

## ECONOMIC POTENTIALS OF PHYSIC NUT (*Jatropha curcas* L.) IN KANO STATE, NIGERIA

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### ABSTRACT

*Inadequate alternative sources of energy and income engender unsustainable exploitation of the environment by the inhabitants of semi arid regions. Therefore, this study was designed to assess the potentials of Jatropha curcas as an alternative source of energy and income in Kano state. Jatropha curcas L. is a drought resistant shrub. It is extremely hardy and will thrive on land, which would not support food crops. Jatropha curcas also produces wood though of poor quality for cooking, animal feeds and can grow on lands which cannot support crop agriculture. also used locally to satisfy various needs over several decades in a sustainable manner. \limited fossil fuel reserves and concerns over security of supply (i.e. the oil crises), initiated the first raise of interest in biomass and other renewable energy forms with the aim of diversifying the energy supply so as to include renewable resources and technology. supply of conventional energy in the country indicated severe economic, political and logistic constraints in making energy available in the rural areas. Nigeria's bio fuel industry can be developed on such biomass as cassava, sugarcane, nypha palm, and J. curcas. Nigeria is the world's largest producer of cassava which is a staple food. However J. curcas can be used to develop a stable bio fuel economy in the country because it is a third generation crop that cannot contribute to the Global Food Crises\Deliberate and focused public sensitization campaign on the utilization and production of J. curcas products in the study area, establishment of a biodiesel refinery in the state, plantation establishment and government partnership with private sector need to be emphasised.*

**KEYWORDS:** Potentials, Biodiesel, Industry, Economic, *Jatropha*

### INTRODUCTION

According to Anon (2007), *Jatropha curcas* L. is a drought resistant shrub that can grow to heights of six meters or more thus, making the collection of seeds more convenient. It is extremely hardy and will thrive on land, which would not support food crops. It also produces seeds for 30 - 50 years and can be propagated by both seeds and stem cuttings. *Jatropha curcas* belongs to the family Euphorbiaceae in the order Euphorbiales containing some 7500 species in 275 genera. Many members are important food sources; others provide waxes and oils as well as medicinal drugs. (Johns and Miller, 1992).

The idea that the fossil fuel reserves are limited (known crude oil reserves are estimated to be depleted in less than 50 years at the present rate of 30 million liters consumption per day (Ayuba, 2009), together with concerns over security of supply (i.e. the oil crises), initiated the first raise of interest in biomass and other renewable energy forms. The total consumption of conventional energy resources (crude oil, natural gas, coal and large-scale hydropower) has grown at an average rate of 9.8% per annum (Okonkwo, 2008) over the last ten year period, while their supply infrastructure have been stretched to the limit. With increasing population, the pressure on the infrastructure for the supply of conventional energy resources will continue to increase. To enhance the energy security of the country and to establish a sustainable energy supply system, the country's policy of having an optimum energy resource mix, by diversifying

the energy supply so as to include renewable resources and technology must be taken seriously. Apart from this, the problem of deforestation and consequently, desertification making fuel wood consumption, as a renewable energy (Achimugu, 2008) also support alternative and sustainable energy supply system. The recent interest on alternative sources of energy place *J. curcas* in the forefront of any discussion on bio-fuel production. (Heller, 1996). Past experiences in the access to conventional energy in the rural areas was reported by Bayo and Akinbanmi (2008) as low (18% for electricity as opposed to 81% in the urban centres). Interest on biomass is increasing in the light of the growing concern about global warming and the resulting climate change. The emission of the greenhouse gas CO<sub>2</sub> can be reduced when 'green' biomass-derived transportation fuels such as biodiesel are used (Anon, 1993). Again, in Nigeria, the demand for fossil fuel is not matched by a corresponding increase in the supply infrastructure. This disproportionate balance favoured the urban areas especially during the perennial fuel scarcity (Bayo and Akinbanmi, 2008). *Jatropha* oil is a viscous oil of (50% by weight) which can be used as biodiesel, in the manufacture of soap, candles and in the cosmetic industry. It can also be used in cooking and lighting thus, having the potential of satisfying rural energy needs while serving as a substitute to fossil fuels to reduce greenhouse gas emissions. *Jatropha curcas* is nicknamed the "the king of the biodiesel plants (Anon, 2008), and is thriving well in Kano state.

