

## Capacity Building Needs of Women Farmers in Jatropha Seed Oil Processing for Sustainable Biodiesel Feedstock Supply and Income Generation

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### Abstract

The scenario of depleting fossil fuel reserves and negative impact of carbon emissions from the fuels on the environment calls for a worldwide paradigm shift. This gave rise to the need to diversify into a more sustainable energy source. As a result, this study focused on determining the skills capacity building needs of women farmers in Jatropha oil processing for sustainable biodiesel feedstock supply and income generation in North-Central, Nigeria. Three research questions were answered for the study. The population was 93. The entire population responded to the questionnaire items. A thirty-30 items Jatropha Oil Processing and Marketing Skills Questionnaire (JOPMSQ) was developed for data collection based on literature reviewed. Three experts validated the questionnaire. Split-half technique was used to establish reliability coefficient of 0.84. Then, Ninety-three (93) copies of the instrument were distributed to respondents using five (5) research assistants. Mean and Improvement Need Index (INI) were used to answer the research questions. Findings revealed that women farmers in the area needed capacity building in 7 skills in planning for Jatropha processing, 8 skills in extracting oil from the seed and 10 skills in marketing Jatropha oil respectively. The study recommended among others that government should train and deploy extension workers to in turn, train the women farmers on the Jatropha oil processing skills thus, enhancing capacity building.

**Key words:** Biodiesel, Capacity building, Jatropha, Processing, Skills, Women farmers

### Introduction

It is no longer news about the universal concern over the negative impact of carbon emissions from non-renewable sources of energy such as petroleum products. This is because it has effect on economic, social and environmental aspects of human life. Consequently, report says in a bid to replacing fossil fuels which have hitherto sustained the world population, different countries in Europe, Asia, South America including Nigeria have been exploring different plant biomass resources for use as diesel fuels (Abdulkareem, Jimoh, Afolabi, Odigire & Patience, 2012; Mujeeb, Vedarmurthy & Shivasharana, 2016). The search continued till August 1982 when the 1<sup>st</sup> International conference on plant and vegetable oil as fuel was held in Fargo, North Dakota (Balat, 2007). It was reiterated that the key concerns in the conference were to address cost of the fuel, the effect of the vegetable oil fuels on engine performance and durability and fuel preparation, specifications and additives; and oil production, oil seed processing and extraction (Ezeonu & Ezeonu, 2016).

About a decade ago, research report stipulates that 95% of biodiesel was still obtained from edible oils which led to unfavourable competition with human consumption (Gui, Lee & Bhatia, 2008). This situation portends high food security risk hence, the need to further explore and utilize non-edible oils with the same potentials. In tropical countries, Jatropha seed oil is being promoted for biodiesel production with optimum technology for its multifaceted benefits (Ezeonu, & Ezeonu,

2016). According to Ezeonu and Ezeonu, Jatropha shell could be used for combustion, husk for gasification, cake for production of biogas after extraction, and the spent slurry as manure, oil as biodiesel in transport engines. There was a recent report on the high value of Jatropha kernel which contains 50% oil in which, extraction using two methods mechanical and solvent methods, holding 85% and 95% oil elements respectively (Abdulkareem et al., 2012). Jatropha oil has great potential as biodiesel due to its comparable properties of fossil oils as per calorific and cetane values (Serine et al. in Ezeonu & Ezeonu, 2016). The crop is a second generation dedicated energy crop and can be cultivated favourably as an intercrop with other food and cash crops on available arable lands (Ben-Iwo, Manovic & Longhurst, 2017; CTA, 2017).

Apart from its original discovery as source of bio-resources, its cultivation in less productive soil would help the soil to regain its loss nutrients. It would also assist in restoration of carbon loss and sequestration (Jan & Sharma in Aransiola, Daramola, Ojumu, Aremu, Layokun & Solomon, 2012; Ezeonu & Ezeonu, 2016). Jatropha is a perennial plant that grows in all types of soil in the tropics (CTA, 2017, Ezeonu & Ezeonu, 2016; Aransiola, et al. 2012). There are about 170 species of Jatropha but the commonest specie grown in Nigeria is the *Jatropha curcas*. As a widely acclaimed bio-fuel crop touted as ideal for growth on degraded land and considered as a weed, Jatropha plant grows up to 8metres and begins flowering at about 120 days after planting (CTA, 2017). As a result of scientific and technological discoveries, processing of Jatropha has now been mechanized (Aboderin, 2010). Using the mechanized processing method saves time and stress to pave way for its processing in large-scale. The processing stages as considered in this paper are seed preparation stage, oil extraction and crude oil refining and the marketing stage.

