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Fertilizer Sector Liberalization: Effects on the Profitability of Nitrogen Fertilizer Application in Egusi, Okra and Tomato Production in Nigeria*

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Abstract: Subsidy withdrawal is an instrument of the on-going liberalization in the fertilizer sector. The effects on rising fertilizer retail prices were evaluated on the profitability of nitrogen (N) application to egusi, okra and tomato, using Cost-Benefit analysis. Returns to N application were positive at the 1996 highly-subsidized fertilizer prices, with highest Value-Cost Ratios (VCRs) at 30, 50 and 60 kg N ha^{-1} for tomato, egusi and okra, respectively. Without subsidy, net returns and VCRs decreased, such that N application to egusi was not profitable. At the higher subsidized and unsubsidized fertilizer prices in the 2004/2005 season, N application to okra and tomato was profitable. Returns and VCRs confirmed 30 and 60 kg N ha^{-1} as economic rates for tomato and okra, respectively. Okra and tomato will accommodate 24 and 385% increase in price, respectively, above the unsubsidized N2900.00 per 50 kg bag, based on target VCR = 2.0.

Key words: Liberalization, subsidy, profitability, nitrogen fertilizer, marginal cost, marginal revenue, Nigeria

Introduction

Vegetable production in Nigeria is mainly in the form of diverse species grown as subsidiaries in mixtures with staple food crops, using traditional farming methods (Denton *et al*., 2000). The food crops are normally grown on relatively fertile lands cleared from bush fallows of varying durations which allow for soil organic matter and nutrient build-up. The prospects of dry season vegetable crop production necessitate the use of iuland valley systems (fadamas) with higher residnal moisture and nutrient enrichment from the sediment load of annual floods. Intensive production systems in rainfed and irrigated farm projects, market gardens and out-grower schemes of sole and mix-cropped local and exotic leaf and fruit vegetable species are recent developments for which regular nutrient enrichment with fertilizer and/or manure must be emphasized. This is to ensure that high fertility levels, consistent with rapid growth, maximum yield and qnality of crops characterize the soil component of vegetable production systems.

Several vegetable crops must have received fertilizers directly or derived nutrients from fertilizers applied to the main food and cash crops with which they are intercropped. The fertilizers were procured to support successive accelerated crop production schemes embarked upon since the mid-1970s. The quantities were 14.2 million and 17.5 million Metric Tounes (MT), by 1996 and 2004, respectively (FMARD, 2002; Ayodele, 2005), ostensibly, to meet the huge demand pool generated by increased awareness of fertilizers' beneficial roles in producing high crop yields. Availability of the highly subsidized fertilizers, whose efficient use ensured profitability and promotion activities that stimulated widespread adoption made consumption growth to be rapid.

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Currency devaluation and exchange rate instability, since 1990, increased fertilizer procurement costs while the attendant inflationary pressures led to higher haulage and distribution costs. The effect is the rising fertilizer budget, especially the size of the subsidy burden. The reaction of government was a deliberate gradual subsidy reduction, such that the 50 kg bag of Urea which sold at N2.00 before 1980 rose steadily to ₦40, ₦80 and ₦150 in 1991-1992, 1993 and 1994-1996, respectively. Ultimately, the two-decade regulation in fertilizer supply operations ended in 1997, because, apart from the huge annual budgetary costs, no consistent growth took place in the sector while the input and subsidy on it were hijacked by unintended beneficiaries (Idachaba, 1994). The expectation is that liberalization would increase fertilizer availability as numerous suppliers compete, to satisfy the customers' needs, capture a larger share of the market and maximize profit.

Unfortunately, the policy met the private sector illprepared. The performance was so unimpressive that government put in place a supply incentive package involving 0.12-0.24 million MT of fertilizers, distributed to states for sale to farmers at 25% subsidy between 1999 and 2004. This package exists alongside the competitive marketing operations through which fertilizer producers and sundry importers sell products at "market-determined prices. The competitive market is developing and still largely inefficient as indicated by field reports that Urea sold at N2400- 2500 per 50 kg bag in 2004 (NAMIS, 2004), in response to scarcity.

