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Herbicides Use by Smallholder Farmers in the Federal Capital Territory, Nigeria

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Abstract

This study was carried out to investigate the use of herbicides by smallholder farmers in crop production and determine the socio-economic factors that influence adoption of herbicides in the Federal Capital Territory of Nigeria. A structured questionnaire was used to collect data from 451 smallholder farmers randomly selected. Descriptive statistics, factor analysis and regression analysis were used in analyzing the data. Results showed that farmers used manual (50%) and chemical (50%) weed control options. Factor analysis revealed that 10 socio-economic factors related to weed control could represent the initial set of 20 factors without much compromise on quality of data. The extracted factors together with their communalities were; sex (0.69), household size (0.82), education (0.68), distance to extension ((0.86), distance to input supply (0.84), land (0.79), agricultural courses (0.75), farming objective (0.59), knowledge (0.8) and livestock units (0.69). Regressing these extracted factors with use of herbicides revealed that the coefficients of variables representing household size (-0.023), education (0.042), farming objective (-0.008), livestock (0.598) and knowledge (0.037) factors were significant determinants of herbicide use. The study concluded that to induce adoption of herbicides, policy efforts should be directed towards reducing family sizes, knowledge, education, livestock ownership, and commercialization of crop farming by farmers. However there is a need for further analysis to ascertain the social and economic worth of herbicides as an option in weed control.

Keywords: Weed, Adoption, Regression, Chemical, Manual

Introduction

The world's population is expected to increase over time, the past 100 years have seen the world's human population increasing by nearly fourfold (UN population Division, 2007); and it is projected to increase from 6.7 billion (2006) to 9.2 billion by 2050. This will put pressure on food demand as food production is not growing at the same pace, it is estimated that up to 25% of the world food production maybe lost as a result of climate change, water scarcity, invasive pests and land degradation among other factors. FAO projections in food demand suggest that cereal demand will increase by almost 50% towards 2050 (FAO, 2003).

To increase crop production in line with increasing demand for food, three primary factors should be considered and these are; increased cropland and rangeland area (15% contribution in 1961–1999); increased yield per unit area (78% contribution); and greater cropping intensity (7% percent contribution) (FAO, 2006). Thus for food production to keep pace with population demand, there is a need to invest in more efforts to increase yields, continued expansion of cropland by conversion of natural habitats, or by optimizing food or feed energy efficiency from production to consumption.

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One serious challenge to productivity increases in both crops and livestock is the threat imposed by pests and diseases. Worldwide 67,000 pest species attack crops: 9,000 insects and mites, 50,000 pathogens and 8,000 weeds. Up to 70% of the pests are introduced, with major impacts on global food production. Across Africa, a weed species of the genus *Striga* have a direct impact on local livelihoods, it affects more than 100 million people and as much as 40% of arable and in the savannahs. These invasive species stunt maize plant growth by attacking the roots and sucking nutrients and water, and thus in addition to the direct financial costs, have implications for food security (Chenje and Aterere, 2006). Invasive alien species such as pests and diseases have been estimated to cause an annual loss of US$12.8 billion in yield of eight of Africa's principal crops and may reduce yields in developing countries overall by around 50% (Nellemann et al, 2009). Rossman, 2009 estimated that alien invasive weeds and pathogens are estimated to be responsible for about 8.5% and 7.5% in yield reduction, respectively, equivalent to US$24 billion and US$21 billion of a crop value of US$267 billion. Different estimates range from US$1.1–US$55 billion in losses every year, corresponding to annual losses of 0.4% (OTA, 1993) to 17% (Rossman, 2009). This does not include increased expenses for more mechanical or pesticide weed control or losses from invasive insects (about 5%) or diseases of livestock.

Weed management is thus an important operation in crop production that should be effectively and efficiently carried out to ensure desired productivity increases for improved livelihoods and welfare. Aadoption of advanced weed control techniques is crucial in improving crop productivity and welfare in agriculture. Knowledge and understanding of the factor that influences the choice of weed control options by farmers is essential in providing direction for policy actions aimed at promoting good agricultural practices in weed control. The strategy for effective weed management in Nigeria has been to develop new technologies and facilitate transfer and adoption through extension services (Ayichi, 1995). The evolution of weed control options has been from traditional (manual) to modern (herbicides) methods. Other supplementary methods include crop rotation and intercropping.

