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ANALYSIS OF ADHERENCE TO DOSAGE RECOMMENDATIONS FOR USE OF PESTICIDES BY ARABLE CROP FARMERS IN NJABA LOCAL GOVERNMENT AREA OF IMO STATE, NIGERIA

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Abstract

Modern practices in crop farming in areas prone to attacks of pests is recently attracting increasing use of chemicals in checking incidences of weeds, insects, birds and rodents not only in farms, gardens but in food and product stores. Many factors have influenced these practices including socio-economic variables which either encourage or discourage the pesticides use. This investigation involved a survey of eighty (80) arable crop farmers' selected using multi-stage random sampling technique in Njaba local Government Area of Imo State of Nigeria. Result reveals that farm size, farming experience, number of times in contact with extension agents in a month, level of educational attainment, and cost of pesticides were factors that influenced use and adherence to recommended dosage of pesticides by farmers. Pesticides when properly applied in the right dosage, under dry weather condition gave good results especially in the short run. Extension outfit should encourage the farmers to process and store their products even for a short period of time. This will enable them be much aware of storage pesticides and help them fetch better prices for their products. Farmers were reminded to recognize and heed the three principles of threshold, interdependence, and complexity in their practice of using most pesticides.

Key words**:** *adherence, control, farm modernization, pesticides*

INTRODUCTION

Pests are plants and animals that are growing in off locations especially where crops and/or livestock are nurtured such that their presence constitutes nuisance and demand to be removed. Pests constitute problems in crop and livestock management. One easy way of exterminating pests and protecting crops is through use of some chemical formulations called pesticides. The use of pesticides in farms truly demands understanding the nexus of ecological interrelatedness and wilful application of guiding policies for protectionist results [7]. Arable crop farms in many parts of south eastern Nigeria are attacked by insects such as leafhoppers, termites, aphids, weevils, cutworms, stem borers, millipedes, beetles, bollworms, black ants, mites and bugs. Other pests' are birds (weaver birds, sun birds, quails) and rodents (squirrels, grass cutters, and cane rats). Farms are attacked by weeds to which most times farmers accommodate the drudgery and culturally check the weeds using hoes, cutlasses and hand rogueing that have little or no adverse environmental effects. In line with principles of agricultural modernization, farmers are now checking weeds using recommended doses of herbicides such as Primextra, paraquat, Dopax, Sencor, Lasso and Diuron with effects lasting for up to a month or two as they kill their target organisms indiscriminately.

Some pesticides like the organo-phosphates malathion and parathion are highly toxic and short-lived in their action while others like the chlorinated hydrocarbons (DDT, dieldrin and

endrin accumulate along the food chains over time in increasingly concentrated forms with varying effects on their target preys and environment [6, 2]. In advanced economies, famers use a mixture of technologies relating to farm level conservation practices, association between disease and insect resistant varieties, spot spraying, rotating pesticide classes, the use of different varieties in different fields, the treatment of seeds, crop rotation and adjustments to the time of operations. This mix of technologies suggests that some farmers are combining chemical use with crop management in a way that preserves pesticides from biological resistance [5]. The accumulation effects of pesticides along the food chains require that farmers be investigated of their reasons for choice of chemical pesticides use, their awareness of adherence to recommended dosage, types and sources of pesticides used and determinants of their decisions to adhere to recommended dosages to be environment friendly. This study therefore investigates (i) types and sources of the pesticides used; (ii) farmers' level of awareness of recommended dosage of pesticides at the time of use; and (iii) factors that influence their decisions to adhere to pesticides recommended dosages.

