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Biofuel Production versus Food Security in Kenya

Evaristus. M. Irandu[1,a] and Parita Shah[1]

[1]Department of Geography, Population and Environmental Studies, University of Nairobi, P. O. Box 30197, 00100 Nairobi

[a]emirandu@uonbi.ac.ke

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ABSTRACT

Biofuels are essential to fulfilling the United Nations Sustainable Development Goals, which place a strong emphasis on ensuring global food and energy security. It is critical to comprehend how managing natural resources, producing biofuels, and ensuring food security are related. A study of the literature suggests that food security may be impacted by the production of biofuels, but further research is needed. The development of biofuels has detrimental effects on the environment and other factors, but it benefits food security.

The purpose of the essay is to add to the existing discussion over Kenya's "biofuel or food security." This is due to the fact that more than 80% of people depend on agriculture, necessitating the need for innovation. Its primary goals are to: a) investigate how combining biofuel and food production can result in sustainable natural resource use; b) list the crops that should be grown to meet both food and energy needs; c) examine the financial incentives for pursuing biofuel energy technologies.

Using in-depth literature review and interviews with key informants, the paper adopts a qualitative research design. Ten Kenyan enterprises that produce biofuels were used as the key informants. The main finding is that food security and biofuel production are not mutually exclusive but rather complementing. It is recommended that policymakers offer appropriate incentives to increase investment in Kenya's biofuel energy generation.

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1. Introduction

“If you start to fuel cars with crops, you are instantly putting the world's billion starving people in competition with the world's one billion motorists. It's as simple as that”. Ed Mathews of Friends of the Earth (BBC, 2007)

With time and over space, global citizens have increased their interest in renewable energy. However, the challenge is in the transition from non-renewable to renewable energy. This has also been aggravated by concerns over climate change due to fossil fuel’s contribution to global warming. In the 21st Century, biofuels especially biodiesel and bioethanol are the most important sources of renewable energy. While the biofuels are categorized under renewable energy, their production has raised issues pertaining to sustainability. A major issue is that biofuels compete with food, indicating unsustainable competition for food and water. Another concern is biofuel production has led to massive deforestation and in turn habitat and biodiversity loss and increased carbon emissions [1].

According to the source of their production, biofuels are divided into three generations. They are divided into groups based on their biomass sources, limitations as sources of renewable energy, and level of technological development. First-generation biofuels are created from food crops like sugar cane, maize, and cassava. The production of biofuels using food crops is not sustainable. The second-generation biofuels are made from non-food crops such switch grass, castor, and jatropha, as well as crop, animal, and solid wastes. The third generation of biofuels uses algal biomass as a source of energy to create biodiesel. From the perspective of food security, the second and third generation biofuels are more viable because they do not result in food shortages while generating energy [2].

As the first-generation biofuel production uses food crops, it has led to the increase in global food and animal feed prices. It has also led to competition for agricultural land and there is not much greenhouse gas reduction when the first-generation crops are used. Moreover, it causes degradation of ecosystems, forests and even pollution and degradation of water due to use of pesticides and fertilizers and, worst, food shortages [2]. Biofuels are categorized into three generations based on where they are produced - according to their biomass sources, limitations as renewable energy sources, and level of technological advancement, they are categorized into several classes. Fuels and food crops from the second generation of biofuels are not in competition with one another. Second generation biofuels provide more energy per hectare than first generation biofuels. They can grow in adverse soil conditions and face minimal competition for suitable agricultural land. The only problem is that the processes needed to produce the biofuel, such as fermentation and distillation, are more costly than oil economically [3]. Commercial development of second- or third-generation biofuels is not possible [4].

During crisis when global fuel prices are high, both farmers and policy makers are put in a dilemma on what to prioritize – food crops or crops for biofuel. In comparison to the first-and second-generation biofuels, the third generation are more sustainable as they are obtained from algae and do not compete with terrestrial land resources. They are grown using saltwater from oceans or salt lakes, wastewater, and sewage. Moreover, there are studies ongoing on the use of algae as food crops but since it is still in research stage, there is little competition between food and algae use for biofuels [4].

The issues of global warming and climate change as well as control of fossil fuels by individual countries has made policy makers and the public realize to look for alternatives. The US, European Union and Brazil have advanced in biofuel expansion. In the late 2000s, countries like Canada, India and China also increased their biofuel production. Biofuels is a good alternative as many crops like camphor, grass and jatropha can have their value raised instead of merely being since as crops with limited value. Today the demand for biofuels is very high in the airline industry.

Famous airlines like British Airways and Lufthansa have been using this sustainable biofuel for their flights [4].
Under the Sustainable Development Goals (SDGs) of the United Nations, energy and food sectors have been prioritized. There is a very complex relationship between food, energy (biofuel production) and natural resources management interaction. This is because biofuels compete with food production as they are produced using crops. In this case, research indicates that biofuel production compromises food security. But one needs to do an analysis to reduce the conflict in this area and individual countries like Kenya need to take their own direction on whether to have crops for food or biofuels or balance both!

Competition for biofuels and food results in increased prices of food and if stakeholders' participation is missed out, hunger ropes in as concentration is on biofuel rather than satisfying people's main needs for survival. Observations based on this reality -right to food were made in 2007 by the then UN Special Rapporteur, Jean Ziegler who observed that when food was being converted to biofuels, food, water and land prices were skyrocketing [5]. This statement was supported by the World Bank President Robert Zoellick in 2008 when he expressed his concern on how biofuels were significantly contributing to increased global food prices [6; 7].

The challenge is that if land is diverted from food to produce biomass, then food prices will increase as both food and biomass compete for the same resource – land. The 'fuel or food security' debate is strong as a car tank of 50 litres is be filled with biofuel from 200 kilos maize in the developed world. This maize can feed a person for a whole year [8].

