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Comparative Analysis of the Profitability of Liquid Fertilizer Usage in Dry Season Vegetable Production in the Southern Guinea Savannah Zone of Nigeria

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Abstract

The gains that farmers stand to make, and the cost associated with the usage, is usually a motivating factor in deciding whether or not to adopt a new technology. Specifically, this study examined the effect of liquid fertilizer usage on the profitability of dry season vegetable production, and compared the profitability of the patterns of usage. A Multi-stage random sampling procedure was used to select 309 dry season vegetable farmers from two states in the Southern Guinea Savannah Zone. Data was collected using an interview schedule. Partial budgeting technique, analysis of variance, and the t-test were the analytical tools employed in the study. The t-test results showed that usage of liquid fertilizer was more profitable than the non-usage. Gross margin analysis showed that usage of sole liquid fertilizer had the highest Return to Capital Invested (RCI) of 2.52. Analysis of variance test showed there was a significant difference between the means of the RCI for the three fertilizer usage categories. The study concluded that the sole usage of liquid fertilizer was the most profitable of the different usage patterns examined. The study therefore recommended that usage of liquid fertilizer should be encouraged among the dry season vegetable farmers. This can be achieved by the inclusion of liquid fertilizer in agricultural support programmes that are designed to ensure availability and affordability of fertilizers.

Keywords: Improved Fertilizer, Irrigation, Small scale farming, Profitability.

1. Introduction

Agriculture in Nigeria is dominated by small scale farmers who are characterized as having less than two hectares of farmland, largely subsistent, known for low usage of resources and are risk adverse [13]. Dry season vegetable production is a common activity amongst small-scale farmers in the Southern Guinea Savannah Zone of Nigeria. This is because it serves as a source of income to the farmers during the extended dry season periods, while still providing food and employment to the farmers. Vegetable production in Nigeria is constrained by unavailability of fertilizers which is a necessary resource for the improvement and the sustenance of the nutrient levels of our soils [2, 12, 14]. The unavailability of the conventional granular fertilizers led to the search for an alternative. Liquid fertilizer was introduced into Nigeria in 2003 as an alternate fertilizer. Previous experimental studies that have assessed the effect of liquid fertilizers in vegetable production have shown that its usage enhanced the quantity and quality of the vegetables [3, 4, 7, 15]. Despite the fact that liquid fertilizer has been around for over a decade, not much has been documented about it in Nigeria.

The decision to use and adopt any technology especially in small-scale agriculture is usually tied to the relative advantage the new technology has over the existing one [9, 16]. This is because if farmers are making enough profits from its usage, there will be higher chances of adoption. In the case of liquid fertilizer usage in dry season vegetable production, an assessment of the profitability associated with its usage will be a first step in determining the relative advantage of the technology. This means that a cost-benefit analysis will put into better perspective the profit the farmers stand to make, while keeping in mind the cost of acquiring the technology. This is more so in Nigeria, where most of the farmers are small-scale, and so the purchase and use of any technology is usually tied to the cost and benefit of the technology. Insights into the profit the farmers stand to make from the new technology usage, as well as a comparative analysis with, or in combination with the

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existing technology will also throw some light on the sustainability of its usage and adoption, since it is known that most times, farmers tend to use a combination of technologies.

Since the foremost intent of any farmers in the usage of any technology is how the technology affects his/her income, in making adoption decision, three criteria must be observed. First, if net farm income remains the same or decreases, the new technology should not be recommended because it is not more profitable than the farmer's present technology. Second, if net farm income increases and variable costs remain the same or decrease, the new technology should be recommended because it is clearly more profitable than the farmer's technology; and third if both net farm income and variable cost increase which is usually the case, the new technology should be recommended if the income increases faster than the variable cost [8].

The main objective of the study was therefore to estimate the profitability of liquid fertilizer usage in dry season vegetable production in the Southern Guinea Savannah Zone of Nigeria. Specifically, the study sought to: (i). determine the effect of liquid fertilizer usage on profitability among the vegetable farmers; and (ii). compare the profitability of the pattern of liquid fertilizer usage.

