. Biofuel manufacture using environmentally friendly renewable raw resources for biofuels is a crucial necessity. By 2030, 5% biodiesel and 15% ethanol will be blended with regular gasoline and diesel, respectively, for use as transportation fuels, according to the CRGE strategy.

According to Biofuels are seen as a chance to guarantee domestic energy security, spur rapid economic growth, and create riches. [31] High hopes exist that biofuels will aid in resolving the nation's current major development problems. Almost all of the raw materials (sugarcane, sugarbeet, cereals, and maize) required to make bioethanol are farmed in Ethiopia. Due to governmental laws that restrict using food crops as feedstock for reasons related to food security, the current production of bioethanol is only a byproduct from sugar plantations. In order to increase agricultural development and agro-processing, job

creation, export revenue, and import substitution of petroleum goods, ethanol production in Ethiopia is linked to sugar mills. A different 5% and 10% ethanol blend has been made available in the nation's capital city, but just a small portion of the potentials are now being used. Furthermore, Fincha and Metehara are the only sugar mills in the nation producing bioethanol. A total of 20.5 million liters of ethanol were used in the country's transportation sector in 2014–15, of which 8 million liters came from the Fincha sugar factory and 12.5 million liters from the Metahara sugar factory [32-34].

There are biofuel businesses operating in several parts of Ethiopia, with a focus on producing bioethanol and biodiesel. Ethiopia also set a goal for a 5% bioethanol blend in car fuel in 2008, which was increased to 10% a few years later. According to official accounts, by combining more the country has the possibility to save \$30.9 million on oil imports since 2008 rather than 38.2 million litres of bioethanol mixed with petrol. Although the recently released Climate Resilient Green Economy strategy calls for 5% biodiesel to be blended into transportation fuel by 2030 the practice has not yet started in the nation. Ethiopia plans to manufacture 181,604 cubic meters of bioethanol from sugar by-products (from molasses) by the conclusion of the GTP period 2010/11-2014/15, in addition to the large-scale development of the sugar industry that is planned and outlined in the national Growth and Transformation Plan (GTP).



**Figure 1:** The share of different Biomass Resources as Fuel in Ethiopia

**Source:** Edited

### 3.1. Status of Biofuels Usage in Ethiopia

As Ethiopia is one of the African countries with the greatest potential for biofuel production, and the government has suggested converting around 23.2 million hectares of "marginal" land for the production of biofuel feedstock, primarily *Jatropha curcas*. A biofuel strategy was also released by the government in 2007 to encourage domestic biofuel development in order to lessen reliance on expensive fossil fuels. The strategy, which was created by the Mines and Energy Ministry, was devised at a time when there was increased interest in biofuels on a global scale as a result of historically high petroleum prices.

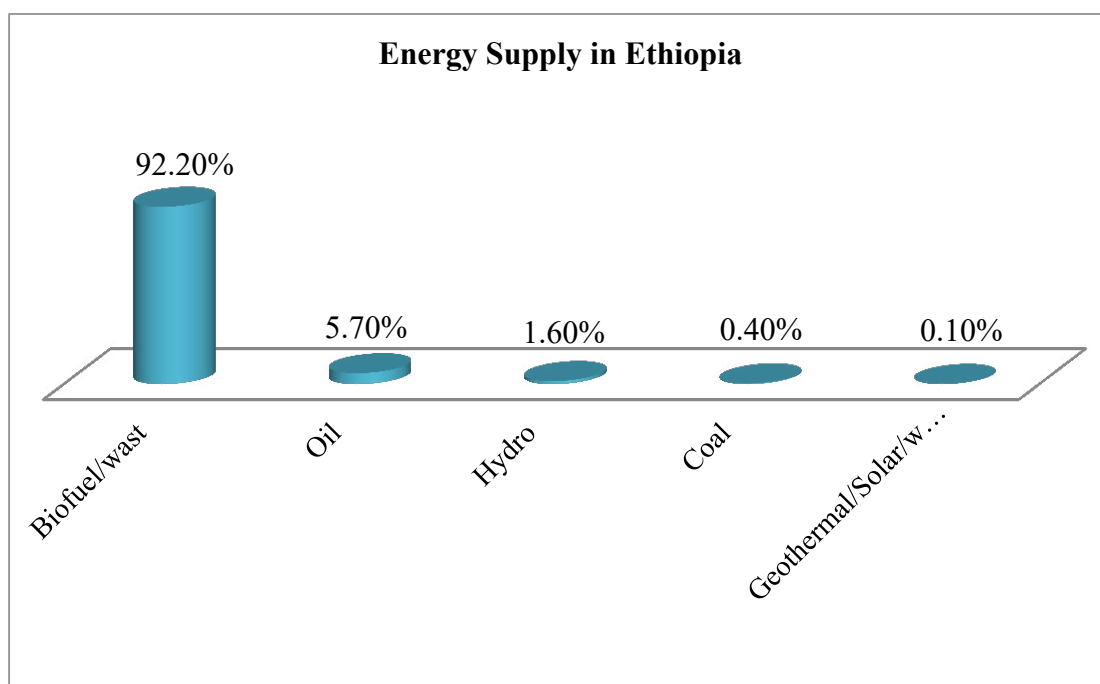
As stated by the 2007 strategy addressed a lot of the issues that are crucial for the sustainable growth of biofuels. The method, however, still left out a number of crucial components. The