In Africa, food security is becoming a challenge as land is being leased to multinational companies who are growing biofuel crops are returns are profitable [9]. However, since the onset of the Covid-19 pandemic, biofuels production was hard-hit but due to the Russian-Ukraine war, biofuel production has peaked causing more of a food crisis especially in countries which depend on agriculture for its Gross National and Domestic Products.

Biofuels are a blessing in disguise. They help clean the environment whereby food waste from hotels and aircraft is being converted into biofuels. This is in line with the Conference of Parties (CoP) 26 of the United Nations Framework to Combat Climate Change and its obligation of sustainability as carbon emissions from the energy sector can be reduced this way.

In the rural areas of Africa, the communities have got a 'win-win' alternative for the development and use of biomass as a biofuel. This is an opportunity for boosting cleaner production, enhancing food security, adding value chain to agricultural waste, more employment opportunities, improving health and boosting a country's economy through rural development. As limited research has taken place on the impact of biofuel production and food security, this paper attempts to fill the gap by contributing to the debate on 'biofuel or food security' with reference to Kenya. The debate is crucial to Kenya's economy where over 70% of the rural population depend on agriculture. It is only innovation and value addition on the solution of agricultural waste which can enhance energy production. The main objectives are to: a) examine how integration of biofuel and food production can lead to sustainable natural resource management

b) identify the crops to be grown to cater for food and energy c) analyze the incentives for investing in biofuel energy technology.

The results of this study will aid in establishing policies that can balance food security and energy security in the nation by allowing policymakers to evaluate the consequences of biofuel production on food security and land use in Kenya.

2. Materials and Methods

The paper adopts a qualitative research design based on literature review, questionnaire survey and key informant interviews. For this study published documents on biofuel crops, their impacts on food security and the environment were used as key sources of literature.

Key informants from 10 companies producing biofuels were selected. These were expected to provide information on biofuel production, its impact on food security and the environment from key stakeholders' viewpoints. These companies highlighted possible challenges and barriers to biofuel production. A questionnaire survey was used on 42 respondents in the Parklands area of Nairobi where the respondents purchase farm produce from the local market, farms, and vegetable vendors. The respondents were selected using simple random sampling. A total of 19 respondents stated that they purchased their veges and fruits from the local City Market, 20 respondents bought their fresh foods from local vegetable vendors commonly known as 'mama mboga' and 3 respondents bought directly from farms. The respondents provided valuable information on households' awareness of biofuel crops and potential impacts of biofuel production. A larger sample size was not possible due to strict adherence to Covid-19 protocols.

3. Results and Discussion

The key findings based on literature review, questionnaire survey and key informant (KII) interviews are presented in this section. Some of the key findings consistent with the findings in other previous studies reviewed are highlighted.

3.1. Sustainable Development Goals for Energy and Food Security

The UN adopted 17 SDGs in 2015 to end poverty, stabilize the Planet to ensure that by 2030 there was economic prosperity and peace for all humans on Earth through natural resource management. As all SDGs are inter-related with each other, an achievement of one SDG leads to the benefit of the other SDGs.

While achieving food security, better nutrition can be obtained but at the same time the type of energy used to generate food is of utmost priority. This is because our modern food systems depend on fossil fuels and consume 30% of the world's energy which emits 20% of the GHG emissions. This indicates that food production needs to come from clean energy thus reducing climate change impacts and maintaining food security. Food waste is also used to produce bioenergy and there is less emission of GHG. To achieve energy-smart food systems, institutions, stakeholder participation, e domestication and application of policy and legal frameworks, and action on the ground are needed [10].

3.2. Biofuel Production and Food Security: Global Perspective

According to Henry Ford (1925), one year's yield of potatoes produced enough alcohol for machinery usage for hundred years to cultivate the field. This indicates that history has indicated that sufficient energy can be produced from food crops, and at a cheaper price which can be affordable by all. We need to move towards a sustainable strategy on renewable fuels as the world's supply and demand has been dominated by fossil fuels since the industrial revolution and its demand since the year 2000 has been increasing as developing countries are heavily relying on them for development. These fuels are natural gas, coal, and oil. Research has indicated that since 2000, the supply of coal has increased by 66%, natural gas by 50%, oil by 22% and renewables have also been growing fast and have increased by 48%. In 2008, biofuels catered for over 75% of the global renewable energy [11].

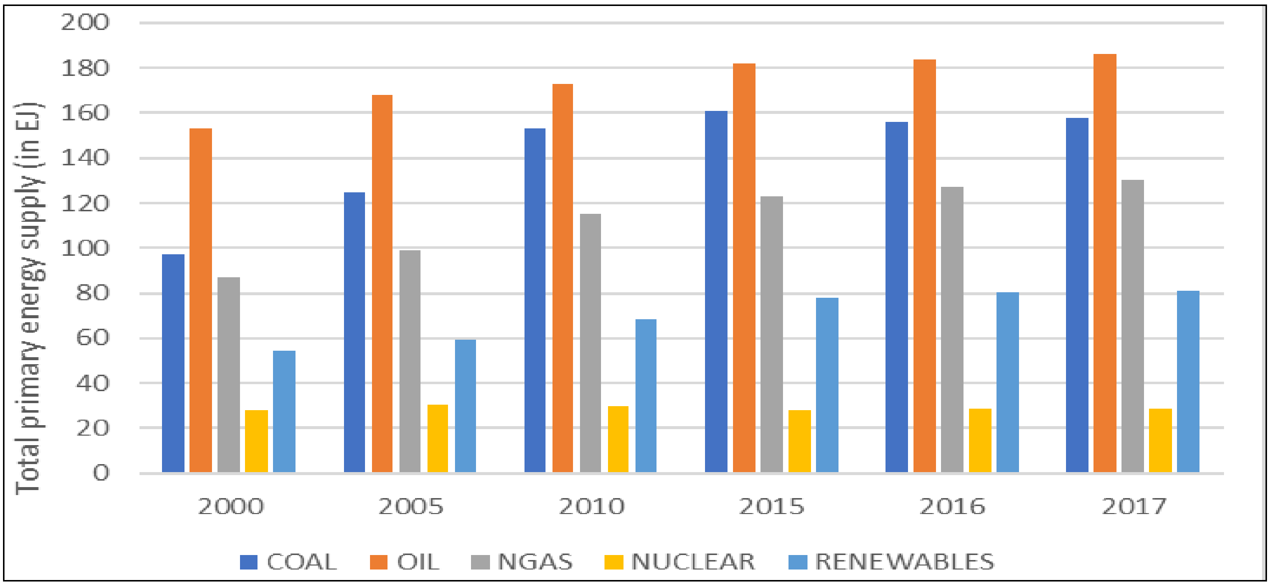

Figure 1: Total primary energy supply globally [11]

