

Economic Benefits of Fungicide Use Among Cocoa Farmers in Osun and Ondo States of Nigeria

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ABSTRACT This study examines the costs, returns and productivity due to fungicide use in cocoa production under the Structural Adjustment Programme (SAP) in South Western Nigeria. Budgetary (gross margins) and production function analyses are the techniques used to analyze the primary data derived from a sample survey of cocoa farmers in Osun and Ondo States of Nigeria. The data were analysed to provide estimates of economic benefits of fungicide use. The study shows that net returns to fungicide use are positive. Fungicides are efficiently utilized by the respondents. However, the efficiency of use varies from one state to the other. It is higher amongst growers in Osun than those in Ondo State but the use rate of fungicide may be increased without any adverse economic consequences in both states.

INTRODUCTION

Past studies have indicated that high costs of chemicals should not be the only factor in determining economic desirability of pesticide application (e.g. Thorold, 1959 and Asare – Nyako, 1974). Other factors such as increased yields, high product prices and possibility of subsidies on agrochemicals are also relevant. According to Thorold (1959) the monetary return to fungicide use on cacao depends on yield level, rather than on disease incidence or on spraying costs. He observed that spraying could be practiced when the potential yield is twelve or more pods per cacao tree. Asare-Nyako (1974) identified four factors to be considered when evaluating the cost of fungicidal control:

- (i) the cost of fungicides;
- (ii) the cost of application which is affected by (a) the frequency of application, (b) the type of sprayer employed and (c) labour costs;
- (iii) yield of crop realized; and
- (iv) the price of the product.

The study indicated that (i) economic consideration is a necessary (and sufficient) condition in the use of fungicide on cacao trees. (ii) it is not economically wise to ignore levels of black pod infection in the application of fungicide(s). (iii) it is necessary to adequately spray cacao plantations with fungicides in order to protect cocoa pods from black pod infection; and (iv) spraying is a viable option in controlling black pod disease. All these studies suggest, in part, that there is need for the provision of

subsidies on such agricultural inputs as chemicals on the one hand and deregulation of marketing arrangement on the other. While the latter is realized under the so-called Structural Adjustment Programme (SAP) with the scrapping of the marketing boards in 1986, the former is negated by the devaluation of the naira against international currencies and the gradual or outright removal of subsidies on agricultural inputs and petroleum products. Thus, SAP policy measures appear to have contrasting effects on the utilization of chemical protectant on cocoa plantations. While the astronomical increase in the domestic price of cocoa under the Nigerian price deregulation policy would be expected to lead to an increase in the usage level of chemicals for crop protection, escalating cost of chemicals could lead in the opposite direction. Clearly, this raises a pertinent question: Are the increases in producer prices under SAP adequate enough to offset the increase in cost of chemicals?

A number of studies (Headley, 1968; Carlson, 1977; Oerke et al., 1995; Alimi, 1999) have attempted to measure pesticide productivity and concluded that the value of the marginal product of pesticides exceeds the marginal factor cost of the pesticide. However, Lee and Langham (1973) and Pingali and Carlson (1985) estimated simultaneous equation models involving crop and pesticide demand and found overuse of pesticides.

Thus the result of studies in respect of pesticide utilization is mixed since some found

over utilization of these chemicals while others found underutilization depending on the methodology employed. This implies the need for further research into pesticide productivity. Given the aforementioned situation, the objective of this study is to estimate costs, returns and productivity of fungicide use on cacao. This is because fungicides used in controlling black pod disease accounted for about 85% of fungicides used in Nigeria. In fact, cocoa pesticides dominate the insecticide and fungicide market in Nigeria (Ikemefuna, 1998).

METHODOLOGY

Primary data were used for this study. The data were sourced from a cross-sectional survey of cocoa farmers in four Local Government Areas (LGAs) each in Osun and Ondo States in the last quarter of 1997. Information was collected on the socio-economic characteristics of the farmers, output of cocoa beans per hectare, fungicide and application costs as well as information on other production costs.