The potentials of *J. curcas* are currently being investigated worldwide. However, attention is mostly focussed on its use as feedstock for biodiesel production. Anon (2007) reported that 10% (B10) of oil used by the railway and Indian Oil Corporation had been successfully prepared from *Jatropha* oil. Olende (2008) observed that there have been major strides all over the world in the use of bio fuel especially in Brazil, China, USA and India but with relatively little action from Africa except for South Africa. He also reported cooperation between the government of Kenya and Japan to produce bio fuel and the construction of a plant for processing *Jatropha* oil into biodiesel by Ghana Bio Energy Ltd, while Malawi's biodiesel association has obtained contracts for a *Jatropha* planting programme, Uganda on the other hand plans to be the pioneer country in Africa to operate a biodiesel plant. Ngethe (2008) reported a pilot rural electrification project powered by biodiesel of *J. curcas* origin in Kenya. In Nigeria, a lot of researches are taking place on plantation establishment, silvicultural requirements as well as its utilisation potentials. Balewu (2008) investigated the replacement of fungus treated *J. curcas* kernel meal in the diet of rats while Balewu and Ogunsola (2008) also looked at the haematological and serum indices of goat fed with fungi treated *J. curcas* kernel cake in a mixed ration.

Popoola (2005) had shown that poverty is one of the reasons why people exploit their environment in a manner that leads to environmental degradation. This research is justified to assess the economic potentials of *J. curcas* in Kano state in terms of acceptability, policy framework, demand and supply potentials of its Products as well as the market outlet and market structure with a view to assess the potentials of *J. curcas* in providing economic benefits that may serve as a vehicle through which the factor of poverty can be eliminated in the study area.

#### **Potentials of The *J. curcas* Small Tree**

Scidev (2010) described *J. curcas* as a hardy multipurpose shrub tree that is found mostly in the wild in Nigeria. The kernels are rich in oil with up to 60% oil content which can be processed into bio diesel. The local inhabitants use it in making soap and in lighting as well as in making candles. The bark has medicinal value while the seed cake can be used as animal feed after detoxification.

Conventional energy resource such as coals and gasoline provides most of the energy needs of the present day world. However, diminishing reserves, high prices, and most importantly environmental concerns necessitated the search for alternative sources of energy. Bio fuels are any fuel derived from organic materials. These include wood, wood-chippings, methane from animal excrement and bacterial activity; or

ethanol from seaweed. Youngsters (2010) opined that Nigeria has the potential of being the world's largest producer of ethanol and biodiesel in the next ten years. In an article titled Bio fuel Economy: opportunity for a Nigerian Bio fuel Industry, Youngsters (2010) outlined how China, Brazil and Thailand produce ethanol from cassava in commercial quantities and incidentally they import cassava from Nigeria. *Nypha* palm otherwise known as the mangrove tree was introduced to Nigeria by the European settlers in the late twentieth century since then it has exhibited prolific growth (covering 504,000 ha in the Niger Delta alone) which makes it an invasive species, efforts to stop its expansion failed. Fortunately it can now be used as a resource for the production of ethanol to substitute cassava which is a staple food in Nigeria thereby reducing competition between fuel and food. However, youngsters (2010) pointed out that the ethanol industry will not be a source of a new affordable fuel for Nigerian masses. This is because the technology used in Nigeria is not adapted to ethanol. Ethanol burns at higher temperatures than gasoline and as such the low quality engines used in Nigeria can easily be damaged when used with ethanol. Youngsters (2010) stated that the bio fuel most suitable for integration into the Nigerian fuel market is bio diesel because it can be used in all diesel engines used in Nigeria without any modification to the engines. *J. curcas* bio diesel can conveniently satisfy the need of the Nigerian fuel economy. The small tree has been used locally to satisfy various needs over several decades in a sustainable manner. *J. curcas* can be used to develop a stable bio fuel economy in the country because it is a third generation crop that cannot cause food scarcity. Its various potentialities were complemented by the fact that it can grow on most of the abundant marginal lands unsuitable for crop agriculture. Developing a *J. curcas* economy could be the best decision Nigeria ever takes because *J. curcas* can be used to generate electricity for local masses which will eventually lead to industrialization and an overall increase in GDP. However, for this to happen there must be a proactive government policy that will ensure that the proposed bio fuel economy remains in the hands of the local people and not hijacked by foreign conglomerates like in the case of the fossil fuel industry (Bene, 2006). International cooperation can however not be ruled out in areas of technology transfer for the extraction of bio fuel and its utilization. For example petrobras a Brazilian company, signed a pact with NNPC in areas of technology transfers for bio ethanol in exchange for market for its products (ethanol).

According to Advanced Biofuels USA (2009), a demand of 13 billion gallons/ year of ethanol was created due to the 10% motor fuel mandate which proved to be very good for the ethanol industry in the USA.