Agronomic requirements that specify efficient use of fertilizers should not be the ouly considerations for making fertilizer recommendations. The costs and returns of yield responses must receive equal attention. This is because, fertilizer use increases costs of production but would become attractive for adoption, if it maximizes net returns (profit). This profit comes from crop yield increases in relation to costs of fertilizer and monetary value of the output. In theory, profit is maximized where Marginal Cost (MC) of fertilizer use equals Marginal Returns (MR) to the fertilized crop, that is, MR/MC = 1.0. This relationship, Value-Cost Ratio (VCR) or Benefit-Cost Ratio (BCR), obtained from Cost-Benefit Analysis should exceed 1.0 for the technology to be profitable and as the condition for its adoption. As indicated above, recent policy measures and postures have led to higher retail prices of fertilizers. In the same manner, farmgate and retail market crop prices rose substantially, more in response to country-wide inflationary pressures and increase in prices of foodstuffs. The impact of this subsidy withdrawal, on profitability was evaluated through the analysis of costs and returns to Nitrogen (N) fertilizer use in egusi, okra and tomato. This involved the highly subsidized prices in 1996 and prices that characterize fertilizer marketing operations in the 2004/2005 cropping season.

Materials and Methods

Egusi, okra and tomato yield data, obtained in fertilizer response studies, conducted during 2001-2003 at Natioual Horticultural Research Institute, Idi-Ishin, Ibadan (7°30'N, 3°54'E, 168 m above sea level) were analyzed for costs and returns. The experiments comprised four rates 0, 30, 60, 90; five rates: 0, 30, 60, 90, 120 and five rates: 0, 25, 50, 75, 100 kg N ha^{-1} applied as Urea (46-0-0) to tomato, okra and egusi, respectively in different sites as allowed by established seasonal rotation of crops within the Vegetable Research Plots.

Treatment yields for each crop were averaged over the years and farmers' yield levels calculated at 70% of the research plot yields.

Additioual data were obtained:

- Prices of ripe tomato fruits, fresh okra fruits and unshelled egusi seeds from Surveys of Ibadan Urban and Rural Markets (NIHORT, 1997); Commodity Prices (NAERLS, 1996) Market Prices of Oyo State (OYSADEP, 2004, 2005 and farmgate prices calculated as 75% of the rural market prices, that is, subtracting the marketing costs (NFC, 1989);

- Labour wages for 1996 and 2005 in ₦. man-day^{-1};
- Price of Urea was regulated at ₦150.00 per 50 kg bag in 1996 when cost to the government for delivery at the farmgate was ₦606.13 and ₦2,900.00 in 1996 and 2004/2005 seasons, respectively.

The following were calculated:

- Incremental yield, as yield from particular N treatment-control, (MT ha^{-1});
- Response rate, as incremental yield ÷ rate applied; kg fruit or seed (kg N^{-1});
- Value of incremental yield, as incremental yield x farmgate price of produce (₦ ha^{-1});
- Incremental (variable) costs, as cost of N fertilizer (subsidized or unsubsidized to farmgate) + cost of labour for application, harvesting and processing the additional output (₦ ha^{-1});
- Incremental profit or returns to N, as value of incremental yield- incremental costs (₦ ha^{-1});
- VCR, as ratio of incremental profit to variable costs.

Results

Agro-economic criteria calculated for analysis of the response in egusi to N rates, based on 1996 prices, are shown in Table 1. Incremental output rose to a maximum of 0.22 MT ha^{-1} at 50 kg N ha^{-1} application while response coefficient decreased at higher N rates. Variable costs as the N rate increased at subsidized and unsubsidized prices, such that lower net returns at higher N rates ensured maximum profit of 50 kg N ha^{-1}.

The highest VCR, of 3.10 was also at 50 kg N ha^{-1} for subsidized N while higher N rates gave values below 2.0. Without subsidy, all N rates gave VCRs below 2.0.

Table 2 shows the costs and returns to N fertilizer use in tomato, 90 kg N ha^{-1} gave highest incremental output and value at 2.98 MT ha^{-1} and ₦39, 783.00 ha^{-1}, respectively. The rise in variable costs with N rates at a magnitude higher than increase in output value caused reduction in VCR as N rates increased. The highest VCR from 30 kg N ha^{-1} showed returns of 9.56 and ₦7.92 for every ₦1.00 invested in subsidized and unsubsidized fertilizer.

Okra incremental output and value of 1.17 MT ha^{-1} and N19, 936.80.ha^{-1} was highest from 120 kg N ha^{-1} application (Table 3). This rate also gave highest incremental profit with and without fertilizer subsidy. However, the higher costs with increasing N rates ensured that the 60 kg N ha^{-1} gave the best VCR of 5.32 and 3.45 with subsidized and unsubsidized Urea, respectively.