A three-stage random sampling procedure was adopted in collecting the data. At the first stage the LGAs were selected, then five villages were chosen from each of the LGAs; that is, a total of 20 villages were selected per state. Lastly eight farmers were selected from each chosen village, thus totaling 160 respondents per state. At the final stage, 320 respondents were interviewed for the study. Information was obtained from each farmer with the aid of a pre-tested structured questionnaire administered by the author with the assistance of trained enumerators.

Two methods were used to estimate the economic benefits derived from chemical control of black pod disease:

- (i) production function analysis and
- (ii) budgetary analysis.

A multi - factor production function investigated in this study is expressed mathematically as:

$$Y = f [X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8] + e \dots\dots\dots(1)$$

Where Y is cocoa output in tonnes of harvested cocoa beans; X_1 is amount of fungicides applied measured in kilogram; X_2 is farm size, measured in hectares; X_3 is capital consumption, measured in Naira; X_4 is labour input, measured in mandays; X_5 is the number of farm locations (diversification index); X_6 is years of formal

education (management index); X_7 is number of weeding per season; X_8 is age of cocoa farm, measured in years; and e, is the error term.

The relevant production function parameters, such as the marginal product and value of the marginal product are estimated. The estimated marginal value products can be compared to the unit price of the input to determine the efficient level of input use.

Both Cobb-Douglas and Lichtenberg – Zilberman (1986) production models were employed in estimating the production relation contained in (1),

A conceptual basis for the production models of both Cobb-Douglas and Lichtenberg – Zilberman models is provided by particular forms for (1) which are expressed as

$$Q = Q(Z, B) \dots\dots\dots(2)$$

Where Q is output, Z is an input, and B is the pest level and

$$B = B(X, B_0) \dots\dots\dots(3)$$

Where X is the level of control agents (e.g. fungicide) and B_0 is the uncontrolled pest level.

For example, consider the forms

$$Q = \alpha Z^\beta B^{-\gamma} \dots\dots\dots(4)$$

$$\text{and } B = B_0 X^{-\sigma} \dots\dots\dots(5)$$

Where α , β , γ , and σ are positive parameters, and other variables are as previously defined. The reduced form for output is

$$Q = \alpha Z^\beta B_0^{-b} \dots\dots\dots(6)$$

Where $a = \alpha B_0^{-b}$ and $b = \beta$. The model represented by equation (6) is the Cobb-Douglas type.

As an alternative to (6), Lichtenberg and Zilberman suggested a production model of the form.

$$Q = \alpha Z^\beta [G(X)]^\gamma \dots\dots\dots(7)$$

Where $G(\cdot)$ is the proportion of the capacity of the damaging agent abated by use of X; $0 < G(X) < 1$. Hence, their model makes explicit the distinction between productive (Z) and protective (X) inputs in accounting for a finite damaging capacity of a pest population.

As Lichtenberg and Zilberman have argued, the nature of damage control suggests that the realized volume of output Q is a function of standard inputs ($Z_1, \dots, Z_n$), and a damage abatement function $G(x)$ that gives the proportion of the destructive capacity of the damaging agent eliminated by the application of a level of control agent X. Some elements of X may be included in Z if the use of X affects potential yield. The abatement function possesses the properties of

a cumulative probability distribution: It is defined on the $[0, 1]$ interval with $G = 1$ denoting complete eradication of the destructive capacity and $G = 0$ denoting zero elimination, i.e. maximum destructive capacity; it is monotonically increasing and it approaches a value of unity as damage control agent use increases.

A first – order logarithmic approximation to the potential output function is used and losses are assumed proportional to damage, so that the production function can be written as

$$q = \alpha_0 + \sum_{i=1}^n \alpha_i Z_i + g(X) + U \dots\dots\dots (8)$$

Where q , z_1 , ..., z_n and $g(X)$ represent the natural logarithms of Q , Z_1 , ..., Z_n , and $G(X)$; and U is assumed to be a white noise error term.

