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COMPARATIVE ANALYSIS OF COST OF PRODUCTION OF BIOFERTILIZER WITH CHEMICAL FERTILIZER

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ABSTRACT
The effects of chemical fertilizer on soil nutrients that prompted research on alternative environmentally friendly biofertilizer development is not enough to totally eliminate the popularity and usefulness of chemical fertilizer by farmers. The sustainability of the later in terms of its economic values is however the ultimate priority for its general acceptance. This study was therefore, aimed at comparing the economic sustainability of producing biofertilizer and commercial chemical fertilizer. The aim was achieved by adopting Bill of Engineering Management and Evaluation (BEME) technique to carry out the unit cost of each raw materials used for biofertilizer production. The capital charge analysis, variable cost, fixed cost, direct production cost and selling price analysis were carried out using appropriate techniques. Fifty-one naira "₦51: 00K" was evaluated as the selling price of the produced biofertilizer compared to one hundred and ten naira (₦110: 00K) selling price of commercial fertilizer. Biofertilizer has a better economic value than that of chemical fertilizer as its selling price differs by 53.6 %.

INTRODUCTION

The effects of indiscriminate uses of chemical fertilizer on soil has led to gradual leaching of soil natural nutrients, soil erosions and accumulation of toxic elements (Archana and Chaubey, 2015; Adekunle *et al*., 2017). However, biofertilizer been one of alternative amendment needed for plant growth and the associated impacts with the use of chemical fertilizers have been worked on by several researchers (Abdullahi *et al*., 2012; Adekunle *et al*., 2017). Researches on biofertilizer exploitation have shown that it has superiority features which enriches the inherent soil nutrients and been an environmentally friendly soil amendment, it has also been identified as long term substitute to chemical fertilizer (Chaveevan *et al*., 2010; Amit *et al*., 2012; Dinu *et al*., 2015).

Studies have shown that the quality of manufacturing products are not just measure by their final finishing, but also their competitive market cost and life span which are functions of demand. (Dubey and Dubey, 2009). Also, to determine if a project is profitable, the manufacturing development system is considered, putting in consideration the capital charges of the basic machineries used for the production processes (Innocent and Nkwor, 2013; Carmen and Ciprian, 2018).Therefore, this paper aimed to comparatively analyze the of cost of effectiveness of biofertilizer with chemical fertilizer.

METHODOLOGY

Cost of the Produced Biofertilizer

The cost of the produced fertilizer was carried out using Bill of Engineering and Evaluation (BEME), to individually estimate each raw material used per unit price. The raw materials estimated by adopting BEME were brown sugar, cow dung, jatropha cake and the utilities, which include (water and unit energy of mixing). These were estimated to form total variable cost of the produced biofertilizer as

depicted in Equation 1.

Variable cost = CW + CU + C ...(1)

Where: CW = cost of raw materials, CU = cost of utilities, C = other cost

Also, the cost of labor, maintenance, capital charges and insurance formed the constituents summed up for fixed cost of the production, which is shown in Equation 2.

Fixed cost = MC + OC + SC + TC + IC ...(2)

Where: MC = maintenance cost, OC = cost of operation, SC = supervision cost, TC = tax and IC = Insurance cost

Equation 2 was used to estimate the fixed cost of the produced biofertilizer; however, the cost of insurance and tax were equated to zero because, they were not accounted for during the experimental formulation.

The summation of variable cost and fixed cost as presented in Equations 1 and 2 respectively, was represented by Equation 3 as the total cost of the produced fertilizer:

Total cost (TC) = VC + FC ...(3)

Also, 5 % of the total cost (TC) was used to determine the selling price, as shown Equation 4.

Selling price = 5 % x TC ...(4)

Costing of the Produced Biofertilizer using BEME

The costing of the produced biofertilizer raw materials carried out in terms of quantities and rates wer tabulated in Table 1, using Bill of Engineering Measurement and evaluation for biofertilizer production (BEME). Table 1 details are presented in the expressions below.