MATERIALS AND METHODS

This study involved a survey of Njaba Local Government Area of Imo state in Nigeria. Njaba LGA shares boundaries in the East with Isu and Nkwere LGAs, in the west with Oru East, in the North with Orlu and in the south with Mbaitoli LGAs all in Imo State This is a geographical region that encapsulates fourteen autonomous communities with its headquarters in Nnenasa along Orlu-Owerri Federal highway in south eastern Nigeria. The communities are Amazano, Umuaka, Isiozi Akah, Ugbelle Akah, Amakor, Ihebina Owerre, Ebeise, Okponakuma, Ibelle, Okwudor, Nkume, Attah, Amucha, and Egwedu. The area derives its name from Njaba River that rises from Isunjaba and drains through Oguta to the Niger Delta area and lies within Latitudes 4^0 $10^/$ N and 5^0 $01^/$N of the Equator and between Longitudes 6^0 $29^/$E and 6^0 $47^/$E of the Greenwich Meridian. The 2006 Nigeria's National population census enumerated the area to comprise of 145,110 inhabitants [3]. The area is truly agrarian as food crops such as yam, cassava, rice, cocoyam, maize, plantain, banana, fluted pumpkin, and sweet potatoes are widely grown. Cash crops grown in the area include oil palm, cashew, cocoa, rubber, and ginger. Livestock such as poultry, sheep, goat, pigs, and N'dama/muturu cattle are reared. Smallholder farmers are in predominance in the area cultivating multiples of small plots with crops grown in mixtures (multiple cropping) and livestock reared both in extensive and intensive care systems.

The study adopted a multi-stage random sampling technique. In the first stage, four autonomous communities were selected following a simple random process. The communities chosen at this stage were Umuaka, Nkume, Egwedu and Isiozi Akah. In the second stage, two villages were also randomly chosen from each of the four chosen communities. This gave a total of eight (8) villages involved in this study. From each chosen village, ten (10) arable crop farmers identified by the Agricultural Extension Agents (EAs) to have adopted use of pesticides in farming in the communities were selected and approached for information. A total eighty (80) such arable crop famers were involved in this study.

Information was gathered from the farmers by personal interview method with a semi-structured questionnaire on issues of challenges in the use of pesticides and adherence to dosages of pesticides both in their farms and post-harvest storage. These among others included socioeconomic information on age, gender, marital status, farm size, farming experience, farm income, level of education of farm owner, number of contact times with extension personnel, distance of farm to pesticide market/source, market cost of pesticides, and ownership/hire of spraying implement (knapsacks).

Descriptive statistics of frequency tables, percentages and mean of observations were used in analysing information of farm household socioeconomic, source and type of

pesticides used, and reasons for adopting pesticide use and challenges. The farmers' level of awareness of deleterious effects of pesticides was done with a rating scale analysis hinged on a five-point Likert scale. The determinants of adherence of farmers to recommend dosages of pesticides were achieved with Probit multiple regression technique where a farmer either adheres (1) or does not adhere (0).

Farmers' level of awareness of recommended dosages of pesticides on a five-point Likert scale type and nominal score value of Unaware (0); Least Aware (1); Aware (2); Much Aware (3) and Very much Aware (4). The mean awareness level was determined thus:

$$\bar{X} = \frac{\sum X}{N}$$

$$\bar{X} = \frac{0 + 1 + 2 + 3 + 4}{5} = 2.0$$

For each pesticide, the Xs was determined by multiplying the frequency of response to each with its appropriate nominal score value and dividing the sum with the number of farmers aware of recommended dosage of the pesticide. Thus

$$\bar{X}s = \frac{\sum fx}{nr}$$

Where:

$\bar{X}s$ = mean score; $\sum$ = summation; f= frequency or number of specifically observed farmers in each level; nr = number of farmers aware of dosage of each pesticide; x = awareness nominal value score. Thus:

$$\bar{X}s = \frac{0(X1) + 1(X2) + 2(X3) + 3(X4) + 4(X5)}{nr}$$

Decision rule:

Less than 1.0 = Unaware level;
1.10 – 1.61 = Least Aware;
1.62 – 2.00 = Aware;
2.10- 2.63 = Much Aware;
2.64 – 3.14 = Very much Aware.

The threshold score of 2.0 and above indicates famers' perceived level of awareness of pesticide dosage while using it.