Different forms for $G(\cdot)$ can be motivated as alternative relationships between damaging capacity and the level of control agent. In this study Weibull, and logistic specifications are used for the abatement function. One source of damage is pertinent – blackpod disease – which is controlled by application of fungicides X . Hence the abatement functions are written as

$$G(X) = 1/[1 + \exp(-\sigma X)], \text{ and } \dots\dots\dots (9)$$

$$G(X) = 1 - \exp(-X^c), \text{ respectively } \dots\dots\dots (10)$$

The production functions (in log form) and fungicide demand functions implied by the two specifications of $G(X)$: the Weibull distribution, and the logistic distribution respectively are as follows:

Logistic Distribution

Production Function

$$q = \alpha + z\beta - \gamma \ln[1 + \exp(u - \sigma X)]^{-1} \dots\dots\dots (11)$$

Demand Function

$$X = \frac{u}{\sigma} + \frac{1}{\sigma} \ln \left[\frac{PQ}{w} - \frac{1}{\gamma\sigma} \right] \dots\dots\dots (12)$$

Weibull Distribution

Production Function

$$q = \alpha + z\beta + \gamma \ln[1 - \exp(-X^c)] \dots\dots\dots (13)$$

Demand Function

$$X = \frac{1}{c} \ln \left[c\gamma X^{c-1} \frac{PQ}{w} + 1 \right] \dots\dots\dots (14)$$

Estimation Method: Parameter estimates from a Cobb-Douglas specification are obtained using ordinary least squares (OLS) method. To estimate the production coefficients of the damage control specifications using OLS method, the parameters μ , (in logistic) and c (in

Weibull) are first obtained as follows:

To obtain the production parameters, U and in logistic function, the demand function for fungicide is expressed as

$$X = a_0 + a_1 \ln \left[\frac{PQ}{w} - \frac{1}{\gamma\sigma} \right] \dots\dots\dots (15)$$

Where $q_0 = \frac{\mu}{\sigma} + \frac{1}{\sigma} \ln \gamma \sigma$ and $q_1 = \frac{1}{\sigma}$

Following the suggestion of Lichtenberg and Zilberman (Op.cit), $\frac{1}{\gamma\sigma}$ was assumed to be sufficiently small thereby implying that the proper specification of fungicide demand is a linear function of $\ln[PQ/w]$.

This approximate demand relation was estimated using OLS and the parameter σ is recovered from the estimate of a_1 . To obtain the remaining parameter, γ , it is assumed that damage is strictly proportional to potential output, i.e., we assume that $\gamma = 1$.

To obtain the parameter, c , in Weibull function, $c\gamma X^{c-1}(PQ/w)$ is taken to be a very close approximation to $c\gamma X^{c-1}(PQ/w) + 1$ so that the relation (15) will be a good approximation to the demand function given above.

$$X = \frac{1}{c} \ln \left[c\gamma X^{c-1} \left(\frac{PQ}{w} \right) \right] \dots\dots\dots (15)$$

The relation in (15) was rearranged to yield the demand function,

$$X + \frac{c-1}{c} \ln X = a_0 + a_1 \ln(PQ/w) \dots\dots\dots (16)$$

Where $a_0 = (\ln c\gamma)/c$ and $a_1 = 1/c$. By and large, then, a Weibull damage abatement function implies that demand should be specified as the function in (16).

This demand relation is nonlinear in parameters. Hence, the parameters could not be estimated by straight forward linear regression. Hence, a fairly simple iterative procedure was used. The first stage of such a procedure involves an OLS regression of $X + \ln X$ on a constant and $\ln[PQ/w]$. For reasonable values of c , $(c-1)$ will be quite close to one so that $X + \ln X$ will be a good approximation for the left-hand side of (16). Estimate of c was derived from the estimate of a_1 . The approximation error was reduced by using the estimate of c obtained from such a regression to recalculate the left-hand side and redoing the OLS regression using the recalculated value of the dependent variable, a step which was repeated until a consistent value was obtained for c .

