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Consideration of Costs and Returns to Nitrogen Fertilization in Okra Production

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ABSTRACT

Crop-Benefit analysis was used to assess fresh fruit yield responses of two day-neutral okra varieties: NHAe 47-4 and LD 88-1-8 to nitrogen (N) fertilizer application in trials conducted over three years at Ado-Ekiti in the sub-humid agro-ecological zone of south-western Nigeria. Fruit yield increased with N application in all years and reflected in high returns at subsidized and unsubsidized fertilizer (urea) prices. Value-Cost ratio (VCR) was highest at 60 kg $N.ha^{-1}$ for the two varieties in 2007 and for NHAe 47-4 in 2008 but at 30 and 120 kg $N.ha^{-1}$ for LD 88-1-8 and NHAe 47-4, respectively in 2009. The current economic environment in 2010, characterized by higher producer prices due to nationwide inflationary pressure on food items and regime of high fertilizer prices from a deregulating market necessitated an assessment of the returns from the responses to application of subsidized and unsubsidized urea. Profitability of N application increased as VCR rose to 1.57 and 2.39 for NHAe 47-4 and LD 88-1-8 at 60 kg $N.ha^{-1}$. This 60 kg $N.ha^{-1}$ is the economic rate to recommend for fresh fruit production in sole okra.

Introduction

Improved day-neutral okra varieties have prospects for higher yields that should be expected to meet the output demands of fresh okra fruits in target urban markets. One of the strategies for yield expansion in okra production systems is to address the problem of poor soil fertility, especially widespread nitrogen (N) deficiency. A fertilizer programme through which the N needs are met is a component of the improved package of technologies that should be available to the emerging elite farmers who favour sole okra production.

The essence is that traditional smallholder farmers, who account for >95% of total okra production in Nigeria annually, use little or no N fertilizer (Anon, 2006). This is despite the research findings that confirm increased productivity of okra from applied N fertilizer in the savannah and forest agro-ecological zones (Adelana, 1985; Majanbu *et al*., 1985) and the recommendations in several extension bulletins and production guides (IAR&T, 1991; Olufolaji and Denton, 2000; FFD, 2002). Unfortunately, the adoption rate has been low and often attributed to inefficient fertilizer supply and delivery systems and that the recommendations are too technical, cumbersome and not easily understood by farmers. It is now clear that more weight ought to have been given to the lack of consideration for costs and returns to fertilizer use as complement to the agronomic requirements and advantages. The farmer needs to be convinced that the extra costs incurred by adopting the technology of fertilizer use would be more than compensated for by the value of the higher crop yields that translate to huge profits and benefits. Thus, the potential benefit accruing to the farmer from N fertilizer use in okra production must be assessed as an indicator of the financial contribution to the farming-family income, and so to poverty alleviation. This profit, therefore, becomes the greatest motivation for adopting improved farm technology which has N fertilizer application as a vital component.

In this paper, N fertilizer response data were utilized to evaluate the effect of changing economic environment, especially the recent government policy postures in the fertilizer market and ensuing price increases occasioned by currency (Naira, ₦) devaluation, on the profitability of N fertilizer use and so determine the economic rates to recommend for adoption in sole okra production systems.

Materials And Methods

Data used for the analysis of costs and returns were obtained from N response studies conducted on okra at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti (lat. 7°42'N; long. 5°14'E, and 456 m elevation during the early seasons of 2007 to 2009. the studies involved application of 0, 30, 60, 90 and 120 kg $N.ha^{-1}$ supplied as urea to two improved okra varieties- NHAe 47-4 and LD 88-1-8 obtained from National Horticultural Research Institute, Idi-Ishin, Ibadan. NHAe 47-4 is short (45 cm tall), early maturing (flowers in 40-50 days) and produces stout, dark-green and spiny fruits (11.5 g average weight) with good draw quality; LD 88-1-8 is tall (1.5 m tall), medium maturing (flowers in 50-66 days) and produces deep green, smooth fruits (12 g average weight) with good draw quality (Olufolaji and Denton, 2000). Okra seeds were sowed 30 cm apart on 1 m ridges and thinned to one seedling.$hill^{-1}$. One-half of the N fertilizer was mixed with 15 kg P and 35 kg $K.ha^{-1}$ supplied as single superphosphate (SSP, 18% P_2O_5) and muriate of potash (MOP, 60% K_2O), respectively and banded on both sides of the seedlings about 10 days after emergence and the remaining N applied at about 50% flowering. Harvesting started when the fruits were 3-5 cm long, fresh and tender. The fruits were snapped off the stems by hand at 3-4 day intervals. Yield was the sum of weighed fruits in all the harvests from each plot

