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Cost of Energy Input in the Production of Cassava (*Manihot Esculenta*)

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Abstract

The economic analysis of input energy in cassava production was considered in this study. Farms were surveyed to collect data on fuel, natural gas, fertilizer, pesticides and chemicals used on the farm for cassava production. The areas of study were Oyo, Ogun, Osun and Kwara States of Nigeria. The data for cost input resources in all the selected farms during cassava production from land preparation to transportation to market or house was obtained using structured questionnaire and oral interviews. Mathematical expressions were developed to evaluate cost analysis for each of the defined unit operations and the cost incurred were then determined. The total cost of production of one hectare of cassava was ₦82,055 and cost analysis revealed that profit of production of one hectare of cassava was ₦123,745. Benefit cost ratio was 2.50, which was greater than 1.0, indicating that cassava production is feasible from the economic stand point.

Keywords: cost analysis, benefit cost ratio, energy, cassava

1. Introduction

Cassava (*Maninot esculenta*) is a drought-tolerant, perennial woody shrub and staple food crop with up to 32% (fresh) starch content which is cultivated extensively as a food crop in Africa, (Bamgboye and Kosemani, 2015; Shubo *et al*., 2017). In terms of production, it ranked as the fifth most important crop in the world after maize, rice, wheat and potato but ranked first in sub-Saharan Africa (Ralf, 2010). Nigeria is the world's leading cassava producer with about 19 percent share in the global market (FAO 2013). In African, over 103 million metric tons of cassava is produced annually, while Nigeria production accounted for approximately 34 percent (35 million metric tons) of Africa's output (FAO, 2015). In spite of this volume, the full yield potential has not been realized since smallholder production rarely exceeds 11 MT per hectare, and most of the commercial/industrial cassava processors face a critical supply constraint. In fact, many commercial cassava agri-businesses operate below processing capacity due to the irregular supply of fresh cassava roots (USAID, 2015).

Cassava utilization patterns vary considerably in different parts of the world (Onyenwoke and Simonyan, 2014). Presently in Africa, 90 percent of cassava produced is consumed as a staple food, providing calories for 500 million people and constituting 37% of the population's dietary energy requirements. (IITA, 2010). Oriola and Raji, 2013; Ugwu and Ozioko, 2015 prescribe processing of cassava tuber into various staples such as gari, starch, flour, pellets and abacha as the best preservation method. Apart from the aforementioned shelf-stable products, cassava can be processed to other food products: biscuits, bread, lafun, baby food and industrial product: ethanol, livestock feed, gum, starch for adhesive, syrup concentrates for drinks, hydrolysates for pharmaceuticals, drugs, and seasoning (Aniedi *et al*., 2012; Ilori and Adetan, 2013). Also, it is an ingredient used for coagulation of rubber latex and manufacturing of dyes, chemicals and binder in textile industries (Kamal and Oyelade, 2010; Ugwu and Ozioko, 2015).

Various energy resources such as mechanical (machinery, human labour and animal draft), chemical fertilizer (pesticides, herbicides), electrical are used in agricultural production. (Vivek *et al*., 2010). Efficient use of energy resources is an important tool of sustainable agricultural production and eco-system (Jekayinfa *et al,* 2013). Ozturk I. (2010) and Payne J. E. (2010), studied the relationship between energy use efficiency and economic growth based on analysis of a broad empirical and statistical data of countries around the world, they concluded

that economic output and energy consumption are linked. Also, Mousavi-Avval *et al*, 2011 reported that presently, productivity and profitability of agricultural production depends on level of energy consumption. Efficient use of energy resources reduces production costs, which boosts factor productivity and therefore economic growth (Vivid Economic, 2013).

Therefore, this study aims at determining the cost of energy resources used at each stages of production in cassava production, identify areas of high cost input which affect the productivity and evaluate the profitability of cassava production in Nigeria.

2. Materials and Methods

2.1 Research Farms Used for Investigation

The areas of study covered Oyo, Ogun, Osun and Kwara States of Nigeria. Ten (10) established farms were purposely selected for this research work. Four farms were selected in Oyo States, while two farms were surveyed in Ogun, Osun, and Kwara States.

2.2 Cost Analysis Procedures

Data on cost of energy resources, such as human labour, fuel, machinery, biological, N.P.K fertilizer and herbicide used for cassava production were obtained from selected farms through field surveys, direct measurements, interviews with farmers and structured questionnaires. The amounts of inputs used in the production of cassava were estimated based on unit operations.Mathematical expressions were used to obtain the amount spent on various stages of production. Data obtained were analysed statistically.

2.3 Method of Cost Evaluation of Cassava Production

To calculate the amount spent on each unit operation, quantitative data on operating conditions was required for each unit operation. The measured parameters for estimating amount spent on each unit operation are as shown in Table 1.

