Engineering Economic Analysis of Organic Fertilizer Production in Nigeria

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Abstract

Organic fertilizer factories in Nigeria were assessed to determine their economic viability and the best technology option. Initial investment and economic performance of the factories were evaluated using questionnaire and records. The study revealed most of the factories (80%) are profitable. In actual performance, 20% of the factories attained viability due mainly to low capacity utilizations. Eighty percent (80%) of the factories used low level technology (LLT) while 20% used medium level technology (MLT).The LLT option recorded higher viability and lower break-even period than the MLT. However, projections of performance for the two options when sensitivity at higher capacity utilizations to selling price and project useful life were computed revealed they are both viable with MLT returning higher viability than the LLT. The study recommend product promotion, private sector involvement, close collaborations between industry and academia, paradigm shift from current agricultural system, and stronger policies from government as steps towards enhanced viability.
Keywords: *Organic fertilizer factories, economic viability, technology option, economic performance.*

1. Introduction

Engineering economics (EE) is a fundamental aspect of engineering practice involving systematic evaluation of the cost and benefit of engineering projects (Neufville, 1990). Engineers and managers use EE to assist with decision making as it is useful for comparing technology alternatives while making project assessment and selection (DeGarmo et al., 1997). It contains a set of tools which could be used to evaluate the economic viability of a technology based project and justify the adoption of technology alternatives. Though having its roots in economics, EE has its own set of unique methodologies.

Engineering economic analysis starts with the computation of cash flows. The outflow profile of the project include pre-production or initial expense, raw materials cost, operating and maintenance cost (e.g. tax, insurance, depreciation, wages/salaries, and other overheads), and any other associated cost. The inflow profile includes total revenue/turnover generated, and salvages value of assets. Minimum attractive rate of return (MARR) which is the lowest rate of return that investors will accept before they invest in light of the investment risk, taken as the interest rate available for the investment, is selected for each project.

In the wake of the global food crisis earlier in 2008, the Nigerian Government spent ₦65 billion to import 650,000 metric tonnes of fertilizer into the country (Reliefweb, 2008). Fertilizer importation for 2007 was 528,000 metric tonnes bought at ₦30 billion while Federal Executive Council (FEC) approved ₦89.3 billion to procure 900,000 metric tonnes of fertilizer in 2010 (Archibong, 2010). This is direct fallout of the fact that fertilizer production in the country is grossly insufficient. In addition, corruption in the process of fertilizer procurement and distribution has made it impossible for ordinary farmers to get access to this agricultural input. Farmers have to fall back on unsubsidized fertilizer in the market putting additional financial burden on them and their productive activities (Sunday Punch, 2008). Despite huge sums of money that is being spent by government on fertilizer procurement and subsidization, the problems of availability, accessibility, and sustainability still loom large. According to Falusi (1997), the major reasons why these problems persisted for so long has been the twin-factors of subsidy and subsidy administration although the latter is believed to be the greater of the two problems. Similar to what obtains in the oil sector, the government has been engaged in subsidizing fertilizer imports but the process is replete with faults. Also noted as responsible for this problem is the failure to recognize the futility of public sector engagement in the supply, distribution activity and price regulating mechanism of fertilizer. Though government is supposed to have disengaged from participation in fertilizer procurement during the fertilizer industry liberalization period between 1996 and 2005 (IFDC et al., 2000), the case in actual reality is not so.

A better approach to solving this input supply problem is local production of fertilizers. Early in July 2011, the Dangote Group concluded plans to build the biggest chemical fertilizer facility in Africa (Daily Trust, 2011). This factory will use ammonia-urea generated from Nigeria's abundant natural gas and is expected to become a significant addition to the local fertilizer industry.

However, chemical fertilizers when used continuously, result in soil acidity, soil depletion, and pollution of the environment. Tropical soils are basically poor and fragile due to low organic matter, low activity clay, and are highly prone to erosion. Organic matter is important in maintaining good physical conditions in tropical soils (Abad et al., 1997). The major advantage of organic fertilizers (OFs), which have organic matter as their major constituent, is that they are environmentally friendly (The Guardian, 2004, Fadare et al., 2009, Adeoye et al., 2005). There is also abundant municipal and industrial waste locally that can serve as raw material (Akinbami et al., 1996). Producing organic fertilizers in Nigeria is like killing two birds with one stone; providing an agronomically effective, affordable, and environmentally friendly fertilizer to farmers; and creating a local fertilizer industry with attendant advantage of redirecting the money spent currently on importation into the local economy, creation of investment opportunities for industrialists, provision of jobs, sustainable waste management and environmental health in Nigerian cities, and improved food production and food security.