Parker and Vernon (1982) reported that herbicides could save up to 80% of the labour normally used in manual weeding. Ayoola and Adedzwa (2006) encouraged use of integrated approach (manual, herbicides and intercropping) which resulted in higher yields, least cost and high margins in cassava and soybean than any other methods. Herbicides and other pesticides contribute as modern inputs to the achievements of green revolution objectives in many parts of the world (Ayoola, 2001). Promoting use of herbicides has thus been one of the key strategies for improving crop production in Nigeria.

It is believed that there is reluctance by farmers to utilize new techniques and this is one of the reasons why they are poor and have problem of food insecurity. According to CIMMYT, 1980, socio-economic circumstances of farmers are crucial in determining decisions on the farm. According to Damen, 2000 decisions by farmer to adopt particular techniques such as improved options to weed control are guided by the need for such practices, enabling and predisposing factors. This paper was designed to establish determinants of herbicides use by smallholder farmers in FCT, Nigeria in order to provide policy makers and development agents with focus and direction for promoting herbicides use by farmers for improved crop productivity that will go a long way towards addressing weed challenges and food shortages.

Materials and Methods

Study area

The study was carried out in Federal Capital Territory (FCT) of Nigeria with a total human population of 1,405,201. Out of this population size, the farming population is 446, 506 and the total farming households is about 93,092 distributed in 6 council areas (FCTFDP, 2007).

Sampling

Random sampling technique was used to draw a proportionate sample from each council area to build up a total sample of 451 households. A Structured questionnaire was used to collect data on crop production, socio-economic

environment and weed control practices from farmers with the assistance of Fadama project enumerators.

Data Analysis

Data collected were analysed using descriptive statistics, factor analysis and regression analysis. Factor analysis was used to extract key socio-economic factors linked to weed control by farmers from the initial 20 socio-economic variables considered. The factor analysis model was presented as follows-:

Original data set: $X_1, X_2, X_3, ...X_{20}$ .....(1)

The 20 original X_i variables can be written as a linear combination of a smaller set of *m* common factors and a unique component for each variable are-:

$$X_1 = b_{11}F_1 + b_{12}F_2 + ... + b_{1m}F_m + U_1$$
$$X_2 = b_{21}F_1 + b_{22}F_2 + ... + b_{2m}F_m + U_2$$
$$X_3 = b_{31}F_1 + b_{32}F_2 + ... + b_{3m}F_m + U_3$$
.
$$X_{20} = b_{201}F_1 + b_{202}F_2 + ... + b_{20m}F_m + U_{20}$$
.....(2)

The F_j, j = 1,……,m are the common factors. Each U_i, i = 1,……20 is the unique component of variable X_i. The coefficients b_{ij} are called factor loading.

Regression analysis was used to determine the relationship between the representative socio-economic factors and choice of weed control option in crops between traditional methods (manual) and modern methods (herbicides).

The regression model was specified as follows:

$Y = f(X_i, i=1\text{-}10)$ ……(1)

The dependent variable (Y) was the amount of herbicides used in crop production as an indicator of the level of adoption of modern control methods. The independent variables (X_i) are the 10 summarized factors extracted from factor analysis. Different forms of regression namely linear, Cobb Douglas, exponential and semi -log were fitted on the data as given in 2,3,4 and 5 respectively.

$$Y = a_0 + a_1 X_1 + a_2 X_2 + ... + a_{10}X_{10} + U \quad .....(2)$$

$$Log\ Y = a_0 + a_1 logX_1 + a_2 logX_2 + ... + a_{10} logX_{10} + logU \quad .....(3)$$

$$Log\ Y = a_0 + a_1 X_1 + a_2 X_2 + ... + a_{10}X_{10} + U \quad .....(4)$$

$$Y = a_0 + a_1 log\ X_1 + a_2 log\ X_2 + ... + a_6 logX_6 + logU \quad .....(5)$$

Where $a_0 \ldots a_{10}$ = unknown parameters.
U = Error term

The best fitting equation was chosen on the basis of the magnitude of the coefficient of multiple determination (R^2), significance of coefficients, significance of overall production function as given by F value, and the appropriateness of signs of the regression coefficients based on a priori expectations. The t-test was used to determine the significance of variables in the model.

