ECONOMIC ANALYSIS OF YAM BEETLES (*HETEROLYGUS MELES,* BILLB) INFESTATION IN THE NORTH AGRICULTURAL ZONE OF DELTA STATE, NIGERIA

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Abstract

Using survey data obtained from a cross section of 120 small-scale yam farmers, the paper analysed the effects of yam beetles infestation in Oshimili North LGA of Delta State. The demographic profile of respondents showed that farmers in the area were within the active workforce with a mean age of 42 years, and about 41% of them either attempted or completed secondary school. Damage to yam beetles ranged from 27.69% to 39.72% with a mean beetle attack rate of 32.69% that caused a loss of tubers worth ₦ 1.09 million in market value. High cost of pesticides and cost of equipment and labour were reported as major obstacles to the effective control of yam tuber beetles. Regression results indicated that planting date and cost of pesticides had negative and statistically significant effects ($p < 0.01$) on value of yams lost to beetles. Elasticity estimates showed that a 1 percentage delay in planting date will reduce yam loss to beetles by 7%, while a proportionate increase in the level of pesticides applied will reduce yam loss by 5.4%. Therefore a combination of planting dates manipulation and pesticides application that will drastically control the attack of yam tuber beetles and enhance farmers' income is recommended.

Key words: small-scale yam production, yam tuber beetles, level of infestation, planting dates, reduced market value

INTRODUCTION

Eradicating hunger and reducing poverty are major development policy objectives of many developing countries in line with the Millennium Development Goal (MDG) target of reducing to half the proportion of undernourished people in the world by the year 2015. In sub-Saharan Africa however, hunger is as persistent as it is widespread and the situation is even worsened by natural and human-induced disasters, including ethnic and regional conflicts.

Sustained agricultural growth is critical for reducing hunger and alleviating poverty because about 70 percent of the poor in developing countries live in rural areas and depend on agriculture for their livelihoods, either directly or indirectly (FAO, 2006). Furthermore, productivity-driven increases in food production have been shown to have a strong positive impact on the rural economy, leading to increased food availability and a reduction of food prices in local markets. Although Nigeria has only 9% of its population undernourished compared with many sub-Saharan African countries, current efforts to win the war against hunger and malnutrition must be sustained to ensure food self-sufficiency. Therefore in order to address the food security situation in the country in the face of increasing human population and high food prices, policies to boost the supply of major staple food crops such as cassava and yam, must be articulated and implemented as a matter of urgency.

Yam is a major staple food for an estimated 60 million people in West Africa (IITA, 1988), supplying 200 kcal per person/day dietary energy (Orkwor and Asiedu, 1995). The yam crop is unique among food crops in relation to the prestige it enjoys and the central role it plays in the socio-economic life of the people of southwest and south-eastern Nigeria (Hahn et. al., 1995). Among the root and tuber crops, yam is the second most important staple food after cassava that can meet the bulk of carbohydrate requirement of the people.

Nigeria is the largest producer of yam in the world with an annual production of 36.72 million metric tones in 2006 (FAO, 2009). There has been a steady growth in yam production since 1997, with an average annual growth rate of 4.6% per year between 1997 and 2006 (Table 1). In spite of the increase in yam production, infestation by yam tuber beetles (*Heterolygus meles*.) has posed a major constraint to increased yam output. *Heterolygus meles* is a very serious insect pest of yam in

Tab. 1: Annual output in yam production: Nigeria and rest of the World (metric tonnes)

Year	World	Africa	Nigeria	National annual growth rate(%)
1997	35 529 509	34 127 121	23 972 000	
1998	37 067 264	35 645 883	24 768 000	3.2
1999	38 953 415	37 451 888	25 873 000	4.3
2000	39 568 980	38 009 739	26 201 000	1.3
2001	40 007 979	38 401 524	26 232 000	0.12
2002	42 195 571	40 579 260	27 911 000	6.0
2003	44 258 102	42 587 640	29 697 000	6.0
2004	46 935 878	45 204 790	31 776 000	6.5
2005	49 066 755	47 314 591	34 000 000	6.5
2006	51 487 245	49 723 354	36 720 000	7.4

Source: Computed from FAOSTAT (2009)

river-rine areas, particularly in the forest agro-ecological zones, up to the savanna regions along the Benue-Niger rivers and tributaries (McNamara and Acholo, 1995).

Beetle infestation in the Old Asaba Province, which includes Oshimili North Local Government Area (LGA) is usually serious, with over 20% attack rate (Taylor, 1964). Tobih et al., (2007) reported higher rates of beetle attack and infestation ranging from 41.37% to 44.12% for Oshimili North LGA in the 2001/2002 production year. There is no doubt that this rising incidence of tuber damage resulting from beetles attack has serious socio-economic consequences on farmers. Yield is drastically reduced; there is great loss in market value, low farm income and consequently hunger and poverty. The high cost of pest control coupled with the rising cost of other productive inputs have forced some yam farmers to adopt other staple crops while others have abandoned their farms altogether.