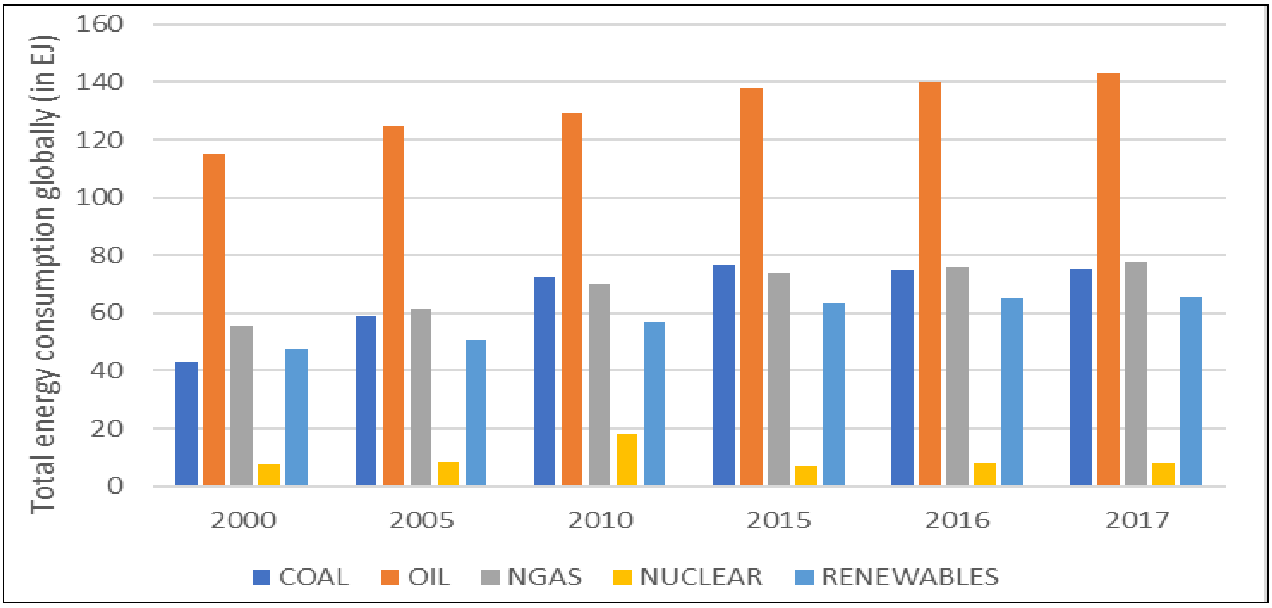

Figure 2: Gross final energy consumption globally [11]

The demand for biofuels has grown since 2007 when oil prices rose globally [12]. The push for biofuels has hit new demand with the Russian-Ukraine war which saw the supply reducing and prices increasing. To add to that, with the focus on climate change agenda, CoPs 26 and 27, demand for biofuels is increasing its quest for renewable energy to cater for cheaper energy for and boost farm incomes of the developing countries. In addition, crops like maize and sugarcane and animal substrate are increasingly being used as feedstocks for biofuels. Most of the biofuels are mainly supplied by Indonesia, Malaysia, and Brazil where there is a lot of animal substrate and sugarcane. Many of the African countries like South Africa, Tanzania, Mozambique, Ethiopia and Kenya have also started gaining momentum to supply biofuels. All these countries have built biodigesters and are funded by Africa Biogas Partnership under the various European Governments [13].

According to the European Union’s Transport and Environment Section, prices of crops from which ethanol is made have soared up since 2017. All oil seeds’ prices have increased by 25% in Europe as biofuel demand increased globally. Furthermore, biodiesel demand has resulted in increase of 38% in vegetable oil prices. This has also been found to be increasing during the time of Covid-19 and the Russian-Ukraine war [14]. Before the war, wheat-ethanol prices jumped globally by 20% while sugar prices jumped by 40% due to sugar-based ethanol. All this is because of biofuels which use land grown crops which is further increasing malnutrition and deforestation [15]. According to June 2022 Guardian newspaper report, both the UK and Europe combined used 17,000 tons of cooking oil for vehicle fuel daily resulting in prices of cooking oil going up [14]. Additionally, 10% of the world’s grains are being used to generate biofuels and this is enough food to feed at least 1.9 billion people [16]. At the same time while biofuels may look environmentally friendly, its impacts could be even worse than those of fossil fuels.

Food and biofuel production must take GHG emissions into consideration and mitigate climate issues. This is because to have healthy lives (SDG 3) and ending hunger (SDG 2), there would be conflicts with other SDGs like increasing energy (SDG 7) and climate change mitigations (SDG 13). Priority must be food security which considers food availability, access, utilization, and stability so that all people have access to safe and nutritious food for a healthy life [16].

Over time, it has been observed that biofuels contribute to GHG emissions indirectly. This is not through the increasing demand for biofuels but the conversion of land from forests and wetlands to pave way for agriculture. This is referred to as indirect land use change. Depending on the feedstocks used for biofuel, GHG increases. If oil crops are used for biofuels, then their contribution to greenhouse gases increases in comparison to sugar-based crops as oil-based biofuels have a high GHG emission compared to sugar-based crops and slightly lower based GHG emission in relation to fossil fuels [16].