Environmental Impact Assessment was not mentioned in the strategy as a process that is required for all new and expanding biofuel projects. Additionally, it said that less fertile, marginal, or degraded lands should be used for the growth of energy crops needed to make biodiesel, but it omitted to define what "marginal land" entails, leaving the procedure for estimating the amount of land that is accessible unclear. The strategy lacked any benchmarks for measuring its success against certain cross-sectoral activities and deadlines because it did not set any goals for obtaining a specific market penetration level or time period. Following the creation of the national biofuel plan, several biofuel investment operations with an emphasis on bioethanol and biodiesel have been carried out in various regions of Ethiopia.

According to in Ethiopia, the fourth pillar of the CRGE strategy includes actions to produce biodiesel and ethanol as well as to decarbonize transportation fuel. By 2030, it is intended to replace 0.28 billion L of diesel and 0.09 billion L of petrol with blends of 5% biodiesel and 15% ethanol. The Biodiesel is predicted to have a CO<sub>2</sub> abatement potential of 0.7 megatons (Mt), whereas ethanol is predicted to have a CO<sub>2</sub> abatement potential of 0.2 Mt. The Ethiopian government hopes to raise its yearly biodiesel production to 1.6 million L, with the expectation that this will bring in USD one billion Jatropha, castor, and palm oil are the favored feedstocks for making biodiesel in Ethiopia, but sugarcane is the main source of ethanol Even while government-owned sugar plants have been making ethanol from molasses for over 30 years and transportation-related blending and distribution activities just started in 2009 Contrarily, initiatives to generate biodiesel didn't start until 2005, when private investors helped, and they received more backing in 2007 with the publication of Ethiopia's "Biofuel Development and Utilizations Strategy"

The Ministry of Water and Energy is now carrying out a

baseline, suitability, and value chain study on Ethiopia's growth of biofuels in order to more precisely map the accessible and suitable area, as describes. Furthermore, estimates of the present land area planted with Jatropha vary widely and the precise size of Ethiopia's biofuel feedstock plantations is unknown. A certain amount of skepticism should therefore be applied when reading data on available and suitable land as well as ongoing investments Like many other African nations, Ethiopia has a high reliance on home energy generated from biomass. Based on the primary energy supply is dominated by waste and biomass, which account for up to 92.2% of the total and Oil (5.7%), hydropower (1.6%), coal (0.40%), and geothermal (0.10%) are the next greatest sources of energy (Figure 2). Nevertheless, compared to the urban region, which has a connection to power at a rate of 92%, the rural area suffers from a lack of access to electricity with a rate of 32% coverage. In Ethiopia, 55.2% of the population lacks access to basic services in 2019 to electricity The GoE aims to increase nationwide energy availability from 45% in 2018 to 100% by 2030, with an annual increase in access of 1.7% from 2010 to 2019



**Figure 2:** Share of total energy supply in Ethiopia

Source: MoWE, 2021

### 3.2. Implications of Biofuels Usage on the Environment

#### 3.2.1 Importance of Studying the Implications of Biofuels Usage on the Environment

According to in underdeveloped nations, the effects of biofuel projects on the environment have not been studied. There are few empirical studies that take into account the synergy and complementing effects of biofuel production on environmental changes in Ethiopia, despite the expectation that biofuels may have a lesser environmental impact than fossil fuels. This highlights the following two crucial questions that must be investigated in order to understand the effects of using biofuels on the environment; (a) how do the manufacturing of biofuel affect the environment? (b) How much will the production of biofuels have an impact on GHG emissions? Though, these needs

are noted if we study the case of biofuels usage and its effects at preliminary stages like when farming activities are relocated due to fresh forest clearing brought on by biofuel production moving to croplands or pastures .