The fertilizer market had two features since 1999: (1) a government intervention package of fertilizers sold at 25% subsidy and (2) deregulated operations of local fertilizer producers and sundry importers, who sell at "market-determined" prices. The effects of these price regimes on profitability

Table 1: Costs and returns of N fertilizer use in egusi

	Application rates (kg N ha^{-1})			
Yield responses	25	50	75	100
Incremental yield (MT ha^{-1})	0.14	0.22	0.16	0.20
Response rate, kg seed (kg N^{-1})	5.60	4.40	2.13	2.00
Value of incremental yield (₦ ha^{-1})	5611.20	8817.60	6412.80	8016.00
Variable costs (subsidized) (₦ ha^{-1})*	1496.38	2149.17	2291.79	2702.33
Incremental profit, (₦ ha^{-1})	4114.82	6668.43	4121.01	5313.67
VCR	2.75	3.10	1.80	1.97
Variable costs (unsubsidized) (₦ ha^{-1})*	1992.19	3142.79	3779.25	4685.57
Incremental profit, (₦ ha^{-1})	3619.01	5674.81	2633.55	3330.43
VCR	1.82	1.81	0.70	0.71

* Subsidized and unsubsidized fertilizer prices at ₦150.00 and 606.13 per 50 kg bag of Urea, respectively in 1996

Table 2: Financial analysis of fruit yield response to N fertilizer application in tomato

	Application rates (kg N ha^{-1})		
Yield responses	30	60	90
Incremental yield (MT ha^{-1})	2.56	2.66	2.98
Response rate, kg fruit (kg N^{-1})	85.33	44.33	33.11
Value of incremental yield (₦ ha^{-1})	34176.00	35511.00	39783.00
Variable costs (subsidised) (₦ ha^{-1})*	3235.66	3895.32	4586.98
Incremental profit (₦ ha^{-1})	30940.34	31615.68	35196.02
VCR	9.56	8.12	7.67
Variable costs (unsubsidised) (₦ ha^{-1})*	3830.64	5085.28	6371.92
Incremental profit (₦ ha^{-1})	30345.36	30425.72	33411.08
VCR	7.92	5.98	5.24

* Subsidized and unsubsidized Urea price at ₦150 and 606.13 per 50 kg bag, respectively in 1996

Table 3: Costs and returns of N fertilizer rates applied to okra

	Application rates (kg N ha^{-1})			
Yield responses	30	60	90	120
Incremental yield (MT ha^{-1})	0.56	1.05	1.03	1.17
Response rate, kg fruit (kg N^{-1})	18.67	17.50	11.44	9.75
Value of incremental yield (₦ ha^{-1})	9542.40	17892.00	17551.20	19936.80
Variable costs (subsidised) (₦ ha^{-1})*	2243.66	2831.32	3374.18	4045.04
Incremental profit (₦ ha^{-1})	7298.74	15060.68	14177.02	15891.76
VCR	3.25	5.32	4.20	3.93
Variable costs (unsubsidised) (₦ ha^{-1})*	2833.64	4021.28	5159.12	6424.96
Incremental profit (₦ ha^{-1})	6708.76	13870.72	12392.08	13511.84
VCR	2.37	3.45	2.40	2.10

* Subsidized and unsubsidized was price at ₦150.00 and 606.13 per 50 kg bag, respectively in 1996

Table 4: Costs and returns to N fertilizer rates in egusi, okra and tomato*

	Application rates (kg N ha^{-1})			
Egusi	25	50	95	100
Value of incremental yield (₦ ha^{-1})	12985.00	20405.00	14840.00	18550.00
Variable costs (subsidized) (₦ ha^{-1})	4835.96	8096.92	10391.88	13190.84
Incremental profit (₦ ha^{-1})	8149.04	12308.08	4448.12	5359.16
VCR	1.69	1.52	0.43	0.41
Variable costs (unsubsidized) (₦ ha^{-1})**	5631.00	9687.00	12777.00	16371.00
VCR	1.31	1.11	0.16	0.11
Tomato	30	60	90	
Value of incremental yield (₦ ha^{-1})	118937.60	123583.60	138450.80	
Valuable costs (subsidized) (₦ ha^{-1})	8537.07	12153.77	16003.21	
Incremental profit (₦ ha^{-1})	110400.53	111429.83	122447.59	
VCR	12.93	9.17	1.82	
Valuable costs (unsubsidized) (₦ ha^{-1})**	9482.76	14045.15	18840.28	
VCR	11.54	7.80	6.35	
Okra	30	60	90	120
Value of incremental yield (₦ ha^{-1})	23553.60	44163.00	43321.80	49210.20
Valuable costs (subsidized) (₦ ha^{-1})	6677.07	10249.14	9169.30	10849.90
Incremental profit (₦ ha^{-1})	16876.53	33913.86	13737.21	17465.28
VCR	2.53	3.31	2.15	1.82
Valuable costs (unsubsidized) (₦ ha^{-1})**	7622.76	12140.52	16574.28	21248.04
VCR	2.09	2.64	1.61	1.32

