Advanced Journal of Agricultural Research
Vol. 1(007), pp. 112-121, November, 2013
©2013 Advanced Journals
http://www.advancedjournals.org/AJAR

Full Length Research Paper

Awareness and Acceptability of the Usefulness and Products of *Jatropha curcas* (L.) Plant in Kano State, Nigeria

Umar, A. F.[1], I. O. Azeez[2] and Labode Popoola[2]

[1]Department of Forestry Fisheries and Wildlife, Kano University of Science and Technology, Wudil, Kano State, Nigeria.
[2]Department of Forest Resources Management, University of Ibadan, Ibadan, Nigeria.

*Corresponding author. E-mail: umaraminufagge@gmail.com

Submitted 3rd October, 2013; Accepted 4th November, 2013

Inadequate alternative sources of energy and low income engender unsustainable exploitation of the environment by the inhabitants of semi arid regions. Literature abounds on the potentials of *Jatropha curcas* as an alternative source of energy. This study reports the awareness and acceptability of the energy and other potentials of *J. curcas* in Kano state. Primary data were collected using FGDs and a set of structured questionnaire administered randomly on 1280 farmers. Information were sought on level of awareness about *J. curcas,* proportion of farmland available for its planting, level of acceptability of its products, government incentives and consent to utilize *J. curcas* and substitute petroleum diesel with *J. curcas* biodiesel. Data was analyzed using descriptive statistics and logit regression at p = 0.05. The usefulness of *J. curcas* for farmland boundary (100.0%) and homestead planting (98.48%) were more popular while its use as live fence was the most (99.24%) acceptable among the respondents. Also, 68.18% of the respondents accepted Jatropha oil while 90.91% accepted its biodiesel. About 83.3% of the farmers had less than a quarter of their farmlands planted with *J. curcas*. However, if market outlet and incentives were to be provided by the government, 30.0% and 55.0% of the respondents respectively, indicated willingness to commit the whole and half of their farmlands to *J. curcas* plant production. Awareness of *J. curcas* is likely to influence knowledge on the importance *J. curcas* seed cake (odds ratio = 4.44) in Kano state. So also, its awareness will likely influence the willingness to use *J. curcas* oil (odds ratio = 2.34), its seed cake (odds ratio = 4.4) and biodiesel (odds ratio = 4.37). Awareness of *J. curcas* plant usefulness but not that of its products is very high in Kano State. Deliberate promotion of the plant products in addition to establishment of a Jatropha System for sustainability of its production among farmers is therefore recommended.

Key words: *Jatropha curcas*, biofuel, government policy, biodiesel feedstock, product awareness.

UNIVERSITY OF IBADAN LIBRARY

INTRODUCTION

According to Dehgan (1984) and Jatrophaworld (2007), *Jatropha curcas* is a drought resistant shrub that belongs to the family Euphobiaceae 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. *Jatropha curcas* can grow to heights of six meters or more thus, making the collection of seeds more convenient. It is extremely hardy and thrives 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 (Heller, 1996). The planting of

J. curcas for biodiesel production is gaining popularity all over the world. The large scale plantation of *J. curcas* being advocated is supposed to alleviate poverty and rehabilitate marginal lands while serving as a shield against environmental degradation (Jones and Miller, 1992; Weiss, 1989).

Jatropha oil is viscous (50% by weight) and can be used as biodiesel (Takeda, 1982; Carr et al., 1985; Ishii and Takeuchi, 1987; Pak and Allexi 1994; Henning, 1996), in the manufacture of soap and candles as well as in the cosmetic industry (Paroda and Mal, 1989). It can also be used in cooking and domestic lighting thus, having the potential of satisfying rural energy needs while serving as a substitute to fossil fuels to reduce green house gas emissions. Hence, Jatropha is nicknamed "the king of the biodiesel plants (Jones and Miller, 1991; Openshaw, 2000).