The marginal products of the damage control

agent (fungicide) corresponding to (6) and (7) at particular levels of input use, say Z^* and X^* , are respectively.

$$\frac{dQ(Z^*, X^*)}{dX} = \gamma \alpha Z^{*\gamma} X^{*\gamma-1} \dots\dots\dots (17)$$

and

$$\frac{dQ(Z^*, X^*)}{dX} = \gamma \alpha Z^{*\gamma} [G(X^*)]^{1-\gamma} \frac{dG(X^*)}{dX} \dots\dots\dots (18)$$

In order to evaluate the economic rationale of fungicide use, the marginal value productivity (MVP) of fungicide was calculated by multiplying estimated marginal product with average price per tonne of cocoa and later compared with the unit price of fungicide.

Budgetary Analytical Technique: Budgeting provides an indication of the approximate financial advantages derived from chemical control of black pod disease of cocoa and thus enables us to decide whether it is worthwhile incurring the inconvenience and risks of applying fungicides to control the disease.

Following the Entomological Society of Canada (1988) two equations are used to estimate net returns derived from applying fungicides to control black pod disease, namely: (1) an equation that calculates net returns to a farmer per treated hectare associated with the use of fungicides to control black pod disease (equation 19); and (2) an equation (20) that calculates total net returns to an average cocoa farmer from chemical control of black pod disease.

$$N = \left[\left(\frac{I}{100+I} \right) (Q)(P) \right] - \left[(BC)(L) \left(\frac{I}{100+I} \right) (Q) \right] \dots\dots\dots (19)$$

$$T = (N) \times (\text{Number of treated hectares}) \dots\dots\dots (20)$$

Independent Variables

I = Efficacy (% increase in marketable yield due to chemical control of black pod)

Q = Yield (realized mean harvested yield, in tonne/hectare)

P = Price of cocoa beans (₦ per tonne of cocoa beans)

BC = Black pod control costs (fungicide plus application costs per hectare per application in ₦)

L = Number of applications per growing season.

Dependent Variables

N = Net returns to cocoa farmer (gross margin per treated hectare to farmer derived from black pod disease control, in ₦/ha)

T = Total net returns to a cocoa farmer (the

total net benefit to an average cocoa farmer, in naira)

RESULTS AND DISCUSSION

Budgetary Analysis Results

Black pod Disease and its Control Costs: Table 1 shows that efficacy of fungicide, that is, percentage increase in marketable yield due to chemical control of black pod disease, reported by the respondents which ranged from 317% in Ondo State to 2400% in Osun State with an overall average of 600%. This perception of efficacy is consistent (in ranking) with the estimated (Cobb-Douglas) fungicide productivity reported in the next section. This shows that farmers in the study areas are not ignorant of fungicide productivity. *Phytophthora palmivora* (the causal agent of black pod) populations were effectively controlled through the use of fungicides. The mean cost of fungicide and its application for each hectare treated for the control of black pod disease was between ₦445.77/ha/treatment in Osun State to ₦771.06/ha/treatment in Ondo State (the study areas) with an overall average of ₦613.53.

Number of Treated Hectares and Net Returns: The average number of hectares per farmer treated for the control of black pod disease ranged from 4.30 ha in Ondo State to 4.82ha in Osun State with an overall average of 4.56ha (Table 2). The average net returns ranged from ₦18,000 in Osun State to ₦36,000 in Ondo State with an overall average of ₦28,000. The total net returns ranged from ₦89,000 in Osun State to ₦155,000 in Ondo State with an overall average of ₦128,000 for the combined study area. This shows that respondents realized that it was profitable to use fungicides to control the devastating effect of black pod disease in the study area. This is consistent with that of the production function analysis in which the contribution of fungicides to output is found to be greater than the unit cost of fungicides. These findings are also consistent with those of economic studies (e.g. Headley, 1968) which indicated that the economic benefits of pesticide use (whether insecticides, fungicides, herbicides, or all three together) were greater than the costs of the control.