2. Material and Methods

2.1 Study Area

The Southern Guinea Savannah Zone is the most luxuriant of the savannah vegetation belts in Nigeria. The area is characterized by low rainfall and long dry periods of up to six months. The soils are low in organic matter and chemical fertility. Dry season vegetable production is a common activity in the zone and fertilizers including liquid ones are used in the area. Rainfall shows two peaks in July and September [11]. As the rainfall decreases, the dry season increases in severity from the south to the north and the vegetation density decreases. Vegetation found in this area is a mixture of short trees and tall grasses. The area is also characterized by high population density and the demand for farm land is equally very high [1].

2.2 Sampling Technique

The population for the study comprised of all dry season vegetable farmers in the study area. Locations, where dry season vegetable production was predominantly carried out,were identified from the 2012 Crop Area Yield Survey (CAYS) manual from Agricultural Development Projects (ADPs) [5]. Twenty-five percent of the listed vegetable farmers were randomly selected from each selected location to give a sample size of 309 vegetable farmers interviewed for the study. Data for the study were collected for the 2013/2014 dry season vegetable production using a well-structured interview schedule administered to vegetable farmers. Focus Group Discussion (FGD) was also organized with the local leaders of the vegetable farmer groups to supplement the data obtained from the interview schedule and pretesting was done with 30 vegetable growers.

2.3 Analytical Techniques

This study made use of partial budgeting technique to calculate the profitability of liquid fertilizer usage in dry season vegetable production in the study area. Partial budgeting assesses the effect of a new technology on farm profitability, estimate changes in production, costs, returns and risk accompanying a specific change in the farming practice [6]. Specifically, the gross margin and net profit analysis was used.

This is specified as follows:

Gross Margin = GVO – TVC (1)

GVO = P x Q (2)

Net Profit = GM – TFC (3)

Where,

GVO = Gross Value of Output

TVC = Total Variable Cost

P = unit price of each vegetable; Q = quantity of vegetable output

TFC = Total Fixed Cost

TVC was then computed by summing up all the cost incurred for labour and purchased inputs for the production season while the TFC was computed by depreciating the fixed cost components which include pumping machines, water pipes and hose, water tanks, knapsack sprayers and simple farm tools. The straight line method of depreciation was used and this is given as:

$$\frac{Cost\ of\ item - salvage\ value}{Useful\ life} \quad (4)$$

For the purpose of this study, the salvage value was assumed to be zero because the vegetable farmers rarely sell-off their equipment and machines.

They use them until they are completely or almost completely condemned.

Profitability indices used were the Operating Ratio (OR) and the Return to Capital Invested (RCI). This is given as:

OR = TVC/GVO (5)

RCI = Net Profit / Total Cost (TC)(6);

where TC = TFC + TVC

GM is best calculated on per hectare basis. This allows for easy projection/estimation of figures based on the actual land size intended for use in vegetable production. Consequently, analysis was therefore done on per plot basis. Thus, the 309 sampled farmers had a total of 448 plots.

The Student t-test Analysis

This was used to examine the effect of liquid fertilizer usage in dry season vegetable production. Mathematically, it is represented as:

$$t = \mu_1 - \mu_2 / \sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}} \quad (7)$$

where

μ_1 = mean profitability of users of liquid fertilizers

μ_2 = mean profitability of non-users of liquid fertilizer

n_1 = sample size of users

n_2 = sample size of non-users

S_1^2 = variance of users

S_2^2 = variance of non-users

The Analysis of Variance (ANOVA) Test

The ANOVA is a parametric test used to compare normally distributed variables for more than two groups. It is used in the analysis of comparative experiments, those in which only the differences in outcome is of interest [10]. The one-way ANOVA was specifically used in the study because there was only one independent variable which was the fertilizer categories. The goal of the ANOVA is to compare the two sources of variability: Mean Square within (MSW) and the Mean Square between (MSB) to generate the F-statistics. This is given as:

$$F_{obs} = \frac{MSB}{MSW} = \frac{variancebetweengroups}{variancewithingroups} \quad (8)$$

If the result of the test is significant (p-value ≤ α 0.05), then there is a need to perform an individual comparison between pairs of groups.