Developed countries such as the US and the EU countries took steps to reduce their dependence on mineral oil by setting up targets on biofuel. However, the high targets set, gave rise to another crisis: the food crisis. Factors such as high oil prices, transportation cost, growing demand, speculation, and pests in Asia, drought in Australia and floods in Bangladesh caused a global food crisis as a result of land used for food crop production being diverted to the production of biofuel. Thus, as submitted by many, including Calder (2007), biofuel hoax was responsible for the global food crises. Stiffler (2008), in his article "Bio debatable food vs fuel" opined that in the middle of the global food crisis the production of biofuel is taking away food from the dinner plate of people into the gas tanks of cars.

To alleviate the food crises, third generation crops such as sweet grass (for biofuel) and Jatropha (for biodiesel) were brought under investigation (Levingston and Zamora, 1983). The recent interest on alternative sources of energy placed *J. curcas* in the forefront of discussions on bio-fuel production. Apart from biofuel, *J. curcas* also produces wood (though of poor quality) for cooking, animal feeds and is used for rehabilitation of marginal lands (Heller, 1996). These characteristics coupled with the hoax towards energy independence placed *J. curcas* in a strategic position for developing countries, especially Nigeria, where the demand for fossil fuel is not marched by a corresponding increase in the supply infrastructure. This disproportionate balance as submitted by Bayo and Akinbanmi (2008) favoured the urban areas especially during the perennial fuel scarcity. However, despite its potentials there are several technical, economic, cultural, and institutional factors that need to be studied. Openshaw (1986) reposed this while iterating the importance of investigating the economic analysis and acceptability of *J. curcas* products by farmers, as well as the policy framework under which the 'Jatropha system" operate. Evolving a Jatropha system itself requires adequate planning, which according to FAO (1991) would futile unless due attention is paid to the interest of whom planning is intended. This paper reports the acceptability status of *J. curcas* in Kano State, in the semiarid part of Nigeria.

MATERIALS AND METHODS

The study covers Kano state which is located in North-western Nigeria within the semi arid region (Figure 1). The state is one of the states bordering the southern fringes of the Sahara desert collectively referred to as the "Desertification frontline states". The state has a total of 44 Local Government Areas and according to the 2006 population census figures (NPC, 2006), it is the most populous state in Nigeria (with 9,401,288 people). The vegetation of the state is typically Sudan Savannah with traces of Guinea Savannah towards the southern part bordering Kaduna and Bauchi states (Iloeje, 2001). The northern and eastern parts of the state are typically Sudan savannah with clear features of desert encroachment in the northern parts of the state. The state is characterised by high daily minimum temperatures of between 35 to 40ºC annually (Mortimore, 1978).

Survey and sampling procedure

Simple random sampling procedure was used for the study in which Kano State was stratified into two (2) zones based on her agro-climatic characteristics. Each zone was then subdivided into sub-zones and the sub-zones were divided into data collection units. Thirty percent (30%) sampling intensity was used to select a total of one thousand two hundred and eighty (1280) respondents for oral interviews using a set of structured questionnaire. The questionnaire was designed to obtain information on the level of awareness about *J. curcas,* proportion of farmland available for its planting, level of acceptability of its products, government