Currently, only few factories produce organic fertilizers in Nigeria probably due to non-availability of information about its economic viability. Though machineries have been invented and fabricated locally for organic fertilizer production (Fadare et al., 2009, Olanrewaju and Ilemobade, 2009), the technology has not been leveraged upon to the extent of leading to viable enterprises. There is a need for EE assessment of the technology used for organic fertilizer production in Nigeria to determine their economic viability.

This study aims at answering the following research question; are the technological options for organic fertilizer production in Nigeria economically viable? Economic viability of two organic fertilizer production technology options available in Nigeria were analyzed using EE techniques that include benefit cost ratio (B/C), annual worth (AW), net present value (NPV), and discounted pay back period (PBP).

2. Review of literature

UNEP (1996) gave a range of technologies currently applied for waste composting, which is the major process in OF production, to be of 4 types. These are minimal technology (MT), low-level technology (LLT), medium-level technology (MLT), and high-level technology (HLT). Though MT is being utilized and practiced in various farms, only two types of technology namely LLT and MLT are used for commercial production of organic fertilizers in Nigeria (Babalola, 2011). Local fabricators and artisans fabricate machinery required to convert organic matter (OM) into organic fertilizers (Olanrewaju and Ilemobade, 2009, Sridhar and Adeoye, 2003) while on few occasion, machineries were imported.

Recycling waste for farm input is a viable option in Nigeria (Egbewumi et al., 1997, John et al., 1996, Sridhar and Adeoye, 2003). A huge market potential exist for OFs despite the fact that the bulk market is yet to be fully developed (Olanrewaju and Ilemobade, 2009). According to Cruz et al. (2008), the economics of organic fertilizer production from solid waste in the Philippines indicate an initial investment of US$4,900. For one cycle (27 to 30 days) within which 100 bags were produced, gross sale was US$300 with total expenses of US$113.41. The net income was US$186.59. The initial investment for the shredding machine and hand tractor can be recovered within 2.68 years. Waste conversion technology projects such as biogas production from waste in Nigeria (Adeoti et al., 2000), and biogas energy production from waste in Uganda (Walekhwa et al., 2010) shows good economic potential. Organic fertilizer application on the farm has produced results comparable and sometimes better than that of other types of fertilizer (Kolade et al., 2005). In comparing different doses of several types of fertilizer including compost, compost fortified with Nitrogen (OMF: organo-mineral fertilizer, a variant of organic fertilizer), and chemical fertilizer for Okra production in Nigeria, it was discovered that OMF returned the most favourable benefit cost (B/C) ratio of 1.9:1, increased net returns of between 20.2% and 74.3% per Ha, and gave maximum profit per naira above the other fertilizers used (Akanbi et al., 2004).

According to DeGarmo et al. (1997), carrying out engineering economic (EE) studies involve five basic methods commonly used to assess economic worth namely Present worth (PW), Annual worth (AW), Future worth (FW), Internal rate of return (IRR), and External rate of return (ERR). These were referred to as economic figures of merit and recommended for EE studies by Berhan (2000). The PW is the equivalent worth of all cash flows relative to a beginning point in time called the present. Thus, for the present worth of a future sum (F) at i percent interest for N periods;

$$PW = F\ (P/F,\ i,\ N)$$

The AW is a uniform annual series of amounts for a stated study period that is equivalent to the cash inflows and or cash outflows under consideration. The annual worth of a revenue (R) and expense (E) cash flow for an enterprise that has initial investment (I) and salvage value (S) at i percent interest for N periods is calculated as;

$$AW = R\text{-}E\text{-}\ I\ (A/P,\ i,\ N)\ -\ S\ (A/F,\ i,\ N),\ \text{or}$$

$$AW = F\ (A/F,\ i,\ N)$$

FW is the equivalent worth of all cash flows relative to an end point in time called the future. The project is desirable when FW ≥ 0. The future worth of a present sum (P) for an enterprise that has annuity (A) and salvage value (S) at i percent interest for N periods could be calculated as;

$$FW = -P\ (F/P,\ i,\ N) + A\ (F/A,\ i,\ N) + S,\ \text{or}$$

$$FW = S + A\ (F/A,\ i,\ N) - P\ (F/P,\ i,\ N)$$

According to DeGarmo et al., (1997), there are other project worth determining techniques that could find relevance in economic assessment and selection of engineering projects. These are net present value (NPV), benefit cost ratio (B/C), and pay back period (PBP). NPV is often used to determine profitability of different projects and often serve as a criterion for selecting the project with better merit out of several alternatives. B/C is another measure of project worth that compares the financial benefits accruable from a project with the cost implication. PBP is computed to determine liquidity and period of capital recovery of engineering projects. It projects the break even period of project options.