The Tukey's Honestly Significant Difference (HSD) test was chosen as the post hoc test to compare the group means. The Tukey's test was actually designed for situations where sample sizes of the group are equal. The test can also be adapted to unequal sample sizes where the adaptation uses the harmonic mean of n-sizes as n*.

It is expressed as $HSD = q \frac{\sqrt{MSE}}{n*}$ (9)

Where q = the relevant critical value of the studentized range statistic

MSE = mean square within groups

n* = number of scores used in calculating the group means of interest

3. Results and Discussion

This section presents the results obtained in the profitability analysis of liquid fertilizer usage among the dry season vegetable farmers. The analysis of the profitability of liquid fertilizer usage based on usage and non-usage is presented in Table 1. The average gross value of output of the users of liquid fertilizer and their non-user counterparts were ₦540,212.50 and ₦351,126.50 respectively. As expected, users of liquid fertilizers incurred less cost for the purchase of fertilizer. They also spent less on the purchase of pesticides. This may be an indication that usage of liquid fertilizer does reduce pest infestation in crops. Even though users of liquid fertilizer had higher total variable cost, statistical analysis shows no significant difference between the costs. However, Table 1 shows that users of liquid fertilizer had a higher gross margin than the non-users, and consequently, a higher net profit. Profitability indices show that users of liquid fertilizer had a lower operating ratio than their non-user counterparts. This implies that on the average, users of liquid fertilizer spent about 37 percent of their gross income from dry season vegetable production as operating expenses, while the non-users spent 52 percent. The return on capital invested of 1.75 and 0.92 obtained shows that for every ₦1 invested by the farmers, the users of liquid fertilizers earned ₦1.75, while the non-users earned 92kobo. This difference was however significant at one percent (t-cal. = 1.985; P = 0.038).

Table 1: Profitability Analysis of Liquid Fertilizer Usage among the Vegetable Farmers (₦/ha)

Variable	Usage of Liquid Fertilizer	Non Usage of Liquid Fertilizer
Gross Value of Output (A)	540,213.50	351,126.50
Rent on land	8,367.00	11,281.20
Cost of hired and imputed family labour	99,778.00	80,114.60
Cost of liquid fertilizers	8,249.00	0.00
Cost of non-liquid fertilizers	14,990.00	34,935.25
Cost of seed	14,166.00	15,144.75
Cost of herbicides	3,595.00	2,863.50
Cost of pesticides	5,656.80	6,617.30
Cost of fuelling & maintenance of pump	23,370.70	26,316.80
Total Variable Cost (B)	178,226.00	174,646.50
Total Fixed Cost (C)	11,328.00	8,368.00
Gross Margin (D = A – B)	361,988.00	176,480.00
Net Profit (E=A-B-C)	350,660.00	168,112.00
Operating Ratio (B/A)	0.371	0.52
Return on Capital Invested (E/B+C)	1.75	0.92

₦200 = 1 USDr

To compare the effect of liquid fertilizer usage among the vegetable farmers, a summary of the profitability of liquid fertilizer usage with its non-usage was done. Table 2 shows that users of sole liquid fertilizer had the highest gross value of output. Fertilizer cost shows that users of sole liquid fertilizer had the least cost. This was very much anticipated since users of sole liquid fertilizer used an average of 4.02 litres of the liquid fertilizer per hectare for the production season. The average price recorded for liquid fertilizer at the time of the survey was about N2, 600/litre. Users of both liquid fertilizer and non-liquid fertilizer on the other hand, had the highest cost of fertilizer. This was essentially due to the relatively high quantity and cost of the non-liquid fertilizer used. Average unit price of the non-liquid fertilizer was ₦109/kg.