The objectives of this study therefore, were to determine the level of yam beetles infestation in Oshimili North LGA, quantify the loss in yam output due to beetle attack, identify factors that influence the quantity of yams lost to beetles and to examine constraints to effective control of yam beetles by farmers in the study area.

MATERIALS AND METHODS

Area of study

The delta north agricultural zone is one of three zones that comprised the agricultural production belt of Delta State, Nigeria. The others are the south and central zones. The northern zone is composed of nine (9) local government areas (LGAs) that include, Aniocha North, Aniocha South, Ika Northeast, Ika South, Ndokwa East, Ndokwa West, Oshimili North, Oshimili South, and Ukwuani. It is the major food crops production belt in Delta State, Nigeria.

This study however was restricted to Oshimili North local government area (LGA) which is composed of nine (9) communities. The LGA has a population of one hundred and fifteen thousand, three hundred and sixteen (115,316) people (NPC, 2006) and its headquarters is Akwukwu-Igbo. Farming is the primary occupation of the people and yam is one of the major food crops cultivated in the area. Yam beetles infestation is however endemic in the area with an attack rate of 41–45% (Tobih et. al., 2007).

Sampling procedure and data collection

Data for the study were collected as primary data from a cross-section of yam farmers using interview schedule that were conducted by the researchers, with the assistance of enumerators that were fluent in both English Language and the local dialect of the people. A two-stage sampling procedure was used to draw samples for the study. Firstly five (5) communities were drawn out of the nine (9) communities that made up the study area using simple random sampling technique. Secondly, 24 farmers were randomly selected from each of the five (5) communities, to give a total sample size of 120 respondents for the study. The five (5) communities chosen are Ugbolu, Ebu, Illah, Atuma-Iga, and Ukala-Okwate. Data collected included socio-economic characteristics of the farmers, production data and information on yam beetles infestation. The survey was conducted between September and November, 2008.

Model specification and estimation

The following econometric model was specified in order to investigate factors that affect the value of yams lost to beetles attack, a proxy for the quantity of yams damaged by yam tuber beetles:

$$VYL_{bt} = f(PLD_{tm}, CST_{pt}, LBR_{st}, YAM_{ut}, u) \quad (1)$$

Where:

VYL_{bt} = the monetary value of the quantity of yams damaged by yam beetles;

PLD_{tm} = the date of planting yams during the farming season (March = 1; April = 2; May = 3);

CST_{pt} = cost of pesticides procured for the prevention and control of yam beetles, a proxy for quantity of pes ticides used;

LBR_{st} = the cost of labour incurred by farmers for the control of yam beetles;

YAM_{ut} = the output of yam in the farming year; and

u = stochastic error term.

Because economic theory does not indicate the precise mathematical form of the relationship among the variables, different functional forms of the above model were fitted but the logarithmic function was chosen as the lead equation based on economic theory, statistical theory, as well as econometric criteria. The logarithmic form of the model is specified as follows;

Tab. 2: Distribution of social characteristics of yam farmers (n = 120)

Parameter	Frequency	Mean (Mode)	Std. Deviation	Minimum	Maximum
Gender					
Male	81 (67.5)*	(Male)	0.46	1	2
Female	39 (32.5)				
Age					
23–31	14 (11.67)				
32–40	46 (38.33)				
41–49	31 (25.83)	42	9.90	23	66
50–58	20 (16.67)				
59–67	9 (7.5)				
Household size					
2–5	34 (28.33)				
6–9	45 (37.50)	8 persons	0.32	2	16
10–13	32 (26.67)				
14–17	9 (7.5)				
Educational status					
No formal education (1)	11 (9.17)				
Attempted primary school (2)	14 (11.67)				
Primary school (3)	28 (23.33)				
Attempted secondary school (4)	13 (10.83)				
Secondary school (5)	36 (30.00)	(5)	0.89	1	7
Attempted tertiary education (6)	4 (3.33)				
Tertiary education (7)	14 (11.67)				
Farming experience(years**)**					
3–9	53 (44.17)				
10–16	45 (37.50)	11	0.59	3	35
17–23	16 (13.33)				
24–30	4 (3.33)				
31–37	2 (1.67)				

*Figures in parentheses are percentage of respondents
Source: Computed from survey data (2008)

$$In\ VYL_{bt} = In\psi_0 + \psi_1 In\ PLD_{tm} + \psi_2\ ln\ CST_{pt} + \psi_3 In\ LBR_{st} + \psi_4 In\ YAM_{ut} + u \quad (2)$$

and the variables are as defined in equation (1).

The Ordinary Least Squares (OLS) technique was used to estimate the regression parameters.