UNIVERSITY OF IBADAN LIBRARY

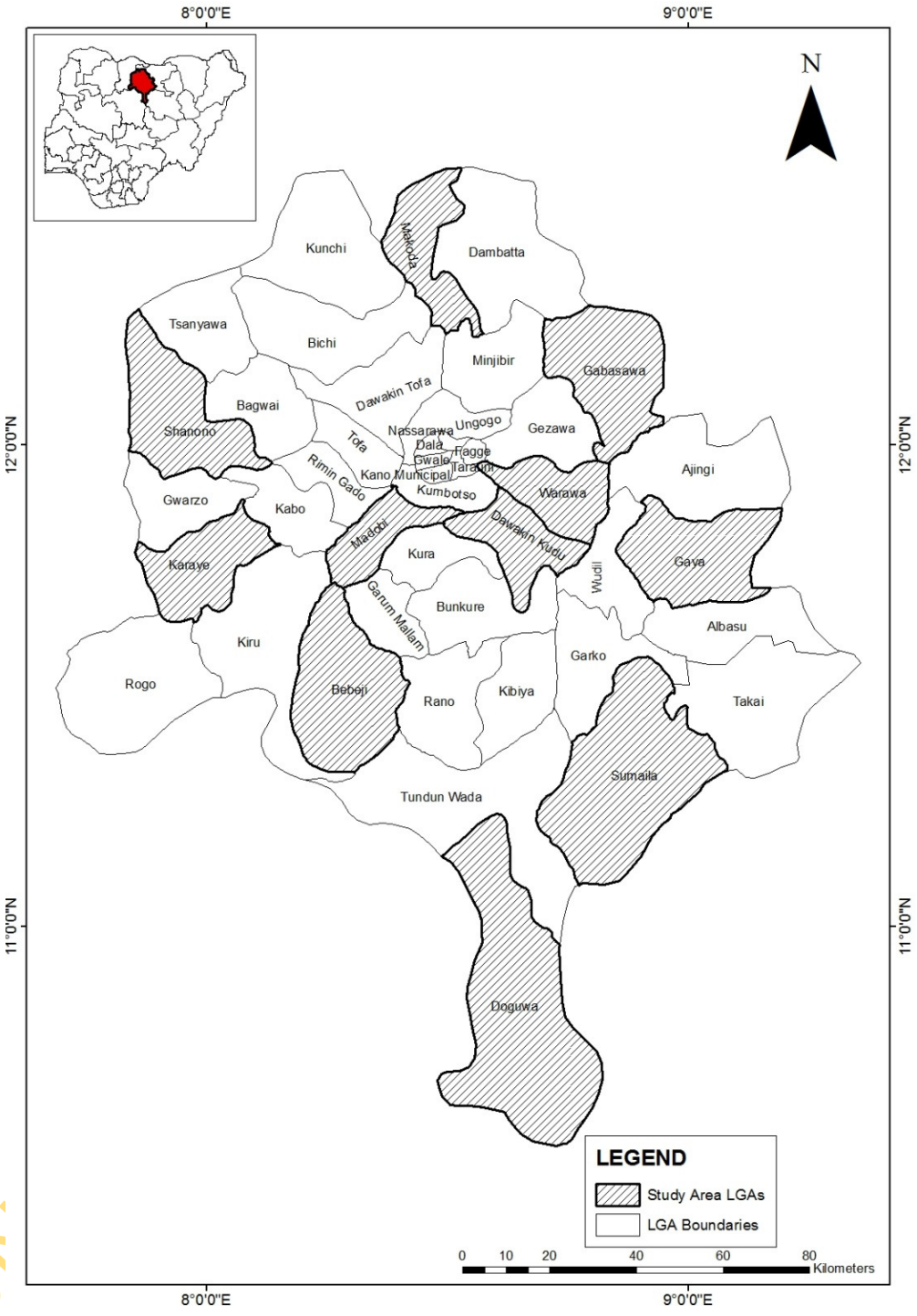

Figure 1. Map of Kano State showing the study area.

incentives and consent to utilize *J. curcas* and to substitute petroleum diesel with *J. curcas* biodiesel. Tools of Participatory Approach were also used to fill the gaps of information that was left out by the questionnaires.

Statistical analysis and analytical tools

The data was analysed using descriptive statistics. Logit regression was also used to test the variables to identify the factors that are likely to influence awareness of

Table1. Farmers awareness of *J. curcas* products and usefulness.

S/N	Awareness	Farmers Aware		Farmers Unaware		Total (%)
		Frequency	Percentage	Frequency	Percentage	
1	Jatropha Oil	400	30.30	920	69.70	100
2	Jatropha Biodiesel	350	26.52	970	73.48	100
3	Live Fencing	1300	98.48	20	1.52	100
4	Farm Boundaries	1320	100	0	0.0	100
5	Homesteads Fencing	1320	100	0	0.0	100

Source: Field Survey

Plate 1. Showing *J. curcas* planting in school premises at Gaya, Kano State.

