International Journal of Development and Sustainability
ISSN: 2168-8662 – www.isdsnet.com/ijds
Volume 3 Number 4 (2014): Pages 908-916
ISDS Article ID: IJDS12112201

Economics of biodiesel production from *Jatropha curcas L.* in Nigeria

M.O. Raufu *, S.O. Olawuyi, K.A. Fayemo, R.O. Akintola

Department of Agricultural Economics, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State, Nigeria

Abstract

The destruction of green-house gases (GHG) is a major concern of agricultural production. The fact that the biofuel can be used to replace fossil fuel or substitute fuel wood is enough to encourage its cultivation. The supply of biodiesel to available market in Nigeria could not justify the demand for the product. Hence, the study examined the determinants of biodiesel production and that of its perceived effect and advantages of biodiesel on the environment and on human's health in the country. Major area of biodiesel production in Nigeria are Abuja, Ilorin and Lagos and a simple random sampling was used to select two (2) out of these three (3) areas, which are Ilorin and Lagos. A snow-bowl sampling technique was used to sample 40 producers of biodiesel fuel, 20 each from the two chosen areas of production, and 70 users of the fuel (40 in Lagos and 30 in Ilorin) who gave information on their perceived effect of biodiesel on the environment and human's health. Descriptive statistics and regression analysis were used to describe the respondents' socioeconomic characteristics and to highlight the determinants of supply of biodiesel and to assess the factors influencing the perceived effects of the use of biodiesel on the environment and on human's health in the study area. The result indicates that there are more female users of biodiesel fuel than biodiesel producers and majority of the fuel producers are still in their active age. Marital status, price of biodiesel and volume of oil extracted from the seeds significantly influenced the supply of the product while the educational status of the fuel users, price of the biofuel and age of respondents determines the quantity demanded of the biofuel based on it perceived effect and advantages on human's health and the environment. Awareness creation and government investment in modern machines for optimal oil extraction from Jatropha seeds were among the recommendation towards encouraging the biodiesel business and minimizing the destruction of the green-house gases by fossil fuels.

Keywords: Jatropha Plant, Green-House Gases (GHG), Biodiesel, Perceived Effects, Non-edible Oil, Trans-esterification

Cite this article as: Raufu, M.O., Olawuyi, S.O., Fayemo, K.A. and Akintola, R.O. (2014), "Economics of biodiesel production from Jatropha curcas L. in Nigeria", *International Journal of Development and Sustainability*, Vol. 3 No. 4, pp. 908-916.

* Corresponding author. *E-mail address:* oyedapo726@yahoo.com

1. Introduction

Jatropha curcas is a shrub tree which grows in all part of Nigeria with little or no maintenance. *Jatropha curcas Linnaeus* is the only plant which pairs a high yield of extractable oil from its seed to a relative low price for the raw oil, this is due to the fact that Jatropha plant seeds produce non-edible oil and kernel consists of about 60 per cent of oil in which the transformation is through esterification into biodiesel. This plant has longevity of 40-50 years, it controls erosion and does not require a fertile land to germinate.

Interestingly, the plant is cherished for its medicinal purposes and does not produce any toxic or harm to the environment, instead, it purifies the environment. It was discovered that 23 per cent of carbon dioxide (CO_2) in the area where *Jatropha curcas is planted* is absolved by the plant per annum (Belewu and Ogunsola, 2010). Apparently, none of the plant part is wasted, all the plant parts has its usefulness. After extraction of the oil from the plant seed, the oil undergoes different processes in which trans-esterification is the major process of refining the oil to biodiesel, thus this biodiesel could be used alone or mixed with petro diesel and use to power any diesel engine.

The by-product in the refining process includes the seed cake (this can be used to feed animals after the treatment of the seed cake with fungal-tail and could also be used as fertilizer), glycerine and husk (from the back of the seed). It is worthy to know that this biodiesel functions more perfectly in diesel engine more than fossil fuel diesel. More so, it leads to minimization of destruction of green-house gases (GHG) which is the major concern of agricultural production. The destruction of GHG leads to total change in climate, this absolutely distort the forecasting of weather condition to predict when to rain for agricultural production processes.

