

1 **AN ANALYSIS OF THE ADOPTION OF GLYPHOSATE HERBICIDE FOR THE**
2 **CONTROL OF SPEARGRASS (*Imperata cylindrica*) BY YAM FARMERS IN GUINEA**
3 **SAVANNA AGRICULTURAL ZONE OF NIGERIA.**

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14
15 **Abstract**

16 *This study analysed the adoption of glyphosate herbicide for the control of spear grass in three local*
17 *government areas (Ankpa, Olamaboro and Omala) of Kogi State between June 2011 and December*
18 *2012. Some of the objectives were to describe the socioeconomic characteristics of the respondents,*
19 *determine the adoption level and ascertain the socioeconomic factors influencing the adoption. A*
20 *total of two hundred and sixteen (216) sets of questionnaire were distributed. The data collected*
21 *were analyzed using descriptive statistics, logit regression analysis, mean scoring from 3-point*
22 *likert scale, z-test and percentage scoring methods. The study revealed that the yam farmers were in*
23 *various stages of adoption. Out of 216 farmers only (186) farmers (84.7%) adopted glyphosate*
24 *herbicide technology, of (186) adopters, 33.3percent were low level adopters, while 41.9percent and*
25 *24.7 percent were medium and high level adopters respectively. The results of logit regression*
26 *revealed that farm size, educational level and income do not significantly influence the adoption.*
27 *However extension visits and knowledge of the use of glyphosate herbicide significantly influenced*
28 *the adoption of glyphosate herbicide at 10%. The 3-point likert type rating scale used in knowing*
29 *the level of seriousness of perceived constraints showed that high cost of herbicides, lack of capital,*
30 *lack of access to credit and lack of technical know how with mean scores of 2.58, 2.57, 2.56 and*
31 *2.33 respectively were perceived to be very serious constraints while unavailability of herbicide and*
32 *poor market information with mean scores of 1.82 and 1.88 respectively were seen to be less*
33 *serious. This study recommends that efforts should be made by extension agents to increase the*
34 *knowledge of farmers on the use of the technology.*
35

36 **Introduction**

37 Few decades ago, Nigeria was ranked as the top producer of yam, providing 36.72 million metric tons
38 annually, Food and Agricultural Organization of the United Nations, (FAO, 1997)¹. Yams are excellent
39 sources of carbohydrate and some minerals. About 85% of a tuber is edible which partly composed of 65–75%
40 water, 15–33% starch, 1–2.5% protein, 0.5–1.5% fibre, 0.7–2% ash and 0.05–0.2% fat. According to
41 Consultative Group on International Agricultural Research (CGIAR) (1996)² carbohydrates rich food like yam
42 and cassava products make up to 60 – 90% of daily food intake in West Africa when compared to about 50%
43 in developed countries. Yam has ritual, socio-cultural and economic influences on the lives of the people
44 (Orkwor *et al.*, 1998)³.

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45 However, yams are particularly sensitive to competition from weeds during part of their growth.
46 Weeds such as *Imperata cylindrica* interferes with crop growth through direct competition for resources that
47 determines growth and through allelopathic interactions thus reducing the quality and quantity of harvest
48 (Akobundu and Ekeleme, 2000)⁴.

49 *Imperata cylindrica* is a serious weed pest among African farmers. It reduces crop yield and quality,
50 limits farm size to the level that family labour can handle and, increases labour requirement for weeding. The
51 weed also causes physical injury to the skin, and increases the presence of pathogens and insects of economic
52 importance.

53 Garrity *et al.* (1997)⁵, the area affected by *Imperata* expands as fallow length becomes shorter. In
54 many farming systems recurrent fires are used to clear vegetation and continuous cropping is replacing the
55 traditional cropping/bush fallow due to increase in population and pressure on land. Small scale farmers suffer
56 more from *imperata* infestation because they do not have sufficient resources to purchase inputs to control the
57 weed in a sustainable manner.