J. curcas in Kano State. Respondents who were aware of *J. curcas* in Kano state were regressed on the following variables: Knowledge of *J. curcas* seed cake, willingness to use *J. curcas* oil, willingness to use *J. curcas* seed cake and willingness to use *J. curcas* biodiesel

$$p1 = b_0 + b_1x_1 + b_2x_2 + \cdots b_nx_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

p1 = Dependent variable (awareness of J. curcas)
a = regression constant
$b_1, b_2 \ldots b_n$ = regression coefficient
$x_1, x_2 \ldots x_n$ = independent variables
(Knowledge of *J. curcas* seed cake, willingness to use *J. curcas* oil, seed cake and biodiesel).

RESULTS AND DISCUSSION

Farmers awareness of *J. curcas* plant usefulness and products

Jatropha curcas products and usefulness were documented by the study in Kano State. Field survey (Table 1) indicated that 73.5% of the respondents were not aware of *J. curcas* biodiesel, while only 30.3% were aware of Jatropha oil from which the biodiesel is extracted. The respondent's awareness of *J. curcas* secondary products was observed to be very low (26.0% for biodiesel). Also worthy of note is the fact that the Jatropha oil is a secondary product, since it is extracted from the seed. However, the primary usefulness of *J. curcas*, viz farmland boundary (100.0%) and homestead planting (98.5%) were popular among the respondents (Table 1). This usefulness had been reported earlier by Sambo et al. (2008) to include but not exclusive to biodiesel, live fencing (Plate 1), farm boundary (Plate 2) planting and homestead fencing (Plate 3).

The numerous products into which Jatropha seeds can be processed includes the crude Jatropha oil, which can be used directly on diesel engines, kitchen stoves, lanterns and in soap making. The crude Jatropha oil can however be processed through trans-esterification to biodiesel which is the refined crude Jatropha oil that

Plate 2. Showing farm-land demarcation with *J. curcas* at Madobi, Kano State.

Plate 3. Showing live fencing of a rural compound with *J. curcas* in Tsanyawa, Kano State.

can be used directly on any diesel engine without modification to the engine. As such it can be used in automotive trucks, tractors, earth moving equipments as well as heavy diesel power generators. It can also be used on marine engines. This is possible, because the inventor of the diesel engine Dr. Rudolf Diesel invented the diesel engine with the intention of running it on any vegetable oil. Incidentally, *J. curcas* biodiesel has the same viscosity with mineral diesel and it can either substitute it wholly or mixed with it.

A combination of mineral diesel and biodiesel is expressed by indicating the percentage of the biodiesel contained. For example B20 indicates that the mixture contains 20% biodiesel while B100 means 100% biodiesel. Press cake is the by-product of the oil extraction. It is used as a combustion feedstock to generate power in thermal engines. It can be detoxified for use as an animal feed (Becker, 1996; Makkar and Becker, 1999; Aregheor et al., 2003). Feedback from FGDs revealed that the leaves and bark of *J. curcas* has long been in use in the study area for medicinal purposes and they are now utilised for pharmaceutical drugs. This is not a new thing as indicated from past studies (Persinos et al., 1964; Levingston and Zamora, 1983; Manandhar, 1995; Heller, 1996; Paroda and Mal, 1989)

Assessment of *J. curcas* products and usefulness acceptability

The acceptability of each product and usefulness by the

Table 2. Assessment of acceptability of identified jatropha products and usefulness.

S/N	Identified Jatropha Products	Acceptable		Not Acceptable		Total
		Frequency	%	Frequency	%	100
1	Jatropha Oil	900	68.18	420	31.82	100
2	Jatropha Biodiesel	1200	90.91	120	9.09	100
3	Live Fencing	1310	99.24	10	0.76	100
4	Farm Boundaries	1320	100	0	0.0	100
5	Homesteads Fencing	1320	100	0	0.0	100

Source: Field Survey.

Table 3. Logit regression on awareness of jatropha products by the respondents.

