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Potentials for Sustainable Commercial Biofuels Production in Nigeria

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Abstract

Biofuel production has since shifted from the sole practice of the West, EU and a few other developed countries to being accepted globally. Many more countries have continued to enact appropriate legislations or formulate policy instruments that serve as the regulatory framework for biofuels production within their administrative jurisdictions. Nigeria's participation was signaled with the introduction of the National Biofuels Policy and Incentives in 2007. Reasons for its invasive global acceptance include the environmental tolerance to its use in preference to the conventional fossil fuels and its potentials of creating socio-economic benefits, particularly in the areas of rural socio-economic development and empowerment. The focus of this paper is to underscore the major potentials for production of biofuels in Nigeria and the problems that may be encountered. It also examined those potentials and how they can be exploited for a sustainable commercial production in a way that brings benefits to the country both in the short and long term.

Keywords: Biofuels; Feedstocks; Agro-ecological zones; Fossil fuels; Policy and Incentives

Introduction

The next few decades will be preoccupied by the discussions on the need for a major shift from the use of fossil fuels to biofuels globally. Some of the reasons necessitating this shift are peak fossil oil production (Aleklett, 2012; Demirbas, 2008) that will inadvertently lead to its depletion; the non-renewability of the fossil fuel resource (Jumbe *et al*., 2009); rising fossil oil prices both at the national and international markets (Amaral and Pezzo, 2007); and, increased air pollution and global warming (Shaibani, 2011). In Africa, Malawi is the only country besides Brazil that has been blending ethanol continuously on a national basis for more than twenty years. In Sub-Saharan Africa, South Africa and Nigeria are also stimulating biofuels production, while most of the other countries are still studying the opportunities of biofuels (Johnson and Rosillo-Calle, 2007).

In Nigeria, fluctuations in the price of crude oil at the international market could be risky for the implementation of the national yearly budget (Ohimain, 2013), therefore, encouraging the search for alternative energy sources in liquid biofuels (MacLean and Lave, 2003). However, issues and concerns about biofuel production from the Nigerian public standpoint draw from the conception that biofuel production will lead to the substitution of food for fuel and agricultural land for fuels (Galadima *et al*., 2011). On the other hand, a growing population of over150 million people at a growth rate of 2.38% (2007 estimate), coupled with increases in automobiles, domestic and industrial use of generators will require a commensurate increase in fuel consumption.

Some reports of biofuel production in the country include, ethanol production from sugar molasses (Highina *et al.*, 2011a), and biodiesel produced from palm kernel oil (Alamu *et al.*, 2007). Similarly, reports of the various dimensions of biofuel production benefits in Nigeria include the capacity to: complement national energy needs (Emmanuel, 2012); serve as alternative transport fuel (Highina *et. al*., 2011b); act as an instrument for effective rural transformation (Agba *et. al*., 2010); and, as socio-economic driver and incentives (Abila, 2011). Crops such as corn/maize (*Zea mays*), palm oil (*Elaeis guineensis*), palm nuts (*Gypohierax angolensis*) rice (*Oritza sativa*), coconut palm (*Cocos nucifera*), *Jatropha curcas*, sugar-cane (*Saccharum officinarum*), cassava (*Manihot esculenta*) and sweet sorghum (*Sorghum bicolor*), which are globally recognized in biofuel production (Romijn, 2010; Schut *et al*., 2011) are also found in abundant quantities in Nigeria (Izah and Ohimain, 2013; Highina *et al*., 2011a) due to its tropical climate that gives it wide variation of climate and soil condition (Akintayo, 2004).

This paper therefore focused on the Nigeria's prospect of biofuels production by highlighting her potential capacities to engage in sustainable feedstock production that can guarantee commercial biofuels production.