Table1. Measured Parameters for Evaluating Cost Input in Cassava Production

S/N	Operation	Required Parameter
1	Land preparing	Quantity of fuel used, l.
		Number of person involved.
		Time taken for preparing the land, h
2	Stem harvesting	Time taken for stem cutting, h
		Number of person involved.
3	Planting	Number of person involved in planting.
		Time taken to plant the stem, h
		Quantity of stem required to plant 1 ha.
5	Fertilizer application	Number of person involved.
		Time taken to apply the fertilizer, h
		Quantity of fertilizer required, kg.
6	Inter – row Weeding	Number of person involved.
		Time taken for the weeding, h
		Quantity of chemical required, l
7	Harvesting	Number of person involved.
		Time taken for the harvesting, h
8	Transportation	Number of person involved.
		Time taken to load and offload cassava tubers, h
		Quantity of fuel used, l

Land Preparation

The quantity of fuel used in land clearing, primary tillage, and secondary tillage was obtained from direct measurement in the farms. The cost of each operation was obtained by multiplying the total amount of fuel used in litres by the unit price of fuel, and the value obtained was added to the labour cost of the tractor operator. Land preparation cost was denoted as C_{lc} and calculated from equation 1.

$$C_{lc} = \left((Q_f \times P_f) + C_l + C_{hm}\right) \quad (1)$$

Where:

$Q_f = Quantity\ of\ fuel\ used\ (L)$

$P_f = price\ of\ fuel\ per\ litre$ (₦)

$C_l = Operator\ labour\ cost$ (₦)

$C_{hm} = Cost\ of\ hiring\ machinery$ (₦)

Unit price diesel fuel is ₦ 140.00 *per litre*

Stem Harvesting and Gathering

The stem used for planting were either obtained from the previous season or purchased. The quantity of cassava stem required, cost of one bundle, number of people required to gather the stem, and their cost of labour were obtained. The cost stem was denoted has C_{sg} and obtained from equation 2a and 2b.

When the stem was obtained from previous season

$$C_{sg} = C_l \times N_l \quad (2a)$$

When the stem was purchased

$$C_{sg} = (Q_{cb} \times C_b) \quad (2b)$$

Where:

$C_l = Cost\ of\ labour\ per\ hectare$ (₦)

$N_l = No\ of\ labour\ required$

$Q_{cb} = No\ of\ cassava\ stem\ bundles\ required$

$C_b = Cost\ of\ one\ bundle$ (₦)

Unit price of stem bundle is ₦ 250

Planting

Planting was done manually with cutlass. Cassava was planted from stem cuttings of about 20 cm in length. The cost of labour for planting cassava stem per hectare was obtained from the farmer.

$$C_p = (N_l \times C_l) \quad (3)$$

Weed Control

Amount spent on weeding operation consists of manual and chemical energy (herbicide) cost. Data on quantity of herbicide, quantity of quantity of fuel, Cost of machinery, number of people involved and cost of labour per hectare was obtained and used in the computation of the cost. Cost of weeding was denoted as C_{wc} and calculated from Equations 4a and 4b.

When it is done using hoe

$$C_{\mathrm{w}} = (N_p \times C_l)\} \quad (4a)$$

When Knapsack sprayer is used

$$C_{\mathrm{w}} = \left\{(N_p \times C_l) + (P_h \times Q_h)\right\} \quad (4b)$$

Where:

$Q_h = Quantity\ of\ herbicide\ (litre)$

$C_h = Cost\ of\ herbicide$ (₦/*litre*)

The cost of 1 litre of herbicide or pesticide was ₦1200

Fertilizer Application

Equation 5 was used to obtain the cost of applying fertilizer in various farms.

$$C_{fer} = \{(Q_{fer} \times C_{fer}) + C_l\} \quad (5)$$

Where:

$Q_{fer} = Quantity\ of\ fertilizer\ used\ (Kg)$

$C_{fer} = Cost\ of\ fertilizer$ (₦/kg

Harvesting of cassava tubers

The total cost of harvesting the cassava root per hectare was obtained from the farmers. It involves the cost of harvesting and de-stumping the cassava root. The cost was denoted as C_{ch}.

$$C_{ch} = (N_l \times C_l). \quad (6)$$

Transportation

Transportation cost was obtained from the labour cost of loading the cassava on the farm, off loading at the industry and the quantity of fuel used in the transportation. This was obtained from the equation 7.