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Knoledgesc	18.090	4.439E3	.000	1	.997	7.187E7
	Willingjo	-18.090	2.340E3	.000	1	.994	.000
	Willingnesssc	-19.113	4.439E3	.000	1	.997	.000
	willingnessbd	.000	4.365E3	.000	1	1.000	1.000
	Constant	21.203	3.684E3	.000	1	.995	1.615E9

a. Variable(s) entered on step 1: knoledgesc, willingjo, willingnesssc, willingnessbd.

respondents were also assessed by the study (Table 2). Live fencing was the most acceptable (99.24%). About 68.18% of the respondents accepted Jatropha oil while 90.91% accepted biodiesel as against 9.09% who doubted its possibility. Almost all the respondents accepted the usefulness of *J. curcas* as farm boundary and household fencing materials. Further, Logit Regression Analysis (Table 3) was used to test the impact of respondents' awareness of the usefulness of *J. curcas* plant and associated products on their willingness to use the products.

As disclosed in Table 3, awareness of *J. curcas* in Kano state is likely to be influenced by the knowledge on the importance *J. curcas* seed cake (odds ratio = 4.44). So also, its awareness will likely influence the willingness to use *j. curcas* oil (odds ratio = 2.34), its seed cake (odds ratio = 4.4) and biodiesel (odds ratio = 4.37).

The high level of acceptance of *J. curcas* by the respondents may be due to its age-long use in delineating farm boundaries and strengthening homestead fencing. The readiness of the respondents to accept *J. curcas b*iodiesel is an Indication of the difficulty in obtaining mineral diesel in the rural areas (Achimugu, 2008) and the anticipation of higher income earnings. The respondents easily accepted the idea of the possibility of becoming producers of biodiesel due to their level of exposure. This assertion agreed with the findings of Singhal and Rogers (2001) that the ability and readiness of farmers to accept new innovations is directly proportional to their access to communication such as radio and television or if they are widely travelled.

He also noted that new innovations are accepted more readily if they can be tried on a small scale such as demonstration plots. However, no demonstration plots of *J. curcas* were encountered during the field survey. Effort was not made by either the government, Non Governmental Organisations (NGOs) or Community Based Organizations (CBOs) to demonstrate the planting, utilization and marketing of *J. curcas* products in the study area. In addition, extension services according to FGD findings, geared at sensitizing farmers on the economic benefit of *J. curcas* was lacking in the study area. This is very alarming if one considers the influence of Rogers five factors on adoption of innovation (ondigitalmarketing.com, 2013) that established a significant association between adoption index and the frequency of contact. High frequencies of contact increase the rate of adoption.

However, Francis et al. (2005) attributed the decline in the quality of extension activities of government organizations to the poor quality of extension agents. A research conducted by Adesiji (2006) and Oxarart et al. (2010) identified poor training as one of the factors

UNIVERSITY OF IBADAN LIBRARY

Table 4. Proportion of *Jatropha* plantings owned by farmers.

S/N	Proportion of *Jatropha* Plantings on farmland	Frequency	Percentage (%)
1	Whole farm	24	1.82
2	Half of farm	31	2.35
3	Quarter of farm	165	12.5
4	Less than a quarter of farm	1100	83.33
	Total	**1320**	**100**

Source: Field Survey

Table 5. Distribution of respondents' percentage of farmland that can be committed to *Jatropha* Biodiesel Production.

S/N	Farmland for Biodiesel Production	Frequency	Percentage
1	Whole Farmland	66	5
2	Half of Farmland	396	30
3	One Quarter of Farmland	132	10
4	< One Quarter of Farmland	726	55
	Total	**1320**	**100**

Source: Field Survey

UNIVERSITY OF IBADAN LIBRARY

responsible for poor quality extension agents. However Azeez (2006) blamed the extension system and not the agents for the short comings of extension in Nigeria.

This is because an extension agent is regarded by farmers as a merchant of ideas, inputs and services. If after accepting the ideas, the widely publicized inputs were not forth-coming, the adoption process will definitely experience a setback.

Status of *Jatropha curcas* Plant Holdings in Kano State

This study also documented the status of *J. curcas* plantation in Kano State with the view to finding out factors that can limit jatropha feedstock production in the state.