National Biofuel Policy and Incentives

Strong policy support was adduced to the increased European biofuel production, especially in Germany, where tax exemption promoted the country as the producer of almost half of the EU biodiesel (Banse *et al*., 2008). Nigeria similarly took a major step towards developing and implementing a national biofuel policy as part of other efforts to tap into the benefits of an alternative to the fossil fuels (NNPC, 2007). The National Biofuels Policy and Incentives (NBPI) 2007 serve as the Nigerian regulatory framework to both local and foreign investors for engagement in biofuel production. The NBPI 2007 in its introduction defines biofuels as "fuel ethanol and biodiesel and other fuels made from biomass and primarily used for automotive, thermal and power generation, according to quality specifications stipulated by the Standards Organization of Nigeria (SON), Department of Petroleum Resources (DPR), and any other competent government agency." In the chapter that deals with Industry Incentives, biofuels production in Nigeria is defined as "all registered businesses engaged in activities related to Biofuels production and/or the production of agricultural feedstock for the purpose of biofuel production and co-generation within the country."

Izah and Ohimain (2013) attributed poor policy framework as a major challenge confronting commercial-scale production of biofuels in the country. While the Nigeria Biofuels Policy and Incentives of 2007 purportedly encouraged national markets by introducing national blending targets of E10 for gasoline, with a projected nation roll-out by 2017; and, B20 for biodiesel in the immediate terms but to climax at B100 by 2020, international markets will likely remain the driver for large-scale biofuel with Brazil been a good example of how enforced national markets resulted into a huge biofuel industry (Koizumi, 2005). Although, Brazil pioneered the commercial production of ethanol, its global leading role has since been overtaken by the United States (Figure 1). The European Union (EU) data of biodiesel production, sourced predominantly from rapeseed (up to 80%) and the rest from sunflower and soybean oil is presented in Figure 2, which shows Germany as the leading producer. Germany produces half of the EU biodiesel owing to the tax exemptions stimulus (Licht, 2007), accounting for 50% of global production of biodiesel; and, uses the product in 5–20% blends or (B5–B20) with fossil diesel or in 100% (B100) pure form (IEA, 2007). The shares of biofuels for transportation purposes in many EU member states have continued to increase due to tax exemptions for renewable energies and the increase in oil prices, which changes the relative prices in favour of biofuels. In Tanzania, the government's inability to provide a profitable market for Moringa tree

it promoted made farmers to lose faith in experimenting with crops subsequently introduced by government (Scott, 1998).

According to Chamdimba (2009), some necessary ingredients of good policies in biofuel development include policies that: are predictable and consistent over time; have clear niche for small and medium entrepreneurs' benefits; are coherent; can stimulate private and public investment; portray transparent governance; and enjoy political will for implementation. A sustainable national programme will in addition require that government provides an equitable balance through legislative framework that protects the rights of the small-scale farmers, without becoming over restrictive (Simmons, 2002). Given the general lack of political will-power to implement the essential provisions of the national biofuel policy and incentives, it is yet to be seeing how the industry will be able to grow in Nigeria. These bother primarily on poor implementation of the provision of much required tax exemptions and other waivers as it was in Brazil (Akande and Olorunfemi, 2009) and the EU (Banse *et al*., 2008), which the sector leveraged on to compete favourably in the same business environment as the long-established and cheaper fossil fuels investment sector.

Nigeria Agro-ecological Zones

Nigeria lies wholly within the tropics along the Gulf of Guinea on the western coast of Africa; and, its territorial boundary is divided into six geo-political zones (Figure 3) for ease of administration and governance.

The country has a highly diversified agro-ecological zoning (Figure 4), which makes possible the production of a wide range of agricultural products.