For each EE analysis, a minimum attractive rate of returns (MARR) is chosen as a constant over time (Neufville, 1990). MARR is the lowest rate of return that investors will accept before they invest in light of the investment risk or the opportunity to invest elsewhere for possibly greater returns. MARR is related in a time sense to the PBP. The smaller the acceptable rate of return, the longer an investor is willing to wait to see a net profit and vice versa (Berhan, 2000).

Several EE studies have been carried out to determine value of investment and select among technology options. The viability of iron ore production in Nigeria (Adebimpe and Akande, 2011), organic fertilizer production in the Philippines (Cruz et al., 2008), biogas production in Nigeria (Adeoti et al., 2000), biogas production in Uganda (Walekhwa et al., 2010), and mushroom cultivation in Nigeria (Adeniyi, 1997, Ilori et al., 1999) have all shown that EE is an effective technique for determining viability of technology projects.

National fertilizer policy for Nigeria stipulates that the government will encourage the exploration and development of the country's raw material potential for fertilizer production as well as encourage producers to use locally available raw materials as much as possible (FFD, 2006).

3. Methodology

The study sample covered six organic fertilizer factories identified in three states of southwestern Nigeria namely Lagos, Oyo, and Ondo states with one each in both Lagos (factory D) and Ondo (factory B) while four of the factories (A, C, E, F) were located in Oyo state. Primary data were derived through questionnaire. It was designed to elicit information on the initial cost of the technology, annual expenses on raw materials, labour, operation and maintenance, annual income, and salvage value. Interviews were also conducted during administration of the questionnaires. Secondary data was sourced from relevant documents. The data was analyzed using quantitative and descriptive statistics. Engineering Economic analysis was also carried out on the data collected. MARR was chosen as 12%. Salvage value was calculated using Straight line method. A depreciation value of 3.75 was recorded for the equipments. This led to the salvage value being fixed at 0 by the 27^{th} year of the project while useful life of the project was fixed at 25 years. Sensitivity of OF production to both useful life (varied at 10, 15, 20 and 25 years), and price (varied at ₦1,000; ₦1,200; ₦1,500 for the LLT option and ₦2,000; ₦2,500; ₦3,200 for the MLT option) were also projected. The market price for LLT products ranged between ₦1000 and ₦1500 while that of MLT was ₦3200. Hence, the lower prices of ₦1000 (LLT) and ₦2000 (MLT) were used to compute the net present values (NPVs), Pay-back periods (PBPs), and sensitivity to useful life. This is in agreement with the methodology of Adeniyi (1997) in which lower limits were used for projections.

4. Results and discussion

4.1 Economic performance of the organic fertilizer factories

Out of the six factories covered by this study, only five of the factories have reliable data of their operations available (Table 1). Factory D had the highest initial costs of ₦5.6 billion, followed by factory B with ₦25 million. The initial costs of factories E, A, and C were ₦21 million, ₦12 million and ₦2.6 million respectively. Out of all the factories evaluated, factory D is the only one that utilizes MLT option (Babalola, 2011). Table 1 reveals that the cost of starting a MLT organic fertilizer factory in Nigeria is much higher than that of starting a LLT factory indicating it is easier to enter the industry through the LLT option.

The cash flows of the five factories were evaluated for the last three operating years and the average value computed. Factory D has the highest annual sales of ₦24,000,000 and biggest profit of ₦4,800,000. However it is also the most risky investment due to its very high initial capital. Profit after sales (without considering salvage values of assets) revealed best performer is factory D (₦4.8 million) followed by factory A (₦3.74 million), E (₦2.45 million), C (₦216,000), and B (-₦2.34 million). Factory B deficit is attributable to its high level of expenses and low sales. Despite its deficit, it owes its sustenance to the fact that it is government owned and also an integrated waste recycling center that is involved with other businesses such as metal and plastic recycling.