Although there is debate about this assertion, it is emphasized that the use of biofuels has a lower environmental impact than the use of fossil fuels since they are projected to emit fewer greenhouse gases into the atmosphere. It's important to keep in mind that developing countries like Ethiopia follow different feedstock-biofuel (bioenergy) pathways and that the type of ethanol production pathway used significantly affects the total environmental impact of biofuels According to diversifying the country's energy supply is important for achieving energy

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security while also lowering exposure to price volatility on the global oil markets. The plan explains how the nation will develop with the goal to preserve its meager foreign exchange reserves through the creation of jobs, rural development, and foreign exchange revenues.

According to Ethiopia's investment in biofuels is strongly tied to the desire to find alternative fuel sources in order to lessen the burden on foreign exchange associated with the import of petroleum. Three crucial areas are outlined in the nation's biofuel sector development strategy and aiming for both domestic and international markets that was important to study about the biofuels usage on environments in Ethiopia even includes

- (1) allocating land that is marginal and mostly unsuitable for conventional farming;
- (2) encouraging the participation of small-scale farmers through contract or out-growers schemes whenever possible; and
- (3) promoting the engagement of such farmers.

Regarding the long-term viability of the environment, the economy and society, biofuels have both benefits and drawbacks. On the one hand, the biggest global drivers of biofuels are the reduction of GHG emissions, energy security, and rural development. Alternatively, there concerns about the increased production of biofuels include pressure on food prices, the possibility of an increase in GHG emissions due to direct and indirect land-use change (LUC) from the production of biofuel feedstock's, as well as the dangers of ecosystem depletion. From an environmental standpoint, the production of biofuels may have serious negative effects on the environment, including the use of large amounts of water, the use of arable land that could have been used for crop farming, the destruction of forests, the loss of the ecosystem and biodiversity, and changes to the structure and fertility of the soil. In addition, a lot of the feedstock's used in the manufacture of biofuels need good agricultural land and can only provide high levels of biofuel by using water, pesticides, and fertilizers

According to the amount of land utilized for the production of biofuels depends on the environmental conditions in the area's ability to support crop yield as well as the need for the area's inhabitants to have enough food produced on the land. The land supply is being reduced to create room. Large-scale forest clearing or an increase in the intensity of agricultural activities may have an impact on the local landscape in regions where biofuel crops are grown. Increased biofuel production may also need the conversion of uncultivated land, which would result in carbon emissions, threats to biodiversity, and possibly increased fertilizer and pesticide use. Key factors causing deforestation are listed in a various investigation as follows; annual permitted cut, as opposed to other variables like population increase and off-farm work options, would have a bigger impact on the deforestation rate. This suggests that it would take more time to balance the carbon produced if uncultivated lands were destroyed to create feedstock .

Based on the literature of the perception that biofuels are more-friendly to the environment than oil is one of the main justifications for support and the carbon neutrality and absence of fossil fuels are sometimes even asserted for biofuels. But there have been some very valid concerns expressed in on the

carbon advantages of existing biofuels. As a matter of fact, fossil fuel derived energy is heavily consumed by biofuels. By the time the biofuel is finally used, there will have been a significant net carbon addition to the atmosphere. Production inputs include tillage, fertilisers, pesticides, irrigation, use of equipment for harvesting and transport, use of steam and energy for processing, etc. Equally important is the fact that the creation of biofuels has additional, non-climate-related environmental implications, such as biodiversity loss and habitat loss owing to changes in land use, soil erosion brought on by tilling, eutrophication brought on by fertiliser runoffs, effects of pesticide exposure, etc. which have not received the same attention as GHG emissions.

Even though, impacts like the release of GHGs and other atmospheric pollutants, increased water use, water pollution, soil erosion, deforestation, loss of biodiversity, creation of money and jobs, energy and food security, human health, and social conflicts. The feedstock, the environmental and socioeconomic context of biofuel production, and the policy instruments in place throughout biofuel production, usage, and trade are only a few of the variables that determine whether these consequences are good or negative, as well as their size. Based on a variety of empirical facts, the use of biofuels types has both beneficial and negative consequences on the environment, as shown in the list below:

**Land usage:** Land use practices for the cultivation of feedstocks can have serious negative effects on the environment and biodiversity, which can be a problematic stage of the entire development of bioethanol.

**Agrochemical use:** According to excessive and incorrect use of pesticides and fertilizers may also have a harmful influence on the environment.

**Water use:** the manufacturing of bioethanol requires a substantial amount of water for the cultivation of the feedstock's. Important environmental challenges, in addition to quantity, include water contamination and the effects of released wash water on pollution.