The proportion of respondents farm holdings committed to *jatropha* biodiesel production was small (Table 4). Only 1.8% of the respondents committed the whole of their farmlands to *J. curcas* plantation establishment. The majority (83.3.0%) could only apportion less than a quarter of their farmland while 2.3% and 12.5% of the respondents had half and a quarter of their farmland dedicated to *J. curcas* plant production.

In view of respondents' awareness of other products and usefulness of *J. curcas,* their opinions were sought on the proportion of their farm, which they are willing to commit to its production (Table 5). Interestingly, 5.0% of them are now ready to turn their entire farm holding to a *J. curcas* plantation while 30.0% were willing to commit half of their farm to *J. curcas* plants alone.

However, in the presence of market outlet (Table 6), about 55.0% of the respondents were willing to commit half of their farmlands to *J. curcas* biodiesel feedstock production. Likewise, 30.0 10.0 and 5.0% of the respondents were willing to commit the whole, a quarter and less than a quarter of their farmland to *J. curcas* biodiesel feedstock production respectively if there was market outlet (Table 6). On this same note, Table 7 shows the percentage of farmland that could be allocated to jatropha by the respondents if government were to provide incentives. About 31.0% of the respondents were willing to dedicate the whole of their farmland to the production of jatropha products. Another 30.0% consented to allocate 30.0% of their farmland to *J. curcas* biodiesel feedstock production. Some 29.0% and 10.0% of the respondents could allocate a quarter and less than a quarter of their farmland to *J. curcas* biodiesel feedstock production respectively (Table 7).

Table 6. Distribution of percentage of farmland allocated to Jatropha by farmers with ready market.

S/N	Farmland For Jatropha With Market Availability	Frequency	Percentage
1	Whole Farmland	396	30
2	Half of Farmland	726	55
3	One Quarter of Farmland	132	10
4	< One Quarter of Farmland	66	5
	Total	**1320**	**100**

Source: Field Survey.

Table 7. Percentage of farmland allocated to Jatropha by farmers with government Incentives.

S/N	Farmland For Jatropha With Government Incentive	Frequency	Percentage
1	Whole Farmland	409	31
2	Half of Farmland	396	30
3	One Quarter of Farmland	383	29
4	< One Quarter of Farmland	132	10
	Total	**1320**	**100**

Source: Field Survey.

Interest to participate in the production of *J. curcas* biodiesel feedstock among the respondents was very high. However, factors such as lack of market outlet, lack of incentives from government and poor government policy environment determine the level of respondent's interest to participate. Government incentives in form of capital, provision of seedlings, extension services etc. play an important role in people's participation in most programmes.

The small holder producers need to be sensitized on the uses of *J. curcas* products so as to trigger their interest to participate in its cultivation as a dedicated energy crop. This will widen their scope on its utilisation and enhance their income generation capacity. It will also reduce their overdependence on fossil fuels and restore their pride after losing the groundnut pyramid, which can now be replaced by barrels of biodiesel. The sensitisation campaign will be easy in the study area because awareness about the *J. curcas* small tree itself is already high. The level of awareness of *J. curcas* in Nigeria had been observed to be increasing as documented in the south west by Joseph (2011) where the small tree locally called "*lapalapa*" was embraced by farmers for income generation.

Investigation further revealed that the promotion of *J. curcas* cultivation in the study area will depend on government investment on the establishment and setting up of Jatropha feedstock refineries (farmers' supply outlet) and an intensive media campaign to familiarise the people with its products. These, according to respondents are most importantly part of the "Jatropha System", which should backstop the production of *J. curcas* biodiesel in the study area. Otherwise it will be another hype as experienced in Jigawa (a neighbouring State to Kano) where several innovative agricultural projects were introduced and accepted by the farmers; only for the farmers to be abandoned with their products after production. The government of Jigawa failed to institute the proper marketing arrangement or establish the ethanol plants that could utilise the commercial sugarcane, which was introduced to the farmers. In the end, the farmers reverted to their traditional farming practices. This scenario must be avoided in the case of *J. curcas* biodiesel promotion. Incentives in terms of provision of tree seedlings and other plantation establishment inputs, interest free loans, establishment of marketing boards and the facilitation of carbon credit funds to the small holder plantation owners can greatly speed up the process of implementing the "Jatropha system' in the study area. Some of the proposed incentives by the federal and state governments include tax exemption on Jatropha products, creation of the Commercial Agriculture Credit Scheme (CACS) to provide credit to those interested in large scale bio diesel production (*J. curcas* is one of the target crops) and exemption from