The climate has direct bearing to the soil fertility of a place that sustains the growth of certain crops (FAO, 1991). The combined effects of temperature, humidity, rainfall, and other climatic variation, determine the different types of vegetation belts in the ecological zones and the types of the indigenous or exotic crops that are and can be grown in Nigeria (Adetiloye *et al.* 2006). While most crops thrive best on fertile soils, others have reasonable yields on moderately fertile soils (e.g., rice, cassava and millet), and others produce well on infertile soils (e.g., oil palm, cashew nut, cassava, *Jatropha curcas* and rye). The technical briefs of the feedstock as reported in Takavarasha *et al*. (2005), shows a minimum requirement of 500mm annual rainfall and temperature of between 25 to 30^0C. Sugarcane, maize, sweet sorghum, cassava, palm oil and Jatropha have been deemed technically and economically feasible in various parts of Africa based on favourable climatic and agricultural practices (Sielhorst, *et al*. 2008).

Cassava offers a more advantageous availability for bio-ethanol production as it grows on both sandy and clay soil with tolerance to lands with low fertility (Facius and Ipsen, 2006) but yield can be low under poor soil condition (Fermont *et al.*,

2009). Nigeria ranks second after the United States in the production of grain sorghum; first in the World production of cassava; and it is an indigenous home to palm oil (Elbehri, *et al*., 2013).

Jatropha curcas is fast becoming a preferred crop for biodiesel production in Nigeria owing to what is viewed as its diverse ecological services, reliability and availability (Maritz, 2008); and since it is inedible, its use may not affect human nutritional requirements directly or indirectly, if its planting does not substitute for planting of food crops or encroach on existing agricultural land. Since the distribution of plants across different environment is determined by the conditions of weather and soil composition (Yahaya *et al.*, 2013), biofuel companies will have the opportunity to access feedstocks that thrive during rainfall season from the southern and northern parts of the country. Irrigated plantations on the mineral rich soil of the northern parts will sustain feedstocks' production during the dry season.

Feedstock Availability

The Nigerian Biofuel Policy and Incentives (NNPC, 2007) qualifies crops such as cassava, sugarcane, oil palm, Jatropha, cellulose-based materials and any other crop as may be approved by the Biofuel Energy Commission as feedstock for biofuel production in Nigeria. Agboola and Agboola (2011) reported cassava and molasses from sugarcane as the main feedstock for Nigeria's bio-ethanol production. Other reports of feedstock used in biofuel production in Nigeria include molasses (Highina *et al*. 2011b); palm kernel oil (Alamu *et al*. 2007). Kaduna State, under its Ministry of Science and Technology instituted a Bio-ethanol Pilot project in collaboration with the Science and Technology Forum, Zaria in 2007. The project developed a mini-processing plant to produce one hundred litres of ethanol per day (100 lit/day) from sugarcane as raw material. This effort was a prelude to a future plan of the State Government to embark on commercial biofuel production. Maritz (2008) reported a 10,000 hectare of *Jatropha curcas* plantation at Lafiagi in Kwara State owned by Eco Afrique, a subsidiary of Ensol.

In Nigeria, cassava and sorghum are the major feedstock used and/or intended for ethanol production, while *Jatropha curcas* is being used for biodiesel production (Agboola and Agboola, 2011; Galadima *et al*., 2011). Among the different biofuel crops, Jatropha has been singled out to deliver benefits through both small and large-scale cultivation (Gilbert, 2011), because early publications noted its potential for degraded land regeneration and erosion prevention alongside energy provision (Jones and Miller, 1992; Openshaw, 2000). While Jatropha can indeed survive under hostile environmental conditions, its yields are much higher in conditions where the plant has adequate access to soil nutrients and water (FAO, 2008; Achten *et al*., 2007). However, with sorghum and cassava being staple foods to the Nigerian people, any commercial exploitation could easily trigger hunger threats and price hike. Even

though the use of palm kernel oil (PKO) under experimental conditions through trans-esterification to produce biodiesel has been reported (Alamu *et al*. 2007), its use will also not likely be so much considered because it is an important staple food in Nigeria. Non-food sources of biofuels, which offer better alternatives as feedstocks in Nigeria, with less impact on food production capacity and therefore food prices include bagasse (Shaibani *et al*. 2011), molasses (Highina *et al*. 2011a) as well as biomass, wastes and ligno-cellulosic materials (Agbro and Ogie, 2012).

