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Competitiveness of *Jatropha Curcas* Production in South-West Nigeria

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Abstract

Nigeria still suffers enormous fuel and energy crises, manifesting in various forms, despite her position as Africa's largest crude oil exporter. Thus, the development of new energy sources such as biofuels from the agricultural sector has been viewed as a way of expanding domestic energy supply, preventing increased dependence on imported oil, as well as diversifying the economy particularly in the face of falling oil prices. This draws attention to *Jatropha curcas*, an inedible hardy shrub, as a viable choice of feedstock for biodiesel. This study examined the competitiveness, comparative advantage and the effect of government policies on *Jatropha curcas* production in Southwest Nigeria. Descriptive statistics and the Policy Analysis Matrix were the analytical tools employed. Although the less than unity values of 0.0219 and 0.022 of the domestic resource cost and social cost-benefit ratio respectively, showed that the zone had comparative advantage in *Jatropha curcas* production, production was not economically profitable under existing government policies as revealed by the negative private profit of ₦587.4393/ton. The prevailing incentive structure also affected producers negatively and policy indicators were found to be sensitive to changes in the exchange rate. The study recommends the large-scale cultivation of the produce and the provision of incentives to producers to enhance the competitiveness of the commodity.

Keywords: Competitiveness, Policy Analysis Matrix, *Jatropha curcas,* Southwest Nigeria.

INTRODUCTION

The Nigerian economy was characterised by the dominance of exports and commercial activities before independence in 1960 and after independence, agriculture continued as the mainstay of the economy as it contributed about 65 per cent to the GDP. In spite of fluctuations in world prices, agriculture provided the foreign exchange that was utilised in importing raw materials and capital goods (Online Nigeria, 2016). The oil boom of the 1970s led to the neglect of the strong agricultural and light manufacturing bases in favour of an unhealthy dependence on crude oil (History Central, 2016). Currently, energy sales accounts for up to 80% of all government revenue and more than 90% of the country's exports (Musawa, 2016). Thus, with declining oil prices, which indicate less revenue from oil and gas exports, recurrent and capital expenditure, have been greatly affected. This has triggered layoffs, mostly in the private sector, and owed salaries in the state civil service. There is also the increase in prices of imported goods as a result of exchange rate volatility with the burden passed on to consumers (Omonisa, 2016). All these and much more are consequences of overdependence on fossil fuels, which are the only sources that currently power the nation's economy, in spite of the abundance of renewable energy potentials. Another major consequence is the increase in atmospheric $C0_2$ concentration resulting from burning fossil fuels that contribute mostly to global warming when compared with other greenhouse gases (IPCC, 2001). The effect of global warming on agriculture include climate change-which causes poor agricultural yields as herbicides become less effective; insect pests- some of which carry plant diseases become more prolific and widespread; reduced stream flows, and an increase in the ranges of livestock disease vector (Climate education for K-12, 2016). As a consequence, many African countries including Nigeria are vulnerable to climate change because their economies depend largely on weather-sensitive agricultural productions systems (Dinar *et al.*, 2006).

This has led to the quest for alternative renewable energy sources such as biodiesel, bio-alcohol, non-fossil methane, non-fossil natural gas, vegetable oil and propane (Ambarish & Mandal, 2014). However, among the proposed alternative fuels, biodiesel has received much attention (Zhou, 2003). This is because it has been argued that biofuel is environment-friendly as carbon dioxide released from burning biofuels is balanced by carbon dioxide intake by growing plants from where biofuels are made (Azih, 2007). The use of biodiesel as a future prospective fuel, in turn, requires that it competes economically with petroleum diesel fuels. This will require a reduction in production costs of biodiesel by using less expensive feedstock containing fatty acids such as inedible oils, animal fats, waste food oil and by-products of refining vegetable oils (Veljkovic *et al*., 2006). The feedstock supply must be viable and sustainable with sufficient quantities available at less expensive prices and must have a limited impact on the environment. This draws attention to *Jatropha curcas,* an inedible hardy shrub which grows relatively well in marginal areas, poor soils and areas of low rainfall (Paltsev *et al.*, 2005; Sarin *et al.*, 2007; Gressel, 2008) as an alternative energy source from agriculture. The ease of growing *Jatropha curcas* and its non-influence on current food markets makes it a viable choice as feedstock for biodiesel. It produces up to forty percent yield by weight of oil per seed and the plant will continue to give seeds for 40-50 years from a single plant. It has great potential as the next generation of commercial biofuel crops because the oil has the lowest relative cost amongst the various types of biodiesel feedstock's (Barta, 2007). Asides energy security, its production as an additional source of income to farmers will greatly help in addressing issues of rural livelihoods and poverty (Brittaine and Lutaladio, 2010).