The biodiesel industry is witnessing an unprecedented expansion throughout the world. This growth in market share will enable the emergence of vertically integrated businesses that will offer high return on investment, create jobs and ensure regional and national economic development (Agland, 2006). It is also pertinent to learn more from the experience of bio fuel projects around the world. This is very important if one considers the opinion of Haney (2009) especially on *J. curcas*, when in 2007 governments and businesses around the globe jumped into the *J. curcas* band wagon leading to the "jatropha hype" and missed opportunities, to cumbersome farming systems of the local communities that are not optimal for the shrub like tree, and the use of inferior strains of *J. curcas*. He also pointed out that *J. curcas* is undomesticated. However Haney (2009), emphasized that the true promise of *J. curcas* can only be realized through breeding, employing proper silvicultural practices and through the creation of a viable global marketplace as a consequence of a developed value chain. He also recognized the fact that indigenous cultures long identified *J. curcas* as a source of cooking and heating oil in addition to its medicinal value while recently, its value as a source of sustainable bio based materials and petroleum substitutes including biodiesel, chemicals and jet fuels are assuming prominence. The overall greenhouse gas emissions are estimated to be 70% less than petroleum biodiesel Haney (2009).

*Jatropha curcas* has considerable potentials for breeding and tree improvement especially because it has separate male and female flowers. Improvements through the traditional crop breeding could produce a 50 to 100% increase in yield. This is quite significant when compared to the yield of rubber which was increased to 400% through breeding (Haney, 2009). However, the use of biotechnology can increase the yield even higher and at the same time reduce the silvicultural inputs. (Haney, 2009) estimated that *J. curcas* can produce crude Jatropha oil at a \$ 1.5/gallons as at present; with improvement through breeding the cost can be reduced to less than \$1/ gallon. Since feedstock constitutes 70% to 80% of the bio fuel cost of production, lowering its cost can increase value in the Jatropha biodiesel value chain. This can be done by empowering growers to produce feedstock at a lower cost. Agland (2006) submitted that the rise in petroleum prices is not a brief occurrence when the 10 year forward price of petroleum of \$70 / barrel is considered this means \$1.75 to \$ 2 for refined products at wholesale without incentives or Subsidy. This presents a potential economic target for alternative fuels such as *J. curcas* biodiesel. The cost of production of biodiesel from vertically integrated Jatropha businesses and processing is given by Agland (2006) as \$1.25\gallon this is

much lower than that from soybean oil which is up to \$ 2/gallon. (Haney (2009) opined that the process of developing *J. curcas* as a veritable and sustainable energy crop is still at its initial stages, yet the opportunity to achieve a momentous leap in yield, profit and short term commercialization exist. Agland (2009) identified the ways to achieve this as focusing on farm to fuel projects that have the four key elements of location price linkage and processing. He also stated that the impetus for this is provided by the fact that governments are becoming more aggressive in terms of policy thrusts that are geared towards alternative fuels. This policy was driven by objectives such as energy independence, clean energy and rural development goals.

The predominantly small to medium scale capacities of *J. curcas* conversion systems fit the capacities of most rural energy requirements for both social and economic activities. The following are some of the economic potentials of *J. curcas* as reported by Sambo *et. al.* (2008);

- Bio diesel production 31 to 37% of the oil extracted from *J. curcas* seeds can be converted to bio diesel which can be used on any diesel engine without modification.
- Energy Independence: With oil priced at over \$100 per barrel, a disproportionate impact on the poorest countries was created (including Nigeria though a major exporter of crude oil). The development of Jatropha based bio diesel industry might confer some kind of energy independence to the country in general and to the state in particular.
- Economic Growth bio fuels from *J. curcas* may create new markets for non wood forest products and stimulate rural development because bio fuels are generated from tree crops; they hold enormous potential for farmers in the near future especially for the two-thirds of the people in the state who derive their incomes from agriculture and forestry. Again its price is not distorted by food prices as the oil is non-edible. The plantation will provide jobs to the local people. The seed cake is an excellent fertilizer, as it is rich in Nitrogen, Potassium and Calcium. Harvested seeds and unrefined crude oil can be exported to developed markets. Yet, it has a short gestation period.
- Sale of seedlings: Selling treated Jatropha seeds, and quality sapling
- Dye and wax: Dark blue dye and wax can be produced from the bark of the *J. curcas* plant; roots help in making yellow dye.
- Wood: Jatropha plant Stem is used as a poor quality wood: Bio fuel
- Medicinal use: *curcas* leaves helps in dressing the wound. Juice of the flowers of *J. curcas* and the Jatropha stem has very good medicinal properties.
- Tanning: Pounded seeds are used in tanning

- Press Cake: *Jatropha* becomes Organic fertilizer and soil improver. Other uses of *J. curcas* extracted oil are as: varnishes, illuminates; soap, pest control and medicinal for skin diseases, as purgative.

The Northern parts of Nigeria (dry and sandy). as observed by Anon (1998) are isolated and fragile with soils that are easily erodible and subject to the stress of deforestation and desertification and prolonged draught as well as decreasing ground water. JKano state is characterized by the presence of vast quantity of marginal lands especially in ohns and Miller (1992) stated that plant species such as *J. curcas* that can grow on lands which cannot support crop agriculture and be able to supply raw materials to the industries, fuel for basic energy needs and improve the environment, need to be studied carefully.

