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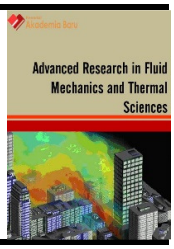

Biofuel development in Nigeria: Prospect and challenges

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ABSTRACT

Biofuel is perceived as a means to ease global energy concerns, promote rural development and mitigate climate change. Therefore, its development has been and will continue to be a priority for most countries. Presently biofuel production is not economically viable, and the drive for its production is driven by the policies of some countries that perceive it as the only possible alternative to fossil fuels and a way out from the declining world crude reserves. Since biofuel offers the opportunities for developing countries to grow new livelihood and reduce the over dependence on imported fossil fuel, as well as obvious benefit to the environment, Nigeria is not left out. Therefore, for Nigeria to step into the biofuels industry in a big way, with every sector being placed in the use of cleaner renewable energy, government need to plan towards producing biofuel from her abundant biomass resources. This idea is expected to boost Nigerian economy through cultivation of arable landmass for provision of feedstock. Therefore, the quest for biofuels no doubt, represents a legitimate ambition. It is in the light of this that the paper reveals the prospects and challenges of biofuel development with the objective of reviewing the current situation in Nigeria. It further identifies inadequate process technology, poor policy implementation and lack of public acceptance as factors hampering its success.

Keywords:
Biofuel, Energy, Feedstock, Nigeria, Development, Prospect, Challenges

1. Introduction

Biofuel is considered as the green renewable energy source that is economical in nature since 22nd century [15]. This has led to it acceptance as the dominant source of fuel over the conventional fossil fuel. In addition, considerable less amount of energy for its production and consumption is required and this has been reported by Patumsawad [33]. Moreover, Biofuel utilization is environmentally friendly as they emits less carbon and, hence, credit less carbon in global warming

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[24, 37]. Currently, the production of biofuel has attracted attention worldwide with African countries now indicating serious interest in its pilot scale production [5]. Biofuel production has been reckoned as a sustainability factor across the globe and Nigeria, as country that is blessed with abundant resources, should not be left out in exploring the potential of its production [22].

The term Biofuel refers to any liquid, solid or gaseous fuel produced from renewable biomass of biological materials [11]. Economically, because its production does not need complex processes, it is noteworthly to note that even local communities are now having access to the use of varous biofeedstocks for bioenergy production with the aim of procuring an alternative source of livelihoods in most African countries [6]. Recent report has indicated that United States of America has projected the production of bioethanol using domestic grown maize to about 132.6 billion litres in 2017 (Figure 1). The statistics ranked US as the largest producer of biofuel globally [18]. Brazil was also reported to produce about 21 billion litres of bioethanol every year. Of the total production, 90% were used primarily for domestic purpose. In Japan and China, both are aiming biofuel production capacity of 6.3 billion litres of bioethanol in 2012, compared with current 3.8 billion [40]. In an effort to improve the activities of biofuel production in biofuel industries, the government of Dutch set it strategy of funding the biofuel industries with 60 million UK pounds in 2006. Interestingly, in Switzerland, massive testing projects were carried out to practically see if biofuel could be used in cars' engines, vehicles and various machines [21]. In Asia, the countries that are massively exploiting the potential of biofuel production include; Indonesia, Malaysia, Philippines, Thailand, People's Republic of China and India [40]. In all of these countries, palm oil is the major feedstock for biodiesel production.