Evidence from research showed that the Nigerian economy had had a boom in the early 70s which was the post-independence era with about 90% foreign exchange earnings; and 30% of GDP from fossil oil (Oniemola & Sanusi, 2009). However, there has been worldwide outcry on the deplorable state of the original source of the fossil oil occasioned by the high carbon emission into the environment. Fossil oil fuels have remained the most reliable energy source worldwide and out of which over 90% is being consumed by the transportation sector (Devanesan, et al. in Aransiola et al., 2012). In another development, it was noted that petroleum-based fuels are limited in reserves and is concentrated only in certain regions of the world and which; sources are on the verge of reaching their peak of production (Aransiola, et al, 2012, Mujeeb et al, 2016). Recently, biodiesel is taking the centre stage as it is receiving increased attention as a blending component or a direct replacement for diesel fuel in vehicle engines (Aboderin, 2010). In the light of that, some literature identified that there has been relentless search for better alternatives and biodiesel appeared to be one of those alternatives. Biodiesel which is mostly extract from plant sources has been found to be biodegradable, non-flammable, non-toxic, non-explosive and more environmentally friendly compared to petroleum diesel (Demirbas, 2008). This view was buttressed by Hanna in Mujeeb et al. (2016), that the main advantages of vegetable oils as diesel fuel are: ready availability, renewability, lower sulfur, aromatic content and biodegradability (Goering et al. in Mujeeb et al., 2016).

Several countries have long keyed in and have made substantial progress in the biodiesel production and utilization. For instance, USA, Brazil, Japan and China are not relenting too. For instance, Germany proposed biodiesel blending quota of 4.4% as far back as January 1<sup>st</sup> 2007, up to a decade ago (Oshewolo, 2012). Oshewolo added that given the giant strides recorded by the countries above, it has become necessary for African countries to follow the same pathway. Thus,

Nigeria cannot afford to be left out given that the country is highly endowed with the biodiesel feedstock. In the context of this paper, women farmers refer to all female gender that have chosen farming as their occupation and on which they depend to meet their needs. Women in North Central region engage in various farming activities including on-farm and off-farm operations. Thus, they engage in processing of oil from various oil crop seeds such as oil palm fruit, ground nut seed, and shear butter. Although the women farmers in the study area are conversant with processing of some seeds to oil, it is skeptical to say they have sufficient skills in the processing of non-edible oil such as that of Jatropha. The present study would reveal capacity building needs of the women in Jatropha processing to oil.

There is no single definition of capacity building but over the years, a general understanding was developed by UNESCO. According to UNESCO (2005) “capacity is the ability of individuals, organizations and systems to perform appropriate functions efficiently, effectively and sustainably”. UNESCO maintained that in the context of development, the concept means the way individuals, groups, institutions and societies strengthen their abilities to perform core functions, solve problems and formulate achievable objectives; to understand and deal with their development needs in a broad context and in a sustainable manner. Capacity building is a process through which individuals, groups and organizations are empowered to meet development challenges (Catholic Relief Services, 2013). In addition, capacity building was defined as effort geared towards improving the level of knowledge, skills and attitude possessed by individuals for proficiency in a given task or job (Asogwa & Ohagwu, 2010).

In the context of this study capacity building as the process of developing and strengthening the skills, instincts, resources and ability that farmers need for them to survive, adapt and thrive in this era of globalization. This also entails adoption of appropriate knowledge, skills, attitudes and resources that will enable the farmers especially women farmers, to be effective and efficient in processing Jatropha produce (seed). From the foregoing, it could be deduced that whenever there is a situation of inability to perform a task or accomplish a responsibility in an expected manner by a person or group of persons, then such individuals need to be updated in appropriate knowledge or skills so required.

The researchers have observed that overtime farmers in some parts of North-central states have been much involved in the processing of other oils such as palm oil, soya bean, and cotton seed oil among others. Interaction with the women farmers in this area shows that in spite of the emphasis on Jatropha as a good source of biodiesel, not many women have been involved in its oil extraction. One probable reason could be because it has been adjudged not to be good for human consumption. Another reason could be that they do not possess the needed skills to profit in Jatropha processing. This study is however, on course as to validate this claim. Jatropha is an underutilized oil bearing crop which produces seeds that can be processed into non-polluting biodiesel and if well exploited, can provide opportunities for goods returns and rural development (Brittaine & Lualadio, 2010). One wonders why only few of the women have identified with Jatropha oil processing enterprise. The tendency is that these women are not so much aware of the procedures for collecting and processing the oil seeds. It could also be because the women lack sufficient skill in processing Jatropha as against other oil crops.