Results

Socio-Economic Characteristics of Respondents

The farmers were predominantly male headed consisting of 96.7 percent male and only 3.3 percent female. Most (93.3%) of the farmers were married and 6.7 percent were either divorced or widowed or single. The mean age distribution of all respondents was 44 years. This indicated that farmers in FCT, Nigeria are fairly old and that the young farmers are few. The average size of farm households was 10 members per household from which the average size of family labour was 5 people per household (Table 1).

The mean years in education for all farmers were 4.4 years which indicated a low level of education dominated by primary level. There was a low level of attendance to agricultural courses with a mean of 0 indicating the lack of training of farmers in agricultural production. The mean number of interactions with weed scientists was 1 and average membership to farmer group per household was also 1. On average, percentage knowledge about weed management issues was 56.90 percent indicating

that farmers were fairly knowledgeable about weed management. The average percentage attitude to weed management score farmers was 94.40 percent indicating a high positive attitude. The average rating of weed as a problem in farming systems was 51.5 percent (Table 1), which indicated the relatively high importance of weeds among other problems.

Farmers were asked to indicate the percentage value attached to subsistence and commercial farming. The mean percentage rate of subsistence farming was 51.24 percent (Table 1). This indicated that more farmers are still subsistence oriented than commercial farming.

The level of extension services delivery was good with farmers meeting extension workers for advice at an average rate of 5 times in the season. The mean distances from extension and input supply services to farmers' villages were 9.3 and 8 kilometres respectively (Table 1). This indicated that there was a distance gap between farmers and agricultural services which could cause concern in terms of access and transactions costs associated with obtaining the goods and services.

The average farm size was 2.1 hectares per household. About 91.1 percent of farmers own dry land and about 54.4 percent of farmers had wetland. The livestock units were on average 0.33 indicating a low level of ownership of livestock by farmers. Ownership of knapsacks was very low with a mean ownership of 0.30 and this was a limitation to use of herbicides as a knapsack is a useful tool in applying herbicides. The mean income received by households was 164,734 naira (USD1229.36) per year (Table 1) indicating a fair availability of some cash that could be used to purchase inputs by farmers.

Table 1 is a summary of the general socio-economic variables considered in this analysis.

Table 1: General Socio-Economic Characteristics of Farmers in FCT, Nigeria

Variable (N=451).	Mean/value	Variable	Mean/value
Age (years)	44.00	Weed science education (meetings)	1.00
Household size	10.00	Land (hectares)	2.1
Size of family labour	5.00	Livestock units	0.33
Education (years)	4.40	Agricultural assets	0.30
Agriculture courses attended	0	Income (USD)	1229.36
Group/s membership	1.00	Weeds problem (%)	51.50
Farming objective (%)	51.20	Knowledge (%)	56.90
Extension services (meetings)	5.00	Attitude (%)	94.40
Distance to extension services (kilometers)	9.30	Sex of household head Male (%) Female (%)	 97 3
Distance to input supplier (kilometers)	7.90	Marital status of household head Married (%) Others (%)	 93.3 6.7

Source: Survey, 2008

Factor Analysis Results

In the orthogonal method of rotation (Table 2), the first extracted factor was mostly correlated with distance to extension (r = 0.924) and was designated distance to extension factor. The second factor was most correlated with farming objective (r = 0.720) and was designated farming objective factor. The third factor was strongly linked to land (r = 0.828) and was designated land factor. The fourth factor was highly correlated with education (r = 0.785) and was designated education factor. Factor five was strongly linked to agricultural courses attended (r = 0.842) and designated agricultural courses

factor. Factor six was highly linked to sex of head of household (r = 0.815) and was designated sex factor. Factor seven was highly linked to livestock units (r = 0.790) and the factor was designated livestock factor.

In the oblique method of rotation (Table 2), the first extracted factor was mostly correlated with distance to input supply (r = 0.912) and was designated input supply factor. The second factor was highly correlated with knowledge (r = 0.794) and was designated knowledge factor. The third factor was strongly linked to land (r = 0.863) and was designated land factor. The fourth factor was most correlated with household size (r = 0.751) and was designated household size factor. Factor five was strongly linked to agricultural course (r = 0.801) and designated agricultural courses factor. Factor six was highly linked to livestock units (r = 0.785) and the factor was designated livestock factor. Factor seven was highly linked to sex of head of household (r = 0.793) and was designated sex factor.