This result shows that most of the organic fertilizer factories in this region are performing well financially and could achieve better financial performance if the enterprises were well taken care of especially if the factories can maximize their installed capacity as all of them operates at abysmally low capacity utilizations (Babalola, 2011). This result also agrees with the findings of Cruz et al. (2008) that organic fertilizer production is financially viable, as well as Adeoti et al. (2000) and Walekhwa et al. (2010) that similar waste to wealth conversion projects are viable in Africa.

The table reveals that most of the factories (60%) do not have tax, insurance, and raw material cost profile. They get access to municipal solid waste needed for their production free of charge. This is the good side of this industry as the main raw material is often recovered free with only the cost of transportation and sorting (which are part of operation and maintenance cost) as associated expenses. The two factories with raw material cost (A and B) produces more than pure organic fertilizers and have to buy other raw material components for their product (e.g. Nitrogen, and Superphosphate chemicals) even though such are needed at micro quantity in the overall production. In agreement with Walekhwa et al. (2010) on viability of biogas production, variation in discount rate (MARR), capital, and operation and maintenance cost could affect the viability of organic fertilizer production in Nigeria.

The economic viability of the factories is shown in table 2. These were based on the annual worth (AW) model, and benefit cost ratio (B/C). The AW model is in agreement with the position of Berhan (2000) that when considering projects that will last several years, where compounding and discounting comes into play, the use of AWs is suggested for evaluating project viability. The result showed that factory A was the most viable with AW value of ₦2.22 million and B/C of 1.29. The AW values of the remaining factories were negative while their B/C was less than 1. This indicates that they are not really viable enterprises which might be due to several factors including high initial cost of investment, low capacity utilizations (CUs), and low revenues. This is not a verdict of non-viability on organic fertilizer production in Nigeria; rather it showed that most of the organic fertilizer factories will have to improve their operational performance from the current low capacity utilization levels they are experiencing if they are going to become viable. The reason for the high performance of factory A could be attributed to its ownership structure. It is a privately owned enterprise (Babalola, 2011) unlike most of the other factories which were owned by governments. Therefore it is operated with a profit motive in mind. Its management is also more efficient while it has a higher capacity utilization, labour productivity, and higher sales in percentage of output than most of the other factories. This position is also supported by the factory's high profit (₦3.74 million) ranked second among all the factories (Table 1).

This result also reveals a worrisome fact that though most organic fertilizer productions were projected to be highly viable enterprises (Cruz et al., 2008) and considered as viable projects in literature (Egbewumi et al., 1997; John et al., 1996; Olanrewaju and Ilemobade, 2009; Sridhar and Adeoye, 2003), the case is not always the same in their actual performance. Other challenges of organic fertilizer production include low level of product promotion and awareness, and weak government policy on organic fertilizer particularly the policies of patronizing chemical fertilizer importation; regarding organic fertilizer as a research item instead of a viable local alternative to chemical fertilizers; and lack of a concerted effort on the part of stakeholders for its full utilization in the food security strategy of the country. Efforts to improve utilization of organic fertilizer products will require financial, legislative, fiscal, and advocacy support.

Table 1: Cash flow profiles of organic fertilizer factories

Description	Values for different factories (₦)				
	A	B	C	D	E
Initial Cost	12,000,000	25,000,000	2,600,000	5,600,000,000	21,000,000
Annual Disbursement					
*Labour	4,800,000	3,600,000	240,000	15,000,000	1,800,000
*Raw Material	360,000	500,000	-	-	-
*O and M Cost	900,000	550,000	120,000	4,200,000	355,200
Sub-total	**6,060,000**	**4,650,480**	**360,000**	**19,200,000**	**2,155,200**
Revenue					
* Sales	9,800,000	2,311,680	576,000	24,000,000	4,603,200
*Salvage Value	888,889	1,851,852	192,593	414,814,815	1,555,556
Sub-total	**10,688,889**	**4,163,532**	**768,593**	**438,814,815**	**6,158,756**
Annual Profit	3,740,000	-2,338,800	216,000	4,800,000	2,448,000

A- Aleshinloye, B- Igbatoro Road, C- Ayeye, D- Ikorodu, E- Bodija, O and M- Operation and Maintenance, ₦157=$1

Table 2: Economic viability of organic fertilizer factories

Factories	Annual Worth Values(₦)	Benefit Cost Ratio
A	2,216,667	1.29
B	(-5,512,411)	0.30
C	(-114,056)	0.84
D	(-706,088,888)	0.02
E	(-217,833)	0.96

A- Aleshinloye, B- Igbatoro Road, C- Ayeye, D- Ikorodu, E- Bodija.