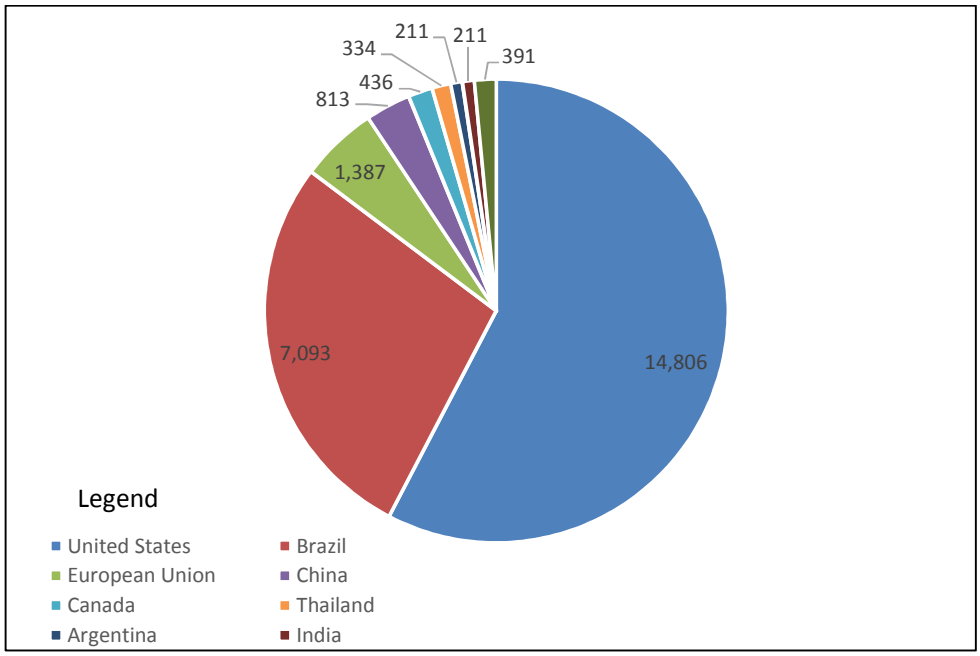

Fig. 1. The world bioethanol production for 2015 (volume is express in million gallons production) [20]

The large production of Palm oil in Asian region was due to the favourable environmental factors, such as climate, temperature and relative humidity that support palm oil cultivation in that region, together with inexpensive labour; which collectively made palm biodiesel production more appealing [38]. Thus, the availability of biofuel feedstock is what led to increased energy security [17]. Nevertheless, the use of gasoline in transportation sector is increasing and the trend seems to be

moving upward considerably. The development and implementation of alternative sustainable energy in this sector have been given a priority globally including Nigeria [32].

Nigeria's target of being among the leading biofuel producing countries is an appealing one. The current realization of the diversification of various existing feedstock could justify the effort of the country in biodiesel production drive [1]. Nigeria mainly depends on fossil fuel as the dominant primary source of energy, which accounts for over 90% of Nigerian foreign exchange earnings [30]. The fear of escalation in the price of petrol, depletion of the total volume of oil reserve (as the oil experts speculate), and increase in air pollution and emission of pollutants are deemed as negative effects of using petroleum fuels. Therefore, it has become necessary for Nigeria, which faces many economic challenges, to find and provide an alternative sources of energy. If achieved, it will help immensely in reviving the gradual dwindling of Nigeria's economy. The Nigerian National Petroleum Corporation (NNPC) has since made a clarion call on this issue, and the final conclusion drawn is that Nigeria needs economy diversification, especially in the oil sector [27]. The focus on biofuel production may be a worthwhile endeavour in view of world's development woes. By investing in biofuel production a lot of development potentials exist which include:

- Provision of employment,
- Economic diversification
- Provision of cleaner environment; a pathway for low carbon energy alternatives
- Poverty reduction and many potential opportunities [1,3].