58 Technologies developed to control *Imperata* have been used successfully in large estates or
59 commercial farms where there is an ample supply of labour, capital, and herbicides. However, very few have
60 been widely adopted by small – scale farmers (Terry *et al.*, 1997)⁶. There are serious concerns about the
61 impact of weeds, particularly *imperata* and *Striga*, on agricultural production and productivity and the low
62 adoption rate of the existing *imperata* management technologies by small – scale farmers in Nigeria, especially
63 in the savanna zone. This development prompted the International Institute for the Tropical Agriculture
64 (IITA), Ibadan to request financial assistance from the Department for International Development (DFID) to
65 implement a 3 – year participatory project (2002–2004) on *Imperata* and *Striga* control in Nigeria.

66 The objectives of the project were to: identify, evaluate, and develop methods for controlling
67 *Imperata cylindrica*. Disseminate improved *imperata* management options using participatory research and
68 extension approach (PREA) and increase the capacity of NGOs (CBOs), research institutions/private sector to
69 facilitate uptake of improved weed management practices in small – scale, disadvantaged farming
70 communities.

71 The weed has been identified as the major natural problem affecting the production of yam by many
72 farmers in some rural communities in Kogi, Benue, Cross River State and other parts of Nigeria (Chikoye *et al.*
73 *et al.*, 2005)⁷. Past research in West Africa has shown that selected herbicides, mechanical, cultural, biological,
74 chemical, alley cropping and cover crops were used individually or as integrated programmes for effective
75 combat of spear grass. For example, Chikoye, *et al.* (2002)⁸ showed that the use of herbicides such as
76 glyphosate or cover crops gave higher crop yield and net benefits in corn, cassava and yam than hand
77 weeding. Cover crops have the ability to shade spear grass and reduce it to non-competitive levels within 2-5
78 years (Udensi *et al.*, 1999)⁹. The use of glyphosate, also, gave higher grain yields and crop value in soybeans,
79 higher tuber yields and crops benefit in yam, higher tuber and stem yields in cassava than the farmer's control.
80 The use of the herbicide gave significantly higher control of spear grass in soybeans when compared with
81 traditional weeding with hoe (Avav and Okereke, 1997)¹⁰.

82 Glyphosate technology has been introduced to farmers by IITA in the study area for over 7 years. The
83 percentage of the farmers who adopted the integrated technologies that were introduced by IITA has not been
84 determined. After the intervention, it is expected that the herbicide should have been adopted by now while

yam production should be on the increase in the study area. However yam output has not seems to be significantly improved upon. It is therefore, important to ascertain the extent of adoption of the technology. Has the glyphosate technology witnessed high or low adoption? Could the problem of poor yam yield be that of inability to adopt the glyphosate technology correctly? This study therefore attempted to ask: what are the socio-economic factors influencing the adoption of glyphosate herbicide technology? What are the adoption levels of the glyphosate technology among yam farmers? What is the output valued in Naira of yam between the contact and non-contact yam farmers? What are the constraints to the adoption of the glyphosate herbicide technology in Kogi State?

Objectives of the Study

The specific objectives of this study are to:

- i. ascertain the socio-economic factors influencing the adoption of glyphosate herbicide technology.
- ii. determine the level of adoption of glyphosate herbicide among the yam farmers in Kogi State.
- iii. compare the output valued in Naira from yam between the contact and the non – contact yam farmers.
- iv. identify the constraints to the adoption of the glyphosate herbicide technology.

Methodology

The Study Area

The study was conducted in Kogi State (see Figure 1) which is in Guinea Savanna Agricultural Zone of Nigeria. The state is located in the middle belt region of Nigeria. It is known as confluence state because the confluence of rivers Niger and Benue met at its capital Lokoja. The State was created on the 27th August, 1991 from parts of Kwara and Benue States. The State lies between latitude 7°30¹N and 7°50¹N and Longitude 6°42¹E and 6°70¹E. Kogi State is made up of 21 local government areas and divided into four agricultural zones namely:- Zone A, with Ayetoro-Gbede as headquarter, zone B with Anyigba as headquarter, zone C has Koto-Karfe as headquarter, while Zone D with Alloma as the headquarter. The State comprises of three major ethnic tribes namely Igala, Ebira and Yoruba (Okun), other minor groups include Kankanda, Kupa, Ogori-Mangongo, Nupe, Bassa-Komo, Bassa-Nge, and Gwari (Koseeds, 2004)¹¹.