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and the treatment means were calculated. Additional data were obtained as follows:

- Labour costs required for fertilizer application and harvesting extra produce based on man-days and the prevailing wages in 2007, 2008 and 2009.
- Farmgate prices of okra, taken as 75% of the average Ado-Ekiti rural market prices during the study period and reports of the Ekiti State Agricultural Development Programme
- Urea was sold at 25% subsidy during the study period being ₦2250.00, ₦3510.00 and ₦3562.50 for a 50 kg bag while unsubsidized prices up to the farmgate were ₦3187.50, 4387.50 and 4531.13 in 2007, 2008 and 2009 respectively

The standard tools for Cost-Benefit analysis are crop budgets which, in fertilizer use, must necessitate the calculation of some agro-economic criteria as follows:

- Farmers' yield level, estimated as 70% of the research plot yields
- Incremental output, as the yield from a particular N treatment minus yield of control, $MT.ha^{-1}$
- Response rate as incremental yield divided by N rate applied, kg fruit. kg N^{-1}
- Value of incremental output: incremental output multiplied by farmgate price, $₦.ha^{-1}$
- Variable (incremental) costs: price of N fertilizer plus labour costs of fertilizer application, harvesting and processing extra produce due to fertilizer use, $₦.ha^{-1}$
- Incremental profit (returns or benefit): value of incremental output minus variable (incremental) costs, $₦.ha^{-1}$
- Value-Cost ratio (VCR): incremental profit divided by variable costs.

The analysis was carried out to determine the profitability of N use under current economic environment in the fertilizer market comprising (1) a regime of regulation that provides fertilizers to states at 25% subsidy and which the states and Local Government administrations can further subsidize; and (2) a competitive open market in which fertilizer prices are unsubsidized and influenced by nationwide inflation and economic liberalization.

Results And Discussion

The two varieties increased in incremental output up till 60 kg $N.ha^{-1}$. The deviations are (1) highest incremental LD-88-1-8 output of 3.6 $MT.ha^{-1}$ at 120 kg $N.ha^{-1}$ in 2007 but 75% of which was achieved at 60 kg $N.ha^{-1}$; and (2) maximum NHAe 47-4 output of 2.8 $MT.ha^{-1}$ obtained at 120 kg $N.ha^{-1}$ in 2009. Response rates were highest at 60 kg $N.ha^{-1}$ in 2007 and 30 kg $N.ha^{-1}$ in 2008 and 2009 with the exceptions being the highest values for LD 88-1-8 at 60 kg $N.ha^{-1}$ in 2008 and for NHAe 47-4 at 120 kg $N.ha^{-1}$ in 2009.

The VCR is used to measure profitability of technology adoption such as N fertilizer application in any crop enterprise. The critical factors for consideration in the determination of profitability are crop yield response, cost of fertilizer application and prices of the output. Response rate data are scarce for okra grown on farmers' plots. The few data on okra from research plots are characterized by high yields and response rates (technical efficiency). In this study, yields are high so an adjustment factor of 70% (Falusi, 1990) was used to calculate farm-level yields. The response rates were maximized at 30 or 60 kg $N.ha^{-1}$ and decreased at higher N rates except in 2009 when 120 kg $N.ha^{-1}$ gave the best response coefficient in NHAe 47-4. Thus, improved technologies which emphasize best fertilizer management practices, especially N use, would increase response coefficients in line with the higher okra fruit yields.

The period of study was characterized by a regime of subsidy on fertilizers with the official price of urea at ₦51,000.00, 70,200.00 and 72,250.00.MT^{-1} in 2007, 2008 and 2009 respectively. Farmgate price of urea had increased in response to subsidy reduction, effects of Naira devaluation and inflationary pressure on fertilizer supply operations. The fertilizer market has been deregulating, so to say, since 1999 bringing in a regime of high official fertilizer prices and an open market where farmers buy fertilizers, sometimes at 3-4 times the subsidized prices. Farmgate okra fruit prices, adjusted to 75% of the rural market prices, rose from ₦5089 to 5878.MT^{-1} between 2007 and 2009 as prices of foodstuffs increased in response to inflationary pressure in the national economy. The impacts of these price regimes should be assessed on the profitability of N use in okra production.

The conventional economic theory of production is that profit is maximized where the Marginal Revenue (MR) from fertilizer use divided by Marginal Cost (MC) = 1.0, that is, VCR = 1.0 at which farmers would continue using the input so long as it increases crop output and does not lead to a financial loss. Since numerous constraints to productivity, especially those linked with access to fertilizers, confront farmers in the tropics, they rarely use the input up to this level but would stop well before the point where MR/MC >2.0 such that VCR = 2.0 should be the target for financial profitability based on domestic prices and targets VCR = 1.0 for economic profitability using border prices (Falusi, 1990).

