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ECONOMIC OPTIMUM OF NITROGEN FERTILIZER APPLICATION IN CUCUMBER PRODUCTION: THE CASE OF CROSS RIVER UNIVERSITY OF TECHNOLOGY (CRUTECH) FARM, OBUBRA CAMPUS

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ABSTRACT

This paper examines the economic optimum of nitrogen fertilizer resources for cucumber production in Cross River University of Technology Obubra campus. Data were collected on fruit weight, price of cucumber, price and quantity of nitrogen fertilizer applied. A single regression analysis approach involving the use of Ordinary Least Squares (OLS) estimation technique was adopted. The ratio of the marginal value product to marginal input cost was used to estimate fertilizer economic optimum. The study revealed that though nitrogen fertilizer had a significant positive influence on output of cucumber, it was not utilized at its economic optimum level.

KEYWORDS: Cucumber, Economic optimum, Nitrogen fertilizer.

INTRODUCTION

Cucumber is widely eaten and used for making salad. It is a good supplier of minerals and vitamins. Greater use of fertilizers has been one of the most important developments in agriculture over the past decades. It is an input which can be applied both for limited and unlimited capital situation (Olayide and Heady 1982).

One of the questions confronting farmers is the determination of the economic optimum level of fertilizer application for profit maximization. In determining how much fertilizer to apply, the farmer must compare the added revenue, which would be received from the application of fertilizer with the additional cost of applying the fertilizer.

Johnson (1982) reported that shortage of capital such as fertilizer often limits production and profit and that when farms are undercapitalized relative to their production potential, farmers do ration their use of capital.

Fertilizer contributes about 19% of average cost per acre in Tobacco farms (Anthonio and Oshun 1973). As production increases, external forces begin to guide the use of resources; reliance on technical efficiency alone becomes less an important means of increasing farm output and income, thus economic efficiency in addition to technical efficiency becomes the most important means of increasing farm output and income (Ogunfowora, 1986). Increase in farm price of crop causes an increase in net return while increase in production cost is responsible for decrease in net return of some crops [Mohamed, 1988]. The key cost reducing factor is the adoption of improved technology such as fertilizer application [Osifu and Anthonio, 1977].

Increasing levels of nitrogen fertilizer [up to 90kg/ha] result in significant increase in fresh pod yield of okro (Amadu and Gupta 1995). Ogar, Idiong, Udom, Abang (2002) reported that fertilizer application in swamp rice production had a positive significant influence on rice outputs. Chikwendu (1998), reported that fertilizer resource was not utilized at its economic optimum level in maize production as the ratio of factor cost to marginal value product was less than one. Evidence abound, however to show that in Nigeria and other developing countries, small scale farmers are economically efficient in resource allocation given the situation under which they operate (Famoriyo 1986). Nwosu (1981), Okuneye (1985) reported that resource efficiency was on the average higher for crops mixture than sole crops. The economic optimum of Nitrogen fertilizer in cucumber production in Cross River has not been studied or known.

It is on this basis that the study on economic optimum of fertilizer in cucumber production is undertaken for Cross River State University of Technology Farm.

METHODOLOGY

The study was carried out for Cross River University of Technology Farm, Obubra campus during the 2003 and 2004 cropping seasons. Obubra is located at latitude 05:59N and longitude 08^0, 16E. The area has mean annual rainfall of 2250-2500MM per annum (CRDP, 1992)

The experiment comprised eight rates of nitrogen fertilizer (calcium ammonium nitrate 26% N) application at 0.0, 80, 100, 120, 140, 180, 200kg/ha lay out in Randomized Complete Block Design (RCBD) with three replications. Each plot measured 4x5 meters ($20m^2$) with 1.0-meter paths separating each plot from the adjourning plot. Cucumber seeds were sown at the rate of 3 seed per hole at the spacing of 0.8x1.0 meter within and between the rows respectively in April (2003 and 2004). The fertilizer was applied two weeks after planting, using side banding method of application. Data were collected on fruit weight, average price of cucumber and average price of nitrogen fertilizer.

A single regression analysis approach involving the use of ordinary least squares (O.L.S) estimation techniques were used to estimate the model. The model is of the form specified below

$Y = a + bx + u$

Y = output of cucumber in tones.

X = Nitrogen fertilizer in kg

U = Error term.

a is the intercept of the equation, while b is the slope of the equation. It is expected that b will carry a positive sign. The elasticity of production will be derived by dividing marginal product over average product.

EP = MPP/APP.

The economic optimum of nitrogen fertilizer resources was determined by ascertaining whether or not the ratio of marginal value product (MVP) to marginal input cost equals one (unity).

$$\text{I. e.} \quad \frac{MVP}{MIC} = 1$$

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MVP = Marginal value product (MPP x price of product)
MIC = Marginal input cost. This is the price of a kg of Nitrogen Fertilizer.
The Average physical product (APP) was derived by dividing total output by total inputs.

$$\text{i.e. APP} = \frac{Y}{X}$$

The slope of the equation (b) is the marginal physical product in the regression table. The marginal physical product in table 2 is derived by dividing change in output by change in input level.

$$\text{Thus MPP} = \frac{DY}{DX}$$

$$\text{Economic efficiency index (EEF)} = \frac{MVP}{MIC}$$

RESULT AND DISCUSSION

The estimated result of the regression equation is in table 1. The variables of nitrogen fertilizer appeared with a positive sign indicating that a kilogram increase in nitrogen fertilizer increased cucumber output by 0.02334 tonne in 2003 and 0.2414 tonne in 2004. Ogar, Idiong, Udom, Abang (2002) obtained a significant positive increase in rice output due to fertilizer application.