Based on the foregoing, the Nigerian biofuels policy was formulated in 2007 with the aim of gradually reducing the nation's dependence on imported gasoline, reducing environmental pollution while at the same time creating a commercially viable industry that can precipitate sustainable domestic jobs. The use of biofuels in Nigeria is anticipated to make a significant impact on petroleum products quality enhancement in view of the current limitations of the fossil-based fuels which have not kept pace with the increasing demand for environmentally friendly fuel (OGNBPI, 2007). However, the issue of competitiveness of the viable feedstock was completely ignored in the policy.

Competitiveness, defined as the set of institutions, policies and factors that determine the level of productivity of a country, encourages producers of agricultural products to offer a high-quality product, reduce costs in relation to the competitive one and to decide on the product line or services that meet the customer's needs. This is done in line with appropriate quality and safety standards in both local and export market (Porter and Schwab, 2008; Ivan *et al.,* 2011). Thus, competitive prices, larger outputs and better welfare which measure the good performance of farmers are outcomes of increased competitiveness. In the same vein, increased competitiveness logically drives production potentials of bio-fuel which have not been well analysed and incorporated into integrated assessment or macroeconomic models. More so, if Nigeria is to adopt the five key policy axes suggested by the European Union as measures to promote the production and use of biofuel in Nigeria, she is expected to minimize the production cost of *Jatropha curcas*. Consequently, the importance of competitiveness in *Jatropha curcas* production at the local, regional and international market cannot be overemphasized.

Further, while previous studies on *Jatropha curcas* production in countries like Ethiopia, Tanzania, Rwanda, Zimbabwe and Nigeria [Wahl *et al.* (2009); Akande and Olorunfemi (2009); Parawira (2010); Kamil *et al.* (2013); Bilal *et al.* (2013) and Raufu *et al.* (2014)] have examined its potentials and production for biofuels, there has been no study to the best of our knowledge on the its competitiveness and comparative advantage in Nigeria. This study, therefore, aims at examining the competitiveness and comparative advantage in *Jatropha curcas* production as well as the effect of government policies on its production. This is pertinent, considering the strong unmet demand in neighbouring countries such as Niger, Chad, Cameroun and Benin for biofuels (IEA,2014) as well as the opportunity for foreign exchange earnings, given the expectation of a steep rise in the value of biofuel trade globally in the next few years, in the bid to reduce energy dependency as well as in the fight against climate change.

MATERIALS AND METHODS

This study was conducted in South West Nigeria. South West Nigeria falls on Latitude 6^0 to the North and 4^0 to the South and marked by Longitude 4^0 to the West and 6^0 to the East. It is bounded on the North by Kogi and Kwara states, in the East by Edo and Delta states, in the South by the Atlantic Ocean and in the West by the Republic of Benin. South West is one of the six geopolitical zones in Nigeria. This zone includes six states which are Lagos, Oyo, Ogun, Ondo, Osun and Ekiti states. It is characterised by a typically tropical climate with distinct dry season between November and March and a wet season between April and October. The mean annual rainfall is 1480mm with a mean monthly temperature range of 18 -24°C during the rainy season and 30-35°C during the dry season. The zone has a land area of about 114,271 square kilometres, representing approximately 12% of Nigerian total land mass. The total population is 27,581,992 and predominantly agrarian. Major food crops grown in the area include maize, cassava, rice, cowpea, plantain and yam while the major tree crops are kola nut, cocoa, citrus and oil palm.