Production – Function Results

Estimated coefficients and marginal

Table 1: Data summary statistics

	<i>I (%)</i>	$\frac{I}{100 + I}$	<i>Q (tonne/ha)</i> Mean	Max	Min	<i>P (₦)</i>	<i>BC (₦)</i>	<i>L</i>
Osun	2400	0.96	0.25	6.34	0.009	80, 000	445.77	7
Ondo	317	0.76	0.5	6	0.03	100, 00	771.06	7
Total	600	0.86	0.38	6.34	0.009	90, 000	613.53	7

Source: Data Analysis
Definitions of variables are as indicated earlier.

Table 2: Total net returns to Cocoa growers from chemical control of black pod disease.

		<i>Osun</i>	<i>Ondo</i>	<i>Total</i>
Average number of Treated Ha		4.82	4.3	4.56
Total Net Returns (₦'000):	Mean	89	155	128
	Min	3.2	9.3	3
	Max	2255	1855	2131
Net Returns (₦'000):	Mean	18	36	28
	Min	0.66	2.2	0.66
	Max	468	431	467

Source: Data Analysis

productivity are shown in Tables 3-5, respectively for the basic Cobb-Douglas type model and each of the damage control specifications.

The three specifications are comparable in terms of signing, significance of parameters and explanatory power. For example, Table 4 shows that each of the specifications explains about 67 percent of the variability in the dependent variable.

The coefficient estimates and statistical significance derived from the different models, exhibit many similarities as well as some differences (Tables 3 and 4). Of particular interests here, the estimated value of marginal product of fungicide is fairly similar in its implications for both the Cobb-Douglas type model and the Weibull damage control specification. The interpretation is that an additional naira spent on fungicide can be expected to yield several naira in return. However, as is evident from Table 6, the logistic specification of the damage control model yields strikingly different conclusions with respect to fungicide productivity. In the latter, an additional naira expenditure on fungicide in Ondo State is expected to return only 90k, implying that fungicide is overused.

The marginal value products (MVP) of the Cobb-Douglas type model are relatively higher than those of the damage control specifications (Table 6). The values (Cobb-Douglas and the Weibull) are significantly different from unity which indicates that the returns could be increased by using more of fungicide.

The ratio of 0.9 for Ondo State indicates that the cost of fungicide is higher than its contribution to production and consequently farm income could be raised through reduction in fungicide use. These results essentially indicate that fungicide is not generally overused by cocoa farmers in the area of study.

The estimated equations suggest that:

- the use of fungicides in controlling black pod disease was a significant determinant of cocoa production in the study areas. This is because the coefficient of fungicide variable is positive and significant in both Osun and Ondo States
- fungicide elasticity of production is less than unity among cocoa growers in both states.
- fungicides were not overused in the study areas as the ratios of MVP to factor cost of fungicides are greater than unity for both states. These are 8.1 and 3.5 for Osun and Ondo States respectively; and
- there is room for cocoa growers in both states to increase their fungicide use rate (without adverse economic consequences) as fungicides were not optimally utilized in the study areas.

To determine optimal fungicide use rate, linear regressions of yield per kilogram of fungicide (kg of dry cocoa beans/kg of fungicide) on fungicide use rate (kg/ha) are presented below:

Osun State

$$Y = 64.776*** - 2.128*** \dots\dots\dots(21)$$

(8.684) (0.804)

Table 3: Estimated production function coefficients for Osun State

Coefficient	Cobb-Douglas	Damage Control	
		Weibull	Logistic
Constant	-6.138*** -1.609	2.73 -4.265	-4.957*** -1.634
X ₁	0.322** -0.146	19.068** -8.69	0.104* -0.056
X ₂	0.266 -0.189	0.358* -0.191	0.376* -0.194
X ₃	0.035 -0.184	0.033 -0.175	0.053 -0.177
X ₄	0.661** -0.276	0.687* -0.271	.692** -0.275
X ₅	-0.323 -0.294	-0.405 -0.295	-0.418 -0.298
X ₆	0.312 -0.292	0.309 -0.286	0.314 -0.289
X ₇	0.425 -0.512	0.39 -0.506	0.377 -0.519
X ₈	0.223 -0.189	0.151 -0.185	0.179 -0.185
R ²	0.17	0.2	0.18
c		0.03	
U			7.72
?			0.2

* - Significant at 10% level
 ** - Significant at 5% level
 *** - Significant at 1% level
 Standard errors in parentheses.