Interestingly, Nigeria is endowed with agricultural resources which are diverse in nature. These include forage grasses and shrubs, Jatropha seeds, animal wastes, and wastes arising from forestry and agricultural activities. These resources could be used for biofuel production. Because of the variation in the environmental condition across the geographical locations in Nigeria, combination of these resources could be found in almost every part of the country. States in the Northern part of Nigeria are known to engage in massive agricultural production which could provide the various types of feedstocks used in biofuel production. The map in Figure 2 shows the diversity of crop cultivation in Nigerian [15]. Policy makers in Nigeria remains optimistic that with the potential feedstock for biofuel production spread across the country, the development of biofuels such as bioethanol and biodiesel presents real opportunities to meet some of the nation's energy needs [29]. The integration of a biofuel economy would help reduce the rise in fuel prices in Nigeria by providing a steady income to local farmers. Moreover, Nigeria is the leading producer of cassava and needs to develop a significant ethanol industry, so as to have presence in the global market [28]. Therefore, it is of the utmost importance that Nigeria and other African countries start implementing biofuels production as part of their mean of economy development [4]. Thus, this paper provides an overview on the biofuel development in Nigeria, focusing on potential and some of challenges hindering biofuel development, with the objective of proffering solutions to these challenges.

2. Prospect for Biofuel Development

The high prospect of Nigeria for biofuel production is mainly due to large acreage of fertile land with abundant potential feedstocks. However one issue that can be taken as a matter of high magnitude is the sustainable economic diversification, which aims at providing the alternative sources of fossil fuel [27]. An observation here is that this will bring a lot of changes, in terms of economic development, to the nation. Employment availability would become a reality [39]. Opportunities for rural development would also be a key priority. For rural settlers, implementation of biofuel production will help create massive employment, from agricultural perspective, for

feedstock cultivation. This is of key priority because as the agricultural activities increase, it will directly increase the annual farm output thereby attracting demand for businesses. Moreover, as agricultural activities is labour intensive [2], the rural settlers will have increase in their expenditure due into increase in personal income. A study by Dauvergne and Neville [14] indicated that the success of Brazilian bio based ethanol production was due to subsidy of the agricultural facilities.

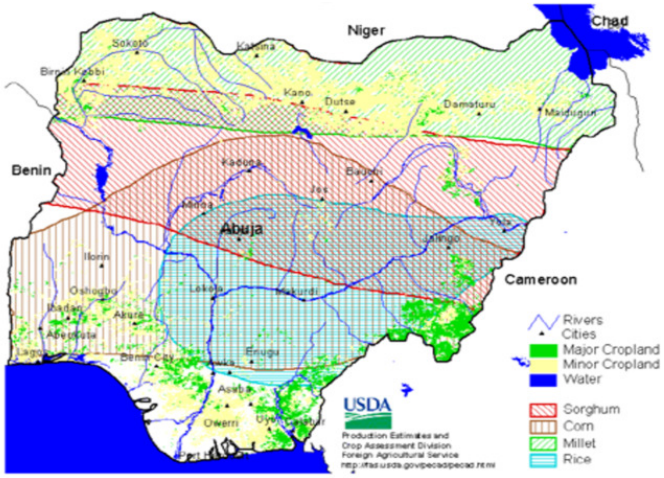

Fig. 2. Crops growing regions in Nigeria [6]

Furthermore, in most of the developing countries, sustainable agricultural production and resources utilization are among the added values of the continued improvement in the biofuel industries [39]. All this can be considered as way forward into the community resuscitation which will contribute in poverty eradication and food security among the rural populace [9]. Furthermore, the biofuel production activities shown in Figure 3 indicates that feedstock plantations are more prevalent in the North -Central and North-West Zones of Nigeria due to the availability of large expanse of unused land. South-West is obviously occupied by bio-ethanol distilleries due to pervasive industrialization of the zone and proximity to the port [9]. Nigerian national statistics suggest that more than 400,000 hectares of land could support high yield sugarcane operations in the country [3, 25]. Thus, two potential crops have been identified for the fuel ethanol initiative in Nigeria: sugarcane and cassava. In addition, Nigeria is currently reputed to be the leading producer of cassava in the world with about 30 million tons annually [3]. Therefore, this potential must be seen against the background of the average yield in Nigeria with an input at about 15 tons per hectare. This analysis indicates that the current national average cassava yield of 15 tons per hectare is adequate to meet the demand of bio ethanol plant take off. Furthermore, according to Ohimain [29] report over $3.86 billion has been invested in sugarcane and cassava feedstock plantations in Nigeria. These led to the construction of 10,000 units of mini refineries and 19 ethanol bio-refineries, for the annual production of 2.66 billion litres of fuel grade ethanol [16]. The outcome of such production was found to help the less privileged women in finding cheap bioenergy for cooking, since they could not afford to buy kerosene for household usage. This made the villagers picked up job in agriculture, making them self-reliant [31]. Therefore, production of biofuel can lead to development of new industries, new jobs, new markets and new technologies.