Tables 2, 3 and 4 show that the values of output, at the respective farmgate prices, increased as N application rose except where yields declined at the higher N rates. Returns to N use also increased profitability whether urea fertilizer was subsidized or not. The increase in profitability was a reflection of the high incremental output and rising crop prices in the respective years. VCR was highest at 60 kg $N.ha^{-1}$ for LD 88-1-8 and NHAe 47-4 in 2007 and 2008. However, the highest VCR of 0.95 showed that N fertilizer use was not profitable for LD 88-1-8 in 2008 whereas N fertilizer application gave VCR of 1.90 and 2.02 for NHAe 47-4 at 30and 60 kg $N.ha^{-1}$ respectively. With the suggestion by Falusi (1990), only the 60 kg$N.ha^{-1}$ application rate is profitable. The VCR was higher in 2009 and maximized at 30 and 120 kg $N.ha^{-1}$ for LD 88-1-8 and NHAe 47-4, respectively. Without subsidy, the VCR reduced but the trends were similar, that is, highest profitability at 60 kg $N.ha^{-1}$ for the two varieties in 2007; VCR = 1.61 and 1.64 at 30 and 60 kg $N.ha^{-1}$ for NHAe 47-4 and financial loss in LD 88-1-8 in 2008; and VCR = 4.79 and 2.33 at 30 and 120 kg $N.ha^{-1}$ for LD 88-1-8 and NHAe 47-4, respectively in 2009.

In order to compare the results with the current economic environment in the fertilizer market, yield responses averaged over the years, the subsidized and unsubsidized urea fertilizer and domestic okra fruit prices in 2010 were used for the analysis. Table 5 shows that N use is still profitable despite the much higher official and open market urea prices. VCR increased to a maximum of 2.9 and 2.0 at 60 kg $N.ha^{-1}$ with subsidy and 2.4 and 1.6 without subsidy for LD 88-1-8 and NHAe 47-4 respectively and decreased at higher N rates. Regulation ensured higher profit from N fertilizer use in fresh okra fruit production and so justifies the retention of subsidy (Idachaba, 1994).

Table 1: Agronomic responses of okra to nitrogen fertilizer application rates

	Application rates (kg N.ha^{-1})			
	30	60	90	120
2007				
LD 88-1-8				
Incremental yield, MT.ha^{-1}	0.8	2.7	3.0	3.6
Response rate, kg fruit. kg N^{-1}	26.67	45.00	33.33	30.00
NHAe 47-4				
Incremental yield, MT.ha^{-1}	0.7	2.2	1.3	0.2
Response rate, kg fruit. kg N^{-1}	23.33	36.67	14.40	1.67
2008				
LD 88-1-8				
Incremental yield, MT.ha^{-1}	0.2	0.8	0.7	0.7
Response rate, kg fruit.kg N^{-1}	6.67	13.33	7.78	5.83
NHAe 47-4				
Incremental yield, MT.ha^{-1}	0.8	1.3	0.9	0.6
Response rate, kg fruit.kg N^{-1}	26.67	21.67	10.00	5.00
2009				
LD 88-1-8				
Incremental yield, MT.ha^{-1}	1.8	2.0	2.0	2.0
Response rate, kg fruit.kg N^{-1}	60.00	33.33	22.22	16.67
NHAe 47-4				
Incremental yield, MT.ha^{-1}	0.6	0.4	1.0	2.8
Response rate, kg fruit.kg N^{-1}	20.00	6.67	11.11	23.33

Table 2: Costs and returns to N fertilizer use in fresh fruit yield of two okra varieties

	Application rates (kg N.ha^{-1})			
	30	60	90	120
LD 88-1-8				
Value of incremental yield	28498.40	96182.10	106869.00	128242.80
Variable costs (subsidized)	8446.22	14852.44	18978.66	24224.88
Incremental profit	20052.18	81829.66	87890.34	104017.92
Value-Cost Ratio (VCR)	2.37	5.48	4.63	4.29
Variable costs (unsubsidized)	9277.78	16515.55	21473.33	27551.10
Incremental profit	19220.62	79666.55	85395.67	100691.70
Value-Cost Ratio (VCR)	2.07	4.82	3.98	3.66
NHAe 47-4				
Value of incremental yield	24936.10	78370.60	46309.90	7124.60
Variable costs (subsidized)	8326.22	14132.44	16578.66	18784.88
Incremental profit	16609.88	64238.16	29731.24	-11660.28
Value-Cost Ratio (VCR)	2.00	4.55	1.78	-0.62
Variable costs (unsubsidized)	9157.78	15795.55	19073.33	21111.10
Incremental profit	15778.32	62575.05	27236.57	-14986.50
Value-Cost Ratio (VCR)	1.72	3.96	1.43	-0.68