Based on orthogonal and oblique rotation outcomes, factor analysis thus produced 10 factors namely sex, household size, education, distance to extension, distance to input supply, land, agricultural courses, farming objective, knowledge and livestock factors. These are the summarized factors that represent the original 20 factors while containing 69% of the value of data in the original set.

Table 2: Summary Results of Factor Analysis

Variable	Communality	Factor rotation		Factor designation
		Orthogonal	Oblique	
Sex	0.691	0.815 (6^{th})	0.793 (7^{th})	Sex
Marital status	0.438			
Household size	0.821		0.752(4^{th})	Household size
Age	0.659			
Education	0.682	0.781 (4^{th})		Education
Family labour	0.812			
Distance to extension	0.860	0.924 (1^{st})		Distance to extension
Distance to input supply	0.842		0.912 (1^{st})	Distance to input supply
Extension services	0.583			
Land	0.787	0.828 (3^{rd})	0.863(3^{rd})	Land
Income	0.761			
Agricultural asset	0.461			
Agricultural courses	0.751	0.842 (5^{th})	0.801 (5^{th})	Agricultural courses
Group membership	0.539			
Weed science education	0.645			
Farming objective	0.587	0.728 (2^{nd})		Farming objective
Weed problem	0.694			
Knowledge	0.800		0.794(2^{nd})	Knowledge
Attitude	0.690			
Livestock units	0.684	0.790(7^{th})	0.785 (6^{th})	Livestock

Source: Survey, 2008

Weed Control Practices by Farmers

Most farmers used manual weed control in all crops than chemical weed control except in rice production where a higher percentage (62.5%) of farmers used herbicides for weed control and 47.5 percent used traditional weed control (Table 3). Most farmers who cropped sorghum (50%), groundnuts (55%), okra (65%) and millet

(57%) practice intercropping while fewer farmers who cropped maize (46%), yam (35%), cassava (14%) and pepper (20%) practiced intercropping. There was no intercropping practice in rice and sesame (Table 3). There were almost equal numbers of users and non users of crop rotation in maize, sorghum, cassava and millet. However there were fewer farmers who practiced crop rotation in yam (37%), groundnuts (40%), rice (6%), okra (40%), pepper (35%) and sesame (28%) (Table 3).

In general, the proportion of farmers who used manual weed control option only was 49.4 percent while those using some chemical were 50.6 percent. However users of chemical control options were integrating it with manual control. About 52.1 percent of the farmers intercropped some of their crops while 54.3 percent practiced crop rotation in their fields (Table 3). For simplicity the two major methods of weed control (traditional and modern) were considered in this analysis.

Table 3: Weed Control Practice by Crops in the FCT, Nigeria

Crop	Weed control practice		Intercropping (%)	Crop rotation (%)
	Manual (%)	Chemical (%)		
Maize	72	28	46	50
Yam	54	46	35	37
Sorghum	65	35	50	50
Groundnuts	70	20	55	40
Rice	47.5	62.5	0	6
Cassava	54	56	14	50
Okra	60	40	65	40
Millet	65	35	57	55
Pepper	100	0	20	35
Sesame	60	40	0	28
All crops	49.4	50.6	52.1	54.3

Proximate Determinants of Herbicides Use by Smallholder Farmers in FCT, Nigeria

Based on the criteria mentioned in the methodology, the exponential regression form was the lead equation and was chosen in this analysis (Table 4). Regression results showed that the coefficients of variables representing household size (-0.023), education (0.042), farming objective (-0.008), livestock (0.598) and knowledge (0.037) factors were the only factors significant at 5 percent level. The coefficient of determination (R^2) was low (0.24) indicating that all the explanatory variables accounted for 24 percent of the variation in the dependent variable while 76 percent was accounted for by other factors excluded in the model and the error term (Table 4). The implications of the these results are that to induce herbicides use in weed control, the dependant variables will have to be decreased/increased by greater margins. The overall model was significant, given the value of F statistic of 12.4.