R² = 0.05 F*** = 7.001

Ondo State

Y = 30.559*** - 0.247X**(22)
 (3.463) (0.119)

R² = 0.03 F** = 4.326

Overall

Y = 44.802*** - 0.592X*** (23)
 (4.188) (0.189)

R² = 0.034 F*** = 9.818

*** - significant at 1% level
 ** - significant at 5% level
 E - values in parentheses

Where Y is the yield increase per unit fungicide (kg/kg) and X is the fungicide use rate (kg/ha).

All the regression equations and their parameter estimates are significant at the 5% level of significance and all the regression slopes have expected negative signs.

Given that the cost of fungicide treatment was ₦405.25/kg in Osun and ₦285.58/kg in Ondo State, and the cash value of cocoa was on the average ₦90/kg in Osun and ₦100/kg in Ondo, the optimal fungicide rate for maximum net returns was 14kg/ha in Osun and about 56kg/ha in Ondo State.

Table 4: Estimated production function coefficients for Ondo State

Coefficient	Cobb-Douglas	Damage Control	
		Weibull	Logistic
Constant	-3.368*** -1.227	4.865 -5.081	-2.907** -1.38
X ₁	0.294* -0.171	18.056* -10.467	0.071 -0.059
X ₂	0.215 -0.133	0.215 -0.133	0.265* -0.129
X ₃	0.029 -0.108	0.03 -0.108	0.04 -0.112
X ₄	0.493** -0.215	0.494** -0.215	0.627*** -0.189
X ₅	-0.163 -0.177	-0.165 -0.177	-0.157 -0.182
X ₆	0.245 -0.159	0.244 -0.159	0.253 -0.168
X ₇	-0.791* -0.411	-0.792* -0.411	-0.734* -0.416
X ₈	0.03 -0.141	0.03 -0.141	0.05 -0.143
R ²	0.67	0.67	0.66

Source: Data Analysis

* - Significant at 10% level
 ** - Significant at 5% level
 *** - Significant at 1% level
 Standard errors in parentheses.

Where

Y = Cocoa output (tonnes)
 X₅ = Number of farm locations
 X₁ = Fungicide (kg)
 X₆ = Years of formal education
 X₂ = Farm size (ha)
 X₇ = Number of weedings
 X₃ = Depreciation charge (₦)
 X₈ = Age of cocoa farm (years)
 X₄ = labour (Mandays)

Table 5: Estimated marginal product of fungicide damage control.

	Cobb-Douglas	Weibull	Logistic
Osun	0.012	0.011	0.025
Ondo	0.007	0.005	0.00001

Table 6: Value of Marginal Product (MVP)

	Cobb-Douglas	Weibull	Logistic
Osun	1440 (8.1)	990 (5.6)	2250 (12.6)
Ondo	630 (3.5)	450 (2.5)	0.90 (0.01)

Note: Ratios of MVP to fungicide unit price in parentheses.

Source: Data Analysis.

Given the cost of fungicide treatment and prices of cocoa beans in each state, the net returns for each fungicide use rate and the lower and upper bounds and expected yields were computed (as equations 24 and 25) for Osun and Ondo States respectively.

$$P = 90YX - 405.25X \dots\dots\dots(24)$$

$$P = 100YX - 285.58X \dots\dots\dots(25)$$

Where P, is net returns (N/ha).

If it is the desire of the farmers to maximize the expected yield, a fungicide use rate of about 14kg/ha should be chosen by Osun farmers whereas their Ondo State counterparts should use more than that amount to maximize their expected net returns. If a use rate of 8kg/ha is used by Osun farmers, expected net returns are not maximized and if a use rate of 20kg/ha is used by them, upper 95% confidence bound net returns are increased but the probability of loss would be increased also.

