Nigeria's Bio-Ethanol: Need for Capacity Building Strategies to prevent Food Crises

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Abstract: This work reviews current bio-ethanol developments in Nigeria and offers recommendations to help sustains this trend of development. The use of staple crops, such as cassava for bio ethanol production is generating mixed reactions among the populace who depend largely on these crops for food due to poor living conditions in the country. This paper reports that while there is a target of 1.27 billion litres of ethanol per year to be blended with petroleum, the government is doing little to increase cassava production and cassava extraction efficiency. The current average yield of Nigeria's cassava stands at 15 tonnes per hectare compared to countries like Brazil with an average of 35 tonnes per hectare. Furthermore agricultural research and development in the country is underfunded, a situation which hampers innovation and growth in the agricultural sector. The need to concentrate efforts on increasing the average yield of cassava is emphasised in this work. This study could not explore the technical aspect of the cellulosic feedstock for bio-ethanol due to the non-standardization of the techniques coupled with the fact that the bio-ethanol industry in Nigeria is still at its infancy. It is obvious that the government lacks comprehensive policies to tackle the challenges that ethanol development will pose to the citizenry. Therefore this paper provides recommendations for policy makers to aid in formulating a sustainable bio-ethanol policy for Nigeria.

Keywords: *Ethanol, Biofuel, Energy crops, Food crise,Cassava*

1. Introduction

Environmental concerns and crude oil price volatility are creating market gaps between conventional and renewable energy sources. The conventional sources of energy are currently being supplemented by renewable energies to reduce and accommodate the high fluctuations in the price of oil in recent years. Bio fuel among other forms of renewable energy is attracting attention globally especially in Brazil and United State of America. It is being touted as the future supply of energy in transportation and electricity generation. Africa, the second largest continent in the world, host 13% of world's populations and 10% of the world crude oil reserves [1]. Africa's energy consumption is less than 5% of global consumption therefore African countries are categorised as poor based on energy consumption, a major developmental index. Bio fuel is not a recent development in a number of African countries like Zimbabwe, Malawi and Kenya as they started blending programmes in the 1980's. In Nigeria, bio-ethanol production is still in its infancy and requires attention from policy makers and financial institutions to develop and build the industry. In many African countries uncertainty exists on the massive utilization of bio-ethanol due to the possible risks of food scarcity. The use of bio-ethanol blend in Nigeria transportation fuel (E10) has triggered sharply polarized views among agricultural scientists, food engineers, policy-makers and the general public. Nigeria in an effort to minimise carbon emissions, energy insecurity and take advantage of renewable energy is investing in bio-ethanol technology in partnership with Brazil. One major concern shared by many on Nigeria's ethanol blend is her capacity to prevent food crises while achieving energy security. Bio-ethanol production in Nigeria adopts the use of cassava (majorly), sweet sorghum and sugarcane as feed stock knowing that these staple crops are the major food crops in Nigeria. Although Nigeria is the largest producer of cassava in the world, but more than 90% of cassava production in Nigeria is used for domestic

food consumption. The government's road map for achieving the bio-ethanol target of 1.27 billion litres/year distances itself from how this will not lead to food shortage in Nigeria. It is obvious that the bio-ethanol target of Nigeria is achievable due to the size of useful land available in the country but there is need for capacity building strategies to sustain bio-ethanol production. Nigeria's size and land usage are presented in Table 1.

Table 1: Nigeria's Size and Land use Parameters [2]

Nigeria	**Percentage (%)**	**Quantity (Million ha)**
A. SIZE		
Total Area	100.0	92.4
Land area	85.9	79.4
Water bodies	14.1	13.0
B. LAND USE		
Agricultural land	**77.8**	**71.9**
Arable cropland	30.5	28.2
Permanent cropland	2.7	2.5
Pasture land	30.6	28.3
Forest and woodland	11.6	10.9
Fadama	2.2	2.0
Other land	8.1	7.5

There is huge potential for bio-ethanol in Nigeria as can been seen from Table 1. Nigeria's total area is 92.4 million hectares out of which 79.4 million and 13.0 million hectares are occupied by land and water bodies respectively. Agricultural land occupies 71.9 million hectares making Nigeria one of the top bio-fuel potential countries in the world. In Nigeria 94% of households engage in crop farming while about 68% of households engage in livestock farming [3]. This work will attempt to review government's effort to advance bio-ethanol in Nigeria, assess the risk of using food crop for ethanol production and recommend policy to help in safe-guarding food security in the country.