Land Availability for Feedstock Production

Majority of the land proposed for biofuel feedstock plantation are the degraded or marginal lands (Openshaw, 2000; Francis *et al.*, 2005) that are claimed not to be readily arable and ordinarily not cultivated for food. These lands assumed to be unproductive and thought to have no negative effects on local household food security are mostly prevalent from the woodland and tall grass savanna through to the short grass and marginal savanna agro-ecological regions of the country (Figure 4). However, Rossi and Lambrou (2008) and Borras *et al*. (2008), pointed out that these lands almost inevitably support very important livelihood functions for the most vulnerable landless and poor people who will fall back on these areas for subsistence and support in difficult times.

Potential investors in biofuels began to perceive the attractiveness of vast areas of uncultivated land in Africa that could possibly be exploited for biofuel cultivation for western markets (Mercer, 2003). Land grabbing is a strong social impact of commercial or large-scale biofuel production (Cotula *et al*., 2009; Friis and Reenberg, 2010). It has the potential of displacing current land users and their associated livelihood strategies (Cotula *et al.*, 2008). This is mostly associated to the developing countries of the world where weak social and environmental governance is dominant. Such defective operational governance administered by weak or corrupt leadership tends to attract investment from overseas investors desiring to reduce their production cost by evading compliance with social and environmental standards, which leads to a phenomenon referred to as 'pollution havens' (Cole, 2000; Cole and Elliot, 2005).

Existing Biofuels Production Infrastructure

The list of existing liquid bio-ethanol producing infrastructure is given in Table 1. It shows the southwest region of the country as the prevalent location of the infrastructure. According to Agbro and Ogie (2012), Nosak Distilleries announced a new ethanol plant for Calabar, Cross River State while UNIKEM recently acquired a second plant, which brought its total ethanol production capacity to 400,000 litres/day or 1.3 billion litres/year. However, from the data which the author received in 2013 from AADL and Nosak Distilleries, their monthly ethanol production rate stood at 825,000 and 7,500,000 litres/month, respectively; while Elijah (2010) puts the total

ethanol demand in Nigeria at 5,140 million litres/year. Substantial quantities of ethanol produced locally is basically for pharmaceuticals, human consumption and other industrial purposes that offer the immediate market demand in the interim. Management of both AADL and Nosak Distilleries believe it could be possible in the future to distill for automobiles when the market is fully developed in Nigeria.

Given the combined installed production capacities of the different existing bio-ethanol distilleries in Nigeria, the country will be able to meet its 5,140 million litres/year total bio-ethanol demand much earlier than the projection of an International Energy Agency report (IEA, 2006) that puts African domestic demand for biofuels at about 3.5 Mtoe in 2030 (i.e. about 2 billion litres).

Available Domestic Market

The domestic energy market in Nigeria includes the ever-increasing automobile sector, pharmaceutical companies, alcoholic beverage companies, the burgeoning human population and the increasing community of telecommunications service providers. Although, there is no harmonized figure for Nigeria but the summary of statistics for Lagos State shows the number of motor vehicles and motor cycles newly registered in the State increased from 184,072 in 2002 to 332,884 in 2011 (LASG, 2012), while more than 60,000 vehicles were reported to be imported into Nigeria annually (Agbo, 2011). In addition, increases and projected increases in population put Nigeria in a good position as a profitable market for biofuel products. Nigeria's population was projected to grow from its 2006 figure of 140 million to 208 million by 2030 (British Council, 2010); and, 239.9 million in mid-2025 and 440.4 million by mid-2050 (PRB, 2013). Furthermore, with an active subscriber base of over 100 million, nine mobile operators comprising five GSM and four CDMA (Code Division Multiple Access) operators (GSMA, 2013), the need for an alternative source of energy to power the numerous remote base stations all over the country for an uninterrupted service is imperative. The high population density of Africa, as an indicator for biofuel production, gives conflicting results. On the one hand, a high population density is favorable. It means that there will be high demand for biofuels, which is particularly important in case of import substitution. It also increases the need for labour, which is imperative as harvesting most biofuel crops are labour intensive. Although many crops can be harvested mechanically, this is unlikely in the African context: there is a lack of qualified labour and spare parts for mechanical production, while manual labour is cheap (Sielhorst, *et al.* 2008).