*Jatropha* is not browsed for its leaves and stem because they are toxic to animals. However, after treatment, the seed or seed cake can be used as animal feed (Trabi *et. al.*, 1997). The seed cake is also rich in nitrogen and can be used as green fertilizer (Heler, 1999). The bark contains tannin, the flower attracts bees, and the oil extracted from the seed (50% by weight) is viscous and can be use in the manufacture of candle and soap by the cosmetic industry. The *Jatropha* oil by itself can be use for cooking and domestic lighting. It can also be used for meeting the rural energy needs as a substitute for mineral diesel oil whose full supply to rural areas was limited by severe infrastructural constraints (Openshaw, 1986).

However, despite these numerous benefits, Anon (1998) stated that the full potential of *J. curcas* is yet to be realized, due to the technical, economic, cultural and institutional reasons that need further consideration and examination.

Poverty has been identified as the reason inhabitants of dry regions exploit their environments in ways which leads to desertification and other environmental degradation (Popoola, 2005). The North Western region of Nigeria was identified as the poorest in the country (Central Bank of Nigeria) the inhabitants earn less than a dollar /day, this coupled with the problem of unemployment in the country and harsh climatic conditions combined to force the inhabitants to exploit the sparse vegetation cover; firewood hawking becomes one of the lucrative businesses in the area. Nowadays, firewood vendors have to travel to far away distances to source firewood. Presently, only the firewood merchants with sound capital base were left in the business. Meanwhile most of the environment was left bare of any woody trees except for thorny shrubs and other xerophytes perennials. The twin factors of loose soil and wind erosion continue to turn most

of the arable land to marginal and wasteland that are not suitable for arable crop production. Against this background, *J. curcas*, can thrive on such poor soils and produce seeds from two to three years after establishment and up to 35 years thereafter. *J. curcas* was known to the inhabitants for centuries; oil can be extracted from the seeds from which biodiesel, soap and other products emerging in the world market can be produced. *J. curcas* described as the most potential species for bro diesel production can bring a whole package of alternative sources of livelihood to the inhabitants of dry regions, the oil from its seeds can be used to power diesel engines directly without any modification, for provision of power for domestic activities such as lighting, refrigeration, processing of agricultural products as well as supplying power to cottage industries. The oil can also be used in stoves for cooking or can be processed into biodiesel for fuelling vehicles. The seedcake can be used in thermal plants or treated (detoxified) and used as fodder. The bark can be used to treat many ailments while the stem can be used as poor quality wood for cooking. The *J. curcas* tree can be used for afforestation of the depleted lands while the sale of *J. curcas* seedlings can sustain several families. Again, western countries demand for alternative fuels present an opportunity for developing countries due to insufficient lands in the respondents developed countries for biodiesel production; especially with the high blending targets usually set.

The growing interest in *Jatropha curcas* as a biodiesel "miracle tree" to assist in alleviating the energy sometimes failed to take in to cognizant the fact that many of the farmers in developing countries have no access to land needed to even grow food crops, and to be economical as a biodiesel fuel, *Jatropha* must be produced in volume. The processors, retailers and the "middle- men;" stand to gain the most. The middle- men have a history of exploiting vulnerable small producers (Benge, 2006).

#### **Biodiesel Production from *J. curcas***

According to Anon (2007), bio diesel is renewable liquid fuels produced domestically that can help reduce the dependence of countries on foreign oil imports. The concept of bio diesel dates as far back as 1885 when the first diesel engine was fabricated by Dr Rudolf Diesel with the sole intention of running it on oil of vegetative origin. He surprised people when he ran the patented engine in 1900 at the Paris show on any hydrocarbon fuel available including gasoline and peanut oil, Dr Diesel predicted the relevance of bio fuels in the distant future. Openshaw (2008) stated that biodiesel production from *J. Curcas* has the following advantages:

- Biodiesel is one of the most valuable forms of renewable energy that can be used directly in any existing unmodified diesel engine.
- Biodiesel can be produced from *J. curcas*.
- Biodiesel is environmentally friendly and ideal for heavily polluted cities.
- Biodiesels produce 80% less carbon dioxide and 100% less sulphur dioxide emissions. It provides a 90% reduction in cancer risks (Openshaw, 1986)
- Biodiesel is biodegradable.
- Biodiesel can be used alone or mixed in any ratio with mineral diesel fuel.
- The oil is preferred if ratio mixture ranges between 5 and 20% (B5 - B20)
- Bio Diesel extends the life of diesel engines
- Biofiesel is cheaper than mineral diesel
- Biodiesel is conserving natural resources

#### **The process of biodiesel production from *J. curcas***

Okonkwo (2008) stated that *Jatropha* seed oil is converted into biodiesel fuel through a process called Transesterification. Crude unrefined *Jatropha* oil is dark greenish yellow in coloration, Transesterification is a chemical process by which a triglyceride molecule or a complex fatty acid is taken and the free fatty acids are neutralized. The glycerine is then removed thus, creating an alcohol ester. Transesterification is accomplished by mixing methanol with sodium hydroxide to produce sodium methoxide. This liquid produced is then mixed with the vegetable oil. The mixture is allowed to settle the Glycerine is left at the bottom and methyl esters, or biodiesel is left on top. It is then washed and filtered. The final product is biodiesel fuel which can be used directly in a diesel engine (Okonkwo 2008). It was reported to burn cleaner than mineral oil diesel fuel to the tune of up to 75%.