However, the major solution to proffer to global warming is invention of biodiesel productions and the usage for all engines. But the distribution, establishment, management, harvesting and uses of this plant is not properly documented in Nigeria. The fact that the biofuel can be used to replace fossil fuel or substitute fuel wood is enough to encourage its cultivation in Nigeria. Hence, adoption of this biodiesel production and marketing would successfully increase economic growth and assist in reducing deforestation. The seeds of Jatropha contain viscous oil, which can be used for manufacture of candles and soap, in cosmetics industry, as a diesel/paraffin substitute or extender. This latter use has important implications for meeting the demand for rural energy services and also exploring practical substitutes for fossil fuels to counter greenhouse gas (GHG) accumulation in the atmosphere. These characteristics along with its versatility make it of vital importance to developing countries (Kumar and Sharma, 2008). Growing Jatropha sustainably has the power to improve the soil for future generations. Non-edible Jatropha is being heralded as one of the best crops for producing plant oil for energy use. Shown in Table 1 is dry matter composition of Jatropha plant components.

The supply of biodiesel to available market could not justify the demand for the product and the advantages of the fuel to human's health and environment have still not gain enough awareness in the country. Therefore the followings are research questions to provide answers to;

1. What is the socio-economic characteristic of respondents in the study area?
2. What are the determinants of supply of biodiesel?

3. What are the factors influencing the perceived effects of the use of biodiesel on the environment and human's health?

Table 1. Dry Matter Composition of *Jatropha curcas* Components

Components	Moisture %	Dry matter %	Relative Compostion	Oil content
Wood	15	85	25	
Leave			25	
Fruit	8.0-23.0	77.0-92.0	50	
Coat	85.0-89.0	11.0-15.0	26.0-30.0	
Seed	3.0-7.0	93.0-97.0	70	33.0-74.0
Shell	10.0-11.0	89.0-90.0	29.9-41.6	
Kernel	2.2-11.3	88.7-97.8	53.9-70.1	21.0-74.0

Source: Kandhal and Madan (1995), Makkar and Becker (1997), Martinez et al (2006), Mattana et al(2005), Openshaw (2000), Shah et al (2005).

1.1. Objectives of study

The main objective of the study is to highlight the economics of biodiesel production from *Jatropha curcas L*. The Specific Objectives are to:-

1. describe the socio-economic characteristics of the respondents in the study area;
2. assess the determinants of supply of biodiesel in the study area; and
3. to highlight factors influencing the perceive effect and advantages of biodiesel on the environment and on human's health.

2. Methodology

The major area of biodiesel production in Nigeria are Abuja, Ilorin and Lagos, in which a simple random sampling was used to select two (2) out of the three (3) areas, which are Ilorin and Lagos. A snow-bowl sampling technique was used, because of the scatteredness of places that this product (Biodiesel) is been produced, to sample 40 producers of biodiesel fuel, 20 each from the two chosen areas of production, and 70 users of the fuel (40 in Lagos and 30 in Ilorin) who gave information on the perceived effect of biodiesel on the environment and human's health.

Data were sourced from producers and non-producers of biodiesel from *Jatropha curcas*, some of which gave information on the perceived effect and advantages of using the product on the environment and human's health. Descriptive statistics was used to describe the socio economic characteristics of respondents. This includes their gender, age, marital status, educational experience and their major occupation. Regression analysis was used to determine the factors affecting the supply of biodiesel and the perceived effect of its use.

2.1. Model specifications

2.1.1. Supply model

The supply function for biodiesel was made to be a function of the supplier's age, marital status, religion, education, occupation, volume of oil extraction from seeds and the price of the biodiesel. The model is represented as follows;

$$Qs = F\ (Age, MS, Rel, Ed, Occu, Oil\ extracted, Price)$$

where;

Qs = Quantities supplied by producers (litres)

Age = Age of respondents (years)

MS = Marital status of respondents

Rel = Religion of respondents

Ed = Education status of respondents

Occu = Occupation of respondents

Price = Price of the oil (=N=)

Oil extracted = Oil extracted from seeds (litres)

2.1.2. Demand model

$$Qd = f(X)$$

where; Xs is independent variables affecting the quantity of biodiesel fuel demanded which include the respondents' age, educational status, occupation and marital status as well as the price of the biodiesel fuel. Qd is quantities demanded by users based on the perceived effects of biodiesel on human's health and environment. This is measured on a Likert scale by asking the respondents to respond to a set of attitudinal statements related to the perceived effects of biodiesel on human's health and environment. The responses are measured with a five points rating scale and it's the total score of each of the respondents that was used as their quantity demanded based on their perceived of the fuel. The respond options include strongly agree, agree, undecided, disagree and strongly disagree as indicated below;