Although Jatropha has been among crops grown in Nigeria, its cultivation is not widespread but it is however, gaining more acceptability (Aboderin, 2010; Aransiola, et al, 2012). Besides, since it

is not good for consumption, then one expects that processing of the oil seed which serves as biodiesel should be given higher attention. Moreover, there is an existing scenario of bio-energy and food security supply crisis. That is, a complex situation where edible oils such as palm oil, soybean, cotton seed among others are competed for fuel. Thus, it is assumed that the women need capacity building in terms of skills in processing Jatropha to extract oil. In a focus group interaction with five (5) women farmers in Zaki-biam in Benue state and five (5) others in Doma in Nasarawa state, the researchers discovered that the women have interest in the Jatropha oil processing enterprises, but lack sufficient capacity to engage in the enterprise. Although the women were keen, they are still skeptical on their profit-making potentials as per where they could market their products. The purpose of this paper therefore, was to determine the capacity building needs of women farmers in Jatropha oil extraction for sustainable biodiesel production in post-oil boom economy. Specifically, the study sought to determine the capacity building needs of women farmers in:

1. planning for Jatropha oil processing;
2. assembling and processing procedures; and
3. marketing the Jatropha oil after extraction.

### **Research Questions**

1. What are the capacity building needs of women farmers in planning for Jatropha oil processing enterprise in North-central Nigeria?
2. What are the capacity building needs of women farmers in assembling and processing Jatropha by women farmers in North-central Nigeria?
3. What are the capacity building needs of women farmers in marketing Jatropha oil in North-central Nigeria?

### **Methodology**

The study adopted descriptive survey design. A survey research design is a plan, structure and strategy that an investigator adopt to find solution to research problems using questionnaire for collecting, analyzing and interpreting data from respondents (Olaitan, et al. in Asogwa, Olaitan and Asouzu, 2013). The study was carried out in North-Central States of Nigeria. This includes Benue, Kogi, Kwara, Plateau, Nasarawa, Niger and Federal Capital Territory, Abuja because Jatropha curcas is grown in appreciable scale in these states. However, due to paucity of research report this study could not give account of production capacities of these states. The population was 93 made up of 28, 22 and 15 lecturers of Home Economics respectively drawn from the Universities, Colleges of Education and Colleges of Agriculture; and 28 extension workers in the states. Three states were purposively selected since these states could easily be accessed and managed.

A Jatropha Oil Processing & Marketing Skills Questionnaire (JOPMSQ) was used for data collection. The questionnaire items were thirty (30) as developed by the researcher based on literature reviewed to elicit responses in line with research questions asked to be answered. Four point rating scale was used and the questionnaire items had two columns including: the needed and performance columns. Hence, the ratings were Highly Needed (4), Averagely Needed (3), Slightly Needed (2) and Not Needed (1). The corresponding rating for performance was High Performance (4), Average performance (3), Low performance (2) and No performance (1).

Three experts validated the questionnaire items; two were from Department of Agricultural and Bio-resources Engineering, University of Nigeria, Nsukka and one from Department of Agricultural Engineering, University of Agriculture, Makurdi. Their suggestions were adopted and the instrument was trial tested in Enugu State using 20 Home Economics lecturers. The

reliability was established using Cronbach Alpha formula with a coefficient value of 0.93. Three research assistants who were versatile in the research area administered the questionnaire to the respondents. The administration of questionnaire was done and retrieved within a period of two weeks (1<sup>st</sup> July, 2017 and 15<sup>th</sup> July, 2017). All questionnaires were returned (100% returned rate). Mean and Improvement Need Index (INI) were used to answer the research questions, determine performance gap and capacity building needs of the women farmers in processing of Jatropha

Weighted mean of each item under the needed category ( $\bar{X}_N$ ) was calculated

Weighted mean of each item under the performance category ( $\bar{X}_P$ ) was calculated

The difference between the weighted means, i.e.  $\bar{X}_N - \bar{X}_P = NG$  (Needed Gap) was calculated

The values of NG in each item indicated the capacity level the women farmers' performance on that item.