#### **The Global Energy Crisis and the Nigerian Economy**

The global energy crises were precipitated in the year 1991 with the first Gulf war when oil production from Iraq (the world's second largest producer of oil) was almost shot down saves for the oil for food program under the supervision of the United Nations (UN) Bob 2009). Oil prices sky rocketed with the attendant wind falls to the oil producing countries including Nigeria.

However, the oil price subsided in later years only to resurface again towards the tail end of 2008 partly due to the invasion of Iraq by the then Bush administration and partly due to the activities of the oil cartel OPEC. The World witnessed the highest escalation in mineral oil prices. According to the IMF (2008), the price of crude oil rose from \$30 a barrel in 2003 to around \$130 a barrel in 2008. It was reported worldwide as the Global Energy Crises and it gave an impetus to the search for alternative sources of energy to mineral oil. Terms such as Biofuel and Biodiesel became very popular in advanced

countries, which are in the forefront in the search for alternatives. They began to set targets for ambitious projects on biofuel with the sole purpose of protecting their economy from dependence on foreign oil supplies that are mostly from countries and regions that are politically unstable and volatile.

The Global Energy Crises affected Nigeria both positively and negatively. The positive impact was in greater crude oil export revenue while the negative impact pertains to the inability of the country to refine its own crude oil. Petroleum resources are imported by Nigeria through the seaport and transported by land to the hinterland at enormous cost, to the final consumer.

Crude oil, over the past five years was the highest contributor after crop production and it contributed an average of about 25% to Nigeria's Gross Domestic Product (GDP). This contribution of energy to GDP is expected to be higher when renewable energy utilization were taken cognizant because they account for about 90% of the energy used by the rural population (NPC, 1997).

The daily consumption of petroleum resources in Nigeria was pegged at 30 million litres per day (Bello, 2009). The four (4) refineries were not functioning properly to cater for the increasing demand for petroleum products. The rural dwellers were the hardest hit by this scenario and the consequence of this was that they looked to their immediate environment for energy. The result was increased deforestation and other environmental degradations.

The National Energy Policy of Nigeria stipulated energy mix to include renewable energy resources (Achimugu, 2008). However, Anon (1998) observed that the search for alternative sources of energy is yet to register any significant strides in most developing countries. Despite this, the scarcity of mineral oil occasioned by the lack of supply infrastructure together with power failures forced the issue of alternative sources of energy, especially bio fuels on the agenda of intellectual discussion. This is partly due to its income generation and the advantages that can be derived from diversified sources of energy. This is important if Nigeria is to be self-sufficient in its energy needs.

Developed countries such as US and the EU countries took steps to reduce their over-dependence on mineral oil by setting up targets on bio fuels. However, the high target set, resulted to another crises:

The food crises, Food crops and land used for their production was diverted to the production of bio fuels. To alleviate the food crises, third generation crops such as sweet grass (for bio' fuel) and *Jatropha* (for biodiesel) were brought under investigation. In twelve states and four (4) river basins, over 278 unexploited SHP sites with total potentials of 734.3 MW were identified.

### **The Food Versus Fuel Debate**

According to Lendman (2008), natural and anthropological factors such as high oil prices, transportation cost, growing demand, speculation, and pest in Asia, drought in Australia and floods in Bangladesh caused a global food crisis. However, many, including Calder (2007), squarely blamed the bio fuel hoax for the Global Food Crises. Stiffler (2005), in his article "Bio debatable food Vs fuel" opined that in the middle of a global food crisis the production of bio fuel was taking away food from the dinner plate of people into the gas tank of cars. He wondered how green bio- fuels are. The food crises however, cannot be caused entirely by the production of bio fuels as observed by Pham (2006). He stated that the agric subsidy given to American the farmer retarded food security in the developing world thereby necessitating American food aid. Some blamed population explosion as in the Malthusian theory to be the main cause (Pregnant pause, 2000).

This scepticism about the diversion of food crops to bio fuel forced the European Commission to back out of its plan to enforce the inclusion of 10% of bio fuel on all gasoline and diesel products (Trenor, 2008). A pressure from different individuals and groups including the economic ministers of the EU countries was responsible for this policy reversal even though not officially ratified.