Table 2. Attitudinal statements related to the perceived effects of biodiesel on human's health and environment

ADVANTAGES OF USING BIODIESEL	SA	A	U	D	SD
1. Biodiesel produces non-toxic substances to the environment which causes less harm.					
2. Production of biodiesel is less capital intensive.					
3. Other product from the plant tree (*Jatropha curcas*) could be used for different purposes.					
4. Increase in production of biodiesel reduces foreign exchange and energy expenditure.					
5. Biodiesel creates new market which stimulates rural development and economic growth.					
6. Biodiesel reduces greenhouse gas emissions (carbon-monoxide, methane and nitrogen).					
7. Biodiesel improves diesel engine operation.					
8. Biodiesel is easy to use.					
9. Biodiesel burns completely because of presence of oxygen in the fuel.					
10. Biodiesel emission is significantly low to have caused destruction of Ozone layer which could lead to acid rain.					

3. Analysis of results and discussion

Table 3 show that there are more female users of biodiesel fuel than biodiesel producers in the study area. About 67.1 percent female uses the fuel compared to 25.0 percent that produces it among the respondents. Majority (55.0%) of the fuel producers falls within an age range of 30-39 years as against 70.0 percent of users within the age range of 20-29 years. Also, 72.5% of the fuel producers were married while 82.9 percent of the users were singled. As regards the educational background of the respondents, all the producers have at least secondary school education and majority of them have a tertiary education and the major occupation of the users is teaching and research.

Table 3. Socioeconomic characteristics of the respondents

		Producers		Users	
	Characteristics	Frequency	Percentage	Frequency	Percentage
Gender	Female	10	25.0	47	67.1
	Male	30	75.0	23	32.9
Age	20-29	6	15.0	49	70.0
	30-39	22	55.0	12	17.1
	40-49	9	22.5	7	10.0
	>50	3	7.5	2	2.9
Marital Status	Single	11	27.5	58	82.9
	Married	29	72.5	12	17.1
Educational level	No formal education	-	-	-	-
	Primary	-	-	9	12.9
	Secondary	3	7.5	20	28.6
	Tertiary	37	92.5	41	58.5
Major Occupation	Student	-	-	-	32.9
	Teaching and Research	12	30.0	35	50.0
	Others	28	70.0	12	17.1

Source: Field survey, 2011

Table 4 revealed that there are significant relationships between the quantity of biodiesel supply in the study area and the marital status and gender of the respondents as well as volume of oil extracted from the Jatropha seeds. There is an inverse relationship between the respondents marital status and quantity supply which is significant at 10 percent level. The biofuel price and volume of oil extracted from seeds are positively related to quantity supply at 5 and 1 percent level respectively. This implies that if the fuel price increases there will be an increase in its quantity supplied which is line with a priori expectation. Likewise, the more the volume of oil extraction from seeds the higher the supply of biodiesel to the market. The finding supports Akintayo 2004 assertion that quantities supplied of biodiesel could be determined by the quantity of oil extracted from the seed during processing.

From Table 5, the quantity demanded of the fuel based on the perceived effects of biodiesel on human's health and environment is influenced positively by the educational status of the users and the price of the fuel and are both significant at 1 and 10 percent level respectively. The age of the users is negatively related to the quantity demanded based on the perceived effect of the fuel at 1 percent level of significant. This

means that as people continue to increase in their level of knowledge, information gotten due to their level of education exposes them to attractive advantages of biodiesel on both the human's health and environment. Some of the users are so attracted to the fuel that they are not discouraged from using the product even with its relative higher price to the country fossil fuel. A litre of petro diesel is sold for 97 naira while a litre of Biodiesel is sold at the rate of 120-130 naira and it burns for 72 hours. But this is the case with younger people than the aged one. As the age increases the quantity demanded falls despite its advantages on health and the environment.

Table 4. Determinants of quantity supply of biodiesel

	Unstandardized coefficient		Standardized coefficient		
Model	B	Std. Error	Beta	t	Sig.
Constant	12808.714	9706.176		1.320	.413
Age	2207.554	1190.453	.406	1.854	.315
Marital status	-5863.313	2947.783	-.416	-1.989*	.097
Religion	1331.152	1732.997	.141	.768	.583
Education	-1567.876	1188.539	-289	-1.319	.413
Occupation	-1.309	1743.281	.000	-.001	1.000
Price	772.345	2253.849	.072	.343**	.039
Oil extracted	72.457	12.138	.989	5.969***	.002

Source: Field survey, 2011

* Significant at 10per cent (10%)

** Significant at 5per cent (5%)

*** Significant at 1per cent (1%)

Dependent Variable: Quantities supplied (Q_s).