3.3. Fuel versus Food Security Debate

The conflict between biofuel and food security is real. This is because biofuel production may negatively impact food security. Feedstocks that would provide food are diverted to produce biofuel thus reducing the amount of food available to feed the people. Demand for biofuels lead to land and water resources competition and increased biofuel production may lead to higher food prices making it unaffordable to the poor [15].

Impacts of fossil fuels like high prices and environmental impacts have made biofuel production expensive. The same applies to food security which faces challenges due to high population, food waste, dietary preferences, changing consumption patterns and the latest being biomass for biofuel production. With increased demand for biofuel crops and bioenergy, prices of food will increase and so will water scarcity. Land also becomes in conflict due to its many uses. Thus, there is the need for formulating integrated policies for the management of water, energy, and land use [16].

Yet, global government initiatives to replace fossil fuels with ethanol and other liquid biofuels run the risk of inciting a "food versus fuel" conflict [8; 9]. The claim is that as both industries compete for the same inputs, any land taken away from producing food or feed to make way for biomass energy will have an immediate impact on food costs.

Food security for the poor, which is dependent on numerous factors, including biofuels, is the primary worry in the biofuels discussion rather than rising global food prices. The effects on poverty and food security are catastrophic when merely considering food prices. The cost of food for consumers rises when food prices are high. But they also help farmers, who make up the majority of the world's impoverished, earn more money [17]. The latter is controversial because farmers' rewards are primarily lost through middlemen.

According to the available data, plantation-style agriculture and a lot of acreage are needed for viable biofuel production. Due to this, automation as opposed to traditional means of production is under pressure, notably from international investors. If their markets are secure, foreign investors (multinational businesses) are motivated by biofuel earnings, but they do not see a financial benefit in investing in Kenyan and other indigenous food crops for local food production [18].

3.4. Biofuel Production and Food Security in Kenya

3.4.1 Energy mix

Due to its reliance on rain-fed agriculture, Kenya is particularly susceptible to droughts that are exacerbated by climate change. The two most important development difficulties the nation is currently facing are poverty and climate change vulnerability. According to estimates, the economic impact of climate change on the nation's economy might cause a reduction in GDP of around 3% per year by 2030 and nearly 5% per year by 2050 [19].

Kenya is a developing nation with limited access to power. The nation has committed to reducing its national GHG emissions by 30% by 2030 to solve difficulties with energy availability and in support of the Paris Agreement. Some of the key industries linked to the nation's GHG emissions include energy and agriculture. Because majority of the population relies heavily on wood fuel, agriculture and land use, land-use change, and forestry industries produce the majority of Kenya's greenhouse gas emissions [20].

By the year 2021, bioenergy (mostly fuelwood) made up roughly 68% of Kenya's primary energy supply, followed by fossil fuels (22%) and electricity (9%), with additional sources meeting 1% of the country's total energy needs [21; 22]. The remaining 45% of the biomass was sourced from public and communal woods, with around 55% coming from farmlands in the form of woody biomass, agricultural residue, and animal waste [22].

To meet the nation's energy needs, imports of fossil fuels are also made. Most of Kenya's electricity comes from geothermal, hydropower, and other renewable sources including wind and solar. In addition, imported coal, crude oil, and oil-related goods are used. Geothermal energy (44%) hydropower (33%) wind (10%) and solar energy (0.5%) are the main energy sources used to generate electricity [22]. Kenya imports fossil fuels, primarily petroleum, at a cost of close to 50% of its yearly foreign exchange. Due to this, the nation is extremely vulnerable to changes in supply and pricing on global markets [19].

3.4.2 Biofuel production in Kenya

Solid, liquid, or gaseous fuel made from or generated from biomass is referred to as biofuel (23). The biomass utilized as a raw material in the production of biofuel is known as feedstock. Food crops, agricultural waste, wood/forestry waste and byproducts, as well as animal manure, may all be included in biomass that is turned to biofuels.

The potential of various biomass resources in Kenya, the possible land areas that might be sustainably used to generate energy crops, and the potential GHG reductions these fuels could bring if used to power contemporary biofuel systems have all been the subject of limited research. This has led to limited biofuel penetration and insufficient use of biomass resources. Kenya's rural populations, urban poor, and unorganized sector all rely on biomass to meet their basic cooking and heating energy demands. This biomass is mostly composed of wood fuel, charcoal, and agricultural wastes and garbage. In the form of woody biomass, agricultural residue, and animal waste, about 55% of the biomass used for primary energy consumption comes from farmlands, while the remaining 45% comes from forests [24].

Kenya's main energy source is biomass because the majority relies on wood fuel for heating. Kenyan homes rely on firewood for heating and cooking in about 80% of cases. The informal sector, urban poor, and rural populations can all get their basic energy demands met with wood fuel. Animal waste by agro-based companies, bagasse by the sugar sector, and municipal trash by local authorities all have significant potential for power generation using alternative biomass resources for both their own use and export to the national grid [24].

Biofuels are classified based on the primary raw material (feedstock) and conversion process employed. First-generation biofuels are created using traditional biochemical techniques from edible plant or animal lipids. Sugar-rich crops like sugarcane (Saccharum officianarum), sugar beet (Beta vulgaris), and sweet sorghum (Sorghum spp.) as well as starch-rich crops like maize (Zea mays), wheat (Triticum spp.), and cassava (Manihot esculenta) can all be fermented to produce first-generation ethanol. Table 1 summarizes the yield of ethanol and biodiesel from different biofuel feedstocks in Kenya.