* 2005 crop prices ** Subsidized and unsubsidized Urea price at ₦2175.00 and 2900.00 per 50 kg bag, respectively, in 2005

Table 5: Feasible fertilizer prices and response coefficients for profitability of N use in egusi, okra and tomato

	1996				2003		
Crop	Subsidized urea price (₦ bag^{-1})	Response rate kg $kg\ N^{-1}$	Highest urea price at VCR = 2.0 (₦ bag^{-1})	Least response rate at VCR = 2.0 (kg $kg\ N^{-1}$)	Subsidized urea price at VCR = 2.0 (N bag^{-1})	Highest urea price at VCR = 2.0 (₦ bag^{-1})	Least response rate at VCR = 2.0 (kg $kg\ N^{-1}$)
Egusi	150.00	4.40	232.50	2.84	2175.00	1653.00	5.79
Okra	150.00	17.50	339.00	6.58	2175.00	3599.63	10.57
Tomato	150.00	85.33	717.00	17.85	2175.00	14061.38	13.20

Urea bag = 50 kg

were evaluated using urea procurement cost in 2005 to analyze the crop responses to N application. Table 4 shows that returns and VCR at 30 and 60 kg N ha^{-1} for tomato and okra, respectively are high enough to make farmers adopt N fertilizer use. The highest VCR for egusi is 1.69 from 25 kg N ha^{-1}, at 25% subsidy.

Discussion

Economics returns and VCRs remained high and positive to the use of uniformly-low priced fertilizers available through subsidy levels maintained at 75% of total fertilizer supply costs in 1996. Subsidy reduction/removal and price decontrol, as instrument of the recent fertilizer market reforms, reduced returns and profitability to fertilizer use in these vegetable crops. This confirms the concern about the effect of rising farmgate fertilizer prices un-profitability in sole and mixtures of food crops in Nigeria (Wedderburn, 1989; Falusi, 1990; Gerner *et al*., 1995).

Although, the theoretical consideration for profit maximization is that MC = MR (i.e., VCR = 1.0). Falusi (1990) had noted this as rarely attained by farmers who stop fertilizers at a stage where MR is twice MC, or more. Thus, VCR should not drop below 2.0 in order for farmers to cover the risks of crop failure that characterizes tropical crop production systems.

This low return and VCRs below 2.0 are disincentive to N application for egusi. The price cannot rise independently of the general increase in food prices, as dictated by inflationary pressures in the economy responsible for 131% increase between 1996 and 2005. The option for profitable N use is to find means of improving yields and technical efficiency of egusi, as the on-going fertilizer sector liberalization does not have room for higher subsidy levels.

Since N use is still profitable in okra and tomato without subsidy, the question to asked is: at what price level will N fertilizer no longer be viable?. The highest feasible urea price and least feasible response rate, after allowing for VCR = 2.0 were calculated using the 2004/2005 price regime (Table 5). Okra and tomato would accommodate 24 and 385% increase above the unsubsidized fertilizer price and still remain profitable. Farmers reportedly paid #3000-3500 per 50 kg bag of urea during the main cropping season when scarcity occurs in the major area of fertilizer use. This should influence the choice to shift fertilizer resource allocation to crops for which profit can be guaranteed.

Fertilizer price may not rise to the level that its use becomes unprofitable in tomato, because of the present monetary policies put in place to aid agricultural development in Nigeria. Thus, huge potential exists for increase fertilizer use on tomato farms, which produce raw materials for food and processing.

Conclusions

The calculation of value-cost ratios has shown that recent fertilizer price increases did not constitute a financial disincentive to the application of N fertilizer for okra and tomato production. The high yields and rising produce prices, due to inflation in the economy, ensured profitable N use at the

higher unsubsidized prices, as outcome of liberalization in the fertilizer sector and the ability to accommodate future increases in Urea prices. The incentive to use unsubsidized N fertilizer for egusi production is least at the present levels of yield and technical efficiency and would require retention of higher price subsidy to be profitable. Since this position contradicts subsidy withdrawal, the main instrument for liberalizing the fertilizer sector, the viable option is to find means, through agronomic research, of improving egusi seed yield and thereby increasing the response coefficient.

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