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4.2 Engineering economic evaluation of technology options

Factories A, B, C, and E engaged LLT option of composting while factory D used MLT. The comparison of EE parameters (Table 3) showed that initial cost of investment for the MLT option was quite high (₦5.6 billion) while average initial investment for the LLT option was ₦15 million. The high cost of entry for the MLT means other companies won't easily enter into the industry through it. It also means the MLT organic fertilizer enterprises has to spend more time paying their initial cost before they could break-even unlike for LLT option.

Though it requires a higher expense to operate (₦19.2 million), MLT has the capacity of generating higher revenue (₦24 million) compared to the LT option (Average annual disbursement; ₦3.3 million; revenue ₦4.3 million).

AW model for the 2 options revealed that the LLT was more viable than the MLT option. This could be attributed to the high initial cost required to set up MLT as this drives up its cost profile. Though the AW values of both options were negative which indicates that both options were not viable at their current level of operation, yet the higher AW value of LLT shows its superiority over MLT at low capacity utilizations (CUs).

Net present values (NPVs) were projected at different capacity utilizations (CUs). The results show that at these higher levels of operational performance, the 2 options are really viable with the MLT having superiority. These results are similar to the findings of Ilori et al. (1999) where negative NPVs were recorded at low CUs while positive NPVs were recorded at higher CUs. This also confirms that most technology projects in Nigeria experiences challenges including low CUs and that their viabilities are attached to the level of capacities they are able to effectively utilize.

A break even analysis of both technology options using discounted pay back period (PBP) model (Table 4) reveals that LLT would use 6 years if it operates at 30% capacity utilization (CU) and 4 years if at 40% CU before it could break even. This is significant because in the United State of America (USA), a project is considered risky if its break even period is higher than 5 years (DeGarmo, 1997). MLT has to operate at 85% CU before it could break even within 5 years. This shows that MLT is economically a risky option for producing OFs in Nigeria unless higher CUs can be attained. This result shows that though LLT is less profitable, it is less risky and its investment can be recovered faster than MLT option.

Table 3: Engineering economic comparism of organic fertilizer production options

Description	Values for the two technology options (₦)	
	Low Technology(LLT)	Medium Technology(MLT)
Initial Cost	15,150,000	5, 600,000,000
Total Annual Disbursement	3,306,420	19,200,000
Revenue	4,322,720	24,000,000
Annual Worth	-906,908	-706,088,888
Net Present Value		
• 50% Capacity Utilization	78,967,200*	1,929,376,000**
• 75% Capacity Utilization	126,025,800*	5,694,064,000**
• 100% Capacity Utilization	170,681,117*	9,458,601,412**

*₦1000/50kg. **₦2000/50kg. n= 25years.

Table 4: Break even analysis of organic fertilizer production options

Description	Discounted Pay Back Period (Years)	
	Low Technology*	Medium Technology**
30% capacity utilization	6	NA
40% capacity utilization	4	21
50% capacity utilization	3	12
60% capacity utilization	2	8
85% capacity utilization	1	5

*₦1000/50kg. **₦2000/50kg. NA- not available.

4.3 Performance projections for technology options; sensitivity analysis

Sensitivity analysis of both technology options to selling price (Table 5) and to useful life (Table 6) was done. This agrees with the methodology of Walekhwa et al. (2010) in using sensitivity analysis to determine the most profitable level of a waste conversion technology project. Average market price for organic fertilizers produced by LLT was ₦1, 500 while that produced by MLT was ₦3, 200 (Babalola, 2011). Hence, prices in table 5 were varied at ₦1, 000, ₦1, 200, and ₦1, 500 for LLT while it was varied at ₦2, 000, ₦2, 500, and ₦3, 200 for MLT. According to information from some of the factories, core organic fertilizer production assets depreciate at about 3.7% hence an average OF facility is expected to have useful life of about 25 years. Therefore, useful life (Table 6) was varied at 10, 15, 20, and 25 years and the annual worth (AW) computed for 50%, 75%, and 100% CUs.