Table 4: Determinants of Herbicides Use by Smallholder in FCT, Nigeria

Coefficients	Linear	Cobb Douglas	Exponential	Semi log
Constant	-2.29 (-1.21)	-1.91 (-2.21)*	-0.12 (-0.32)	-7.07 (-1.32)
X_{sex}	-0.28 (-0.14)	0.516 -1.05	0.12 -0.36	2.92 -0.94
$X_{household\ size}$	-0.15 (-2.19)*	-0.12 (-1.14)	-0.02 (-2.07)*	-0.79 (-1.23)
$X_{education}$	0.28 (-3.57)**	0.1 (-2.20)*	0.04 (-3.02)**	0.72 (-2.68)**
$X_{agricultural\ course}$	0.46 -0.91	0.03 -0.17	0.01 -0.15	0.83 -0.8
$X_{farming\ objective}$	-0.051 (-2.56)	-0.47 (-3.23)**	-0.01 (-2.38)*	-3.51 (-3.94)**
$X_{distance\ to\ extension}$	-0.04 (-0.69)	0.13 -1.05	-0.01 (-0.32)	0.9 -1.14
$X_{distance\ to\ input\ supply}$	-0.05 (-0.69)	-0.3 (-2.32)*	-0.02 (-1.47)	-1.6 (-1.93)
X_{land}	-0.07 -1.02	-0.24 (-1.91)	-0.01 (-0.73)	0.12 -0.16
$X_{livestock}$	4.55 (5.69))**	0.21 (3.85)**	0.6 (4.51)**	1.42 (4.31)**
$X_{knowledge}$	0.22 (8.58)**	1.46 (7.93)**	0.04 (8.85)**	7.29 (6.30)**
R^2	0.23	0.22	0.24	0.21
F	13.40**	10.39**	12.39**	10.06**

**t value was significant at 1 percent, *t value was significant at 5 percent

Discussion

Regression results indicated that out of ten factors extracted, only five were significant determinants of use of herbicides by smallholder farmers in the FCT at 5 percent level. These factors were household size, formal education, agriculture objective, livestock and weed knowledge.

The negative association between household size and use of herbicides implied that as household size increases, the level of adoption of herbicides decreases. This can be explained by the fact the bigger the household size, the greater the supply of family labour for farming operations by small-scale farmers and the less likely farmers feel the need to use labour saving techniques like herbicides. Olayide and Earl (1982) described peasant farming as labour intensive farmers with low investment and expenditure on farm inputs and, apply simple structures, crude tools and other labour demanding equipments. Increasing family size provides labour base for farming operations and decreases the need for labour saving technologies like herbicides by farmers. Furthermore as the family size increases, the demand for financial resources on household upkeep increases and this demand compete with the demand for financial resources to purchase modern inputs like herbicides thus challenging farmers' effective demand for herbicides.

The positive association between formal education and use of modern weed control option indicates that an increase in education will induce adoption of modern weed control methods. This is in agreement with theory which states that education empowers farmers with skills and abilities which enable them to make effective use of modern techniques and technologies in their work (Olaitan, 1995). The role of formal education services in providing

education is crucial in improving the quality of farmers.

The weed knowledge factor was found to be positively associated with use of chemical weed control option. Weed knowledge empowers farmers with knowledge and skills about weed management. According to ICAR, 2006, weed knowledge is important for effective weed management. In a study by Ayoola *et al.*, 2006, farmers indicated that they were constrained in their use of chemical herbicides by relatively poor access to chemicals and lack of know-how.

The positive relationship between the livestock factor and use of modern weed control option was expected as livestock are assets that farmers can sell to enable them purchase improved inputs like herbicides. In agricultural extension systems and strategies in Nigeria's rural development, Madukwe, 1995 emphasized the need to better integrate animal and crop husbandry practices. Ownership of livestock broadens the resource base of farmers that can be supportive in cropping activities.

Agricultural objective was negatively associated with use of herbicides. This implied that farmers who were more subsistence oriented were less likely to use modern weed control options than farmers who are commercially oriented. The objective of agriculture helps in directing decisions on the farm. Commercialization of agriculture thus motivates farmers to employ effective and efficient operations like use of herbicides in order to achieve their commercial objectives.

The paper concludes by recommending that agricultural policy directed towards promoting use of herbicides in weed control by farmers should target farmers with smaller household sizes and pay special attention to improving formal education, educating farmers on agriculture and weed science, livestock rearing among crop producing farmers and promote commercialized farming. However there is a need for further analysis to determine the social and economic implications of using herbicides as a weed control option.

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