However, despite this anti biofuel pressures, the US went ahead with its biofuel policy. On the 19<sup>th</sup> of December, 2007 the Energy Independence and Security Act signed into law stipulated the production of 36 billion gallons of biofuel each year by the year 2020 which is fivefold increase on the current levels. This is important to world food crises because 54% of the corn produced in the world was produced in the US and that substantial amount of it was going into the production of ethanol to fill the gas tank of vehicles instead of the stomach of human beings (Calder, 2007). The concern for the diversion of food crops to ethanol production forced scientists to experiment with second generation and third generation crops like sweet grass and *Jatropha* for ethanol and biodiesel production respectively. This will spare the conventional food crops for human consumption. (Lendman, 2007). The research on *J. curcas* biodiesel was global. In Kenya, pilot projects were stated to provide rural communities with electricity from *J. curcas* biodiesel as reported by Ngethe (2008). In Nigeria, The National Energy Law was signed Achimugu (2008). Biodiesel from *J. curcas* a long known crop in Nigeria has rekindled interest as a hope for reducing rural poverty projects based on bio diesel from *Jatropha* have already started. Bayo and Akinbami (2008) reported a bio electricity production in Nigeria.

### **The Supply of Conventional Energy Resources in Nigeria**

Conventional energy resources include large scale hydro power, nuclear energy and petroleum

resources. The use of conventional energy resources in Nigeria was dominated by petroleum resources. However, the supply of petroleum resources in Nigeria was characterized by a complex of limitations which include the unending conflict in the Niger Delta Area, the perennial corruption in the oil sector, the epileptic nature and inadequate number of the refineries, importation of refined petroleum products and over-dependence on a single source of energy.

Inadequate number of refineries strengthened by the epileptic nature and lack of full capacity utilization also predisposes the country to recurring fuel scarcity. Major Petroleum Marketers Association of Nigeria (MOMAN) blamed the Federal Government for the fuels scarcity. This was because they were uncomfortable with the government move to deregulate the importation of petroleum resources. They also wanted the arrears of 2007/2008 petroleum support funds of seventy billion naira to be settled by the Federal Government (Muhammad, 2009). However it was asserted that the building of more refineries by the private sector, liberalization of the downstream sector and passage and implementation of the Oil and Gas Sector bill are the solutions to the country's energy problems and that even if the existing four refineries were working at full capacity they cannot meet the country's consumption need of 30 billion litres per day (Ayuba, 2009).

This further buttressed the need to diversify the country's energy needs to include renewable energy such as the use of energy crops, which according to Olaoye (2000) is a crop grown primarily to provide a feedstock for biofuels to be burned for heat or electricity. Examples of energy crops include corn (*Zea mays*), sugarcane (*Saccharum officinarum*), poplar (*Populus* spp.), physic nut, (*J. curcas*), sycamore (*Platanus occidentalis*) and Eucalyptus (*Eucalyptus* spp.).

Three major renewable energy resources are identified in conjunction with the prevalence of biomass resources in Nigeria. These are Solar Energy, wind energy and small hydro power development. There are also abundant rivers, waterfalls and streams with high potentials for small hydropower station (SHP) development. Harnessing of these hydro-resources leads to decentralized use and management of power thus, making sustainable rural development possible through self-reliance and the use of local natural resources. This can be one of the most affordable and accessible alternatives to provide off-grid SHP electricity services. Based on Nigeria's level of hydropower development, SHP has installed capacity of between 2 MW and 10 MW; Mini  $\leq$  2 MW; and Micro  $\leq$  100 kW (Olaoye, 2000).

However, 207 SHP potential sites exist” ‘in virtually all parts of Nigeria with an estimated capacity of 3,500 MW”(Sambo, 2009 and Olaoye, 2009). “if solar collectors or modules were used to cover 1% of Nigeria’s land area of 923,773km<sup>2</sup>, it is possible to generate 1850x10<sup>3</sup> GWh of solar electricity per year. This is over one hundred times the current grid electricity consumption level in the country” ECN (1998). Cook and Bevea (1998) however, submitted that large scale biomass energy development could be beneficial or damaging to the environment depending on the path taken, this is because inappropriate bioenergy development could do great environmental damage especially, and the land requirements for biomass production could be large.

The Federal Ministry of Environment is currently promoting the use of an improved wood stove which is supposed to reduce deforestation by 80 percent. However, it is noteworthy that the lack of inadequate energy has been identified as a critical constraint to the development and productive capacity of most African countries (Bob, 2008).

The incessant and perennial fuel crisis in Nigeria is mostly triggered by the inability of the refineries to function and produce at installed capacity. However, recurring strikes by the oil and gas workers and the transporters of petroleum products were responsible for fuel shortages. Consequently, Nigeria’s endowment as the seventh largest producer of crude oil is not being harnessed. Presently, Nigeria imports over 90% of its domestic petroleum products.