### 3.3 Opportunities and Challenges for Expanding Biofuels Production and Usage in Ethiopia

According to Fossil fuels have come under fire and are becoming more expensive, which has increased interest in alternative energy sources, especially biodiesel and bioethanol, as a way to address economic, environmental, and social issues. Ethiopia is regarded as one of Africa's best suited nations for the use of renewable energy sources, including biodiesel, because of its geographic location and ideal climatic circumstances. Ethiopia's biofuels industry has the potential to greatly enhance by diversified revenue sources, rural food security can be achieved. In addition to its positive effects on the economy, biodiesel production has a big impact on lowering GHG emissions and accelerating the switch to clean energy. When combined with additional strategies for green growth like increasing the use of hybrid and plug in electric vehicles and blending biodiesel with diesel, the potential for the transport industry to reduce CO<sub>2</sub> emissions is almost 1.0 Mt CO<sub>2</sub>e. Kerosene, which is largely used for cooking in urban areas and for illumination in rural

areas due to a lack of power, has been replaced by biofuels that have been blended for use as transportation fuels.

The strain on Ethiopia's balance of payments has increased significantly as a result of its high import costs for petrol. Consider the 3.3 million tons of oil that Ethiopian Petroleum Supply Enterprise (EPSE) purchased in 2017 for USD 1.37 billion. The amount of imports is 10% higher than the total from the prior year, but the expenditure is 248 million USD higher than it was last year, and it is still rising as shown in table 1. Because it is increasing over time, this hurts the cost balance. To move away from imported oil fuels and towards domestically produced biofuels, Ethiopia has been reviewing its energy policies in reaction to the rise in oil prices and partially in response to climatic fluctuations.

As stated by because of the perceived economic and environmental benefits, the government has prioritized the development of biofuels in Ethiopia, and there is a great deal of interest among investors to participate in the industry. However, if certain obstacles are not addressed, the development of biofuels in Ethiopia could fail to live up to expectations. Similar to many developing nations, Ethiopia may face challenges with its energy policy, educational system, unsteady economy, lack of core technology, and weak capacity building initiatives. These are just a few of the potential roadblocks that could slow down Ethiopia's biofuel development.

According to and Ethiopians looked to the production of biofuels as a solution to the problems of energy security and climate change. The performance of the industry, however, has not been promising and projects to create biofuels are being carried out, as was already mentioned, albeit at a slow pace. State-run sugarcane plantations and processing facilities are operating

in Ethiopia despite the significant financial requirements, even though this is typically the case for biofuel projects envisioned by private agribusiness enterprises. Private agribusinesses who bought land in Ethiopia for the production of biofuels typically experienced the following difficulties;

- Investors frequently lack a detailed business plan, annual activity schedule, or Environmental Impact Assessment (EIA) to direct biofuel development activities.
- Companies use or own farm equipment, and they employ a number of farm employees that is out of proportion to the amount of the available land.
- Companies haven't worked closely with local, regional, or federal government, and they hardly ever pay land rent fees. As a result, they can no longer count on getting as much support if they encounter certain challenges.
- There are frequently very shaky connections between businesses and the neighbourhood. Conflict ensued and operations were hampered because some of them failed to live up to expectations and keep the promises they made to the locals. For farms operating in rural areas, a fundamental challenge is the availability of both skilled and unskilled workforce.

Another barrier to the development of biofuel is the debate over whether food or fuel is more important. Unless a consensus is formed with the public and investors through conversations and awareness-raising activities to persuade the public about the benefits and drawbacks of the biofuel development goals, it could be one of the challenges to be faced. Utilizing non-edible biomass sources, though, can overwhelm it. Similar to the food vs. energy debate, the connection between biofuels and other environmental and economic repercussions such deforestation, biodiversity, water accessibility, energy security, food security, and loss of access to land also merit careful attention.

Aspects	Opportunities	Challenges
Cost	It is produced using renewable resources.	Diesel fuel is currently more expensive than fossil fuel.
Energy	The supply of fossil diesel fuel is constrained, but biofuels can be produced.	Manufactured primarily from edible oil, which could lead to food supply shortages and price increases.
Availability	Made from a variety of materials	Reduced fuel efficiency
GHG emission	Significantly lower emissions of hazardous carbon (CO <sub>2</sub> , CO, TCH)	Food supply disputes
Energy security	Production of first-generation biofuels is more difficult to scale up than that of fossil diesel. considerably greater lubricating qualities much lower carbon emissions than those using conventional diesel	Only diesel-powered engines can use it because it is less suitable for use in low temperatures. prone to luring moisture more so than fossil diesel
Air pollution	Significantly lower PM emissions	increased NO <sub>x</sub> levels