2. Nigeria's Bio-Ethanol Feedstock and Industries

Nigeria bio-ethanol production like most countries in the world comes from first generation feedstock like cassava, sugarcane and sorghum. Cassava is the main feedstock for Nigeria's bio-ethanol because the country imports about 50% of its sugar consumption. The world annual cassava production is estimated at 208 million tones per year with about 60% grown in Africa. Figure 1 shows cassava production in some selected countries with Nigeria leading the production chart. Nigeria produces more than 40 million tonnes of cassava yearly with the average yield of 15 tons/hectare as compared to 25-30 tons/hectare obtainable in other countries. Nigeria has more than a million hectares of land that could support cassava commercial plantation if financial institutions will invest adequately [3]. The key driver's of Nigeria's bio-ethanol are 1) urgent need to reduce energy insecurity 2) increase electricity accessibility 3) need to raise GDP from 3.5% to 8% per annum and 4) maximise the use of available resources. The plan to blend ethanol with petroleum for domestic use is driven by

the need to reduce the cost of fuel importation, since Nigeria's refineries are not working at optimum capacity and to respond to climate change. Elijah I. Ohimain stated that, an investment of over $3.86 billion has already been committed to the construction of 19 ethanol bio refineries, 10,000 units of mini-refineries and feedstock plantations for the production of over 2.66 billion litres of fuel grade ethanol per annum. Also an additional 14 new projects are in the offing. Of the 20 pioneer projects, 4 are at the conception phase, 8 are in the planning phase, and 7 are under construction with only 1 operational. Many have argued that a sustainable bio-fuel policy will be needed to regulate sales, use and production [4-6].

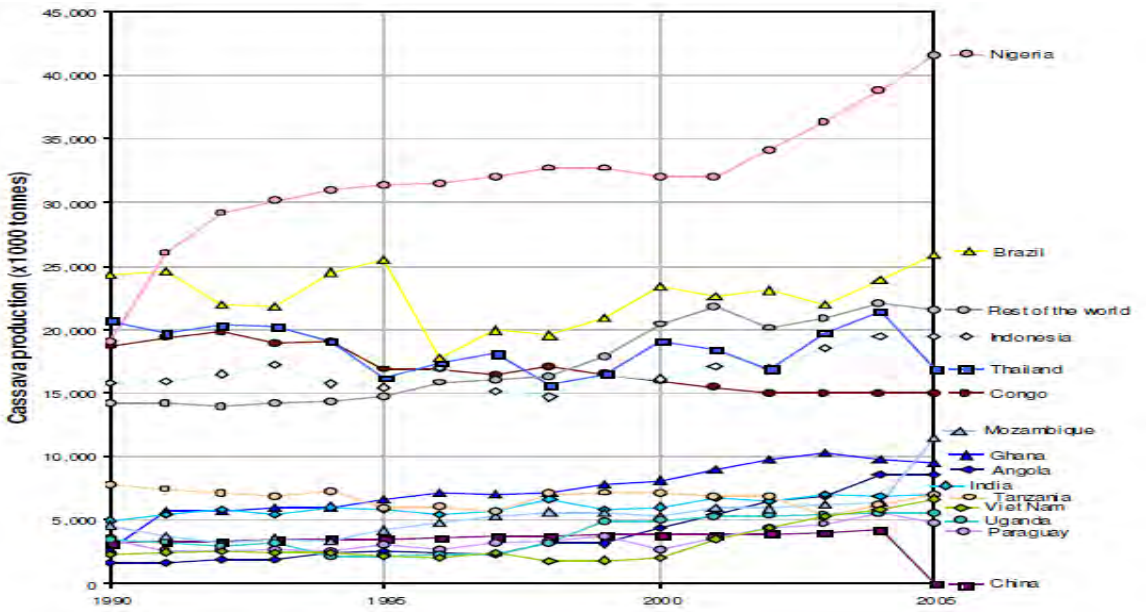

Fig. 1. Cassava production in selected countries 1990- 2005 (Source: F AO, 2007)

Table 2. Some Selected Ethanol Plant in Nigeria

Name of Company	Plant Location	Feed stock	Installed capacity (million litres/year)
Dura Clean	Bacita	Molasses/Cassava	4.4
AADL	Sango Ota	Cassava	10.9
CrowNek	Ekiti	Cassava	64.0
BV Energy Company	Bayelsa	Cassava	75.0
Akoni	Lagos	Cassava	53.0