$$C_{tr} = \{(Q_f \times P_f) + (C_{hv} + C_{load})\} \quad (7)$$

Where:

$$C_{load} = \text{labour cost of loading and off loading}$$

2.4 Economic Indicators

Gross return, net income and benefit-cost ratio as economic indicators were calculated based on the existing price of the inputs and outputs. Gross return, net income and benefit-cost ratio were calculated using Equations 8 to 10 (Ozkan *et al*., 2004; Canakci *et al*., 2005):

$$\text{Gross return} = (\text{Grain yield} \times \text{Grain price})\ (₦/\text{ha}) \quad (8)$$

$$\text{The net income of production} = (\text{Gross return} - \text{Total Expenditure})\ (₦/\text{ha}) \quad (9)$$

$$\text{Benefit Cost Ratio} = \frac{\text{The net income of production}}{\text{Total expenditure per hectare}} \quad (10)$$

3. Results and Discussion

3.1 Result and Discussion

The cost of energy inputs used in the production of cassava, total expenditure, gross return, and net income are shown in Table 1. It was observed that total expenditure per hectare varied from ₦64,698 to ₦98,200. The variation was due to the different amount of biological energy input, chemical energy input and difference in method of equipment acquisitions. Gross return and net income per hectare varied from ₦170,000 to ₦240,000 and ₦91,100 to ₦154,202, respectively. Variation in gross return and net income was due the variation in farm size, level of mechanization, quality of cassava cultivars used, and quantity of fertilizer applied.

The average total expenditure for cassava production per hectare was ₦82,055, as shown in Table 2. This is lower than ₦127,871 and 113,554 obtained in Cross rivers and Akwa Ibom States of Nigeria by James *et al.,* (2011) and Ebukiba (2010) for cassava production. Low expenditure for cassava production in this study was attributed to higher farm size and level of mechanisation. It was observed that in all the farms, the amount spent on manual energy resources was the highest. Averagely, the amount spent on manual energy was ₦35,056 (42.72%) of the total cost input, as shown Table 3. This value is lower than ₦83,370 (65.2%) obtained by James *et al.,* (2011). Higher amount spent on labour by James *et al.,* (2011) was attributed to low level of mechanisation. Farmers depend on hired labour for various farm operations which in turn increases the cost of production. The amount spent on biological energy (cassava stem) and machinery were ₦11,325 (13.80%) and ₦11,200 (13.65%), respectively, as shown in Table 3 and Figure 1. On nitrogen, phosphorus and potassium fertilizer, ₦6,141 (7.48%) was spent each. This was because, all the farmers in the study areas used NPK fertilizer of ratio 50:50:50. Generally in all the farms, the amount spent on agro-chemicals was the least. The average amount spent on agro-chemicals from the total cost was ₦1,470 (1.79%).

Operation wise, cost of inputs used in cassava production is shown in Table 3. The amount spent on fertilizer application was the highest in most of the farms and followed by land preparation. The average amount spent on fertilizer application and land preparation were ₦21,465 (26.16%) and ₦15,700 (19.13%) of the total expenditure, respectively as shown in Table 4 and Figure 2. High amount spent on fertilizer application and land preparation was attributed to high price of fertilizer and fuel in Nigeria. On stem gathering and planting operations, ₦13,305 (16.21%) was spent. Also, the average cost of harvesting and transporting the cassava tubers to the market were ₦13,420 (16.35%) and ₦11,465 (13.97%), respectively. The least amount of ₦6700 (8.16%) was spent on weeding in the entire surveyed farm.

The average gross return obtained per hectare was ₦205,800 as shown in Table 5. This was closer to ₦213,238 obtained by Oduntan *et al*.,(2012) for cassava production in Ondo State, Nigeria. The average net income per hectare was ₦123,745. This was similar to the findings by James *et al.,* (2011) of (₦123,160). Ethah and Angba,

(2016) obtained ₦137,869, which was also relatively closer to the finding in this study. The benefit-cost ratio from cassava production was 2.50, as shown in Table 5, since this value is greater than 1, cassava production in the area of study is a profitable venture. This value of benefit-cost ratio was compared and found to be consistent with findings reported by other authors for cassava production, such as 2.30 (Zaknayiba *et al*., 2014), 2.02 to 2.18 (Oduntan, *et al*., 2012) and 2.97 (NzehEmeka and Ugwu, 2014).

Table 2. Economic analysis of input energy in cassava production per hectare (₦/ha)

Energy resources	**farm 1**	**farm 2**	**farm 3**	**farm 4**	**farm 5**	**farm 6**	**farm 7**	**farm 8**	**farm 9**	**farm 10**
Human Labour	25720	30220	29200	31390	32615	27970	56502	32500	53300	31150
Machinery	14000	14000	14000	14000	14000	14000	-	14000	-	14000
Fuel	4480	7280	5600	4760	7000	4480	700	5600	700	5200
Agro- chemicals	2000	1200	2000	1100	1000	2200	1000	2200	1000	1000
Nitrogen Fertilizer	3666	7333	3666	5500	5500	5500	9166	5500	6416	9166
Phosphorus Fertilizer	3666	7333	3666	5500	5500	5500	9166	5500	6416	9166
Potassium Fertilizer	3666	7333	3666	5500	5500	5500	9166	5500	6416	9166
Biological Energy (cassava stem)	11300	11000	10000	12500	10000	11750	12500	11750	11200	11270
Total expenditure	64698	86699	71798	80250	81115	78900	98200	79550	89248	90098
Gross return (yield cost)	200,000	240,000	226,000	190,000	224,000	170,000	220,000	184,000	184,000	220,000
Net return	135302	153301	154202	109750	142885	91100	121800	104450	94752	129902