A multi-stage sampling procedure was used to select representative Jatropha farmers. In the first stage, 2 states (Osun and Oyo) were randomly selected out of the 5 states where Jatropha is being planted in South-West Nigeria. The second stage involved the selection of 15 Local Government Areas (LGAs) - 6 in Osun and 9 in Oyo out of 17 LGAs (7 in Osun and 10 in Oyo) in the two States based on probability proportionate to size. In the last stage, 10 Jatropha farmers were randomly selected from each of the Local Government areas to make up a total of 150 Jatropha farmers. Primary data employed in this study were collected on yield, input requirements, market prices for inputs and outputs, transportation costs and storage costs. In addition, secondary data on port charges, import and export tariffs and exchange rate were sourced from the Nigeria Ports Authority, International Trade Statistics and the Central Bank of Nigeria.

The main analytical tool used in this study is the Policy Analysis Framework (PAM) which is a computational framework, developed by Monke and Pearson (1989) and augmented by Masters and Winter-Nelson (1995), for measuring competitiveness, input use efficiency in production, comparative advantage and the degree of government interventions. The PAM framework uses detailed information on a farm level production budget, explores the composition of production and other system related costs and how changing various production constraints and/or the policy environment can change the profitability of a production system (Akter *et al.,* 2003). It is a product of two accounting identities (Table 1). The first identity defines profitability as the difference between revenues and costs, measured in either private or social terms. The second identity measures the effects of divergence (distorting policies and/or market failures) as the difference between observed private values and social values that would prevail if divergence were removed. There are two types of profits—private profits evaluated at market prices and social profits evaluated at social or efficiency prices. If there are no market distortions, the two are often the same. If, however, there are market failures or distortions then the two diverges from one another. Their divergence acts as a signal for policy intervention.

Table 1: Policy Analysis Matrix (PAM) Framework

	Revenue	Costs		Profits
		Tradable Inputs	Domestic Factors	
Private prices	A	B	C	D
Social prices	E	F	G	H
Divergence	I	J	K	L

Source: Based on Monke and Pearson (1989)

A = Private revenue

B = Tradable input cost at private price,

C = Domestic factor cost at private price,

D= Private profit = [A–(B+C)],

E = Social revenue,

F = Tradable input at social price],

G = Domestic factor cost at social price

H = Social profit = [E–(F+G)];

I= Output transfer: [A–E

J = Input transfer = [B–F],

K = Factor transfer = [C–G],

L = Net policy transfer = [D–H] = [I-J-K].

The data in the first row of the PAM framework provides a measure of private profitability, defined as the difference between observed revenue and cost. This captures the competitiveness of the agricultural system given current technologies, prices of input, output values , and policy transfer. The second row of the PAM is used to measure social profit which is calculated at shadow price. The social profit reflects social opportunity costs and it measures efficiency and comparative advantage. A positive social profit indicates that the system uses scarce resources efficiently and contributes to national income (Nelson and Panggabean, 1991). A negative social profit indicates social inefficiencies and suggests that production at social costs exceed the costs of import, thus indicating that the sector cannot survive without government intervention at the margin. The final row of the matrix represents transfers that come into play due to policy-induced market distortions. This captures the divergences between the first row (measured at private prices) and the second row (measured at social prices). The difference between private and social values of costs, revenues , and profits can be explained by policy interventions (Mohanty, *et al.*, 2003). Several important indicators such as the nominal protection coefficients on output and input {NPCO=A/E} and {NPCI= B/F}, effective protection coefficient {EPC= (A–B)/(E–F)}, domestic cost ratio {DRC= (G/(E–F}, subsidy ratio to producer {SRP =(L/E)}, private cost ratio {PCR = (C)/ (A-B)}, profitability coefficient {PC = (D/H)}, {PSE = L/A} which are useful in asserting the level of competitiveness between crops or production systems can be calculated from the PAM framework.