Public Support for the Development of Biofuels Industry

The national programme on biofuels production enjoys a wide public support in Nigeria as it is viewed as a positive means of rural development and employment creation. In a work that sampled the public opinion about biofuel production in

Nigeria (Galadima *et al*., 2011), 91.89% of the total respondent strongly agreed to the capacity of the programme generating more revenues that boosts the country's Gross Domestic Product (GDP) due to potential increase in farm output. Local production of biodiesel can be of immense economic benefit to the poor rural women, who could use it for cooking in the household as a substitute for the often unavailable and unaffordable traditional fossil kerosene fuel (Aguilar *et al*., 2011). It has the potential of liberating women from the toilsome burdens of fetching firewood for cooking and heating (Singh and Sooch 2004) and empowering them, by making fuels more accessible and affordable whilst freeing more time for other activities.

Additionally, with the unpredictable future prices of fossil fuels (Hill *et al.*, 2009; Nasidi *et al.*, 2013) cum the expected increases in the price of fossil fuels (Sielhorst *et al.*, 2008) and the shifting attention to biofuel production (Ohimain, 2013), planting of energy crops will be encouraged thereby resuscitating hopes in farming. This will expectedly lead to the emergence of several smallholder and outgrower schemes in the local communities that are able to receive soft loans and other incentives as provided for by the Nigerian Biofuel Policy and Incentives. One of such schemes is the Jatropha Growers, Processors and Exporters Association of Nigeria (JAGPEAN) founded in 2012. Cooperatives such as JAGPEAN, when operating in the best interest of members are essential in negotiating better prices and in making companies accountable to contractual agreements (Rist *et al*., 2010). JAGPEAN has continued to inaugurate its state chapters nationwide; having regular meetings with the relevant agencies of government; and in collaboration with national and international organizations such as United Nations Development Programme (UNDP), hosting awareness and sensitization programmes in the production of jatropha for biodiesel production.

Conclusion

The climatic suitability of the Nigerian environment to the breeding of a wide variety of feedstock makes it sustainable for commercial biofuel production enterprise. Therefore, biofuel production may not necessarily rely on feedstocks that also constitute some of the Nigerian staple foods. Existing biofuels producing infrastructure such as ethanol distilleries and biodiesel refinery will ensure a quick start in production. Expanse of uncultivated land extending from the middle to the more arid regions of the country could be used in the commercial cultivation of drought-resistant Jatropha and cassava, mostly favoured in producing biodiesel and ethanol. The more arable land used for food provisioning will not be encroached upon. The implementation of the national policy on biofuels and Incentives, backed with the required political-will, will ensure compliance on the delineation between crops, which should and should not be used for biofuels production, and as such, substantially puts to rest the anxiety over 'food for fuel' belief. This will lead to an

increased public acceptance that will provide the optimum environment for the sustained growth of the sector.