Table 1: Bill of engineering measurement and evaluation for biofertilizer production

S/N	Raw Materials	Specifications	Unit rate (₦)	Amount (₦)
1	Cow dung	6 kg	8:00	24:00
2	Jatropha cake	2 kg	12:00	24:00
3	Brown sugar	2 kg	60:00	120:00
4	Energy	0.08 kWh x 0.5	25.2	1.008
5	Water	3L	2.00	1.008
Total				**175.008**

Location and period of study: Zaria, Kaduna State. (March-April, 2019)

If the cost of cow dung per kg is ₦8, and there is 6 kg that was utilized, then:

The cost of cow dung used = 8 X 6 = ₦24: 00K

If brown sugar cost ₦60 per kg, then the cost of 2 kg = ₦120: 00K

For jatropha cake, 2 kg was used. Therefore, if the cost per kg = ₦12: 00K; the cost of 2 kg will be: 2 X 12 = ₦24: 00K

The cost of utilities was carried out by multiplying the liters of water used by the price of water per liter. The quantity of water used was 3 L, with bases of ₦2:00 K per liter = 2 X 3 = ₦6:00 K

Also, the cost of energy used was carried out based on the unit of power consumed by the mixer, used for moisten the cow dung. The power rate of the mixer used as shown in Figure 1 was 0.08kWh, which was multiplied by 30 mins of the mixing time.

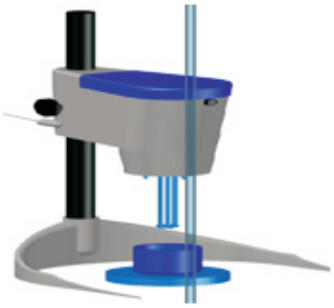


Figure 1: The mixer used, sketched with 3D-autocardtool

As retrieved from https://www.globalpetrolprices.com/Nigeria/electricityprices/, the international tariff rate used as at March, 2019 was $0.07 per unit of energy consumed, which is equivalent to ₦25.2 when ₦360 to $1 was applied as a conversion factor.

Bill of Engineering Management and Evaluation on the Capital Charges

The materials of construction of the digester used to produce the fertilizer were evaluated as the capital charge analysis by adopting BEME technique as depicted in Table 2.

Table 2: Bill of Engineering Measurement and evaluation for the digester construction

S/N	Materials	Specifications	Unit Rate (₦)	Amount (₦)
1	Stainless steel type 304	2 square meters	₦21, 600)	₦43, 200)
2	Temperature gauge	1	₦10, 000	₦10, 000
3	Pressure relieve valve	1	₦3, 800	₦3, 800
4	Labor		₦26, 000	₦26, 000
Total				**₦83, 000**

$1 = ₦360 (March, 2019)
The total cost of materials procured for the construction of the digester and the digester construction labor cost were estimated to formed the capital charge as shown in Table 2. The cost of maintenance and the operating labor cost were evaluated based on 1 % and 2 % of the capital charge respectively. The calculations are summarized as:
If the cost of capital charge = ₦83, 000, as shown in Table 2.
Since the maintenance cost is 1 % of capital charge, therefor; maintenance = ₦830
Also, if operating labor costis 2 % of the capital charge, the labor cost will be = ₦415
Therefore, the fixed cost = cost of maintenance + cost of labor = 830 + 415 = ₦1245

Thus:

Cost of production = Variable cost + Fixed cost = 175.008 + 1245 = ₦1420.008

Selling price = 5 % of the production cost based on 1.4 kg = 5/100 x1420.008=?71
Therefore, if ₦71: 00K was achieved based 1.4 kg, the selling price for 1 kg will be = 71/1.4=₦51

On the large-scale production:
I. Experimentally, it has been determined that; 1.4 kg of biofertilizer was produced in 1 hour.
II. Assumptions: Lets the operating time per day be 10 hours and 300 days in a year
If the operating time is assumed to be 10 hrs, for 1.4 kg/day will be 1.4 x 10 = 14 kg
If 14 kg is produced in large scale per day, therefore = 14 x 300 = 4200 kg will be produced for 300 days
If the selling price for 1 kg = ₦51. Therefore, 4200 x ₦51 = ₦214, 200 will be achieved annually.