Table 3. Some Selected Proposed Plants

No	Name of Company	Project information	Budget
1	Jigawa,Benue, Anambra and Ondo State	Integrated bio-ethanol refinaries and sugarcane farm	$4 Billion
2	Nasarawa State	Integrated bio-ethanol refinary and cassava farm	$27 Million
3	Casplex	Ethanol refinary and cassava farm	NA
4	Ekiti State	Integrated bio-ethanol refinary and cassava farm	$100Million
5	Petrobras	Ethanol plant	$200 Million
6	Kogi State	Ethanol plant	$1 Million
7	Taraba state	Ethanol plant	$115 Million
8	Niger State	Ethanol plant	$314 Million
9	lemna	Ethanol plant	$50 Million

Production of bio-ethanol from non-edible crops/oil seed and cellulosic substances are going to create a new window of opportunity for agriculture, mitigate green house emissions and end Fuel-Food debate. The entire supply chain and process of the first generation feedstock (e.g. Cassava) needs to be re-evaluated to derive added value from bio-ethanol. Currently bio-ethanol from energy crops grown for traditional markets is too expensive for use as fuel and this is causing rising cost of food especially in Nigeria where government regulations is ineffective. Table 2&3 shows bio-ethanol plants in Nigeria requiring mostly cassava as feedstock.

3. Cassava: Feedstock versus Staple Food

Nigeria produces more cassava than any other country in the world followed by Brazil. Nigeria's cassava production is almost double the production of Indonesia and Thailand. Cassava is a very versatile commodity with numerous uses and by products. The crop is abundant in 24 of the 36 states, requires minimum labour input, and remains the most important food security crop for millions of Nigerians. The leaves can serve as vegetables; the stem is used for plant propagation and grafting while the roots are typically processed for human and industrial consumption. Cassava flour has applications in the biscuits and confectionary industry, dextrin pre-gelled starch for adhesives, starch and hydrolysates for pharmaceuticals, and seasonings. Table 4 show Cassava production from 1990 -2005.

Nigeria's Cassava is traditionally processed into food products like, gari (roasted cassava granules),cassava chips and pellets, fufu flour, starch, cassava flour (lafun and elubo), etc consumed by the populace. Cassava in Nigeria is consumed mostly as gari in almost every part of the country. In some places the cassava root is a major staple while in other areas (especially in the south west) cassava leaves serve as vegetables. Since the populace is highly dependent on this crop, its use for bio-ethanol will lead to food crises. Already over 60% of the population is poor and survive with less than a dollar per day. The use of cassava for monosodium glutamate, glues/adhesives is also common but in small quantities when compared with its use for food. The ethanol content of cassava root depends on yield per hectare, technology used in the extraction and the variety of the cassava. A conservative average for a ton of cassava will be about 100 litres of ethanol [7-9]. The government target is to blend ethanol with PMS using a ratio of 9:1 meaning the government is adopting E10. Using the 2010 PMS consumption as baseline, total PMS consumption stood at 12.775×10^9 litres where over 60% was imported due to the poor state of the refineries in Nigeria. The drive to produce 1.2775×10^9litres (or 1.2775×10^6 m^3) of ethanol from cassava will require about 12.8 million tones of cassava. The average per capita food consumption in Nigeria is about 600 calories per capita per day where more than 300 calories per capita per day is from cassava in different forms. The consumption of gari may account for more than 70% of cassava consumption in Nigeria [10]. If the same cassava is to be used as feedstock for ethanol, it means that about 30% of total cassava production in Nigeria will not be available for the production of daily calories per capital per day.

Converting 30% of cassava production in Nigeria into ethanol will mean that around 3.83 million tonnes of gari will be lost in circulation thereby increase gari scarcity and threatening food security. The argument is that for every $1m^3$ of ethanol produced for fuel from cassava root, about 3 tones of gari are lost. According to Phillips et al [7] 16% of cassava produced is used in industries (excluding ethanol based industries) as raw materials, a value that must have increased since 2001. Since there is no data on the current percentage, if we assume 25% at the end of 2010 and allowing 10% for post harvest losses and wastes, it means just around

65% of cassava production will be left for other uses including food production and ethanol production).