Table 5 revealed that viability of the technology options increases with increasing prices and increasing CUs. The result shows increase in price from ₦1, 000 to ₦1, 500 for LLT results in 88% AW increase or almost twice the initial returns. MLT price increase from ₦2, 000 to ₦3, 200 also results in 104% AW increase or about twice the initial returns. This huge change implies that a little fluctuation in price will lead to significant changes in the viability of the options. Since average market price for LLT products is ₦1500 and it is less sensitive to selling price, a low priced strategy is more suitable to it than MLT and it could be conveniently priced within the price range under this study. However, the MLT product is highly priced. An appropriate strategy is to ensure organic fertilizer prices are lower to that of the chemical fertilizers while maintaining it at a profitable level. A more conservative price for MLT organic fertilizer will ensure a deeper market penetration.

Table 6 revealed that as long as the organic fertilizer facilities continue to operate for several years and at higher CUs than they are currently operating, they will remain economically viable. The assessment confirmed that organic fertilizer production is viable at 50%, 75%, and 100% CUs over project life ranging from 10 to 25 years. The MLT option could generate higher income at the projected CUs and over the project life. Hence, it could be strategically relevant in the future of sustainable waste management and organic fertilizer production in Nigeria. This result is similar to the findings of Ilori et al. (1999) where the technology options revealed sensitivity to capacity utilizations, prices, and useful life by showing a positive correlation between the options' performances and increases in the 3 parameters.

4.4 Comparison of the organic and chemical fertilizer industries in Nigeria

The cost of procuring the quantity of organic fertilizer that could be produced by the industry's installed capacity was compared to that of chemical fertilizer procurement by government in 2008 (Table 7). It revealed that Nigeria is spending more money (₦100, 000) to buy a metric tonne of chemical fertilizer compared to the amount she would have spent on organic fertilizers produced by the 2 technology options (LLT=₦30, 000 per tonne; MT=₦64, 000 per tonne). This result is a powerful tool for reviewing and rationalizing fertilizer policy in Nigeria. It implies that the country can actually spend less per tonne to acquire quality, effective, locally manufactured, and environmentally friendly fertilizer. This is supported by the position of the National Fertilizer Policy for Nigeria (FFD, 2006) that the government would encourage the exploitation and development of the country's raw material potential for fertilizer as well as encourage its use for fertilizer production as much as possible.

Table 5: Sensitivity of organic fertilizer production to selling price

Capacity Utilization (CU)	Annual Worth Values (₦)					
	*1000	*1200	*1500	*2000	*2500	*3200
50% CU						
• Low Technology	6,770,372	9,170,372	12,770,372	-	-	-
• Medium Technology	-	-	-	229,911,111	469,911,111	805,911,111
75% CU						
• Low Technology	12,770,372	16,370,372	21,770,372	-	-	-
• Medium Technology	-	-	-	709,911,111	1,069911,111	1,573,911,111
100% CU						
• Low Technology	18,770,372	23,570,372	30,770,372	-	-	-
• Medium Technology	-	-	-	1,189,911,111	1,669,911,111	2,341,911,111

n=25years, r= 12%, *Selling Price (₦/50Kg).

Table 6: Sensitivity of organic fertilizer production to useful life

Capacity Utilization (CU)	Annual Worth Values (₦)			
	*10	*15	*20	*25
50% CU				
• Low Technology	6,555,747	6,650,013	6,719,591	6,770,372
• Medium Technology	169,777,778	172,515,556	230,340,741	229,911,111
75% CU				
• Low Technology	12,555,747	12,650,013	12,719,591	12,770,372
• Medium Technology	649,777,778	652,515,556	710,340,741	709,911,111
100% CU				
• Low Technology	18,555,747	18,650,013	18,719,591	18,770,372
• Medium Technology	1,129,777,778	1,132,515,556	1,190,340,741	1,189,911,111

*-Calculated at N1000/50kg. **-Calculated at N2000/50kg, *Useful Life (Years).

Table 7: Organic and chemical fertilizer procurement in Nigeria

Description	Fertilizer Quantity (metric tonnes)	Procurement Cost (₦)	Tonne-Naira Ratio
Low Technology	10,000	300,000,000*	1:30,000
Medium Technology	4,000,000	256,000,000,000**	1:64,000
Mineral Fertilizer	650,000	65,000,000,000***	1:100,000

*₦1500/ 50kg. **₦3200/ 50kg, (1000kg= 1 metric tonne), ***Mineral Fertilizer procurement by Nigeria in 2008. Source: Reliefweb (2008) and Babalola (2011).