Kogi State has total land mass of about 30,354.4 km and is the fifteenth largest state in the country in terms of land mass. The state is bordered by nine other states and is the most centrally located state in the country (Koseeds, 2004)¹¹. Based on the 2006 census Kogi State population stood at 3,278,487, Kogi State has an average maximum temperature of 32.2c and average minimum of 28.8c. Lokoja, the State capital is generally warm throughout the year.

Kogi State has two distinct climate; dry season which starts from November and ends in February while raining season begins from March and stops in October. Annual rainfall ranges from 1016mm - 1524mm. About 80% of the populations are involved in subsistence farming. Among the arable crops grown in the state are: yam cassava, sweet-potatoes, cocoyam, groundnut, beniseed, rice, maize, millet, sorghum, bambara nuts, and pigeon pea, while tree crops include oil palm, citrus, mango, cashew, plantain, banana, guava, and kolanut and livestock such goats and sheep are reared (Koseeds, 2004)¹¹.

Population and Sampling Technique

Data collection was carried out in three stages. The first stage was through the use of purposive sampling to select three local government areas (Ankpa, Olamaboro and Omala) (Table 1) where the adoption of the glyphosate technology was experimented by IITA. The second stage was by random sampling to pick three cells of Agricultural Development Project (ADP), Agricultural Extension Structure from each of the three local government areas. Each of the cells has 20 contact farmers. The last stage was the use of random sampling to pick 12 contact and 12 non-contact farmers of the technology from each cell. This translated to 36 respondents who adopted and 36 who did not in each of the three local government areas. In summary, 108 contact and 108 non - contact farmers were randomly selected in the three identified LGAs to make a total of 216 respondents. The summary of the sampling procedure is given in Table 1.