According to the estimate revealed in this paper about 30% of cassava production is needed by the ethanol plants to deliver the 10% blended needed for the E10 in transportation. It is very obvious that 35% of the remaining cassava production can not feed the Nigeria populace of about 150 million who depend heavily on cassava products for survival due to its low cost availability and traditions. The daily consumption of ethanol in this paper does not include ethanol for cooking, a scheme the government is also seriously considering. This will increase the ethanol need as calculated in this study and will increase the need for cassava. Also the informal exportation of cassava to some neighbouring countries like Niger is not accounted for in this study. It is obvious that there is the danger of food insecurity in the country if she continues to pursue her cassava based ethanol policy without looking into other substitute energy crops.

Furthermore there is the need for second generation feedstock for Nigeria's ethanol needs. This can be obtained from the waste from wood industries, bamboo etc. Table 4 shows the production of cassava and yearly yield in Nigeria. it will be observed that the cassava production yield fluctuates without an trend of definite increment. The current yield stands at 15 tonnes / hectare.

Table 4: Levels of Cassava Production from 1990-2003 (tonnes)

Year	Production	Yield
1990	19,043,008	11.65
1991	26,004,000	10.19
1992	29,184,000	10.59
1993	30,128,000	10.59
1994	31,005,000	10.59
1995	31,404,000	10.68
1996	32,050,000	10.66
1997	32,695,000	11.88
1998	32,698,000	10.75
1999	32,070,000	10.64
2000	32,810,000	10.64
2001	32,586,000	10.80
2002	34,476,000	9.98
2003	33,379,000	10.92
2004	38,211,000	11.60
2005	42,012,000	11.60

Source: FAO (2004) &Authors

4. Capacity Building Strategies

Ethanol production in Nigeria has the potential to radically change the economic condition of the country which presently relies solely on the exportation of crude oil. The Nigerian agricultural sector which is currently dedicated only to food production, will also receive a boost. The construction of Ethanol plants in Nigeria is taking place within a non-consolidated governmental policy framework, though there are efforts to address this situation. The political environment in Nigeria is known to have lots of challenges, and the bio-ethanol

industry is no exception. No adequate policy framework exist that directly addresses the challenges and peculiarities of the bio-ethanol industry in Nigeria; however, this work will provide recommendations and capacity building strategies to sustain current developments in the Ethanol industry in Nigeria.

4.1 Research and Development Centres

One key attribute of the success of the Brazilian ethanol industry was the huge investment in agricultural research and development by both the government and the private sector. The results of most of the research carried out by some government owned agencies (like EMBRAPA) together with universities have allowed Brazil to play a major role in Bio-ethanol technology [11, 12]. There is need for Nigeria to learn from countries like Brazil and US on how to efficiently utilize agricultural land for optimum yield. Nigeria produces more than 40 million tonnes of cassava yearly with an average yield of about 15 tons/hectare as compared to 25-30 tons/hectare obtainable in other countries. Increasing efficiency of inputs and processes to optimize output per hectare of feedstock comes only through research. The growth rate in Brazil's efficiency in ethanol production is about 4% per year. Innovations in the industrial process of cassava (saccharification and fermentation) will allow an increase in carbohydrate extraction from the cassava root up to 70 %. The government's budget and policies have not laid emphasis on research and development but more on ethanol plant construction and cassava plantations. There are more than 70 universities in Nigeria and more than 4 of the Universities are Universities of Agriculture, well equipped to carry out research on the second generation feedstock for ethanol, but the government has consistently ignored the role of research institutions in its Bio-ethanol development. The government needs to empower the Universities through its various agencies to carry out substantial research to aid the development of a more sustainable ethanol technology.

4.2 Financial Institutions, Private Investments and government incentives

Nigeria's bio-ethanol feedstock production is government led and has little input from private firms. The industry needs more participation from commercial agricultural firms and support by financial institutions. Government intervention at the initial phase of bio-ethanol production is necessary but access to finance and availability of affordable loans should be encouraged. In Nigeria for instance, no insurance or commercial bank gives soft loans for the cultivation of cassava for bio-ethanol production. The banks are unwilling to provide finance due to market uncertainties and perceived high risks. The lack of adequate data to guide financial institutions and insurance firms in taking decisions are due to gross variations in the data obtained from the government and the private sector. There are a number of incentives the government can deploy to stimulate the Nigeria's bio-ethanol industry [13]. These include:

- **Pioneer Status**: All registered businesses engaged in activities related to biofuels production and/or the production of feedstock for the purpose of biofuel production and co-generation within the country shall be accorded Pioneer Status within the provisions of the Industrial Development (Income Tax Relief) Act.
- **Withholding tax on interest, dividends, etc**.: Biofuel companies shall be exempted from taxation, withholding tax and capital gains tax imposed under sections 78, 79, 80 and 81 of the Companies Income Tax Act in respect of interest on foreign loans, dividends, and services rendered from outside Nigeria to biofuel companies by foreigners
- **Waiver on import and customs duties:** Biofuel companies shall be exempted from the payment of customs duties, taxes and all other charges of a similar nature.

- **Waiver on Value Added Tax: T**his shall also apply to all Biofuel companies operating in Nigeria.
- **Long term preferential loans:** Preferential loan arrangements will be made available to investors in the biofuel industry to aid the development of large scale outgrower schemes and large scale integrated operations, including plantation, plant, and within the gate co-located power generation plants. An Environmental Degradation Tax shall be charged on oil and gas upstream operations to provide a source of funding for preferential loans.

5. Policy Recommendations

The development of bio-ethanol in Nigeria is a welcome idea coupled with the benefit of job employment and increased revenue for the government. The sustainability of bio-ethanol implies that government needs to improve on their present commitment and learn from the success stories of countries like Brazil and inculcate suggestions that will help to sustain the bio-ethanol development in Nigeria. In lieu of that the following recommendations are given:

(i) Effective and robust loan facilities: There is the need for long term loan facilities to motivate farmers into practicing commercialized farming. Agricultural incentives like little or no interest rates on short term loans, low interest on long term loans should be made available to farmers. The recapitalization of banks in Nigeria was to allow cash flow to small business but this is not the case.
(ii) The land use act: There are so many flaws in the land use act that needs to be amended, the land use acts needs to favour land for agriculture purposes.
(iii) Tax exception: Tax incentives should be given to private investors willing to invest in the bio-fuel feedstock.
(iv) Export and import duties: The waiver of duties on imports and exports related to bio-fuel should be considered by the government to kick start her ambition in the bio-ethanol field. Since the government has a poor record in the management of bio-ethanol blend. The management of bio- ethanol blend should be private sector driven
(v) Well equipped R&D: The technology of bio-ethanol in Nigeria should have indigenous perspectives, the government and the private sector should jointly fund research both at home and abroad to validate their outcomes at every point. Bio-fuel industry comes with new technology. The Universities of Agriculture in conjunction with Universities of Technology available in the country should be given the responsibility of pioneering this research.
(vi) Bio-fuel policy and legislature: Nigeria's bio-fuel policy at the moment is still sketchy and need thorough work to establish a frame work and legislature for industry. Clean energy and techniques should be well promoted and the consequences of breaking the law should be severe. The law to govern the bio-fuel industry should be corruption proof.
(vii) Promoting the use of second generation feed stocks: This will reduce the risk and threat to food security especially in Nigeria where the first generation feed stocks are the main source of food.
(ix) Setting up a Bio-fuel Feedstock regulatory body: A body like this will be given the responsibilities to oversee the sale, price and consumption of feedstock for domestic consumption and for the bio-fuel industry
(x) Brazil and the US partnership: The government should involve the two leading countries in bio-fuels to shape its bio-fuel policy and technology.

6. Conclusion

The development of the bio-ethanol industry in Nigeria is an important milestone in achieving energy self-sufficiency and sustainable development, especially in the transportation sector.

This paper has reviewed efforts of the Nigerian government towards bio-ethanol blend in the country, the risks and dangers involved in kick-starting ethanol production without proper policy and developmental frameworks to increase cassava production and yield. Commercial agriculture must play a pivotal role in this development of bio-ethanol without leading to food insecurity. There is need for the government to encourage and give incentive for cassava production in the country. The need for government to involve research institutions in the development of bio-ethanol and cassava cannot be over emphasis. The government also has to design incentives for financial institutions to grant soft loans for the purpose of cassava cultivation on a large scale. The government's ambition to advance bio-ethanol technology in Nigeria poses a threat to its populace of about 150 million if adequate frameworks are not put in place as recommended in this work. If the government wants to continue its bio-ethanol technology the paper recommends that the decision makers should carefully review the policy recommendations in this work.

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