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Adoption of Improved Herbicides Spraying Technology among Farmers in Ayamelum L.G.A of Anambra State, Nigeria

S. I. Ume[1*], V. E. Uloh[2], T. Nwaneri[1] and D. A. Adikwu[1]

[1]Department of Extension and Management, Federal College of Agriculture, Ishiagu, Ivo L.G.A., Ebonyi State, Nigeria.
[2]Ebonyi State College of Education, Ikwo, Ebonyi State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study analysed the position of the farmers in Ayamelum L.G.A. of Anambra State in the adoption of improved herbicide spraying technique. A total of one hundred (100) herbicide sprayers were selected using multi-stage random sampling technique for the detailed study. Data for the study were generated through the use of structured questionnaire and oral interview during the 2010-2011 cropping season. Descriptive statistics such as percentage was used to determine the socio-economic characteristics of the farmers and constraints to their adoption of herbicide spraying technique. Logit analytical model was used to determine the levels of farmers' adoption of the technology. The major findings of the study indicated that farmers had positive attitude towards adoption. The result further revealed that income, educational level, membership of cooperative societies/organization and extension contact were the major determinants of adoption. The major constraints to herbicide technology transfer were; poor extension contact, inadequate fund and low literary level of the respondents. Considering the impact of the aforementioned variables on the

**Corresponding author: E-mail: umesmilesi@gmail.com;*

adoption process, the need to increase farmers' access to; agricultural credit scheme, extension contact and education should be intensified.

Keywords: Adoption; improved herbicides; spraying technology; farmers.

1. INTRODUCTION

Green revolution and some innovative technologies have enabled man to produce high crop yield to help sustain the ever-growing world population. The success was partly due to use of herbicides [1]. The growing use of herbicides and the associated effects on the environment and human health particularly in the rural areas of the developing countries is causing cruel dilemma, since the effects are complex and difficult to control [2]. Herbicide toxicity is usually through misuse, handling, poor formulation or through exposure to the herbicide in contaminated soil, air, drinking water and food. These scenarios are reinforced by inadequate supporting services and extension by the appropriate authorities [3]. Unfortunately, most of these chemicals including paraquat and picloram which are highly persistent and circulate in African markets are either severely restricted or banned in their countries of production [4] and are capable of causing various forms of diverse of metabolic and systemic dysfunctions, and in most cases outright pathological conditions. The abuse of chemical use could result in cancer, birth defects, neurotic and immunological disorder to both the users and nonusers [5]. The developed countries catch on the poor pesticide regulatory bodies and poverty in most developing countries to dump these toxic wastes over there. The toxicity rate in Africa as asserted by [6] was two million people annually. In Nigeria, [5] reported that 10,000 people die each year from pesticides poisoning while, about 400,000 suffer acutely. These estimates may not give the true picture because of under reporting as agricultural production are widely scattered and hospitals and general medications are minimal in the rural areas of the developing countries [1]. Furthermore, the affected people often fail to report illness and death, hence such cases may go unreported [2].

In Nigeria, section 1 of the Pesticides Registration Regulation decree 1996 prohibited the manufacturing, import, export, advertisement, and distribution of any pesticides, herbicides inclusive in the country unless it has been registered in accordance with the provision of these regulation [3]. The Federal ministry of Environment and the pest control services of Federal Ministry of Agriculture are agencies designated for regulation\approval of pesticides industries and providing the general public on information about banned or severely restricted pesticides [5]. Unfortunately, the effectiveness of these agencies remain very poor and seriously limited by among others; lack of legislative authority, lack of trained personnel on pesticides regulatory procedure, lack of formulation control and pesticides residues analysis facilities and capabilities and lack of equipment and material [5,3]. To effectively control banned herbicides and other pesticides in the country, the pesticide regulatory agency should develop a mechanism to regulate pesticide registration, inspection, surveillance, laboratory analysis evaluation and public enlightment [2,3].

Nevertheless, the effective use of herbicides bearing in mind, the agro-ecology and human health implications, depends on choice of herbicide, use of protective materials, particle size, selection of equipment, calibration, storage of herbicide container, field mixing and spraying method [7]. To successfully transfer these technologies to such herbicide users with limited scope for increasing safe use of herbicide based on their limited resources and technologies available to them need to be guided. There is need for appropriate authorities (governments and manufacturers) to ensure that in local markets, only appropriate herbicides will be placed and providing easy understanding literature of the herbicide provided [8,5]. Furthermore, [1] and [3] suggested on the need to assist sprayermen with problems relating to application equipment and assuring delivering of suitable formulation at the right time. This is imperative since the impact of misuse and improper spraying of herbicides would result in ineffective control of weeds, extremely high application costs, waste of expensive input and potentially dangerous to man and his environment and damages to crops [7,1,3].