Data modelling assumptions

The PAM constructed for this study made use of farm budget values obtained from the production of Jatropha. For computing social prices for Jatropha inputs and output, world prices were used as the reference prices in the study. The U.S. FOB (Free on Board) Gulf price was used as reference prices for Jatropha. This world price was adjusted for transportation costs and marketing costs to be comparable with farm gate prices. However, considering Jatropha as an export commodity to the United States of America (USA), social price at the farm gate was calculated by subtracting marketing costs from the respective world reference price, converted to domestic currency. This price was converted to domestic currencies using market exchange rates and finally, marketing costs were added to compare with farm gate prices.

The social price of land is the opportunity cost of land taken to be the net return (profit) of the competing crop production system i.e. the net return (profit) that would be earned from the next best alternative production system. However in this study it was not possible to study alternative crops to estimate the social price of land therefore, the social price of land was taken to equal the private land rental rate. Following Yao (1997) the social valuation of labour was obtained by dividing labour into peak season and off-peak season components. The wage rate in the peak-season is the opportunity cost of labour for the period considered and the opportunity cost of labour in the off peak season is half the prevailing wage rate. With this, social price of labour was calculated as:

$$PL = \frac{WP + 0.5WO}{2}$$

Where; PL= Social price of labour

Wp = prevailing wage rate in peak season

Wo = prevailing wage rate in off peak season

Likewise for seedling, hoes, cutlasses, tractor hired and wheelbarrow, the private prices were also used as social prices. In a PAM framework, inputs were disaggregated into tradable and non-tradable. Land, labour, hoes, cutlasses, tractor and wheelbarrow were assumed to be totally non- tradable while seedling is the only tradable input.

Sensitivity analysis

PAM is a static model, which cannot capture the potential changes in policy parameters and productivity (Akter *et al.,* 2003). To minimize this limitation, following Yao (1997) and Monhanty *et al.,* (2003), Sensitivity analysis was conducted to analyze the effects of exchange rate on competitiveness and policy indicators at ±20%. Sensitivity analysis provides a way of assessing the impact of changes in the main parameters on both private and social profitability (Monke & Pearson 1989). The sensitivity analysis illustrates the reaction in the policy indicators such as NPC, DRC, EPC and SRP due to changes in the aforementioned factors.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents

Table 2 shows the socioeconomic characteristics of Jatropha farmers in the study area. More than three-fifths of the farmers were male with more than half between ages 25 and 44 years and married. The average age and household size of the farmers stood at 37 years and about 5 persons per household respectively. While most of the respondents had secondary school education, a significant proportion had no formal education and were primarily engaged in farming with an average farm size of about 5 hectares. In addition, more than half of the farmers were trained in Jatropha cultivation with more than three-fifths having 3 to 4 years' experience in its production. Further, more than four-fifths of the respondents reported not having had extension contact.

Table 2: Socio-economic characteristics of Jatropha farmers in South-West Nigeria

Variables	**Frequency**	**Percentage (%)**
Sex		
Male	100	66.7
Female	50	33.3
Age (Years)		
≤ 24	15	10.0
25 – 44	92	61.3
45 – 64	42	28.0
≥ 65 Mean: 37years	1	0.7
Marital status		
Single	53	35.3
Married	83	55.3
Widow/widower	4	2.7
Divorced	10	6.7
Level of Education		
No formal education	33	22.0
Primary education	19	12.7
Secondary education	54	36.0
Tertiary education	44	29.3
Household size		
≤ 3	45	30.0
4 – 6	88	58.7
7 - 9	16	10.7
≥ 10 Mean: 5	1	0.6