The Probit regression model for determining factors influencing use and adherence was framed as follows:

$$Y_{ij} = \alpha_j + \beta_j \sum_{k=1} H_{ijs} + \varepsilon_{ij} \quad \ldots (1)$$

Where the H_{ijs} are vectors of s explanatory variables of the j^{th} household using pesticides; Y_{ij} is a vector of binary variables such that Y_{ij} =1 if the j^{th} household using pesticide adheres to recommended dosages of pesticides, and 0 otherwise. Since Y_{ij} can only assume two different values for the decision yes or no, represented by 1 or 0, the expected probability can be defined as follows:

$$E(Y_{ij}) = E\left[\alpha_j + \beta j \sum_{k=1}^{s} H_{ijs} + \varepsilon_{ij}\right]$$

$$= \alpha_j + \beta_j \sum_{k=1}^{s} H_{ij}\, E(H_{ij}) \quad \ldots(2)$$

Equation (4) defines the proportion of households with characteristics (H_{ij}) likely to adhere to dosage specifications. The empirical model was specified thus:

$$EXP\ Y_{ij} = \beta_0 + \beta_1 \ln(ED_{ij}) + \beta 2 \ln(EC_{ij}) + \beta 3 \ln(MD_{ij}) + \beta 4 \ln(CP_{ij}) + \beta 5 \ln(SE_{ij})$$

$$+\beta 6 \ln(FS_{ij}) + \beta 7 \ln(WR_{ij}) + \beta 8 \ln(FE_{ij}) + \beta 9 \ln(FY_{ij}) + \varepsilon_{ij} \quad \ldots (3)$$

Where:

The dependent variable EXP Y_{ij} is a farmer's decision to use and adhere to pesticide recommendations as defined in equation (1);
ED = Level of Education of the farm owner (Years);
EC = Number of contacts with extension in a month;
MD = Distance of source/market for pesticide (Km);
CP = Cost of pesticides used (₦);
SE =Ownership of spraying equipment (yes/No);
FS = Farm size (Ha);
WR = Farm wage rate (₦);
FE = Farming experience (years);
FY= Annual Farm income (₦);
ei = Stochastic error term.

The explanatory variables were both the continuous and binary/nominal types.

RESULTS AND DISCUSSIONS

Table 1 showed that slightly more than one third (33.75%) of the farmers using pesticides in their operations were aged between 41 and 50 years. Cumulatively, farmers aged at most 50 years accounted for 61.58% of those relying on pesticides in plying their trade.

Table 1. Socio-economic of Arable crop Farmers in Njaba LGA of Imo State, Nigeria

Socio-economic variable	Category	No. of farmers	Percentage (%)
Age (years)	Below 41	23	28.73
	41-50	27	33.75
	51-60	21	26.25
	61 and above	9	11.25
	Total	80	100.00
Marital Status	Single	3	3.75
	Married	62	77.5
	Widowed/ Widower	15	18.75
	Total	80	100.00
Level of Education (years)	No formal Education	12	15.00
	Primary school	52	55.00
	Secondary school	15	18.75
	Tertiary school	1	1.25
	Total	80	100.00
Farm Size (Hectare)	0.1- 1.0	8	10.00
	1.1 – 2.0	50	62.50
	2.1 - 3.0	16	20.00
	3.0 and above	6	7.50
	Total	80	100.00
Annual Farm Income (₦)	Below 50,000.00	28	35.00
	51,000-100.000.00	27	33.75
	101,000-150,000	10	12.50
	Above 150,000.00	15	18.75
	Total	80	100.00
Farming Experience (Years)	Below 6 years	11	13.75
	6 -10	36	45.00
	11 -15	14	17.50
	16 - 20	13	16.25
	21 - 25	6	7.50
	Total	80	100.00

This age is one when most the farmers are saddled with the responsibility of providing basic household assets and paying school fees for their children and therefore do the needful in ensuring reliable means of earning personal and farm income. Use of pesticides prevents avoidable losses that arise from attacks of organisms on crops in the field as well as in the store rooms. On marital status, the Table revealed that only 3.75% of the farmers were single with the rest either married (77.5%) or widowed/widower (18.75%). This goes to confirm a strong linkage between modernizations of income generating operations with ties on household's responsibilities [1] which marriage enshrines.