RESULTS AND DISCUSSION

Social characteristics of yam farmers

The social characteristics of yam farmers in the area of study are presented in Table 2. It indicated that both men and women were actively involved in yam production with 32.5% of the farmers being female while 67.5% were male. Yam is culturally regarded as a "man" crop in Oshimili North area of Delta State and this may have informed the dominance of men in yam production.

A relatively small household size was found in the study with a mean size of 8 persons per household, although 41% of the households have family sizes ranging between 10–17 persons. Majority of the farmers (60%) are in their active and productive years, thus there is the likelihood that the mean size per household among this group could increase with time. The findings do not however support the preponderance of large family sizes among the poor in rural areas reported by Eboh (1995).

About 65 percent of the farmers had some form of formal education while 35% either dropped from school or never attended at all. The modal educational status amongst the yam farmers was secondary education. Illiteracy and lack of education poses significant constraints to agricultural productivity in sub-Saharan Africa. According to Biswanger (1989), farmers who can read, understand and analyse issues are more likely to adopt modern agricultural innovations in order to increase overall productivity, than their less educated counterparts. Furthermore, apart from being early innovators that provide examples that may be copied by illiterate farmers, educated farmers are better able to copy those who adopt innovation first, thereby enhancing wider diffusion of the new technology in the community (Weir and Knight, 2004)

Farming experience, the number of years spent in yam production, ranged between 3 and 37 years, with a mean experience of 11 years. In fact, about 44.17% of the farmers have spent between 3 and 9 years farming, 50.83%, 10–23 years while the remaining 5% have been involved in yam production for upwards 24 to 35 years. The distribution shows that a number of respondents were relatively young in yam farming. This is in consonance with the mean age of 42 years found.

Level of yam beetles infestation

The level of yam beetles infestation in the five (5) communities studied is shown in Table 3. Yam output ranged from 57 352.91 kg in Atuma-Iga to 128 445.09 in Illah, while the quantity of yam lost to beetles attack ranged from 15 880.63 kg to 40 884.72 kg in Atuma-Iga and Illah respectively. The percentage infestation by yam beetles was highest in Ugbolu (39.72%) and lowest in Atuma-Iga (27.69%). Ugbolu, Illah and Ebu are situated along the River Niger, the breeding ground for yam tuber beetles (McNamara and Acholo,1995). This contiguity to the breeding ground may be responsible for the relatively higher level of infestation in these locations than Atuma-Iga and Ukala that are not bordering the River. In the entire study area, yam beetles caused a loss of 155 456.78 kg worth of yam tubers, valued at N=1.09 million at farm-gate price. The overall rate of beetles attack was 32.69%. The results are in agreement with the attack rate of 31% to 51% reported by Tobih et al. (2007) and those of Taylor (1964), in the same agricultural zone.

A number of measures such as delayed planting, shifting cultivation, interplanting/cropping and application of pesticides such as *Endosulfan* and *Carbofuran* were used by farmers to control beetles infes-

Tab. 3: Yam output and levels of yam beetles infestation

Location	Yam output (kg)	Yam loss to beetles (kg)	% infestation
Illah	128 445.09	40 884.72	31.80
Ebu	91 732.78	30 432.35	33.18
Atuma-Iga	57 352.91	15 880.63	27.69
Ukala-Okwate	103 809.87	30 841.97	29.71
Ugbolu	94 203.13	37 417.11	39.72
Total	**475 543.78**	**155 456.78**	**32.69**

Source: Computed from survey data (2008)

tation with varied results. Delayed planting involved the manipulation of planting dates to prevent the onset of attack, although it resulted in the production of seed yams and a reduction of ware yams in most cases. Since the farms are within the infested zone, shifting cultivation as a measure was reported not to be effective against the onslaught of the voracious pest. On the whole the use of pesticides was reported to be quite effective by the farmers that applied it. However, the cost of pesticides was a great burden that reduced the profitability of their operations.

Regression results

The estimated results for the regression model (2) are shown in Table 4. The Adjusted R-squared shows that the independent variables jointly explained 54% of the variation in the dependent variable (value of yams lost to beetles). Although the results indicate some degree of autocorrelation in the data, generally the results conform with *a priori* expectations on the size and signs of the regression coefficients. Furthermore, it shows that planting date and cost of pesticides exerted negative and statistically significant effects on value of yams lost to beetles in Oshimili North LGA of Delta State. The results imply that the earlier the planting date, the higher the incidence of beetles' attack, while delayed planting led to lower yam tuber damage. Furthermore, a 1 percentage delay in planting date will reduce yam loss to beetles by 7%. Manipulation of planting dates during the cropping season is one cultural method that farmers have adopted to prevent and control the attack of yam beetles in the area. The date of planting range between March to May, and fields cultivated in March have been found to be highly susceptible to yam beetles attack than late planting in May (Tobih et al., 2007). However, delays in planting have been found to reduce the yield of ware yams, but lead to the production of seed yams.