Based on prices (□) in 2007

Table 3: Benefit-cost analysis of fresh fruit yield responses in two okra varieties to N fertilizer application

	Nitrogen application rates (kg.ha^{-1})			
	30	60	90	120
LD 88-1-8				
Value of incremental yield	7481.60	29926.40	26185.60	26185.60
Variable costs (subsidized)	9393.44	15366.88	20237.82	25266.26
Incremental profit	-1911.84	14559.52	5947.28	919.34
Value-Cost Ratio (VCR)	-0.20	0.95	0.29	0.04
Variable costs (unsubsidized)	10538.06	17656.12	23671.68	29844.74
Incremental profit	-3056.46	12270.28	2513.92	-3659.14
Value-Cost ratio (VCR)	-0.29	0.70	0.11	-0.12
NHAE 47-4				
Value of incremental yield	29926.40	48630.40	33667.20	22444.80
Variable costs (subsidized)	10338.44	16116.88	20552.82	25108.76
Incremental profit	19587.96	32513.52	13114.38	-2663.96
Value-Cost Ratio (VCR)	1.90	2.02	0.64	-0.11
Value of incremental yield	11483.06	18406.12	23986.68	29687.24
Incremental profit	18443.34	30224.28	9680.52	-7242.44
Value-Cost Ratio (VCR)	1.61	1.64	0.40	-0.23

Based on 2008 prices (□)

Table 4: Analysis of fresh fruit yield responses to N application rates in two okra varieties

	N application rates (kg.ha^{-1})			
	30	60	90	120
LD 88-1-8				
Value of incremental yield	74062.80	82292.00	82292.00	82292.00
Variable costs (subsidized)	12796.93	18293.86	23440.79	28587.72
Incremental profit	61265.87	63998.14	58851.21	53704.28
Value-Cost Ratio (VCR)	4.79	3.50	2.51	1.88
Variable costs (unsubsidized)	13958.66	20617.32	26925.98	33234.64
Incremental profit	60104.16	61674.68	55366.02	49057.36
Value-Cost Ratio (VCR)	4.31	2.99	2.06	1.48
NHAe 47-4				
Value of incremental yield	24687.60	16458.40	41146.00	115208.80
Variable costs (subsidized)	10696.93	15493.86	21690.79	29987.72
Incremental profit	13990.67	964.54	19455.21	85221.08
Value-Cost Ratio (VCR)	1.31	0.06	0.90	2.84
Variable costs (unsubsidized)	11858.66	17817.32	25175.98	34634.64
Incremental profit	12828.94	-1358.92	15970.02	80574.16
Value-Cost Ratio (VCR)	1.08	-0.08	0.63	2.33

Based on prices (□) as at 2009

Table 5: Financial analysis of fresh okra fruit yield responses to N fertilizer application under current price regimes

	Application rates (kg N.ha^{-1})			
	30	60	90	120
LD 88-1-8				
Farm level incremental yield	0.65	1.28	1.33	1.47
Value of incremental yield	40885.00	80512.00	83657.00	92463.00
Variable costs (subsidized)	12804.61	20590.68	26079.09	31930.93
Incremental profit	28080.39	59921.32	57577.91	60532.07
VCR	2.19	2.91	2.21	1.90
Variable costs (unsubsidized)	14388.62	23748.70	30831.12	38266.97
Incremental profit	26496.38	56763.30	52825.88	54196.03
VCR	1.84	2.39	1.71	1.42
NHAe 47-4				
Farm level incremental yield	0.49	0.91	0.75	0.84
Value of incremental yield	30821.00	57239.00	47175.00	52836.00
Variable costs (subsidized)	12176.29	19127.69	23801.43	29456.92
Incremental profit	18644.71	38111.31	23373.57	23379.08
VCR	1.53	1.99	0.98	0.79
Variable costs (unsubsidized)	13760.30	22295.71	28553.46	35792.96
Incremental profit	17060.70	34943.29	18621.54	17043.04
VCR	1.24	1.57	0.65	0.48

Based on prices (□) in 2010

The profit, attributed to rising farmgate prices of okra fresh fruits, would provide the incentive for sustained use of subsidized urea fertilizer. The regime of deregulation in the economy ensured that values of output were high enough to guarantee huge returns to N use in okra. Thus, 60 kg N.ha^{-1} is the economic rate to recommend for sole okra production inline with the agronomic requirements determined based on analysis of fruit yield responses and N uptake in locations of the forest (Adelana, 1985) and guinea savannah (Majanbu et al., 1985) agro-ecological zones of Nigeria.

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