The northern cities suffer the most in the incidence of fuel crisis especially the rural poor because the petroleum supply infrastructure was lopsided in favour of the urban dwellers. IMF (2008) also observed that the poor of developing countries have been hardest hit by food and fuel cost increases. Consequently, the rural poor looked inwards (to the sparse vegetation cover) for their energy needs which results in desertification pressures. To alleviate the over dependence on imported oil, the search for alternatives to petroleum fuel was initiated. The major alternatives are hydropower, wind energy solar energy and nuclear energy. Other alternatives include bio energy. Bio energy comprises of all forms of energy derived from organic sources. Bio fuel can be liquids like bio ethanol and bio diesel, or gaseous, like bio gas According to Dufey et al.( 2007), the term “Biofuel’ is a used to describe fuel derived from organic matter for the generation the of electricity, transport,, or heating These include biogas, bioethanol, and biodiesel. Biogas is a product of fermentation used for electricity generation. Bioethanol on the other hand is an alcohol produced through fermentation and distillation of starchy plants like sugarcane grain and cassava which can be used alone or blended with gasoline. Biodiesel is produced from oilseed-

bearing plants, such as palm kernel, soybean , and castor oil seeds the extracted oil referred to as Pure Plant Oil (PPO) can be processed further into biodiesel. The biodiesel can be mixed with petroleum diesel or used purely to run diesel engines without modification. However, the PPO can only be used on slightly modified diesel engines (Mitchell 2010).

It is estimated by the IEA that bioenergy may meet 25% of the world’s energy consumption by 2050 (Otto, 2008 and Dufey *et. al.*, 2007). Presently, IEA (2007) estimated that fossil fuel constitutes 60% of global oil consumption. COMPETE (2008) stated that the major objectives behind most bioenergy policy in most African countries including Nigeria are rural development and smallholder participation.

Kano State inaugurated an inter ministerial committee on *J. curcas* bio diesel development,the committee invited memoranda from the private investors etc some private investors such as Shashawat submitted proposals to the government for partnership and collaboration on bio diesel production from *J.curcas*.

#### **Climatic and Environmental considerations for bio fuel Production in Nigeria**

Nigeria comprises of five ecological zones namely; the mangrove swamp forests, the riparian forests and the savanna. None of the ecological zones is in its primordial state, each has suffered some form of exploitation and is facing its own peculiar environmental problem; deforestation, erosion, and or desertification. Availability of biomass resources follows the pattern of the nation’s vegetation (Sambo, 2009 and Olaoye, 2001). The rain forest provides the highest quantity of woody biomass while the guinea savannah generates more crop residues than the sudan and sahel savannah zones.

The species has its natural distribution area in the Northeastern part of South America. Thus far, no particular data was found on any on ecosystems in which it naturally occurs. Studying the ecosystem of its natural occurrence is important, as the areas to which the plant has been distributed by men secondary centre of diversity are not necessarily alike, nor are the current cultivation areas. The species has its natural distribution area in the Northeastern part of South America (Bindraban and Brandenburg, 2007).

The savannah ecological zone in Nigeria was classified into as derived savanna, Guinea savanna, the Sudan and Sahel savanna. Guinea savannah areas are facing the problem of deforestation while the Sudan and the Sahel savannah are threatened by desertification due to their proximity to the Sahara desert (located on the Southern fringes of the Sahara). Production of bio fuel in Nigeria is gradually being embraced by various stakeholders.

Bio ethanol production from cassava in Kano State was started in partnership with a foreign firm called Petrobas. Other efforts include biodiesel production with *J. curcas* as the source of bio diesel feedstock in the Sudan savannah because of the abundance of marginal lands. Many authors showed the ecological implications of bio fuel production.

#### Effect of climate on the productivity of *J. curcas* in Kano State

*J. curcas* being an extremely drought tolerant small tree, due to its low water requirement is suited for afforestation of marginal lands in Kano State. This is because sufficient quantities of marginal lands are available in the state which could be utilized for *J. curcas* cultivation. The ability of *J. curcas* to grow on marginal waste or arid lands means that it cannot displace arable crops. Thus, the fear that bio fuels production can lead to food crisis were allayed. Again, the uncertainties of climate change; including the probability of lower rainfalls confers another advantage to *J. curcas* cultivation in the state. Kano State has about million ha of land that is uncultivable wasteland; *J. curcas* can thrive on almost any kind of soil. It can withstand long periods of drought; it needs minimum tending and cannot be browsed by animals. Browsing is an important factor for the survival of planted trees in Kano State *J. curcas* has less pests and diseases problems. Its plantations are expected to start yielding at the 2<sup>nd</sup> or 3<sup>rd</sup> year and they can produce seeds to the tune of 25 tomes/ha. Desertification pressures, especially in northern and eastern parts of Kano State necessitated the state government to engage in various afforestation efforts. Many projects, with local national and international funding were embarked upon to tackle it's menace in the State. However, these efforts were thwarted by the inability of the government to provide alternative sources of livelihood, energy and income to firewood utilization in the state. *J. curcas* cultivation can easily provide the average citizen with job security through plantation establishment activities, seed collection and processing, oil extraction, biodiesel production, marketing and sales of products as well as energy for domestic use such as lighting refrigeration and small scale industrial processing. The rate of deforestation in Kano State is such that firewood sourcing from far away areas has become the norm. With over 10 million people and almost permanent state of kerosene scarcity, the provision of alternative sources of energy becomes imperative.