In table 2, the elasticity of production with respect to nitrogen fertilizer was 0.6% in 2003 and 0.60 in 2004 showing that one percent increase in nitrogen fertilizer caused output of cucumber to increase by 0.61% in 2003 and 0.6% in 2004. The R^2 of 0.94 for both years indicates that 94% of variability in output of cucumber is explained by the independent variable (Nitrogen Fertilizer). The F-ratio of 92.4 in 2003and 94.0 in 2004 indicates the over all

Table 1: Regression Result

YEAR	Variables	Intercept (a)	Regression Coefficient (b)	t-ratio	f-ratio	R2
2003	Nitrogen Fertilizer X	1. 86	0.0233	6.39	92.36	0.939
2004	Nitrogen Fertilizer X	1.99	0.2414	9.7	94.0	0.94

Table 2: Estimated elasticity of production (EP), Average physical Product (APP), Marginal Physical Product (MPP), Marginal Value Product of Nitrogen Fertilizer (MVP), Marginal Input Cost (MIC), and Economic Efficiency Index of Nitrogen Fertilizer (EEF).

Year	APP	MPP	EP	MVP	MIC	EEF= MVP/MIC
2003	0.0384	0.0233	0.607	2330	55	42.4
2004	0.0404	0.02414	0.60	2414	55	43.9

Source computed from table 1 and field data 2003 and 2004.
Note: Price of cucumber is ₦100/kg, while price of nitrogen fertilizer is ₦55 per kilogram.

significance of the model at one percent level. The t-ratio of 6.4 in 2003 and 9.7 in 2004 shows that nitrogen fertilizer significantly influences output of cucumber.

The result in table 3 shows that nitrogen fertilizer applied at 180 kg gave the highest total product of cucumber for both years. However, the marginal product and marginal value product are highest at 180kg and 120kg nitrogen fertilizer application in 2003 and 2004 respectively. The result in the table shows that as more nitrogen fertilizer was applied (up to 180kg) output of cucumber significantly increases, and decline thereafter. This agrees with the law of diminishing returns. This result conforms with the finding of Amadu and Gupta (1995) who observed that increasing levels of nitrogen fertilizer (up to 90kg/ha) significantly increase fresh pod yield in okro.

Also in table 3, Average physical product (APP) was highest at nitrogen fertilizer application of 80kg for both years.

In table 2, the index of economic optimum is more than one indicating that nitrogen fertilizer resources are inefficiently allocated on the average. Chikwendu (1998) obtained similar result. The economic optimum index is 42.4 in 2003 and 43.9 in 2004 indicating that fertilizer resources were underutilized.

In table 3, the marginal value product for both years is consistently greater than the marginal input cost except for 200kg/ha level fertilizer application where it becomes negative, thus the profit maximizing level where MVP = MIC could not be attained. But there is a possibility of making more profit by adding more fertilizer input. The profit maximization point is located in stage II where the marginal products are falling. If production is allowed at the output level of 5.5755 tones or 5575.5kg achievable by 170kg/ha of fertilizer, MVP will be ₦55 and is equal to the price of a kilogram of nitrogen fertilizer, in 2003. Similarly if production is allowed at the output level of 5.6655 tones or 566.5kg/ha

TABLE:3 DETERMINATION OF OPTIMUM NITROGEN FERTILIZER LEVEL IN CUCUMBER PRODUCTION IN 2003 AND 2004.

2003 CROPPING SEASON

Calcium Ammonium Nitrate $Ca(NH_4)_2NO_3$ (X)kg/ha	Output of Cucumber (Y) ton/ha	Average Physical Product (APP)	Marginal Physical Product (MPP) kg/ha	Total Value Product (TVP) ₦/ton	Marginal Value Product (MVP) ₦/kg	Marginal Input Cost (MIC) ₦/kg
0.0	2.24			224000		
80	3.19	0.0399	11.9	319000	1190	55
100	3.82	0.0382	31.5	382000	3150	55
120	4.67	0.389	42.5	467000	4250	55
140	5.29	0.03778	31.0	529000	3100	55
160	5.57	0.0348	14.0	557000	1400	55
180	6.61	0.0367	52.0	661000	5208	55
200	6.27	0.0313	-17.0	627000	-1700	55

2004 CROPPING SEASON

Calcium Ammonium Nitrate $Ca(NH_4)_2NO_3$ (X) kg/ha	Output of Cucumber (Y) ton/ha	Average Physical Product (APP)	Marginal Product (MPP) kg/ha	Total Value Product (TVP) ₦/ton	Marginal Value Product (MVP) ₦ kg	Marginal Input Cost (MIC) ₦/kg
0.0	207			207000		
80	3.56	0.0445	18.63	356000	1863	55
100	4.16	0.0416	30.00	416000	3000	55
120	5.23	0.0436	53.50	533000	5350	55
140	5.56	0.0397	16.50	556000	2600	55
160	6.08	0.0380	26.00	608000	2600	55
180	6.77	0.0376	34.50	677000	3450	55
200	6.21	0.0311	-28.00	621000	-2800	55

COMPUTED FROM FIELD DATA 2003 AND 2004

achievable by 150kg/ha of Nitrogen fertilizer, MVP will be ₦55 and is equal to the price of a kilogram of fertilizer in 2004.

RECOMMENDATION

Based on the finding that marginal value product (MVP) is greater than marginal input cost (MIC), farmers are encouraged to apply more nitrogen fertilizer to make more profit and to allow for optimum nitrogen fertilizer utilization in cucumber production.

CONCLUSION

The study has shown that nitrogen fertilizer had significant effect on output of cucumber. However this resource was not used at its economic optimum level. It is on this basis that the above recommendations are made.

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