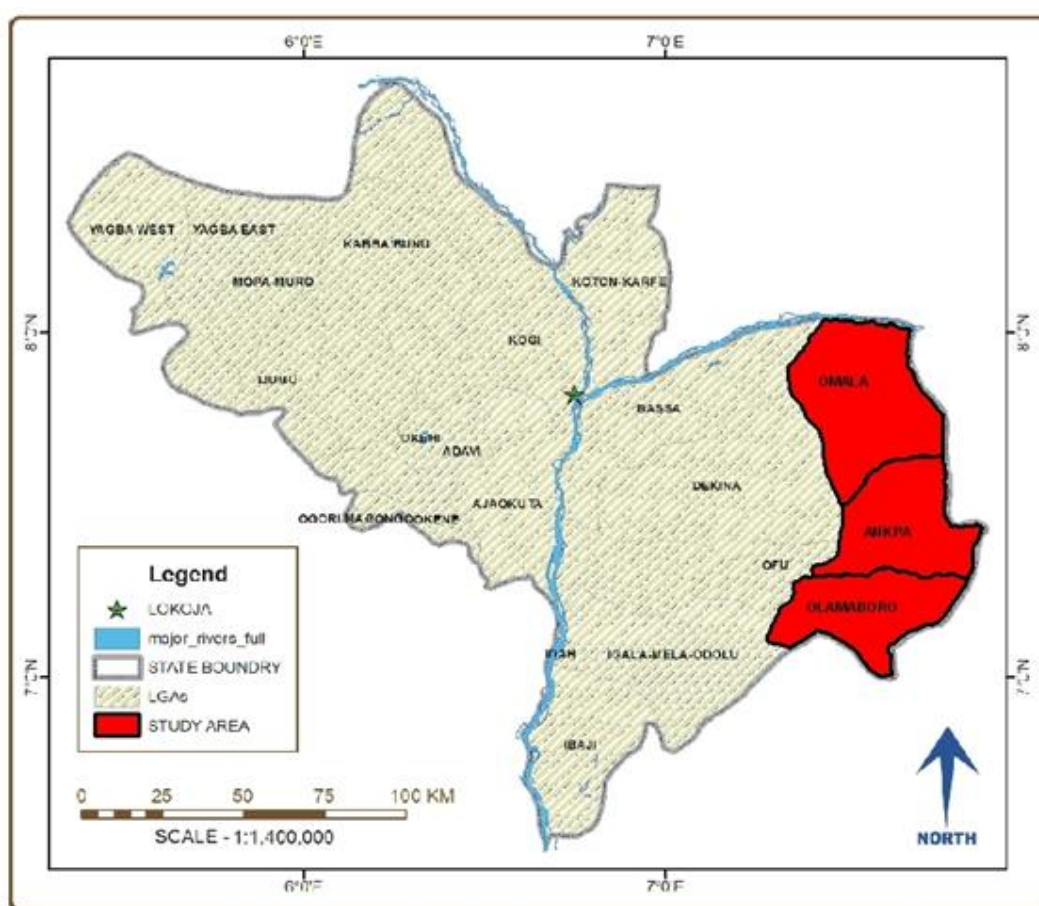


Fig.1: The Study Area

Source: GIS Lab, Kogi State University,

140 **Table 1: Distribution of Respondents by Local Government/Communities**

Zone	Local Government Area	ADPAgric Extension cells	Herbicide Contact farmers	Herbicide Non-Contact farmers	Total No of Respondents
A	Ankpa	Inye	12	12	24
		Ankpa town	12	12	24
		Ogodo	12	12	24
		Subtotal	36	36	72
B	Olamaboro	Okpo town	12	12	24
		Imane	12	12	24
		Ogugu	12	12	24
		Subtotal	36	36	72
C	Omalla	Abejukolo	12	12	24
		Ibado	12	12	24
		Ogodu	12	12	24
		Subtotal	36	36	72
Total			108	108	216

141 **Source:** Field survey, 2012

142 **Data Collection Methods**

143
144 Data for this study were gathered essentially from primary source. The primary data were collected
145 by a structured questionnaire containing thirty six (36) relevant questions for the study. These were validated
146 by experts in the Department of Agricultural Economics and Extension, Kogi State University, Anyigba to
147 reflect all the objectives of the study. The questionnaire was divided into four sections and each section
148 contained relevant questions on the objectives.

149
150 In section A, respondents provided information on their socio-economic characteristics. Section B
151 focused information on the levels of adoption of glyphosate herbicide technology among the yam farmers.
152 Section C obtained information on the output valued in naira from yam by contact glyphosate herbicide
153 contact and non contact. Section D contained information about the constraints to the adoption of glyphosate
154 while Section E provided information about the factors influencing the adoption of glyphosate herbicide
155 among farmers. The researcher collected the data with the assistance of ADP extension workers who were
156 trained and used as enumerators.

157 **Method of Data Analysis**

158 **Objective 1**

159
160 To find out the socio-economic factors influencing the adoption of glyphosate herbicide. Logit
161 regression was used to achieve this as adopted by Feleke and Zegeye (2006)¹² to analyze the influence of
162 socio-economic characteristics on the adoption of improve maize varieties in southern Ethiopia. The model is
163 specified as follows:

$$164 \quad \text{Ln}y = \text{Ln} (p/1 - p) \text{_____}$$

$$165 \quad \text{Ln} (p/i_p) = b_0 + b_1x_1 + b_2x_2 + \text{_____} b_8 + e$$

166 Where;

167 Y= Glyphosate usage (1= usage, 0 = otherwise)

168 P = probability of the use of glyphosate.

169 Ln = Natural logarithm function.

170 B_0 = Constant.
 171 $B_1 - B_8$ = Logistic regression coefficients.
 172 X_1 = Age of the farmer (in years).
 173 X_2 = Level of education (in years).
 174 X_3 = Household size (number of persons).
 175 X_4 = Farm size (in hectares)
 176 X_5 = Farming experience (in years)
 177 X_6 = Yam output valued (in Naira)
 178 X_7 = Extension contact (No of visits in the year)
 179 X_8 = Ability to apply agro- chemicals (Yes = 1, No = 0).