The result further showed that the higher the level of pesticides applied, the lower the attack of yam beetles, and *vice versa*. Thus farmers who spent more on pesticides experienced less beetles attack than those who applied pesticides rarely. The elasticity estimate indicated that a 1 percentage increase in pesticides application will reduce the quantity of yams lost to beetles by 5.4%. Therefore a combination of planting dates manipulation and a programme of pesticides application will drastically control the attack of yam tuber beetles and enhance farmers' income.

The cost of labour for pesticide application, though had a negative effect, was not significant. Pesticides application for the control of yam beetles is carried out occasionally on the farm and thus farmers may not incur much cost to undertake the operation. This situation may account for the non-significance of this variable. Yam output showed a direct relationship to the dependent variable, although not statistically significant. The incidence of yam beetles attack does not depend on the volume of output. Output may be low and yet there can be a 100% attack rate, while there may be low incidence of yam beetles infestation where output is high.

Constraints to yam beetles control

Yam beetles attack caused a lot of hardship to farmers. Apart from the damage they cause to yams thereby reducing their market value, they make farmers incur undue cost in an attempt to curb their menace. Although farmers are ready to adopt practical measures to control the attack of yam tuber beetles, their efforts are constrained in a number of ways.

Five major factors posed serious constraints to the effective control of yam beetles in the study area as presented in Table 5. High cost of equipment and labour for the control of beetles was the most limiting obstacle to yam beetles control as reported by 76.7% of farmers. This was followed by high cost of pesticides (67.7%) and

Tab. 4: Regression results of determinants of value of yams lost to beetles attack

Variable	Estimated coefficient	t-statistic	p-value
Planting date	– 0.82	– 7.01	0.00*
Cost of pesticides	– 0.43	– 5.40	0.00*
Labour for pesticide application	– 0.21	– 1.33	0.19^{ns}
Yam output	0.09	1.37	0.17^{ns}
F-statistic = 35.80 D-W statistic = 1.82 Adjusted R^2 = 0.54 n = 120			

*significant at the 1% level, ns = not statistically significant
Source: authors' calculation

Tab. 5: Factors limiting effective control of yam beetles

Constraint	Illah (n = 24)	Ebu (n = 24)	Atuma (n = 24)	Ukala (n = 24)	Ugbolu (n = 24)	Entire study area (n = 120)
Lack of information on beetles control	5 (21)	7 (29.2)	10 (41.7)	8 (33.3)	4 (16.7)	34 (28.3)*
High cost of pesticides	20 (83.3)	16 (66.7)	19 (79.2)	14 (58.3)	12 (50)	81 (67.5)
Residual effects pesticides on yam & soil	8 (33.3)	9 (37.5)	4 (16.7)	7 (29.2)	10 (41.7)	38 (31.7)
High cost of equipment & labour	20 (83.3)	18 (75)	16 (66.7)	18 (75)	20 (83.3)	92 (76.7)
Effect of pesticide on yam quality & storage	19 (79.2)	13 (54.2)	15 (62.5)	11 (45.8)	17 (70.8)	75 (62.5)

*Figures in parentheses are percentage of respondents
Source: Computed from survey data (2008)

effect of pesticides on yam quality and storage (62.5%). Cost of pesticides and equipment for their application constitute an addition to the overall cost of production by farmers, and given the high cost of seed yams and land preparation farmers' bear during the planting season, most farmers are unable to cope with the extra burden. Thus farmers are unable to procure pesticides to treat their yam setts and seed yams to prevent the attack of beetles. Furthermore, many farmers are of the opinion that control of beetles by pesticides affects the quality of yams and their storage ability. Therefore they are likely to be reluctant to apply pesticides even if accessible. Lack of information on beetles control elicited the least response as 28.3% farmers claimed not to have access to technology of yam beetles prevention and control. The result thus indicates that 72.7% of farmers in Oshimili North LGA had access to information on beetles' prevention. Therefore the high incidence of beetles infestation found in the study is due to farmers' failure to adopt appropriate control measures.

CONCLUSION

Yam is a staple food for the majority of Nigerians. Therefore increased production of this important crop will help to achieve the objective of self-sufficiency in food production as well as meeting the Millennium Development Goal (MDG) of reducing the proportion of hungry people in the world by half the year 2015. However, damage to yam tubers by beetles poses serious treat to the livelihood of farmers and to the national goal of reducing hunger and poverty. Therefore, there is the need to invigorate the extension units in the Ministry of Agriculture in order to provide farmers with cheaper and appropriate technology for the prevention and control of yam tuber beetles. Since the technologies of beetles' control appear costly for farmers to adopt, a revival of the policy of input subsidisation that will make pesticides and the equipment to apply them cheaper and affordable to farmers is advocated.

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