UNIVERSITY OF IBADAN LIBRARY

import duty on equipment for the establishment of biofuel industries.

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. However, the success of *J. curcas* biodiesel feedstock production upon which energy and other products depends requires a holistic planning regime called the Jatropha system. The central theme in the Jatropha system is the institution of a balanced demand-supply chain to ensure sustainability of the production system.

Recommendations

Deliberate and focused public sensitization campaign on the utilization and production of *J. curcas* products need to be mounted in the study area. 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 also be given serious consideration.

REFERENCES

Achimugu SA (2008).The Nigerian bio energy policy and Incentives: The National Workshop on *Jatropha curcas* for Renewable Energy Development, Kano.

Adesiji GB (2006). Competency Needed by Village Extension Agents of Osun State Agricultural Development Programme, Nigeria, Agroresearch 8(1) 93-101.

Aregheor EM, Becker K, Makkar HPS (2003). Detoxification of a toxic variety of *Jatropha curcas* using heat and chemical treatments, and preliminary nutritional evaluation with rats, South Pacific J. Nat. Sci., 21 (2003): 50–56.

Azeez IO (2006). Prospect and Challenges of Forest Conservation Extension for Sustainable Rural Development: The Experience of Public Extension Services in Southwestern Nigeria. J. Trop. For. Res., 22 (1): 44 – 52.

Bayo A, Akinbanmi JFK (2008). Bio-electricity Production in Nigeria Experiences So Far: A Community Case Study. The National Worksop on jatropha for Sustainable Energy Development. Kano.

Becker K (1996). Effect of different treatments on level of toxins in *Jatropha curcas* meal and effect of feeding on growth of fish (carp), rats and chickens, A report, Institute for Animal Production in the Tropics and Subtropics, (University of Hohenheim, Stuttgart, Germany (kbecker@uni-hohenheim.de).480 (1996), pp. 27

Calder R (2007). The bio fuel hoax in world food crises http/ www.biofuelworld.org- uk.com 10/04/2007 vol 21No72.23/06/09

Egunyanga V (2009). Senator Plays Military Action in Niger Delta. www.mediatrust.com. 23/06/09

Carr ME, Philipps BS, Bagby MO (1985). Xerophytic species evaluated for renewable energy resources. Econ. Bot. 39(4): 505-513.

Dehgan B (1984). Phylogenetic significance of interspecific hybridization in Jatropha (Euphorbiaceae), Syst. Bot., 9 (1984): 467-478.

FAO (1991). Land use planning applications. Proceedings of the FAO Expert Consultation, *1990*, Rome, Italy, 10-14 December 1990. World Soil Resources Reports 68. Rome, FAO. 206 pp.

Francis G, Edinger R, Becker K (2005). A concept for simultaneous wasteland reclamation, fuel production, and socio-economic development in degraded areas in India: Need, potential and perspectives of jatropha plantations. Nat. Res. Forum. 29: 12-24

Heller J (1996): Physic nut - *Jatropha curcas* L. - Promoting the conservation and use of underutilized and neglected crops (1). Institute of Plant Genetics and Crop Plant Research, Gatersleben/ International Plant Genetic Resources Institute, Rome. 66 pp.

Henning R (1996). Combating desertification - Fuel from *Jatropha* plants. *In* UNIDO Symposium on development and utilization of biomass energy resources in developing countries, Vienna, Dec.