5. Conclusion and recommendations

Most (80%) of the organic fertilizer (OF) factories are profitable with 60% having no raw material cost. In actual performance, 20% of the factories attained viability. This is due mainly to low capacity utilizations (CUs) of the factories. Other factors associated with the level of viability of the factories include low level end-user awareness of the product, ownership structure of the factories, and weak policy of government on organic fertilizers production and utilization. 80% of the factories used low level technology (LLT) while 20% used medium level technology (MLT). Average initial investment for the LLT option was minimal and that of MLT was substantial. This is significant to the economic performance of both options. LLT option recorded higher viability and lower break even period than the MLT. Projections of performance of the two options at higher capacity utilizations however revealed MLT option as having higher viability than the LLT when sensitivity to CUs (using net present value), selling prices and project useful life (using annual worths) were computed. The cost of procuring organic fertilizers was cheaper than that of chemical fertilizers. The amount for 1 tonne of chemical fertilizer is about twice that of 1 tonne MLT product and about thrice that of 1 tonne LLT product. All these show that organic fertilizer production, under the right conditions, could be very viable and that it has a bright future in the country if widely adopted.

Organic fertilizer production factories should develop strategies to promote and create awareness about their products so as to penetrate deeper into the market, improve and maximize their CUs, as well as leverage on the positive and beneficial nature of organic fertilizer production and usage. More private investors should come into the industry. A close collaboration between the organic fertilizer industry and the academia through seminars, R & D, trainings, and advocacy is vital. Government on its part should evolve a strong financial, legislative, fiscal, and industrial policy in support of organic fertilizer production and utilization in the country. The creation of a governmental agency or department within the Federal Ministry of Agriculture and Rural Development having oversight responsibility for the promotion and patronization of organic fertilizers as a viable local product and an effective and environmentally beneficial agricultural input would also go a long way in encouraging organic fertilizer production. Organic fertilizer products should also be listed among the products to be given priority attention by relevant government agencies. Conscious efforts should be made to change the peculiar agricultural system in the country. This means a change from fallow system, shifting cultivation, and chemical based agriculture. The government should realize and wake up to the fact that its fertilizer policy should look inwards. Encouraging organic fertilizer production using locally available raw materials is a sound strategy for sustainable development and food security.

References

Abad M.B., Clement M.D., Aragan R.P., and Camarero A.S. (1997). "The influence of solid urban waste compost and Nitrogen mineral fertilizer on growth and productivity in potatoes". *Community Soil Science and Plant Analysis*, 28 (17&18):1653-1661.

Adebimpe R.A. and Akande J.M. (2011). "Engineering Economy Analysis on the Production of Iron Ore in Nigeria". *Geomaterials*, Vol.1 No.1, April 2011. www.scirp.org/ journal/ Paper Information. aspx?paperID=4676. Accessed on 19th of September, 2011.

Adeniyi, A. A. (1997). "An Assessment of the Technology and Market Potential for Mushroom Cultivation in South-western Nigeria". A M.Sc. thesis submitted to the Technology Planning and Development Unit, Obafemi Awolowo University, pg 22.

Adeoti O., Ilori M.O., Oyebisi T.O., and Adekoya L.O. (2000). "Engineering design and economic evaluation of a family-sized biogas project in Nigeria". *Technovation*, Vol. 20: 103-108.

Adeoye, G.O., Sridhar M.K.C., Akinsoji, N.A., and AdeOluwa O.O. (2005). "Evaluation of naturally decomposed solid wastes from municipal dump sites for their manurial value in southwest Nigeria, *Journal of Sustainable Agriculture*, 26(4), 143-152.

Akanbi W.B., Adediran J.A., Olaniyan A.B., and Togun A.O. (2004). "An economic analysis of split application of organo-mineral fertilizer on okro in humid forest zone of Nigeria". Dentscher Trpentag, October 5-7, 2004, Berlin, pp: 56-61.

Akinbami, J. F. K. Akinwumi, I. O., and Salami, A. T. (1996) "Implications of environmental degradation in Nigeria". *Natural Resources Forum*, 20(4): 319-331, 1996.

Archibong, E. (2010). "Federal Executive Council approves N89 billion for fertilizer procurement". Accessed on 24th of October from ww.nigeria70.com/Nigeria _news_ papers/fec_ approves _ n89b_for_fert_procur/263848.