Table 1. Ethanol and biodiesel production from feedstock in Kenya

Ethanol feedstock	Ethanol yield (Litres/tonne)
Cassava	160-180
Sugar cane	70(cane juice)
	10(molasses)
Sweet sorghum	40
Biodiesel feedstock crops	
Castor	448
Coconut	364
Cotton	146
Croton	336
Sunflower	414
Jatropha	336

Source: Authors, 2022

Production of biofuel in Kenya is currently hampered by lack of policy frameworks. The Government has taken several initiatives to address this gap. For example, the GoK Sessional Paper No. 4 of 2004 on energy seeks to encourage wider adoption of renewable energy technologies [25]. The Energy Act of 2006 mandates the government to pursue and facilitate the production of biofuels [26]. Though the government is yet to adopt a biofuels policy in response to its mandate under the Energy Act, an initiative has been taken to develop a biodiesel strategy. The Ministry has constituted a National Biofuels Committee to address biodiesel issues. The membership of the National Biofuels Committee includes public sector, private sector, and non-governmental organization participants in the energy value chain [27].

3.4.3 Biofuel crops

Kenya has a big potential for biofuel feedstocks. These consist of a large variety of biofuel crops such as coconut, castor, jatropha, cotton, rapeseed, croton, and sunflower. Others that can be applied are maize, sugar cane, palm, and soya, although these have a potential to pose competition on land-use and food security. Table 1 summarizes the yield of ethanol and biodiesel from selected biofuel feedstocks in Kenya.

Due to its high oil content and capacity to thrive in dry climates, castor is used to make biodiesel. Moreover, it is a very invasive species. Jatropha, a crop that is not edible, is a significant biofuel that is well-liked in Kenya. It is a plant with many uses that spreads erratically. Its seeds contain about 35% oil. The oil can either be converted straight into gasoline or into biodiesel [28].

Any nation's population is expected to vary significantly over time, but this is especially true of Kenya, where the population is expected to nearly double from 47.5 million in 2019 to 91.6 million by 2050 [29]. Increased demand for food and the land needed to generate it, as well as increased reliance on forests and woods to produce energy, all put pressure on the availability of land. Population growth also causes settlements and built-up areas to grow and reduce space for forest wood.

The literature assessment determined that Kenya has enough areas of appropriate agricultural land to meet future food demands of the expanding population notwithstanding this land pressure. The bioenergy industry has chances to produce biomass and energy crops thanks to the accessibility of marginal land and grasslands. This could reduce reliance on fossil fuels, charcoal, and wood fuels by providing fuel for both home and industrial sectors.

From the questionnaire survey, it was found that respondents were aware of biofuel crops (agricultural crops) specifically grown as fuels for energy production in Kenya. The respondents identified the following biofuel crops, namely, sugarcane, maize, cassava, wheat, palm oil, soya beans and simsim (Figure 3). It is apparent from Figure 3 that the majority of respondents mentioned maize and palm oil as major biofuel crops.

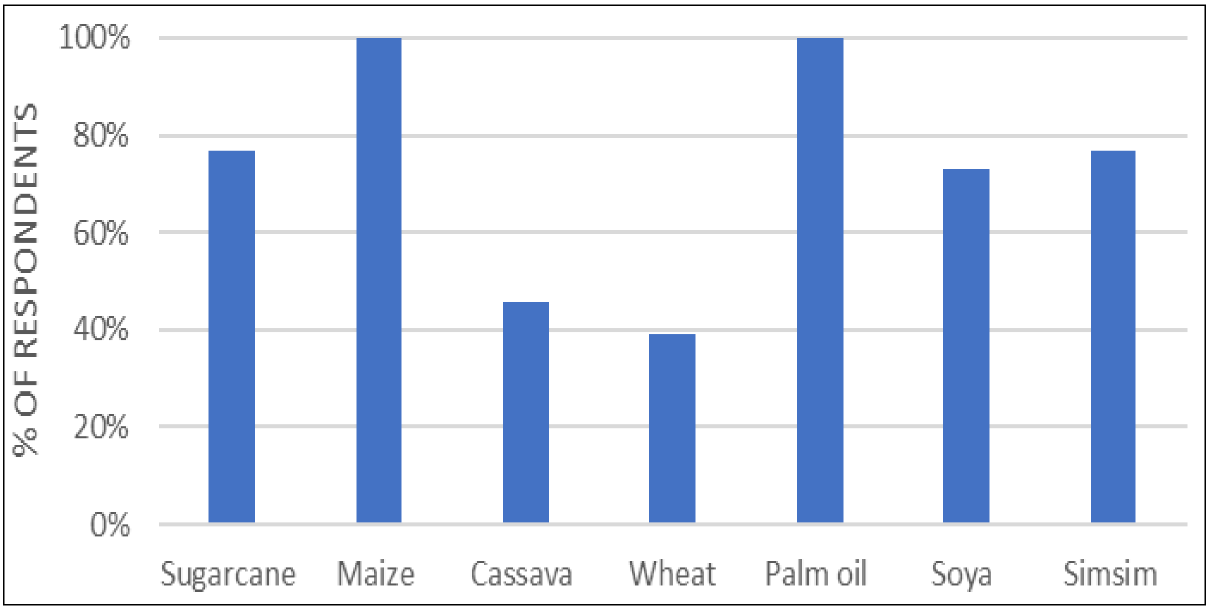

Figure 3: Biofuel Crops in Kenya
Source: Authors, 2022

This result is consistent with the opinions of Nigerian academics who have examined the effects of bioenergy development on food security in Nigeria [29]. They discovered that the most widely grown energy crops in Nigeria include oil palm, peanut, cotton, coconut, soya bean, jatropha, and sesame for biodiesel and sugar cane, rice, maize, cassava, and sorghum for ethanol.

3.4.4 Agricultural Waste and Residue Feedstocks

Energy demand in Kenya is a significant issue for the agricultural industry as well as many other sectors. The country's widespread reliance on firewood and charcoal creates a significant environmental risk of deforestation.