Where NG is Zero (0), it means the capacity building is needed for the item because the level at which the women farmers performed that skill is equal to the level which the skill is needed. But where the NG is negative (-), it means capacity building is not needed for that item because the level at which the women farmers performed the skill is higher than the level at which the skill is needed. Then, where the NG is positive (+), it means the capacity building is needed because the level of performance by the women farmers for that skill is lower than the level at which it is needed (adapted from Okafor & Ifeanyieze, 2014).

## Results

Results of the study are presented in Tables 1 to 3.

### Research Question 1

What are the capacity building needs of women farmers in planning for Jatropha oil processing enterprise in North-central Nigeria?

**Table 1: Need Gap Analysis of women farmers in planning for Jatropha oil processing enterprise N=93**

S/N	Items Statement	$\bar{X}_N$	$\bar{X}_P$	$\bar{X}_N - \bar{X}_P$ (NG)	Remark
1	Formulating specific objectives for Jatropha oil processing enterprise	3.41	2.56	0.85	CBN
2	Periodic review of objective of Jatropha processing enterprise	3.46	2.50	0.96	CBN
3	Identifying sources of Jatropha seeds (i.e. raw materials)	3.36	2.70	0.60	CBN
4	Arranging for labour/assistants	3.51	2.60	0.91	CBN
5	Identifying sources of funds	3.47	2.30	1.17	CBN
6	Identifying tasks involved in the processing of Jatropha oil	3.45	2.12	1.33	CBN
7	Gathering/assembling the seeds from their locations (local markets)	3.43	2.20	1.23	CBN
8	Clean the seeds of dirt/contaminants	2.56	3.50	-0.94	CBNN
9	Identify best source of heat	2.51	3.00	-1.09	CBNN
10	Assemble/Arrange processing material/equipment	3.92	3.94	-0.01	CBNN

N= number of respondents,  $\bar{X}_N$ =mean of needed,  $\bar{X}_P$ =mean of performance,  $\bar{X}_N - \bar{X}_P$  (NG) = Need Gap, CBN=capacity building needed, CBNN=capacity building not needed

Data in Table 1 showed that the performance gap values of seven (7) out of ten (10) skills items ranged between 0.78 and 1.33 and were positive indicated that the women farmers needed capacity building in the seven skill items. Three (3) out of the eleven 11 skills items had

performance gap values of -0.01 and – 1.09 and were negative indicating that the women did not need capacity building in these three (3) skill items. Generally, the women farmers needed capacity building in Jatropha oil processing for biodiesel in North-central Nigeria.

### Research Question 2

What are the capacity building needs of women farmers in assembling and processing Jatropha by women farmers in North-central Nigeria?

**Table 2: Need Gap Analysis of women farmers in assembling and processing Jatropha N=93**

S/N	Items Statement	$\bar{X}_n$	$\bar{X}_p$	$\bar{X}_N - \bar{X}_P$ (NG)	Remark
1	Dry the Jatropha seeds under sun to extract moisture to 2-6%	2.40	3.32	-0.92	CBNN
2	Roast the seeds using frying pan, for 10mins	2.30	3.51	-1.21	CBNN
3	Remove the seed husk	3.51	2.56	0.85	CBN
4	Pound the seeds using pistle mortar to appropriate texture	2.82	2.02	0.81	CBN
5	Screw-press the extract oil living the paste.	3.43	2.20	1.23	CBN
6	Heat the extract on fire using clay pot to separate oil.	3.48	3.02	0.46	CBN
7	Remove/separate oil from solvent	3.42	2.56	0.85	CBN
8	Skim the oil with cup	3.36	2.00	1.36	CBN
9	Filter the oil by sedimentation	2.17	3.45	-1.28	CBN
10	Clean and dry containers prior to next usage	3.45	2.40	0.78	CBN

N= number of respondents,  $\bar{X}_N$ =mean of needed,  $\bar{X}_P$ =mean of performance,  $\bar{X}_N - \bar{X}_P$  (NG) =Need Gap, CBN=capacity building needed, CBNN=capacity building not needed

Data in Table 2 that the performance gap values of six (6) skills ranged from 0.46 to 1.36 and were positive. This indicates that the women farmers needed capacity building in the 6 skills items. Four (4) of the skill items had performance gap values of 0.92 to -1.28 and were negative. This show the women farmers needed capacity building in those four skill items. Generally, the women farmers needed capacity building in those four (4) skill items since they did not possess the requisite capacity for high proficiency in the processing of Jatropha seed to oil.

### Research Question 3

What are the capacity building needs of women farmers in marketing Jatropha oil in North-central Nigeria?