Nevertheless, these improved herbicides use and application techniques had been disseminated to the users in the study area through the extension service arm of Agricultural Development Programme (ADP). Consequently, it becomes necessary to assess the adoption

rates of these improved technologies, with view a of making appropriate policy recommendations that will promote safe use of the resource to avoid its hazardous effects on crop, environment and man.

The specific objectives of the study are to:

(1) Describe the socio-economic characteristics of the herbicide users;
(2) Determine the categories of adopters and their levels of adoption;
(3) Determine the relationship between the farmers' socio-economic characteristics and the rate of technology adoption and
(4) Ascertain the constraints to the adoption of the improved herbicide technologies.

2. METHODOLOGY

The study was carried out in Ayamelum Local government area (LGA) of Anambra State, Nigeria. Ayamelum comprised of six communities, Anaku, Igbankwu, Omor, Ifite Ogwari, Umumbo and Omasi. The local government area has population figure of 282,180 people [9]. Ayamelum is bounded in the east by Anambra east, in the west by Uzo-Uwani local government area (LGA) of Enugu State and In the north and south by Ezeagu and Anambra West LGAs respectively. It is located between latitude 07' 31° and 08' 28℄ of equator and longitude 08' 54° and 07' 64° of Greenwich Meridian. It has mean temperature of 28 – 39℃ and rainfall of 1500 mm – 1800 mm. The soil type is hydromorphic, hard to till and subject to water logging. The inhabitants of the study area are predominantly agrarians and cultivate crops like rice, cassava and maize of which herbicides are commonly used to control weeds. They also rear animals like goats, sheep, pigs and poultry [10].

Eighty herbicide users were selected using multi-stage random sampling technique. First, four communities were randomly selected out of six communities. The selected communities were Anaku, Omor, Igbakwu and Omasi. Then, from the list of herbicide users compiled by extension agents and local leaders, twenty respondents were randomly selected from each of the four communities. This brought to a total of eight users for detailed study.

Structured questionnaire was used to collect information on users' socio-economic characteristics such as age, credit, income, co-operative organization and level of education and constraints to herbicide technology adoption. Secondary data was collected from journals, published and unpublished reports and other periodicals. Descriptive statistics such as percentage response was used to capture herbicide users socio-economic characteristics, categories of adopters and constraints to technology adoption. Logit analytical tool was used to capture the level of technology adoption.

Logit model can be represented explicitly by taking Y as a probability ρ and making its' logarithm to depend linearly on the dependent variables. The probability is expressed as

$$\text{Prob } (Y_t=1)\ f(Z_t) = 1, \quad 1 = e^n = \frac{e^n}{e^n + 1}. \quad [3]$$

Z_i is a theoretical variable (observable). To obtain the value of Z_i, the likelihood of observing the sample needs to be formed by introducing a dichotomous response variable Y_i such that

Y_i = (1 if ith farmer is high adopter of herbicide spraying technologies)
(0 if the ith farmer is a low adopter of improved herbicide application technologies)
For this study, Z_i can be expressed as

Four functional forms (linear, semi-log and Cobb-Douglas) of production function were tried and explicitly represented as

Linear function:

$$Y = b_0 + b_1 x_1\ b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + ei \quad (1)$$

Double log function (Cobb Douglas):

$$\ln(y) = \ln b_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 + b_5 \ln x_5 + ei \quad (2)$$

Semi double log function:

$$Y = \ln b_0 + b_1 \ln x_1 + b_2 \ln x_2 + b_3 \ln x_3 + b_4 \ln x_4 + b_5 \ln x_5 + ei \quad (3)$$

Exponential function:

$$\ln Y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5 + ei \quad (4)$$

Y = rice yield (kg), x_1 = farm size (ha), x_2 = seed (kg), x_3 = fertilizer (kg), x_4 = labour (manday), μ = error term, A_0 = constant, β_1 – β_4 = coefficient estimates with respect to the input used.

The choice of the best functional form was based on the magnitude of the R^2 value, the high

number of significance, size and signs of the regression coefficients as they conform to *apriori expectation*.