Source; (Datta, 2019)

**Table 1: Some Opportunities and Challenges of Biofuel Production and usage in Ethiopia in a Sustainable and Socially Responsible Manner**

#### 4. Mitigation and Adaptation Strategies

Governments frequently highlight climate change mitigation as a major policy objective for the growth of biomass fuels, but in the case of Ethiopia, the government is transparent about the justifications for its support of biofuels. The reasons include improving the balance of trade through import substitution and the creation of new export markets, as well as ensuring energy security by using biofuels .

stated that in the majority of Ethiopia, grazing land, agricultural land, forest, and bush land are the main types of land use. Biofuel plantation land is either acquired through forest clearing or by acquiring farmed land in accordance with the local farmers. The out-growers scheme and large-scale biofuel plantation options are available to different companies in Ethiopia. The consequences in terms of food hunger and environmental devastation will always be severe. In addition to biodiversity loss and land degradation brought on by inevitable soil erosion and increased runoff, destroying the forest and bush land would seriously harm the environment.

Based on report by lowering GHG emissions and local pollutants, biofuels are good for the environment. Bioethanol is water soluble, non-toxic, and biodegradable; it may substitute for 10% of the world's petrol without destroying more rain forests and with less environmental impact than conventional agriculture. As opposed to fossil fuels, which are made from long-dead biological materials, biofuels emit relatively little carbon dioxide. Hydrocarbon-based fuels, on the other hand, produce more harmful byproducts, such as carbon monoxide, while biofuels, on the other hand, produce compounds like nitrogen oxides. Thus, using biofuel to replace imported oil and petroleum and boost Ethiopia's economy has enormous potential to reduce global warming . The developments made by the bio fuel sector have resulted to environmental difficulties with regard to tree species, wildlife, degraded soil, watershed issues, etc. Afforestation and/or deforestation initiatives in the nearby degraded areas, agricultural boundaries, grazing and rangelands, and the retention of an acceptable tree density (i.e., 10 trees per hectare) are some of the mitigation measures given for the anticipated negative impacts. Crop residue management on farmland, rain-water collection systems, terracing, low tillage, and agroforestry adaptation are all proposed as viable mitigation techniques for the possible soil erosion caused by the project's intervention .

#### 5. Conclusions

A tremendous way to increase economic growth, food security, environmental sustainability, welfare, and alleviate poverty is to invest in biofuels. By reducing reliance on oil imports, the growth of biofuels also plays a critical role in stabilizing the macroeconomic environment for Ethiopia. This suggests that expanding biofuel investment on land that is not used by smallholders for cultivation is crucial to increasing the returns from biofuel investments. The process of finding potential land for biofuel development appears to have been rushed, and little attention was taken to allocate property that would be ideal for biofuel production while not in direct conflict with other environmental or food production goals. The government failed to create an institutional structure with good coordination

or give commercial biofuel producers the required support. Commercial investors were not assessed for their capacity or commitment. Several government agencies, including the Ministry of Agriculture, the Ministry of Water and Energy, the Ethiopian Investment Agency, the Ethiopia Sugar Corporation, and regional governments, were involved in the land allocation process, monitoring, and provision of policy support for investors engaged in biofuel development. In order to enhance the involvement of biofuel developers in generating and supplying biofuel feedstock's, processing, and distributing biofuel, it is also critical for the market for biofuel feedstock's and products to flourish. Though, the biofuel advancement policy needs to be evaluated and shall contain strategies based on an acquaintance of the present situations and future development targets taking its tradeoffs, land use design and economic benefits of biofuel compared to petroleum fuels into consideration. Ethiopian biofuel development is only possible if it is economically viable and all risks to its development are eliminated. So it is crucial to take into account best existing practices in related domains and include public opinion in decision-making in order to prevent undesirable outcomes. With regard to the good effects on the environment and the conservation of fossil fuel resources in Ethiopia's transportation sector, the results will generally assist decision-makers in making supportive decisions in the implementation of biofuel policy and the introduction of electric vehicles.

From the analysis in this review paper, the following Conclusions are made;

- The development of biofuels should be in line with SDGs efforts to reduce greenhouse gases and its underlying concepts.
- The productivity of agricultural land may be negatively impacted by the cultivation of biofuel crops like *Jatropha*, hence a thorough investigation of these crops is warranted.
- Modern energy services made possible by biofuel technology can result in more employment and income opportunities, technical development, a cleaner environment, energy security, and generally improved economic and social well-being for people in Ethiopia.

#### Conflict of Interest

The author declared no conflict of Interest.

#### Data Availability Statement

No data was used for the research described in the article.

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