To determine the amount needed per annum for the raw materials, since price of raw materials for bench scale per hour was ₦175.008
For 10 hours operating time, it will be = 10 x 175.008 = ₦1750.08
If ₦1750.08 is used per day, therefore; ₦525024 for 300 days
Taking into consideration the 31.8 % contributed by the feedstock in producing biofertilizer using the material balance analysis.
Therefore:
The sum contributed in the production based on the 31.8 per annum was 31.8/100 x 525024 = ₦166957.632
If the selling cost per annum was ₦214, 200; the gross profit will be ₦214, 200 - ₦166957.632 = ₦47242.368
Thus, % profit = (Sale price - production cost)/(production cost) x 100= (214200-166957.632)/166957.632 x100 = 28.3 %
The income taxis 10 % of gross profit obtained, which is0.1 x 47242.368 = ₦4724.2368
Therefore, the net profit will now be = % profit - tax income
= ₦47242.368 - ₦4724.2368 = N42, 518.1312

RESULTS AND DISCUSSION

The Cost Evaluation of the Produced Fertilizer

Table 3 shows the total variable cost of the produced fertilizer. The total amount of variable cost was one hundred and seventy-five-naira, eight kobo only "₦175.008" as presented in the Table.

Table 3: Variable cost of the produced fertilizer

Variable asset	Biofertilizer (₦)
Cost of raw materials	168
Cost of water	6.0
Cost of energy per unit	1.008
Total variable cost	175.008

The summation of raw materials cost, which was ₦168 and the cost of utilities were amounted to the variable cost of the produced fertilizer as shown in Table 3. Also, table 4 presented the fixed cost of the produced fertilizer.

Table 4: Fixed cost of the fertilizer

Fixed Asset	Biofertilizer (₦)
Maintenance cost	830:00
Operatinglabor cost	1,660
Fixed cost	2,490

As shown in Table 4, the fixed cost of the produced fertilizer was two thousand, four hundred and ninety naira only "₦2,490",which was obtained from the cumulative sum of maintenance cost of eight hundred and thirty naira only "₦830"and the operating labor cost of one thousand, six hundred and sixty naira only "₦1,660". Table 5 therefore, shows the production cost of the produced fertilizer, resulting from the sum of total variable cost and fixed cost. These amounted to the total sum of two thousand, six hundred and sixty-five-naira, eight kobo only ₦2,665.008 as the production cost.

Table 5: Production cost of fertilizer

Operating cost	Biofertilizer (₦)
Total fixed cost	1245
Total variable cost	175.008
Total operating cost	2,665.008

Profitability of the Project

On the large-scale production, one hundred and sixty-six thousand, nine hundred and fifty-seven-naira, sixty-three kobo "₦166, 957.63" was recordedin Table 6 as the total investment per annum. Also, the profit obtained after tax deduction was two hundred and eight thousand, eight hundred thirty-eight-naira, thirteen kobo only"₦208,838.13". The result obtained proved that, the scale up of this project is only profitable but also economically viable.

Table 6: Profitability of the project

Item	Amount (₦)
Investment per annum	166, 957.63
Income per annum	399,000
Profit before tax	232,042.37
Income tax	23,204.24
Profit after tax	208,838.13

Operating period per annum = 300

Comparison between Cost of Commercial and the Produced Fertilizers

The price of NPK 20:10:10 and 15:15:15 formulations shown in Table 7 as at April, 2018 were ₦5,500 and ₦6,500 per 50 kg, which are equivalent to ₦110 and ₦130 per kg respectively.

Table 7: Commercial fertilizer prices based on their formulations

Fertilizer specifications	prices
NPK (15: 15: 15)	₦6, 500/50kg
NPK (20: 10: 10)	5, 500/kg

Market survey; El-Hayat fertilizer firm (April, 2018)

The comparison carried out with the commercial fertilizer was based on the 20:10:10 specifications, which was one hundred and ten naira only"₦110" per kg. However, the cost of 1 kg of the produced biofertilizer was evaluated to be fifty-one naira only "₦51" as shown in Table 8.

Table 8: Cost Comparision between Commercial and produced Fertilizer

Fertilizer Type	Selling price/kg (₦)
Commercial fertilizer (20:10:10)	110
Produced fertilizer	51

It was observed as recorded in Table 8 that; the selling price of commercial fertilizer is 53.6 % higher than that of the produced fertilizer, which proved therefore that, the produced fertilizer is more economically viable when compared with the commercial fertilizer.

CONCLUSION

It is concluded based on the investigation that; biofertilizer has potential to be produced from a cheap natural source, whose end product is relatively cheaper than the commercial synthetic fertilizer. This is an evidence as it was proved from this work that, the cost price difference based on 1 kg was 53.6 % higher in commercial fertilizer compared to the produced fertilizer. The produced fertilizer is therefore, more economically viable and cheaper than the commercial fertilizer.

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