3. RESULTS AND DISCUSSION

Table 1 reveals that majority (90%) of the respondents were male. This could be attributed to the fact that the spraying enterprise is both capital and labour intensive and with high level of risk, which only men could be equal to the task. The study further showcased that 76.6% of the herbicides sprayers were within the age bracket of less than 40 years. This age bracket is youthful and could be innovative, easily motivated and adaptive [10].

Also majority (68.7%) of the sprayermen had no formal education. This implies that most of the respondents would not be able to read and comprehend extension guides and manuals/ written messages on precautionary safety measures of herbicide's use [6]. The majority of the sprayermen (75%) had spraying experience of more than 10 years. The implication is that these sprayersmen are expected to have acquired enough practical knowledge on how to overcome certain inherent problems associated with the business such as toxicity of the herbicide.

The Table 1 indicated that some of the respondents had poor extension outreach as indicated by 37.5% of the respondents This implies that the extension functions including innovations dissemination, technical assistanance and acquisition of herbicide inputeluded many of the users. Availability of credit helps in procurement of spraying inputs such as accessories, spare parts and protective materials. [1] The table also revealed that the sprayermen had poor access to credit, accounting for about 40%.

Furthermore, the result of the study shows that most of the respondents (75%) were not members of cooperative organization. The implication is that a large number of the herbicide sprayermen do not have access to training and technical assistance on safe herbicide use as offered by cooperative to her members [3,6].

Table 2.1 on categories of adopters, revealed that most of the respondents (62.5%) were low adopters, while 37.5% were high adopters. The cause of low adoption of technology as [3] asserted include; non-availability and un-affordability of inputs, difficulty comprehending innovation and as well as high costly of innovation adoption. These findings did not conform with [6] who opined that material based technology which is known to be relatively easier to transfer, adopt and as well offer much attraction to the farmers could be the reasons for high adoption rate. To categorize the farmers into two – adoption groups, the average innovation adopted was computed. Farmers with adoption score above three [11], was considered as high adopters, while those below three (3) was considered as low adopters. Based on this classification, thirty (30) respondents were found to be high adopters, while fifty (50) were classified as low adopters. Similar methods were used by [10].

Table 1. Farmers and farm characteristics between adoption groups = 100

Variable	Frequency	Percentage
Gender		
Male	72	90
female	8	10
Total	80	100
Age(yrs)		
<40	61	76.6
40-50	11	13.5
>50	8	9.9
Total	80	100
Educational level(yrs)		
No formal education	40	50
Primary education	5	18.7
Secondary education	20	25
Post secondary school	5	6.3
Total	80	100
Spraying experience(yrs)		
<10	20	25
10-20	45	56.3
>20	15	19.7
Total	80	100
Extension contact		
contact	30	37.5
Non- contact	50	62.5
Total	80	100
Credit (N)		
Access	32	40
Non-access	48	60
Total	80	100
Cooperative (dummy)		
Non-members	60	75
members	20	25
Total	80	100

Source: Field Survey Data, 2014

The logit model analysis result of level of technology adoption as shown in Table 2.2 showed that the following variables discussed therein were found to be significant to technology adoption. The coefficient of the income of the farmer was positive and significant at 1% probability level. This finding agree with [7,1], who were of the opinion that high income farmers would afford to purchase and use quality chemical spraying equipment with its accessories and protective clothes in comparison to poorer household, who rarely wear protective clothes since they cannot afford them.

As expected, the coefficient of the educational level attained (the number of years spent in schooling) was found to be significant at 1% level of probability. [10] reported that education creates favourable mental attitude for the acceptance of new practices especially on information and management intensive practices. Moreso, educated people are likely to be cautious in adhering to safe use and handling of chemicals particularly hazardous ones by following manufacturers' instructional manuals on the use of the chemical and wearing all the necessary protective cloths while spraying [2].

The statistical test showed that the coefficient of cooperative membership was positive and significant at 10% probability level. Cooperative society helps to educate and train members on safe methods of chemical usage and enlighten them on the consequences of its abuse. More so, cooperative helps members to procure genuine herbicides at appropriate time and affordable prices [5,3].

The coefficient of extension contacts was positively related to level of adoption and significant at 5% probability level. In Nigeria, agricultural information is disseminated to the farmers mainly through extension arm of Agricultural Development Programme (ADP). Nevertheless, the frequency and quality of extension contact with farmer and their farms helps to broaden the knowledge of the later on how best to handle and use especially potential dangerous herbicides to avoid misuse and abuse which could lead to intoxicity [3].