Primary occupation		
Farming	47	31.3
Trading	34	22.7
Civil service	13	8.6
Private salary job	22	14.7
Artisans and Crafts	34	22.7
Training		
Yes	77	51.3
No	73	48.7
Experience in prod. (years)		
≤ 2	41	27.3
3-4	99	66.0
5-6	10	6.7
Extension visits		
Yes	27	18.0
No	123	82.0
Farm size (Ha)		
≤3	41	27.3
4-6	84	56.0
7-9	9	6.0
≥10	16	10.7
Total	**150**	**100.0**

Source: Field survey, 2015

Competitiveness of *Jatropha curcas* production

Competitiveness, the ability of a farming system to earn a profit at the actual market prices, was measured using Private Profit and Private Cost Ratio. The result of the analysis as shown in Table 3 indicated that Jatropha farmers are earning subnormal return as revealed by the negative private profit of ₦587.4393/ton. In other words, Jatropha production is not competitive based on the current technologies, inputs and output prices, and prevalent government policies and transfers. The Private Cost Ratio

(PCR) (also an indicator of competitiveness) of greater than unity obtained further confirmed that *Jatropha curcas* production is unprofitable in the study area and thus uncompetitive.

Table 3: Competitiveness in Jatropha production

Product	Revenue ₦/ha	Cost of tradable inputs ₦/ha	Cost of domestic factors ₦/ha	Net private profitability ₦/ha	Private Cost Ratio
Jatropha seeds	63,500.00	76.36	64,011.07	(587.43)	1.009

Source: Authors' computation, 2015

Note $1= ₦196 at the time of the analysis.

Comparative Advantage in Jatropha Production

On the other hand, the comparative advantage was measured using the social profit, domestic resource cost, and the social cost-benefit ratios. The result of the analysis as presented in Table 4 indicates a positive social profit of ₦2,233,395.9/ton. This implies that Jatropha farmers efficiently utilized scarce resources in the production of the commodity. The less than unity value of the domestic resource cost, another indicator of comparative advantage, implies that the zone has a comparative advantage in the production of Jatropha. That is, its production is economically efficient. In other words, the cost of domestic resources used in production was lower than the value added in social prices. This was further confirmed by the less than unity value of social cost benefit ratio which measures how much greater the value of output created is, relative to the associated cost of production in social prices.

Table 4: Social profitability and Comparative Advantage of Jatropha curcas production in Southwest Nigeria

Product	Revenue ₦/ha	Cost of tradable inputs ₦/ha	Cost of domestic factors ₦/ha	Net social profitability ₦/ha	Domestic Resource Cost	Social Cost-Benefit Ratio
Jatropha seeds	228,3460	76.36933418	49987.73	2,233,395.901	0.0219	0.022

Source: Authors' computation, 2015

Transfers and effects of government policies

As earlier discussed, the effect of government policies can be identified by divergences. The result from Table 5 shows an NPCO coefficient value of less than unity (0.03) indicating that domestic farm gate price is less than the international price for Jatropha output. In other words, the market price is below the international price. This implies that Jatropha production is not protected by existing policies as a result of the application of substantial output tax. NPCI values of unity indicate that the input costs in the production system are equal to the world reference prices. This suggests that government neither taxed nor subsidized tradable inputs used for Jatropha production by policy (Pearson *et al.*, 2003).

The EPC which reveals the degree of protection accorded to the value added process also had values less than unity (0.028) for Jatropha production indicating the absence of incentives. As such, producers were not protected through policy intervention on value added processes. The profitability coefficient which measures policy incentives as an estimation of net policy transfer also showed a mixed indication net transfers. Negative net transfers further confirmed the absence of incentives as the private profit was lower than the profit obtained at world reference prices.

Subsidy ratio to producer (SRP) indicates the level of transfers from divergences as a proportion of the undistorted value of the system revenue (Monke and Pearson, 1989). Hence, if market failures are not an important component of the divergence, then SRP shows the extent to which a system's (farm) revenue have been increased or decreased because of policy. Table 5 indicates a negative SRP value for Jatropha production implying that the divergences were used to subsidize other commodities. This suggests that there is a decrease in the gross revenue of the farmers.