Kano State is one of the states referred to as the "desertification frontline states" due to their proximities to the Sahara desert adjudged to be harshest desert in the world ( ). An integrated approach that will evaluate the actual problems militating against the success of

afforestation efforts need to be devised. The production of biodiesel from *J. curcas* may help in soil erosion control, provision of income and an alternative to firewood gathering as well as ensuring energy independence. The inhabitants were hitherto dependent on imported petroleum products for domestic cooking, lighting and refrigeration.

*J. curcas* is not browsed by animals and is hardy and as such it can wouldn't face the problems other afforestation tree species faced in such environments as Kano State that has large population of grazing and browsing animals *J. curcas* has a very poor quality wood and as such not suitable as a source of fuel wood thus, escaping the risk of being cut as firewood. Kano State like in most in developing countries may seem to have a great amount of marginal land that is not under any use, where *Jatropha* could be grown; however, most of the lands are for use to graze/browse livestock. *Jatropha* is toxic to livestock, is not a good species for agro forestry systems. Except for live fencing to protect food crops from livestock; and *Jatropha* wood is poor for fuel wood and charcoal. Grasses and shrubs on which livestock feed cannot grow in *jatropha* plantation ; trees are no different than any other agricultural crop, and obtaining optimal yields is dependent upon a variety of things as listed by Benge (2006).

- the use of improved germplasm,
- sites or fertile soils
- adequate moisture.

Although *Jatropha* may look promising as a tree/shrub for marginal lands, without added nutrients, moisture and improved germplasm, it can only produce marginal yields (Mitchell, 2008). According to Olaoye(2001) citing Tolbert and Schiller (1996) and Hoffman *et al.* (1995) in Graham *et al.*(1998) cultivation of crops may lead to more soil erosion than growing short rotation poplar or *jatropha*. and it will use more fertilizers as well Ranney and Mann (1994) stated that the prior environmental effects of the former land use before the establishment of the energy crop determines the environmental value of the energy crop. Tolbert and Schilller (1996) also stated that the physical characteristics such as topography, soil type , temperature and organic matter will strongly influence the productivity of energy crops and therefore the likelihood that they will be grown.. water quality and wildlife will be strongly influenced by the location of the energy crops in relation to other land uses.

#### CONCLUSIONS

Awareness of *J. curcas* is very high in the study area. However, awareness of the utilisation of its products and the opportunities it offers in terms of income and employment generation is very low.

Planting of *J. curcas* by the respondents is not as a result of their awareness about biodiesel. Planting of *J. curcas* is an age long activity for demarcation of farm boundaries. Acceptability of *J. curcas* products by the respondents was found to be very high. Their willingness to utilize, Jatropha biodiesel, Jatropha oil, and the treated seedcake for animal feeds is also high.

#### RECOMENDATIONS

1. Deliberate and focused public sensitization campaign on the utilization and production of *J. curcas* products need to be mounted in the study area.
2. Establishment of large scale plantations of *J. curcas* on the marginal lands available in the state should be encouraged.
3. Establishment of a biodiesel refinery in the state.
4. Provision of capital for the establishment of large scale refineries, plantations and

marketing boards through Commercial Banks, Commercial Agriculture Credit Scheme (CACS). National Investment Promotion Scheme (NIPS) and the utilization of Community Banks for small scale producers should be given serious consideration.

5. To create consumer demand by the government through media promotions.
6. Kano State Government should implement the recommendations of the Inter-Ministerial Committee on Jatropha Development in Kano State which submitted its report in October 2010
7. The Kano State Government should partner with private Invests such by Omni Point Global Resources (OGR) and Shashwat; that have submitted their proposal through the Inter Ministerial Commission on Jatropha Development so as to position the state as the front runner in the area of *J. curcas* biodiesel production in Nigeria.



Plate 1: Live fencing of farmland using *J. curcas*. At Karaye



Plate 2 Planting of *J. curcas* in a school premises at Gaya



Plate 4: Live fencing of a rural compound with *J. curcas* at Tsanyawa



Plate 5: Showing farm-land demarcation with *J.curcas* at Madobi

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