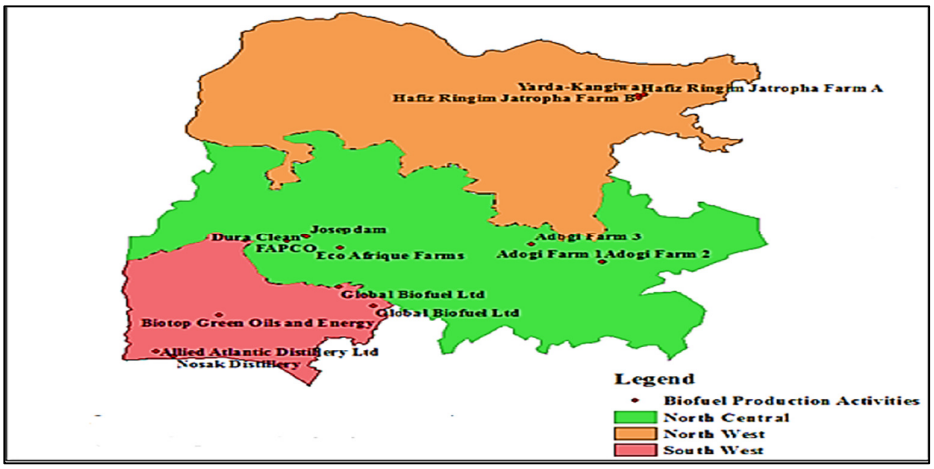

Fig. 3. Biofuel production activities in selected zones in Nigeria [9]

It is very interesting to note that biofuel development will open new job opportunities as it will expand and modernize rural agriculture. Agriculture which was once the highest employer of labour will regain its glory as it will employ over 100 million of the Nigerian working population which is approximately 60 percent of the population [7]. This will further reduce the poverty level in the country as graduates will be employed to provide logistics in the implementation and expansion of biofuel production [16, 25].

3. Challenges with Biofuel Development

The global biofuel development is faced with a number of challenges which must be surmounted to ease its commercialization. The challenges of impact on food prices, competition with farmland, technological development, infrastructure, popularity and policy are much more apparent in developing countries. In Nigeria, the challenges lie in improving farming practices to enhance quality and yield of feedstock, provision of enabling infrastructures (viz; power, roads and water) to boost feedstock production. There is also the challenge fiscal and regulatory policies that will attract investors, and funding research on biofuel development from biomass feedstock. These influential factors are described as follows.

3.1 Biofuel Cost

The main challenge of biofuel production at commercial level is high cost of production which determined the price. Nigeria is one of the countries faced with high fuel price. The price of the biofuel is several times higher than fossil fuel (diesel and gasoline) [35]. The various production processes such as; feedstocks localization, choice of cheaper harvesting method and choice of cheaper transesterification method are all deemed as steps that can be taken in order to reduce the cost of biofuel production. Improvement techniques such as oil refinement can be adopted so have a biofuel yield with improve physical and engineering properties.

3.2 Biofuel Feedstock Competing with Food

The various feedstocks used for biofuel production which includes corn, palm oil, soybean, sunflower, coconut are regarded as first generation biofuel feedstock and their incorporation into biofuel production poses more threat to food availability [34]. Therefore, mass production of non-

edible feedstock such as Jatropha curcas, Madhuca indica, and Pongamia pinnata etc. for biofuel production needs to be encouraged. Some nonedible feedstocks are found to be potentially rich. Their cost of production is low and such feedstocks can be grown in the marginal land. Thus, priorities should be given to feedstocks and their standardization. The key to the success of both the starchy feedstock and oil palm plantation lies with the farmers and labourers. In the past, agricultural industries failed due to non-involvement of the local people on what happen to their resources or in setting the price at which their labour or resources will be sold. Therefore, for biofuel production to succeed in Nigeria, production of biomass feedstock must remain in the hands of local farmers so that they would have steady income.