According to the Government of Kenya, up to 50,000 hectares of forests and woods are lost each year, degrading soils and water systems and causing annual economic losses of over USD 19 million [29]. As a result, Kenya may find it highly appealing to pursue prospects to provide alternative fuels for energy that support the agriculture economy.

The desk review established that a large potential for biofuel production exists by utilizing agricultural wastes and residues. Crops such as cassava, maize and sugarcane generate a lot of agricultural residues biomass, while livestock produce large quantities of wastes. These agricultural residues and wastes could be used as alternative biofuels reducing pressure on forests and agricultural land.

Similar observation corresponded with the key informants representing major biofuel producing companies in Kenya. The key informants (KII) represented Biogas International based in Nairobi County and Kings Biofuel Company based in Murang'a County respectively. The key informants revealed that they utilize biofuel feedstock to generate biofuel. The feedstock was from agricultural and industrial wastes including jatropha, castor, animal waste and kitchen waste.

A SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was conducted to establish opportunities and barriers for biofuel production in Kenya. The results are shown in Table 2. SWOT analysis indicates that although biofuel production has certain socio-economic and ecological benefits to the country, there are barriers/challenges. For example, more research needs to be done to obtain adequate database for sustainable biofuel production and thus the need for investment in R&D technologies for biofuel production.

Table 2. SWOT Analysis for Biofuel Production

Strengths Reduction in importation of fossil fuels Carbon sequestration Reduction of GHG emissions Energy security	**Weaknesses** High capital outlay Low energy yield Large amount of land needed Weak enforcement of legal and regulatory framework for production, distribution, and marketing Emissions from wood fuel are health hazards Limited research data/information for biofuel production Inadequate R&D on efficient biofuel feedstocks and technologies Competing interests over land use between biofuel production and commercial uses Competing uses of ethanol
Opportunities Creation of green jobs Increased income earning opportunities for rural communities Diverse green energy options Infrastructure development Increased energy supply	**Threats** Reduction in available land Land degradation More water required Food insecurity

Source: Authors, 2022

3.4.5 Food Security

As was mentioned, concerns have been expressed about the impact of biofuels on food security. The "food vs. fuel" debate contends that the production of biofuels puts food production in direct competition with it, raises food costs, and jeopardizes the food security of populations and nations at risk (30; 31; 32). Like the Sahel region, many emerging nations are net food importers and are severely impacted by rising food and biofuel prices. Because they spend a larger percentage of their income on food, the poor are more vulnerable [32].

Large quantities of feedstock are needed to directly produce biofuel from biomass, such as firewood and charcoal, or new-generation biofuels, such bioethanol or biodiesel. This suggests repurposing agricultural land from the growth of food crops to the production of biomass for biofuel. It is feared that this could result in food shortages and higher food costs on a national, regional, and international level.

Several elements can either favorably or negatively affect food security, such as land access and tenure, post-harvest losses, input pricing, transportation infrastructure, violent conflict, rainfall unpredictability, and water availability. Nonetheless, a person's ability to obtain enough food for a balanced diet is just as important as the availability of food. Hence, food insecurity is also significantly influenced by poverty and a lack of chances for earning a living. Biofuels can provide prospects for income and rural growth while decreasing local food production, which can have both good and negative effects on food security [17; 33]. According to the questionnaire survey, the likely causes of food insecurity in Kenya are shown in Figure 4.

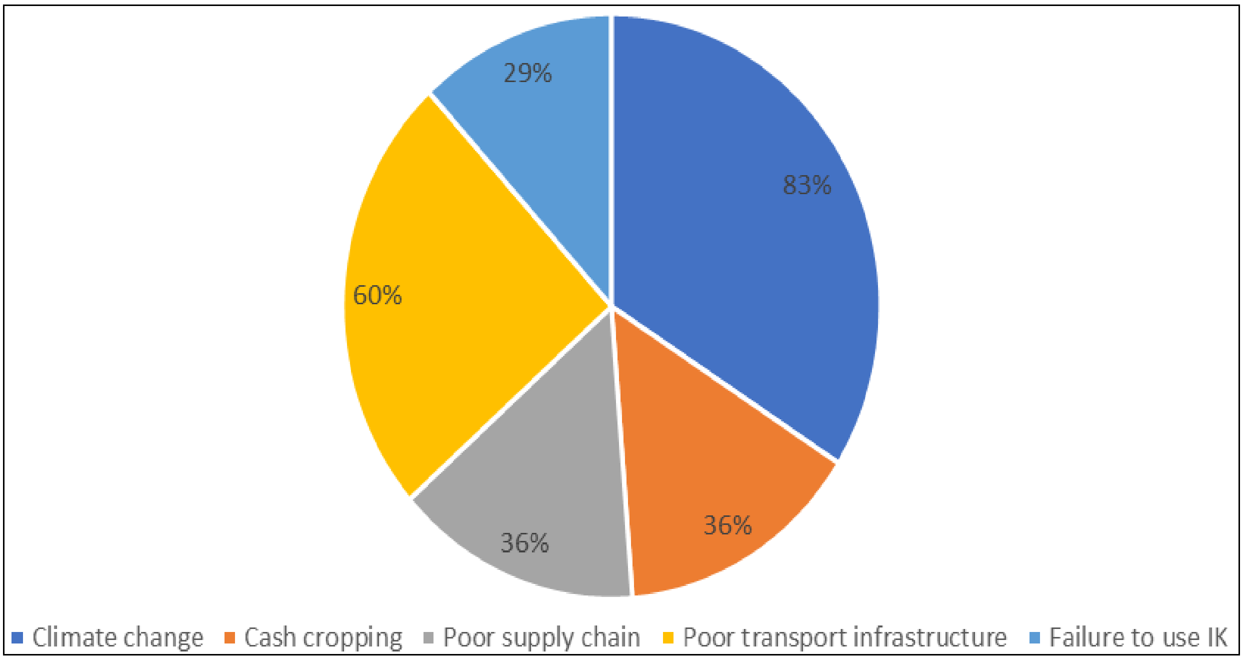

Figure 4: Causes of food insecurity in Kenya
Source: Authors, 2022

It is apparent from Figure 4 that production of biofuel crops was not mentioned as a cause of food insecurity. This implies that respondents did not feel that biofuel production compromised food security. However, when asked to give reasons for discouraging production of biofuel crops in the country, food insecurity was mentioned by all the respondents as shown in Figure 5.