To determine the probability of various profit levels at optimum fungicide use rate in both states, we apply the confidence interval formula to equations (24) and (25) to obtain:

$$P_c = 90 (Y + t_{\alpha/2} s_y) X - 405.25X \dots\dots\dots(26)$$

$$P_c = 100 (Y + t_{\alpha/2} s_y) X - 285.58X \dots\dots\dots(27)$$

Where P_c is the critical profit (N/ha), $t_{\alpha/2}$ is the one – tail t critical value with v degrees of freedom, and s_y is the standard error of yield prediction.

In Osun State, the probability of achieving a profit level greater than the expected (N31138/ha) at 8kg/ha (average use rate for Osun) using 14kg/ha was 56%. Also, the probability was 55% that profit at 14kg/ha will be greater than the expected (N31891/ha) at 20kg/ha. Based on the expected profit of a use rate of 10kg/ha, a use rate of 14kg/ha is seen to yield a higher profit level with 54% probability. Viewed against 12kg/ha, a use rate of 14kg/ha will yield a higher profit with 54% probability in Osun State. In Ondo State, the probability of exceeding the expected profit (N43727/ha) at 19kg/ha (average use rate for Ondo State) using 56kg/ha was 59% probability. The implications of the foregoing are: (i) as the distance between optimum level and actual practice decreases, improvements due to implementation of the optimum becomes less apparent; (ii) given the actual use rate of about 8kg/ha (19kg/ha) in Osun (Ondo) State, an extension programme recommending that cocoa growers in Osun (Ondo) State increase their use rate to 14kg/ha (56kg/ha) would have a fair chance of succeeding because the likelihood of doing better than a farmer using the current rate was 56% and 59% respectively for Osun and Ondo States; and (iii) fungicides were not over used in the study areas. These findings greatly support the contention in the previous section and are

consistent with earlier studies (e.g. Headley, 1968; Alimi, 1999) which report that pesticides were not overused by the respondents.

SUMMARY AND CONCLUSIONS

This study has examined the costs, returns and productivity of fungicide use on cocoa production under SAP in southwestern Nigeria. Budgetary (gross margins) and production function analyses are the quantitative techniques used. The primary data on cocoa agriculture were derived from a sample survey of 320 cocoa farmers in Osun and Ondo States in southwestern Nigeria. These were analysed to provide estimates of economic benefits of fungicide use.

The budgetary analysis shows that it was profitable to apply fungicides in controlling black pod disease in the study areas. The total net returns (gross margin) ranged from N89, 000 in Osun State to N155, 000 in Ondo State with an average of N128, 000 for the combined study area. The average fungicide procurement and application costs for each hectare treated for the control of black pod disease were N445.77/ha/treatment in Osun State and N771.06/ha/treatment in Ondo State with an overall average of N613.53. With regard to fungicide productivity, the study shows that fungicides are not overused although productivity estimates are somewhat sensitive to the functional form chosen.

Essentially fungicides were not overused – in most cases, it was shown that net returns could be increased by using more fungicide in the study area as implied by the ratio (> 1) of MVP of fungicide to its factor cost. Specifically farmers in Osun State would have to double their current use rate to optimize fungicide use while their counterparts in Ondo State would have to triple theirs to achieve the same goal. Cocoa production is found to be inelastic with respect to fungicide use in the study area.

Based on the results of this study, it is suggested that cocoa farmers increase the quantity of fungicide used per hectare as the ratio of the marginal productivity to unit cost of fungicide is greater than unity among the respondents. To ensure this, cash flow problems and high cost of fungicide reported by the respondents may be addressed in the following ways:

- (a) supplying credit to growers at the right

time, that is, when production efforts are initiated
 (b) removing import duty on fungicides meant for agricultural use including cocoa. This can be achieved by separating the custom import tariff between fungicide for agriculture and those for other uses.

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