4. Biofuel Production Technology

In order to enhance biofuel production yield, technological advancement in the areas of oil extraction, transesterification and fermentation processes for biodiesel and bioethanol production are required. This can be done by engaging in rigorous researches in biotechnology, plant agronomy, and precision agriculture techniques. According to Hassan and Abdul Kalam [17], to achieve successes in the first stage of development, the government must take the first step to provide local farmers with seeds necessary to start the industry. This is the only way Nigeria could be able to use biofuels to improve the standard of living of its citizens.

5. Policy

Government needs to implement a standard policy that will function as a platform for other stakeholders including industries, non-governmental organizations (NGO), research institutes and private investors to contribute their quota in developing the biofuel industries [10]. This policy is expected to cover sectors such as; funding, subsidization schemes, information extension, tax relief, investments, authorization of standard biofuel blends. Moreover, as reported by Balogun [8], encouraging private sector investment in biofuel production will go a long way in boosting rapid growth of the local biofuel industry. This will encourage mass production of the feedstock as well. Thus, the implementation of the biofuel policy is crucial in developing a stable and productive biofuel economy.

6. Public Acceptance

The willingness of the public to switch to biofuels from gasoline fuel in transportation sector is imperative to ensure the success of the implementation. As observed by Balogun and Salami [9], failure of public support towards biofuel implementation will create an inimical effect which may lead to production failure as already witnessed in the case of natural gas in Canada and New Zealand. Therefore, it is important to make it well-acquainted to the communities about the conservative and liberal aspect of biofuel utilization, specifically the economic and environmental benefits.

7. Promotion of Research and Development

The major challenge facing biofuel production has been its promotion, especially promotion in terms of subsidies. Since the production involves huge investment, the private sector may not be able to finance the entire project. Therefore, government needs to stimulate the interest of both private and public sectors, especially the collaborative effort of the two in research and development.

This is implementable if biofuels companies contribute 10 percent of their revenue for the purpose of funding research into feedstock production, improved farming practices and local technology development. For this to succeed, the Petroleum Technology Development Fund (PTDF) which was, mandated to fund research and development in biofuels [12] should undertakes the 90 percent contribution of the fund which is far more than the total contribution by the biofuel companies

8. Conclusion

World is now threatened with two major crisis; energy and global environmental pollution resulting in rapid climate change. The use of biofuel is a promising approach to reduce dependence on gasoline fuel, thereby alleviating the global warming. Moreover, development of biofuel industry in Nigeria is an important milestone in achieving sustainable energy development especially in transport sector. But the current bio-fuels production activities in Nigeria are still at low scale and needs motivational policies to be put in place and enforced, so as to ensure that the public and environment derive maximum benefits from the venture. For Nigeria to achieve its ambition for sustainable development in biofuel production, it must take a holistic approach to meet the challenges of massive investment in biomass feedstock research, and appropriate institutional and policy frame works, as outlined in this paper. Biofuel production in Nigeria should follow the sustainable paths, viz: ensuring sustainable feedstock supply, economic feasibility and social desirability as well as developing new technologies that will unlock the benefits of the second and third generations of biofuels.

For its presence in the biofuel global market to be felt, Nigeria should adopt a two-part biofuel industrial development. These are: ethanol industry based on Cassava, and biodiesel industry based on Jatropha. It is hoped that the laudable programmes towards rural community participation in feedstock production, and attractive policies on biofuels will be given a boost. By implementing the suggestions highlighted in this paper, Nigeria could easily become a major force in the global biofuel economy.

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