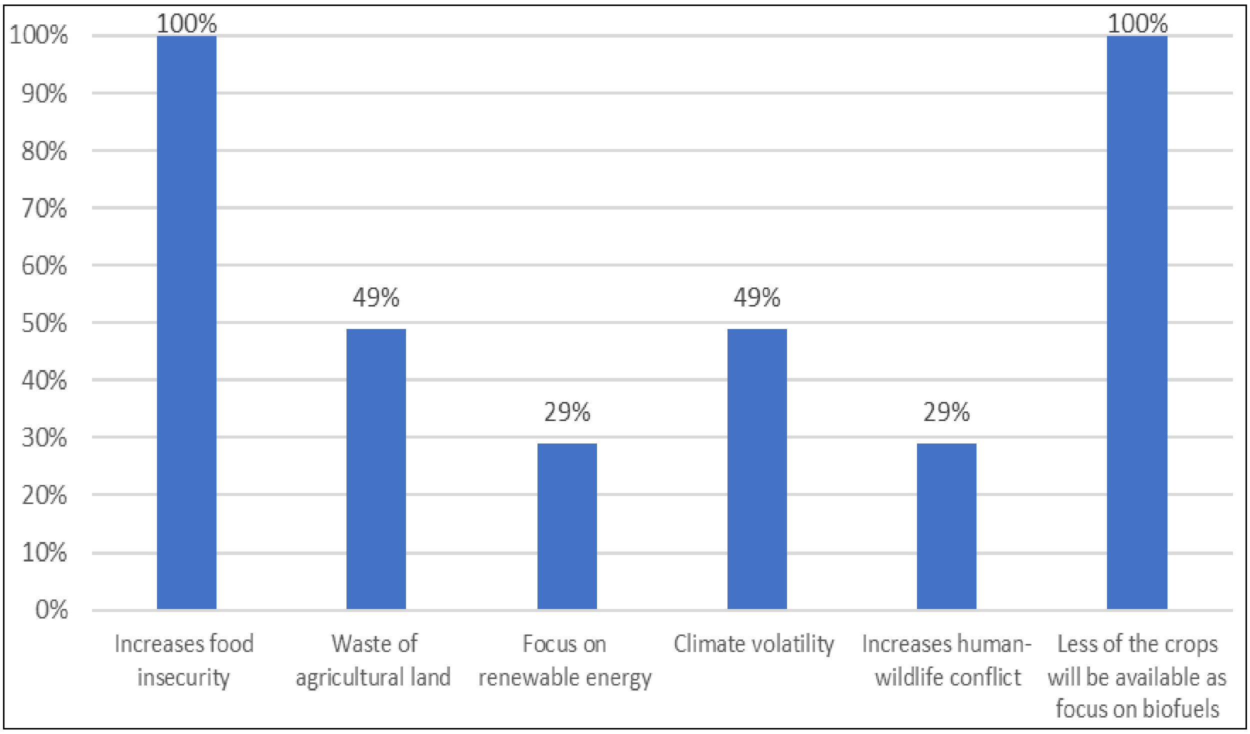

Figure 5: Reasons for discouraging growing of biofuel crops
Source: Authors, 2022

These findings seem to support the ongoing fuel versus food security debate where biofuel production can be a double-edged sword. It was established in the desk review that the ‘‘biofuel or food security debate’’ has resulted in the development and implementation of sustainability criteria such as biofuels certification and standards as voluntary or mandatory systems reducing potential negative impacts associated with bioenergy production. However, the development of numerous standards has its own downside as it tends to increase the potential for inefficiencies in the market and abuses such as “shopping” for standards that meet criteria [34].

Research has also shown that, despite the benefits, there may be sustainability hazards in the world's expanding biofuel business. One of the issues is the quick increase in the cultivation of biofuel crops on agricultural and forestry land. The pressure on land will increase because of the world's population's rapid growth and the resulting rise in food and biofuel consumption. Even though the biofuel sector is still in its infancy in developing nations like Kenya, large-scale mono-crop plantations of bioenergy crops are currently under construction and will put food crops in competition with them for resources such as land, water, nutrients, and other inputs. Moreover, it may result in habitat fragmentation, a loss of biodiversity, and an increase in the number of invasive species [35; 36].

Land grabbing can result from the production of biofuel, as is the case in Kenya's Tana Delta. Large expanses of land are purchased, leased, or otherwise alienated by national government agencies, private investors, and wealthy food insecure nations to produce crops, biofuel, or minerals for export [35; 36].

To grow irrigated sugar cane for the production of biofuels in the central floodplain of the Tana delta, the Tana Athi River Development Authority (TARDA, a government agency), and the

Mumias Sugar Company (a private company), received approval from the National Environment Management Authority (NEMA) in 2008. (Figure 6). The best grazing land in the delta's floodplains and ethnic unrest would have resulted from the project's success. The project's anticipated 40,000-acre spatial footprint encompasses the richest pastures in the delta's center. The Galana ranch's proposed dryland grazing opening is an inadequate mitigation strategy for pastoralists. The proposed sugar project would affect activities like fisheries and agriculture because of the change of water regime in the delta.