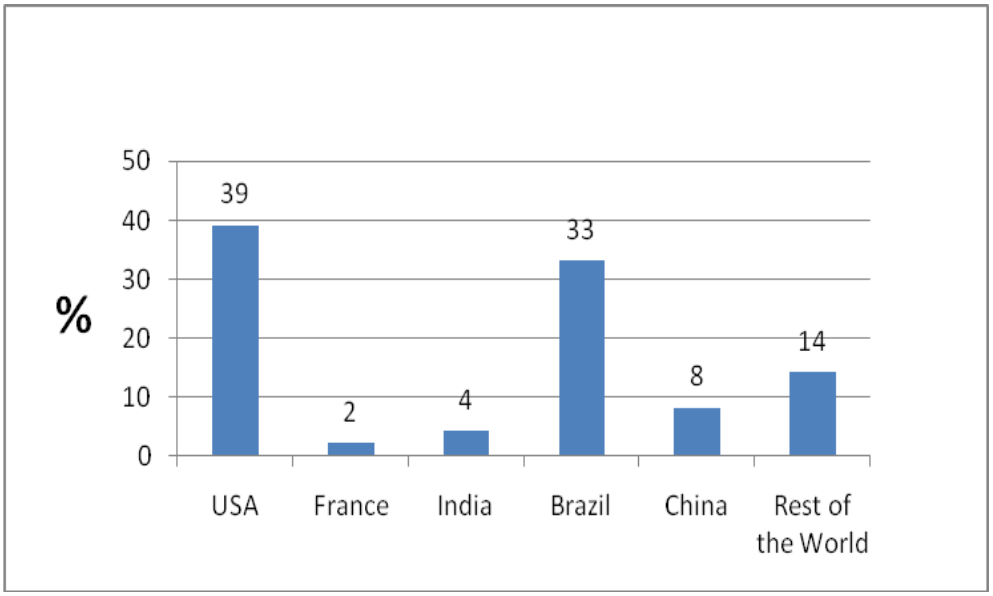

Figure 1 Global Top Producers of Ethanol (*Source: Plotted with RFA figures, 2007*)

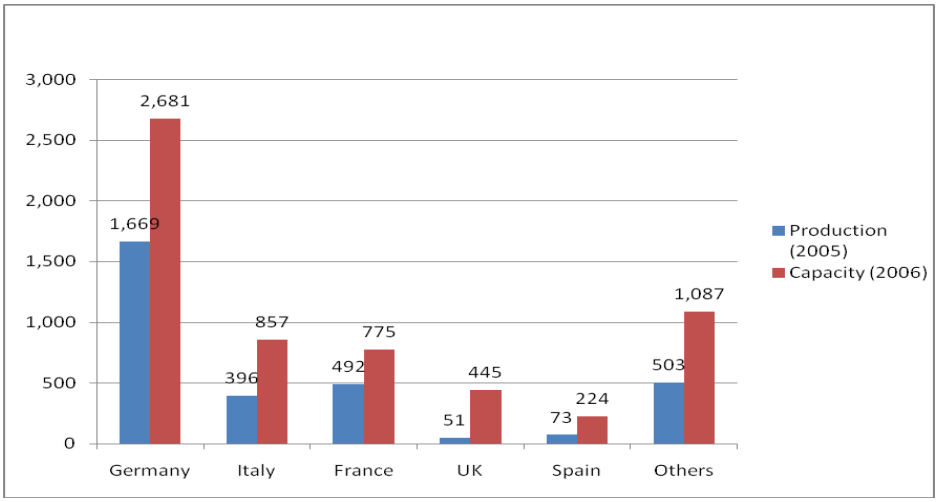

Figure 2 Main Producers of Biodiesel in the EU (*Source: IEA, 2007*)