In terms of level of education, Table 1.0 also revealed that only 15.0% of the farmers had no formal education meaning that as high as 85.0% of them had various levels of formal education. More than half (55.0%) of the pesticides using farmers in the area had at most primary education with 18.75% of them having at least secondary education. Possession of formal education to a large extent enabled the farmers appreciate and ensured commitment to their use of modern innovations including pesticides. The size of farm holdings by the farmers showed that they could best be described as small scale farmers. Considering the size of lands under cultivation of their arable crops, more than half (62.5%) of them cultivated between 1.1 and 2.0 hectares of land with a cumulative of 27.0% of their number cultivating at least 2.1 hectares of land. These indeed were small-scale farmers with incomes that relatively were low as 35.0% of them earned below ₦50,000.00 and only 18.75% of them earned above ₦150,000.00 as annual farm income. The farmers had many years of farming experience as the least experienced of them (13.75%) had less than six years' experience in farming. Years of experience in farming could guide wise decisions including their adoption of modern technologies meant to facilitate practices in a developing economy [4]. Experience truly informs a farmer that pesticides when properly applied in the right dosage, under dry condition give good results especially in the short run.

Pesticide Types and Sources to Farmers

Farmers in Njaba area of Imo State sourced pesticides used in their operations from available markets and the agricultural extension personnel of Imo State Agricultural Development Programme (IMADP) attached to different cells and blocks. Table 2.0

showed different types of pesticides used by the farmers and the places they reported to have sourced them.

Table 2. Distribution of Farmers by Pesticides Used and Sources in Njaba LGA of Imo State, Nigeria

Pesticide	**Source**		
	Local Market	Urban Market (Owerri)	IMO ADP Extension
Primagram	28 (35.00)	15 (18.75)	37 (46.25)
Furadan	22 (27.50)	16 (20.00)	42 (52.50)
Gesaprim 500 FW	36 (45.00)	14 (17.50)	30 (37.50)
Uproot	22 (27.50)	16 (20.00)	42 (52.50)
Paraforce	13 (16.25)	15(18.75)	52(65.00)
Ridene	20 (25.00)	20 (25.00)	40 (50.00)
Phostoxin	18 (22.50)	22 (27.50)	40(50.00)
Action 40	10 (12.50)	35 (43.75)	35 (43.75)
Aldrin Dust	28 (35.00)	16 (20.00)	36 (45.00)
Primextra	19 (23.75)	21 (26.25)	40(50.00)
Mean	22 (27.50)	19 (23.75)	39 (48.75)

Note: Figures in parentheses are percentages**.**

Table 2 showed on the average that about half of the arable crop farmers (48.75%) sourced the pesticides they used from the Imo State Agricultural Development Extension personnel while 27.0% and 23.75% of them sourced their own used pesticides from local markets and the urban markets respectively. This suggests a confirmation of interdependence principle in farming as applied to sourcing and use of pesticides. The distribution further shows that use of high input resources such as pesticides in farming is facilitated more by agricultural extension agency than does the farmers on their own patronizing each segment of the distributive market considered in isolation.

Awareness of Pesticides Use Dosage

Pesticides and other chemicals used as insecticides, herbicides and drugs become effective and objectively used when their correct measures under specified conditions are used on their target organisms. The user therefore has to be aware of the correct dosage to use especially the threshold quantity and under what other conditions as recommended by the formulator. The level of awareness of pesticides dosage as perceived by the farmers is presented as Table 3.