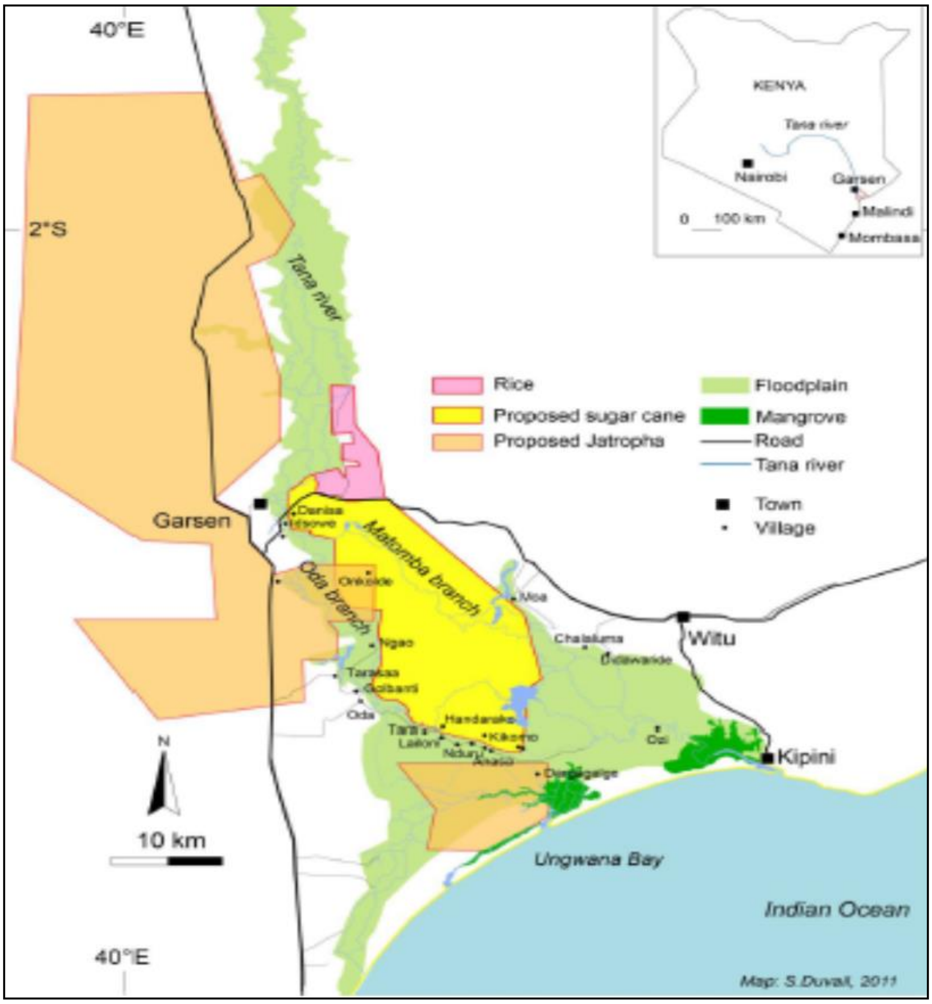

Figure 6: Proposed growing of sugarcane in Tana Delta for biofuels [36]

3.4.6 Incentives for biofuel investment

According to the SWOT analysis (Table 2), weaknesses and threats were identified and may hamper sustainable biofuel production in Kenya. To overcome these challenges, there is need for the Government of Kenya to provide an enabling environment to attract both domestic and foreign direct investments (FDI) in biofuel (bioenergy) production. Some of the ways of incentivizing biofuel feedstock producers are discussed here.

a) There is need to set up mandated blending targets to create a national market for biofuels and force petroleum companies to source biofuels, hence driving investment in biofuel production. The Government should impose high tax on imported fossil fuels which would reduce or eliminate their importation. This would reduce import expenditure and reduce reliance on fossil fuels. The local biofuel producers would be motivated to invest in bioenergy production as substitute for fossil fuels.

b) The Government should fund biofuels research and development that may lead to breakthroughs in bioenergy technology to make the country achieve SDG 7.
c) The Government should offer financial assistance to landowners and operators that produce advanced biofuel feedstocks (second and third generation feedstocks). Qualified feedstock producers should be identified and given some reimbursement for the cost of growing herbaceous and woody feedstocks. The Government can determine the amount of reimbursement to be given to biofuel feedstock producers and for how long. This would go a long way in motivating farmers and potential investors to invest their money in biofuel feedstocks' production to increase output of bioenergy in the country.
d) The Government should provide sustainable policies and regulatory frameworks for biofuel production (green energy governance) through sustainable institutions and in partnership with the private and public sectors [37].

4. Conclusion

Despite the controversy regarding the impact of biofuel production on food security, it is apparent from available literature and questionnaire interviews that both biofuel production and food security are not alternatives but complementary. In this connection, there is a need to strike a balance between biofuel and food security. The country needs to attain both food security (SDG 2) and energy security (SDG 7).

The dichotomy of 'fuel or food' is an oversimplification of a rather complex issue. From the literature reviewed, there are many causes of food insecurity, besides biofuel production. Some of the causes include burgeoning population, climate change, access to land and land tenure, post-harvest losses, prices for farm inputs and transport infrastructure among others. However, it is apparent that there is still no consensus on the 'fuel or food debate'. Research indicates that production of some edible feedstocks such as maize and cassava can compromise food security.

The paper makes the following recommendations:

1. That the Government provides suitable incentives to enhance investment in biofuel energy production in Kenya to make the country energy secure and achieve SDG 7.
2. There should be sufficient funding for research and innovations on the state-of-the-art biofuel technology.
3. Universities and other research institutes can collaborate with the government and bioenergy sector operators in R&D for breakthrough in sustainable biofuels.
4. Laws be enacted to ensure environmental sustainability of biofuels in Kenya.
5. Biofuels should not be produced on cleared forest, wetlands, and grasslands.
6. Biofuels' sustainability standards in Kenya can follow many mechanisms developed for similar processes such as the Gold Standard for verified GHG emissions.

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