UNIVERSITY OF IBADAN LIBRARY

1995. UNIDO, Environment and Energy Branch, Industrial Sectors and Environment Division, Vienna, Austria.

Iloeje NP (2001): A new geography of Nigeria. New Revised Edition. Longman Nigeria Plc. 200 p.

Ishii Y, Takeuchi R (1987). Transesterified curcas oil blends for farm diesel engines. Trans. Am. Soc. Agric. Eng. 30(3):605-609. Jatropha world (2007): http//www.jatrophaworld.com

Jones N, Miller JH (1991). *Jatropha curcas* - A multipurpose species for problematic sites.Land Resour. Ser., 1 (1991): 1–12.

Jones N, Miller JH (1992). *Jatropha curcas*: a multipurpose species for problematic sites. Land Resources Series No.1. Asia Technical Department, World Bank, Washington.

Joseph (2011). Farmers show more interest on Jatropha. African Newspapers of Nigeria Plc.

Levingston R, Zamora R (1983). Medicine trees of the Tropics. Unasylva 35(140): 7-10.

Makkar HPS, Becker K (1999). Nutritional studies on rats and fish (carp *Cyprinus carpio*) fed diets containing unheated and heated *Jatropha curcas* meal of a non-toxic provenance. Plant Foods Hum. Nutr., 53 (1999), 183–102.

Manandhar NP (1995). An inventory of some herbal drugs of Myadi district, Nepal. Econ. Bot. 49(4): 371-379.

Mortimore MJ (1978). Adapting to Drought: Farmers, Famines, and Desertification in West Africa. Cambridge University Press UK 305pp

NPC (2006). State Populations, in National and State Population and Housing Tables: 2006 Census Priority Tables (Vol. 1). National Population Commission, Nigeria. Available at www.population.gov.ng (27 - 09 – 2011).

Ondigital marketing.com (2013). http://ondigitalmarketing.com/textbook/foundations/factors- that-influence-technology-adoption-rate/ (25/07/2013)

Openshaw K (1986). Concepts and Methods for Collecting and Compiling Statistics on Biomass Used as Energy UN Statistical Office. New fork, USA

Oxarart A, Monroe M, Long A, Yanong R (2010). What Extension Agents Want: A Needs Assessment for Natural Resource Programs in Florida. School of Forest Resources and Conservation, University of Florida. 14pp. Available at http://sfrc.ufl.edu/extension/agent_support/index.html

Pak M, Allexi A (1994). Testing engines fuelled with physic oil. *Landtechnik* (Germany) 49(1):29-30.

Paroda RS, Mal B (1989). New plant sources for food and industry in India. In: G.E. Wickens, N. Haq and P. Day (Eds.) New Crops for Food and Industry. Chapman and Hall, London. pp. 135-149

Paroda RS, Bhag Mal (1989). New plant sources for food and industry in India *In* New Crops for Food and Industry (G. E. Wickens, Haq, N. and Day, P. Eds.). Chapman and Hall, London. pp. 135-149

Persinos GJ, Quimby MW, Schermerhorn JW (1964). A preliminary pharmacognostical study of ten Nigerian plants. Econ. Bot. 18(4):329-341.

Sambo AS, Bala EJ, Zarma IH (2008). Preliminary Study of a Pilot Rural Electrification Project. Using Biodiesel from Jatropha in Nigeria: The National Workshop on Jatropha Oil for Sustainable development, Kano.

Singhal A, Rogers EM (2001). India's communication revolution: From bullock carts to cyber marts. Thousand Oaks, CA: Sage.

Stiffler L (2008)."Bio-Debatable: Food vs. Fuel," Seattle Post-Intelligencer, Seattle, WA, Available at: http://seattlepi.nwsource.com/local/361634_biodiesel03.html.

Takeda Y (1982). Development study on *Jatropha curcas* (sabu dum) oil as a substitute for diesel engine oil in Thailand. J. Agric. Assoc. China 120:1-8.

Weiss E (1989): Guide to Plants Tolerant of Arid and Semi-arid Conditions: Nomenclature and Potential Uses. Margraf, Weikersheim.

UNIVERSITY OF IBADAN LIBRARY