$R^2 = 0.987$, Adjusted $R^2 = 0.892$

Std. Error of the Estimate = 1545.193

F = 10.447

Table 5. Table showing factors influencing the quantity demanded based on the perceived effects and advantages of Biodiesel on human's health and environment

	Unstandardized coefficient		Standardized coefficient		
Model	B	Std. Error	Beta	t	Sig.
Constant	42.413	9.282		4.569	.006
Age	-.260	.397	.134	4.656***	.005
Education	2.835	.622	.914	4.555***	.006
Occupation	-.224	.465	-.115	-.481	.651
Price	.030	.017	.365	1.789*	.065
Marital status	-0.56	.070	-.184	-.793	.464

Source: Field survey, 2011

* Significant at 10per cent (10%)

*** Significant at 1per cent (1%)

Dependent Variable: Quantity demanded based on perceived effects of biodiesel on human's health and environment.

R^2 = 0.824, adjusted R^2 = 0.648 Std. Error of the Estimate = 0.930

F = 4.676

4. Conclusion and recommendation

despite the fact that the distribution, establishment, management, harvesting and uses of *Jatropha* plant is not properly documented in Nigeria, there are more female users of biodiesel fuel than biodiesel producers and majority of the fuel producers are still in their active age. Marital status, price and volume of oil extracted from the seeds significantly influenced the supply of the product while the educational status of the fuel users, price of fuel and age of respondents determines the quantity demanded of the biofuel based on it perceived effect and advantages on human's health and the environment.

It is therefore recommended that more awareness about the production and uses of the product should be carried out specifically for the younger ones in their active age to sensitize them into the business and the aged in general on the advantages of the use of the fuel to human's health and the environment. This will minimize the destruction of green-house gases (GHG) which is the major concern of agricultural production. Likewise, credit should be made available for those interested in biodiesel production and marketing

business. Also, government should invest in modern technology vis-a-vis optimal oil extraction from Jatropha seeds so as to maximize its production and supply.

References

Belewu, M.A. and Ogunsola, F.O. (2010), ''Haematological and serum indices of goat fed fungi treated Jatropha curcas kernel cake in a mixed ration'', *Journal of agricultural biotechnology and sustainable development*, Vol. 2 No. 3, pp. 035-038.

Kandhal, J.B. and Madan, M. (1995), ''Jatropha curcas; a renewable source of energy for meeting future enegy needs'', Renewable *energy,* Vol. 6 No. 2, pp159-160.

Kumar, A. and Sharma, S. (2008), ''An evaluation of multipurpose oil seed crop for industrial uses (Jatropha curcas): A review'', *Industrial crops and products,* Vol. 28 No. 1*,* pp. 1-10*.*

Makkar, H.P.S. and Becker, K. (1997), ''Potential of *J. curcas* seed meal as a protein supplement to livestock feed, constraints to its utilization and possible strategies to overcome constraints'' In: G.M. Gubitz, M. Miltelbash and M. Trabi (Eds). Biofuels and industrial products from *Jatropha curcas*. Dbv_verlag fur die technische Universitat Graz, Graz, Austria, pp. 190-205.

Martinez-Herrera, J.P., Siddhuraju, G., Francis, G., Ortiz, D. and Becker, K. (2006), ''Chemical composition, toxic /antimetabolic constituents, and effect of different treatments on their levels in four provenances of *Jatropha curcas L*'', *From mexico. Food chem*., Vol 96, pp. 80-89.

Mattana Saturnino, H.D., Pacheco, D., Kakido, J., Tominaga, N. and Ponbel, N. Goncalves, (2005), ''Culturado pinhao-manso (*Jatropha curcas L.*)'', In : EPAMIG – CTNM (Eds), Informe Agro pediario : producao oleaginosas para biodiesel. Belo Horizonte, Brazil, pp. 44-78.

Openshaw, K. (2000), ''A review of *Jatropha curcas*; an oil plant of unfulfilled promise'', Biomass and Energy, Vol. 19 No. 1, pp1-15.

Shah, S., Sharma, A., Gupta, M.N., (2005), ''Extraction of oil from *Jatropha curcas L*. seed kernels by enzyme assisted three phase partitioning'', *Industrial Crops and Products*, Vol. 20 No. 2, pp. 275–279.