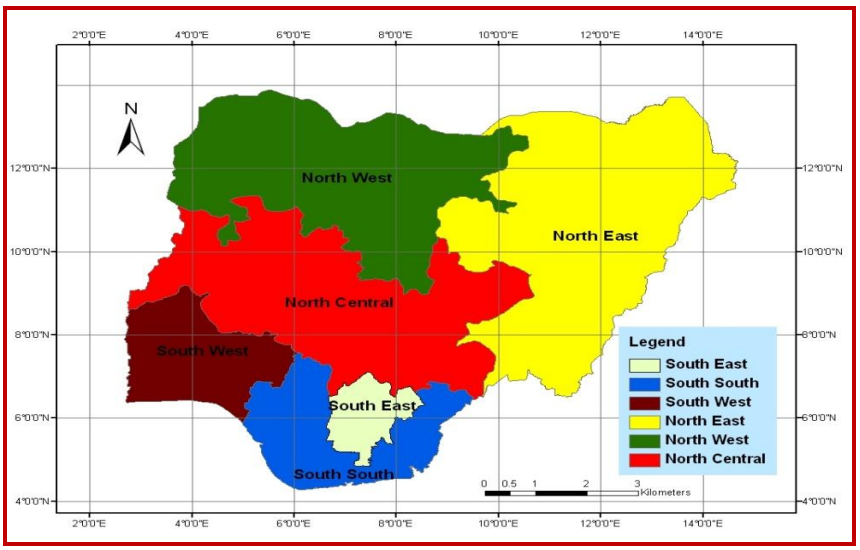

Figure 3 The Six Geopolitical Zones of Nigeria (*Source: Author*)

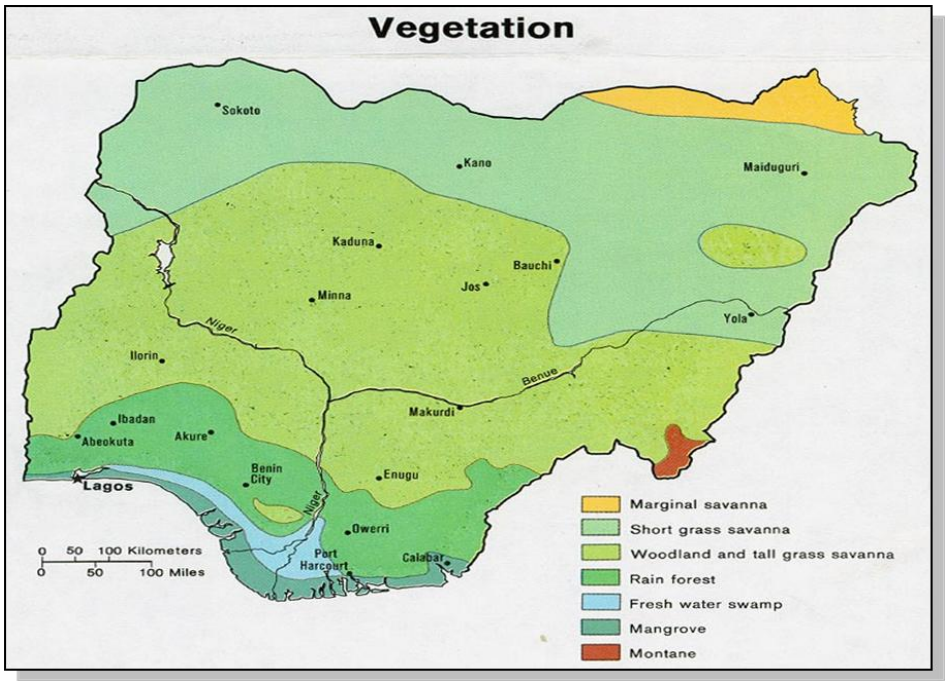

Figure 4 Agro-ecological Zones of Nigeria (*Source: www.maption.net*)

Table 1 Ethanol Production Infrastructure in Nigeria

Name of Company	Location	Feedstock	Installed Capacity (million L/year)
Nosak Distilleries Ltd.	Lagos	Crude Ethanol	43.8
UNIKEM	Lagos	Crude Ethanol	65.7
Intercontinental Distilleries	Ota-Idiroko	Crude Ethanol	9.1
Dura Clean	Bacita	Molasses	4.4
Allied Atlantic Distilleries Ltd.	Igbesa	Cassava	10.9
Envirofriendly Energy Ltd*.	Kano	*Jatropha curcas*	0.3
Total			**134.2**

***Source**: Elijah (2010)*

**Data supplied by the Author. Envirofriendly Energy Ltd. plans to commission two other biodiesel refineries in Lagos and Osun States respectively.*

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