Table 2: Profitability Analysis of Dry Season Vegetable Production Based on Fertilizer Usage Category (₦/ha)

Variable	Sole Liquid Fertilizer	Liquid and Non Liquid Fertilizer	Sole Non Liquid Fertilizer
Gross Value of Output (A)	632,226.50	448,199.50	351,126.50
Rent on land	10,154.00	14,195.00	11,281.20
Cost of hired and imputed family labour	105,527.50	94,027.50	80,114.60
Cost of liquid fertilizers	10,402.75	6,094.50	0.00
Cost of non-liquid fertilizers	0.00	30,092.75	34,935.25
Cost of seed	15,013.75	13,317.75	15,144.75
Cost of herbicides	3,884.25	3,306.00	2,863.50
Cost of pesticides	4,220.25	7,090.80	6,617.30
Cost of fuelling & maintenance of pump	26,326.00	20,413.70	26,316.80
Total Variable Cost (B)	167,913.00	188,538.00	174,646.50
Total Fixed Cost (C)	11,815.80	10,839.50	8,368.00
Gross Margin (D = A – B)	464,313.50	259,661.50	176,480.00
Net Profit (E=A-B-C)	452,497.70	248,822.00	168,112.00
Operating Ratio (B/A)	0.33	0.42	0.52
Return on Capital Invested (E/B+C)	2.52	1.25	0.92

₦200 = 1 dollar

Even though users of both liquid fertilizer and non-liquid fertilizer had a higher fertilizer cost than users of non-liquid fertilizer, statistical analysis showed no significant difference in the fertilizer cost of the two categories (t-cal. = 13.65; p = 0.110). However, fertilizer cost for sole users was statistically different from the other two categories (F (2,445) = 4.291, p = 0.008). Overall, users of both liquid fertilizer and non-liquid fertilizer had the highest total variable cost while the users of sole liquid fertilizer had the least variable cost.

Profitability indices confirm that users of sole liquid fertilizer had the lowest operating ratio and highest return to capital invested. This was followed by users of both liquid fertilizer and non-liquid fertilizer and lastly, users of non-liquid fertilizer.

Returns to capital invested were compared to confirm the profitability of the pattern of liquid fertilizer usage. The results of the ANOVA as presented in Table 3 shows that there are significant differences between the means of the returns to capital invested for the three fertilizer use categories, (F(2,445)=12.002, p = 0.01). The Tukey's post hoc multiple comparison tests shows that there were no statistical difference in the means of the returns on capital invested of users of both liquid fertilizer and non-liquid fertilizer, as well as that of users of sole non-liquid fertilizer, although, they had different values. The implication for this is that the difference is however not great enough to say that they really differ from each other. That of users of sole liquid fertilizer, on the other hand, was statistically different from the other two. This means that usage of sole liquid fertilizer in vegetable production was significantly more profitable than the usage of a combination of liquid and non-liquid, and the usage of sole non-liquid fertilizer.

Table 3: Tukey's Multiple Comparison Test for Profitability of the Pattern of Liquid Fertilizer Usage

Fertilizer Category	Fertilizer Category	Mean Difference	Mean Square Error	p-values
Usage of sole LF	Usage of both	1.272	0.293[b]	0.001
	Usage of Non-LF	1.600	0.241[a]	0.001
Usage of both	Usage of Non-LF	0.328	0.210[a]	0.563
F – value	12.002			

The mean difference is significant at the 0.05 level

a = subset 1(indicates that the means in this subset are not statistically different from each other but different from those in b)

b = subset 2 (indicates that the means in this subset are not statistically different from each other but different from those in a)

LF = Liquid Fertilizer

4. Conclusions

This study concludes that usage of liquid fertilizer in dry season vegetable production is more profitable than the non-usage. As such, its usage should be encouraged among the dry season vegetable farmers. This may be by way of ensuring that all agricultural support programmes that are designed to assist farmers with subsidized fertilizer look into the possibility of the inclusion of the liquid fertilizer in the programmes. This will encourage the producers/importers of the product to keep up its production and ensure its availability.

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