Table 3. Average energy input cost in the production cassava from the farms (₦/ha)

Input	**Cost ₦**
Human Labour	35056
Machinery	11200
Fuel	4580
Agro- chemicals	1470
Nitrogen fertilizer	6141
Phosphorous fertilizer	6141
Potassium fertilizer	6141
Biological energy (Cassava stem)	11,326
Total expenditure	82,055

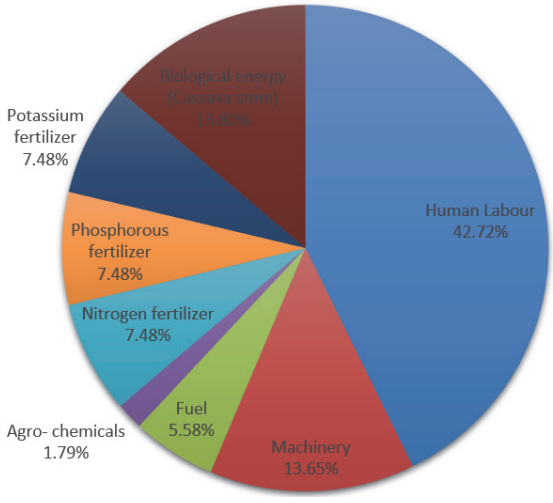

Figure 1. Pie Chat of the Energy Input Cost in the Production of Cassava

Table 4. The operation –wise energy input cost in the production of cassava (₦/ha)

Operation	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 8	Farm 9	Farm 10
Land preparation	12000	14500	14000	15000	14000	12100	22000	15900	22400	15100
Stem gathering and planting	13000	14000	11500	14550	12200	13000	14500	13500	13500	13300
Weeding	4800	8500	8500	5500	6900	6500	8200	6000	4900	7200
Fertilizer application	13398	25999	13398	19700	22015	19700	26000	19700	23248	31498
Harvesting	12000	13000	13200	14000	13500	14500	14000	14000	13500	12500
Transportation	9500	10700	11200	11500	12500	13100	13500	10450	11700	10500
Total expenditure	64698	86699	71798	80250	81115	78900	98200	79550	89248	90098
Gross Return (yield cost)	200,000	240,000	226,000	190,000	224,000	170,000	230,000	184,000	184,000	220,000

Table 5. Average energy cost analysis of cassava production in each stage of production

Operation	Cost ₦
Land preparation	15,700
Stem gathering and Planting	13,305
Weeding	6700
Fertilizer application	21,465
Harvesting	13,420
Transportation	11,465
Total expenditure	82,055

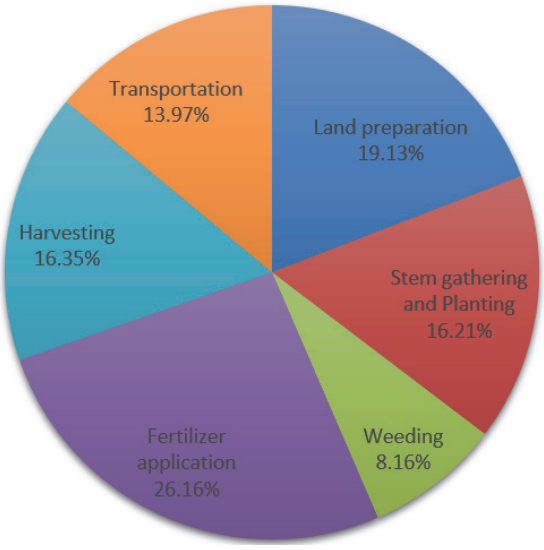

Figure 2. A pie chat of average energy cost analysis of cassava production in each stage of production

Table 5. Economic analysis of cassava production in Nigeria

Cost and return components	Unit	Value
Total gross value of production (yield cost)	₦ ha^{-1}	205,800
Total cost of production	₦ ha^{-1}	82,055
Net income	₦ ha^{-1}	123,745
Benefit cost ratio	-	2.50

4. Conclusions

The total cost of energy input in cassava production per hectare was ₦82,055, with a profit margin of ₦123,745. Benefit cost ratio was 2.50, indicating feasibility of cassava production from the economic point of view.

Increasing the level of mechanization of the farms, using high yielding variety of stem and optimum use of fertilizer will further increase the profitability of cassava production.

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