**Table 3: Need Gap Analysis of women farmers in planning for Jatropha oil processing enterprise N=93**

S/N	Items Statement	$\bar{X}_n$	$\bar{X}_p$	$\bar{X}_n - \bar{X}_p$ (NG)	Remark
1	Locate market for Jatropha oil	3.52	2.31	1.21	CBN
2	Carryout market survey to determine current market survey to determine current market situation	3.43	2.35	1.08	CBN
3	Proper packaging of oil in suitable containers	3.22	2.10	1.12	CBN
4	Fix prices for various sizes of containers	3.14	2.01	1.13	CBN
5	Advertise the oil through various media	3.23	2.05	1.18	CBN
6	Record sales on daily basis	3.15	1.55	1.60	CBN
7	Record income from sales (profit)	3.25	2.51	0.74	CBN
8	Record expenses	3.48	3.02	0.46	CBN
9	Prepare profit and loss account record	3.43	2.20	1.23	CBN
10	Prepare a balance sheet	3.42	2.49	0.93	CBN

N= number of respondents,  $\bar{X}_n$ =mean of needed,  $\bar{X}_p$ =mean of performance,  $\bar{X}_n - \bar{X}_p$  (NG) =Need Gap, CBN=capacity building needed, CBNN=capacity building not needed

Data in Table 3 showed that the performance gap values of all the ten (10) skill items ranged between 0.46 and 2.63 and were positive. This indicated that the women farmers needed capacity building in all the ten (10) skill items in marketing the Jatropha. This implies that they lack the capacity to identify appropriate venue and environment for buyers.

### Discussion of Findings

The findings of the study revealed that women farmer in the rural areas of North Central Nigeria were lacking in eighteen (18) skill items (7 in planning, 4 in seed preparation and processing and 7 in marketing) of Jatropha processing to oil. This therefore indicated that the women farmers needed capacity building in 18 skill items identified by this study for processing Jatropha for oil (biodiesel) in North Central Nigeria. This finding was corroborated by Amusa and Dumbiri (2010) who noted that skills are needed by farmers to ensure proficiency and competency in performing occupational tasks. The findings are in agreement with the study by Ukonze and Olaitan (2010) in competency improvement needs of women in Agriculture in processing cocoyam into floun and chips for insecurity in southeastern Nigeria. This study revealed improvement need of the women in planning (12 items), processing (13 items) and marketing (7 items). The findings also agrees with that of Okafor and Ifeanyieze (2014) on the study titled capacity building needs of Agricultural science teachers in fishery for effective teaching of students in secondary schools in Anambra State Nigeria. The study revealed that teachers needed capacity building in 25 items in planning and constructing fish pond with positive performance gap values.

The findings of the study were also supported by that Aboderin (2010) who revealed that processing of Jatropha seeds for extract oil requires modern technology skills which culminates in higher technical knowledge and skill competencies. The findings of this study also conforms with that of Asogwa, Olaitan and Asouzu (2013) on entrepreneurial skills required by women retirees for processing of the pineapple fruits to juice as a sustainable business in Enugu State, Nigeria. The study found that 9 skills in planning were revealed, 16 skills in process of the pineapple fruits into juice and 7 skills in marketing of the pineapple juice.

## Conclusion

Various research results revealed that Jatropha seed is a useful bio-resource for biodiesel production. It has been documented that Jatropha oil has higher potentials for global acceptance as a commercial alternative to fossil fuel. In this case, since Nigeria is one of the countries experiencing depletion of fossil fuel reserve, there was the need for government to boost the capacity of the rural women to source and process more of the oil. To this end, government need to research into simplified methods by which the women farmers could adopt and provide mechanisms for ready market. This will help improve the income accruing to the women who are engaged in the processing of Jatropha oil from the seeds. On the other hand, government could also empower the producers of the crop with tools and funds through loans and subsidies so that the Jatropha crop can be cultivated in commercial scale. Moreover, it has been confirmed that encouraging its production and utilization as biodiesel is a worthwhile investment because it is a second generation feed stock which also have positive effect on marginal soils.

## Recommendations

The following recommendations were made by the study.

1. Government should adopt capacity building measures such as energy talks, seminars and workshops where the skills of the women and farmers could be enhanced.
2. Government should ensure that more extension agents were trained to in turn empower the women through the train-the-trainer educational programme to facilitate the process.
3. Extension workers should redouble efforts in enlightening and attracting the presence of more experienced skilled practitioners in oil processing. This will beef up the women farmers' capacity especially in rural farming communities.

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