Table 3. Farmers' level of Awareness of Recommended Dosage of Pesticides Used in Njaba LGA of State, Nigeria

Pesticide	**Pesticide Dosage Awareness Level**			
	Very much aware (4)	Much aware (3)	Aware (2)	Least aware (1)
Primagram	13(52)	5(15)	25(50)	30(30)
Furadan	16(64)	8(24)	20(40)	35(35)
Gesaprim 500 FW	9(36)	11(33)	12(24)	20(20)
Uproot	7(28)	9(27)	9(18)	12(12)
Paraforce	5(20)	7(21)	7(14)	10(10)
Ridene	5(20)	3(9)	8(16)	8(8)
Phostoxin	0(0)	0(0)	1(2)	1(1)
Action 40	6(24)	8(24)	6(12)	4(4)
Aldrin Dust	16(64)	6(18)	20(40)	25(25)
Primextra	9(36)	7(21)	9(18)	12(12)

Table 3 revealed that the farmers were much aware of the dosage recommendations of pesticides such as premextra, Action 40, Ridene, Paraforce, Uproot, and Gesaprim 500 FW. In like manner, they were aware of the dosage recommendations for Primagram, Furadan and Aldrin Dust. However, they were least aware of phosphotxin insecticide. This was not surprising considering that their small scale of production could not leave them with bountiful grains for storage, hence the least awareness of the use of phosphotoxin.

Determinants of Decisions to Adhere to Recommended Pesticide Dosages.

Farmers decided either to adhere to recommended dosage of use of pesticides or simply refused to do so. Some factors influenced such decisions as revealed by probit regression estimates in Table 4.

Table 4.0 showed that the decision of the farmers to adhere strictly to recommendations of the makers of pesticides at the time of use was positively influenced by number of contact with Agricultural Extension agents in a month, level of educational attainment, annual farm income, farm size and cost of pesticides. This meant that as these factors increased the farmers adhered more to makers' recommendations on measures and conditions for using the pesticides. However, the farmers decision to this adherence was significantly but negatively influenced by years of farming experience of the farmers.

Table 4. Maximum Likelihood of First-Stage Probit Estimates of Factors influencing Small Farmers Decision to Adhere to Recommended Pesticide Dosages in Njaba, Nigeria

Variable	Coefficient	Std. Error	t-ratio
Constant	1.175***	0.74	6.58
Number of contact with Extension Agents in a month	0.048**	0.18	1.99
Education Level	1.272**	1.54	2.31
Distance of pesticide source/market	-0.036	0.36	-0.24
Cost of Pesticides	4.321*	2.71	1.45
Ownership of Spraying equipment/Knapsack	2.226	0.775	0.064
Annual Farm income	0.167**	1.105	3.42
Farm size	0.212***	1.227	3.81
Farming Experience	-0.049**	0.213	2.97
Farm wage rate	-1.084	0.612	1.11
Likelihood ratio Test	71.32***		
R-Squared	0.762***		

*Significant at 10.0%; ***significant at 1.0% alpha level.

This was plausible that as farmers had more years of experience in farming, they got used to guess or estimates (threshold quantities) for use of the pesticides than on strict compliance to pesticide recommendations. The interplay of factors positively was influencing and others negatively influencing adherence to dosage recommendations showed complexity of reasoning in making the decision to adhere or not adhere to formulators' recommendations in application of pesticides.

CONCLUSIONS

Use of pesticides has formed part of modern practices in farming adopted by small farmers to enhance their operations. Local and urban markets complemented the state agricultural extension outfit (IMADP) in providing farmers with their needed pesticides in Njaba local government area of Imo State, Nigeria. The small farmers were at different levels in their perceived awareness on adherence to chemical dosages recommended by formulators of pesticides at the time of use. They were more aware of adhering to dosages on pesticides used in their field to control insects, birds, rodent pests, and weeds than they were of the ones used in controlling pests on products in their stores.

Many factors influenced farmers' adherence to dosages recommended on pesticides and included farm size, farming experience, number of times in contact with extension agents in a month, level of educational attainment, and cost of pesticides. Pesticides when properly applied in the right dosage, under dry weather condition gave good results especially in the short run. Extension outfit should encourage the farmers to process and store their products even for a short period of time. This will enable them be much aware of storage pesticides and fetch better prices for their products. Farmers should recognize and heed the three principles of threshold, interdependence, and complexity in their practice of using most pesticides.

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