Table 3 shows the constraints to the adoption of improved herbicide use.

The most important factor was poor extension outreach as represented by 80% of the respondents. This implies that most respondents were ignorant of the improved technology on spraying technique, hence making them more vulnerable toxic effect effects of herbicides. The rate of adoption of technology, in no small measure, is a function of effective extension contact with the sprayers. This corroborates with [11] finding that in rural areas interpersonal extension contacts played decisive roles in eventual adoption of technology.

Table 2.1. Adoption category by respondents

Category	Frequency	Percentage
Low adoption (3 innovation and below)	50	62.5
High adopters (above 3 innovation)	30	37.5
Total	80	100

Source: Field Survey, 2014

Table 2.2. Logit result of farmers' adoption group

Variable	Coefficient	Standard error	t-value
Income(x_1)	1.578	0.908	1.739***
Credit in Naira (X_2)	0.174	0.224	–7.746
Age of farmers(yrs) (X_3)	0.028	0.006	4.157
Farm size (X_4)	–0.186	0.017	-11.152
No. of years of farming experience (X_5)	0.116	0.225	–5.153
Educational attainment (X_6)	0.904	0.681	–1.328**
Household size (X_7)	0.345	0.104	3.301
Membership of cooperative (X_8)	0.493	0.157	3.144*
Extension contact (X_9)	1.054	0.736	1.431***
Log likelihood	–81.157		
Degree of freedom	- 9		
X^2 likelihood	- 70.248		
Correcting of prediction	- 92.7%		

Source: Field Survey Data, 2014

** = 10%, ** = 5%, *** = 1%*

Table 3. Problems encountered in the adoption of innovation

Variable	Frequency	Percentage
Poor extension contact	64	80
Lack of fund	61	76.3
Low literacy level	56	70
Problems of negligence and gross carelessness	52	65
Adulteration and substandard	50	62.5
Innovation difficulty to comprehend	42	52.5
Innovation not reliable	28	35
Innovation not environmental friendly	24	30
Lack of interest	18	22.5

Source: Field survey, 2014
**Multiple responses*

Furthermore, 76.3% of the respondents complained about inadequate fund. The implication is that, most sprayers cannot afford to wear protective clothes while spraying and as well as being unable to replace defective accessories of the spraying machines, thus, resulting in considerable intoxication of the sprayers [1]. This is synonymous with [10] who remarked that paucity of fund for adoption of technology is a persistent problem in adoption process.

Low literacy level was reported by 70% of the respondents. [1] specifies that many agrochemical workers are not lettered enough to read instructions/labels on agrochemical containers. Nevertheless, some of these workers are literate in their vernacular language but this is of little use, if the labels are in foreign language.

Problems of negligence and gross carelessness had resulted in the abuse and mishandling of herbicides as represented by 65% of the total respondents. [4] reported that negligence and carelessness of the respondents could be in form of non-adherence to manufacturers' manual instruction but prefer shortcuts, use of agrochemical containers as drinking water and food containers and storing of the agrochemical in bedroom and near food gallery.

More so, adulteration and substandard herbicides was reported by 62.5% of the respondents. This finding concurs with [2] who opined that problems of substandard in developing countries could be attributed to loopholes in export and import procedures of which agrochemicals generally are neither adequately audited nor tested before being shifted to these nations.

Furthermore, 52.5% of the respondents were of the view that innovation is difficult to comprehend as regards to herbicide formulation, of which according to [7], local chemical formulators cannot maintain adequate standard, which could be partly due to inexperience, inadequate facilities and technical knowledge. [2] also attributed poor formulation to cases of adulteration and misrepresentation.

4. CONCLUSION AND RECOMMENDATIONS

The major conclusions drawn from this study were; extension contacts, educational attainment, income of the farmers and member of cooperative societies were the major determinants in predicting potential adopters of improved herbicide use technology prior to its transfer.

The major constraints to improved herbicide technology adoption were that poor extension outreach, inadequate fund, low literacy level, negligence and gross carelessness of the sprayer men, adulteration, substandard and innovations that are difficult to comprehend.

Based on the above results, the following recommendations are proffered:

- Appropriate policies that will enable farmers to have access to: credits, educational programmes, frequent extension contacts and enhance easy access of herbicides and spraying equipment with its accessories at affordable cost to sprayer men.
- Pesticide regulatory bodies should religiously audit and test herbicides before its imports into the country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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