Babalola O.O. (2011). "Engineering Economic Analysis of Organic Fertilizer Production in Southwestern Nigeria". A M.Sc. thesis submitted to the Technology Planning and Development Unit, Obafemi Awolowo University, Ile-Ife, Nigeria.

Berhans M.T. (2000). "Basic Development and Decision Processes: Technical and Economic Analysis". www.africantechnologyforum.org. Accessed on 19th of September, 2011.

Cruz dela N. E., Aganon C. P., Patricio M. G., Romero E. S., Lindain S. A. and Galindez J. L. (2008). "Production of Organic Fertilizer from Solid Waste and Its Utilization in Intensive Organic-Based Vegetable Production and for Sustaining Soil Health and Productivity". www.agnet.org/library/eb/587. Accessed on 19th of September, 2011.

Daily Trust (2011). *"*Dangote to build biggest fertilizer plant in Africa*".* www.dailytrust.dailytrust.com/ index.php. Accessed on 12/08/2011.

DeGarmo, E. P., Sullivan, W. G., and Bontadelli, J. A. (1997). "Engineering Economy" 8th Ed. Macmillan Publishing Company. New York, USA.

Egbewumi O.O., Sridhar M.K.C., Asuzu, M.C. (1997). Composting through community action; A rural experience in Nigeria, Journal of Appropriate Technology, UK, 23:34-35.

Fadare, D.A., Bamiro, O.A., Oni, A.O.(2009). "Energy Analysis for Production of Powdered and Pelletized Organic Fertilizer in Nigeria". *Asian Research Publishing Network (ARPN) Journal of Engineering and Applied Sciences*. Vol.4, No.4, ISSN 1819-6608.

Falusi, A. O. (1997). "Agricultural development and food production in Nigeria: Problems and Prospects." National Agricultural Research Project, Monograph no. 5, p. 159 -164.

FFD (2006). "National Fertilizer Policy for Nigeria". Federal Fertilizer Department (FFD), Federal Ministry of Agriculture and Rural Development, Nigeria.

IFDC (International Fertilizer Development Center), IITA (International Institute of Tropical Agriculture), and WARDA (West African Rice Development Association) (2000). "Agricultural Input Markets in Nigeria: An Assessment and a Strategy for Development". Report of the Stakeholders' Workshop held on October 19th, 2000 at Abuja, Nigeria.

Ilori M.O., Adeniyi A.A., Akarakiri J.B., (1999). "Technological and Economic Assessment of Mushroom Cultivation in Nigeria". *Ife Journal of Agriculture*, Vol. 20, No. 1 & 2.

John N. M., Adeoye G. O., and Sridhar M. K. C. (1996). "Pelletization of compost: Nigerian Experience". *Biocycle*, U.S.A., 37: 53-54.

Kolade O.O, Coker A.O., Sridhar M.K.C., and Adeoye G.O. (2005). "Palm kernel waste management through composting and crop production". *Journal of Environmental Health Research*, Volume 5, Issue 2.

Neufville De R. (1990). "Applied System Analysis: Engineering Planning and Technology Management". McGraw Hill Inc, New York, 205-217.

Olanrewaju O.O. and Ilemobade A. A. (2009). "Waste to Wealth: A Case Study of the Ondo State Integrated Wastes Recycling and Treatment Project, Nigeria". *European Journal of Social Sciences*, Vol. 8, No. 1, pp 15.

Reliefweb (2008). "Food Security: Federal Executive Council okays N64.64 billion for Fertilizer Supply". Accessed on 24th October 2010 from www.reliefweb.int/rw/rwb.nsf/ db900sid/ SKAI-7D5PGX.

Sridhar, M. K. C. and Adeoye, G. O. (2003), "Organo-mineral fertilizers from Urban wastes: Developments in Nigeria", *The Nigerian Fields*, 68: 91-11.

Sunday Punch (2008). "All knocks for government's fertilizer distribution". Sunday, July 20th, 2008. P40.

The Guardian (2004). "From Ibadan, A Testimony On Waste". Sunday, August 14th, 2004. PB28.

UNEP (1996). "Principles of municipal solid waste management". Report of the proceedings of a seminar implemented on 21-24 October, organized by the United Nations Environmental Program in Puerto Princessa, Philippines.

Walekhwa P.N., Lars D., and Mugisha J. (2010). "Economic viability of biogas energy production from family-sized digesters in Uganda". Second RUFORUM Biennial Meeting, 20-24 September 2010, Entebbe Uganda.