Producer Subsidy Estimate (PSE) analysis was used to gauge government intervention in production. A negative value of the PSE indicates the overall transfer of benefits from producer to consumer and taxpayers while a positive value indicates the overall transfer of benefits from consumer to producer. Results showed a negative PSE value of -35.181 which indicates the transfer of benefits from the producers to the society.

Table 5: Protection coefficient and incentives on Jatropha production

Product	NPCO	NPCI	EPC	PC	SRP	PSE
Jatropha seeds	0.03	1	0.028	-0.00026	-0.978	-35.181

Source: Authors' computation, 2015

Sensitivity analysis of *Jatropha curcas* production

The result from Table 6 shows that neither an increase nor a decrease in exchange rate by 20% had any effect on private profits. Specifically, a greater than unity PCR value implies that *Jatropha curcas* production is uncompetitive given both scenarios. While social profit improved with a 20% increase in exchange rate, it decreased with a 20%

decrease in the exchange rate. Also, DRC and SCBR improved at 20% increase in the exchange rate (₦196/US$ to ₦235.2/ US$) implying depreciation of the naira against the US dollar and thus favouring comparative advantage. This conforms to the findings of Ogbe *et al.*(2011) that the overvaluation of exchange rate reduces the competitiveness of the local producers in international markets because they are practically taxed and increases it with the depreciation of exchange rate as they are being subsidized.

Negative output transfer for both an increase and a decrease in exchange rate by 20% showed that the negative effect of prevailing government policies on Jatropha farmers profit was higher with an increase than a decrease. An NPCO value of less than unity also revealed that producers of Jatropha were not protected by policy. This is an indication of implicit tax on *Jatropha curcas* production while an NPCI value of unity indicates equal protection on tradable inputs used in production at both an increase and decrease in exchange rate.

The EPC value reduced with an increase in exchange rate and increased with a decrease, indicating that producers were not protected through policy intervention on value added processes. The PC value showed a transfer of income from the system at both an increase and a decrease in exchange rate. This is further confirmed by a negative SRP which indicates an overall transfer from producers to society and taxpayers while the negative PSE value also indicates a transfer from the producers to the society. However, a negative PSE value of -28.07 at a decrease in exchange rate indicates less transfer from producers to taxpayers.

Table 6: Sensitivity analysis for Jatropha production

	Base value	20% increase in exchange rate	20% decrease in exchange rate
Private profit	-587.439	-587.439	-587.439
Social profit	2,233,395.901	2,693,897.901	1,781,855.021
Output transfer	-2,219,960.000	-2680462.000	-1768419.120
Input transfer	0.000	0.000	0.000
Net transfer	-2,233,983.34	-2,694,485.341	-1,782,442.460
DRC	0.022	0.018	0.027
PCR	1.009	1.009	1.009
SCBR	0.022	0.018	0.027
NPCO	0.028	0.023	0.035
NPCI	1.000	1.000	1.000
EPC	0.028	0.023	0.035
PC	-0.00026	-0.00022	-0.00033
SRP	-0.978	-0.982	-0.973
PSE	-35.180	-42.431	-28.070

Source: Authors' computation, 2015

CONCLUSION AND POLICY IMPLICATIONS

The study is an application of the policy analysis matrix (PAM) to *Jatropha curcas* production. Generally, Nigeria has a comparative advantage in the production of *Jatropha* *curcas* but its production was not competitive owing to the absence of government support in the form of subsidies on inputs. This coupled with the poor market for the product, reduced competitiveness. In addition, the international reference price was higher than the price of *Jatropha curcas* seeds locally indicating that farmers were not protected through government macroeconomic policies as indicated by the incentive structures. However, results revealed that government support in the form of incentives and subsidy on inputs used for Jatropha production could ensure the competitiveness of the product since Nigeria has a comparative advantage in its production. Consequently, it is recommended that government should open up more land for *Jatropha curcas* cultivation to encourage large-scale cultivation as well as provide support to farmers in the form of incentives and subsidy on inputs used, for its production to be competitive.

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