180

181 **Objective 2**

182 To determine level of adoption of glyphosate herbicide among the yam farmers in Kogi State,
 183 adoption level was measured by using likert scale in which scores were given to each adoption stage as used
 184 by Iwueke (1990)¹³. Values were assigned for each stage of the adoption process, the values assigned were 0
 185 for unawareness, 1 for awareness, 2 for interest, 3 for evaluation, 4 for trial, 5 for adoption, and 0 for rejection
 186 and 4 for discontinuance. Using Iwueke methodology of measuring adoption level, the integrated package of
 187 yam production technology was used, the integrated package has the following steps; step 1 direct application
 188 of glyphosate at 4 and 8 weeks after planting + 1 hoe weeding at 12 weeks after planting, step 2 involved the
 189 use of fusillade post emergence at 3weeks after planting + 2 hoe weeding, 8 and 12 weeks after planting, step
 190 3 involved pre-tillage application of glyphosate followed by mucuna at 6 weeks after planting + 2 hoe weeding
 191 at 8 and 12 weeks after planting. A farmer who adopted these 3 steps will score a maximum point of 15. Based
 192 on the above criteria, a farmer was considered as a low adopter if he recorded a score between 1-7 while a
 193 score between 8-11 implied that such farmer was medium adopter while score between 12-15 was considered
 194 high adopter and a score of 0 was for non-adopters.

195

196 **Objective 3**

197 Z-test statistics was used to determine the significant differences in yam output valued in Naira
 198 between glyphosate herbicide contact farmers and non-contact farmers. The z-test model can be explained as
 199 used by Okporie (2006)¹⁴ where z-test was computed as;

200

$$201 \quad \bar{Z} = \frac{\bar{X}_A - \bar{X}_B}{Sd}$$

202

203
 204 Where $\bar{X}_A$ = Mean of sample A (Contact farmers)

205 $\bar{X}_B$ = Mean of sample B (Non contact farmers)

206 Sd = Standard error of the difference between means obtained

207

$$208 \quad Sd = \bar{S}X_A - \bar{S}X_B = \sqrt{\frac{S^2_A}{N_A} + \frac{S^2_B}{N_B}}$$

209
 210

Objective 4:

This objective was achieved by calculating the mean score from 3-point likert rating scale to indicate level of seriousness of the constraints, in this case very serious attracts 3 points, serious was 2 points while not serious attracts 1. These points were summed up to get a total point of (3+2+1 = 6). The total point was divided by 3 to have an average of 2 points. In essence, a mean score above 2 was categorized as very serious constraints and any one below 2 was grouped as non-serious constraint. This description was in accordance to (Anyanwu *et al.* 2002)¹⁵.

Results and Discussion

Table 2: Result of the Logit Regression Analysis of Socio-economic factors influencing adoption of glyphosate Herbicide

Variables	Coefficients	Std Error	Z	P>[z]
Age	-.094	.0353428	2.66	0.008*
Education	.019	.046789	0.41	0.684
Household size	.092	.0756999	1.21	0.206
Farm size	.092	.0756651	1.22	0.223
Farm experience	.045	.030775	1.46	0.143
Income.	8.80	3.60e-06	0.24	0.80
Extension Visit	.138	.082071	1.68	0.092*
Knowledge of application of glyphosate	3.27	.5606729	5.84	0.000**

Source: Computed from field survey data 2012

LR Chiz (8) = 68.65***

Pr = 0.0000

NB: Figures in parentheses are t-values* and ** denotes 10 and 1 percent level of significance respectively.

Socioeconomic Factors Influencing the Adoption of Glyphosate Herbicide Technology

The result of the logistic regression analysis for the determinants of socio-economic factors influencing the adoption of glyphosate herbicide among yam farmers in the study area is shown in table 2 it contains the explanatory variables which have been found to be significant at 10% and 1% level of probability using logistic regression statistics.

From the result of the logistic regression in Table 2 the coefficient of determination (LR) of 68.65 and the adjusted (pr) 0.0000 which implies that 100% of the changes experienced in the total farm income of the farmers were explained by the variables in the model and the prior ratio of 68.65 was significant at 1% and 10%. The result indicates that age of the respondents had coefficient of -.0939357 on the adoption which is statistically negative significant at 10%. This implies that age of the farmer was not a significant determinant of adoption of glyphosate herbicides in the study area. Education of the respondents had a coefficient of .0190617 which was not significant but positive. Household size with coefficient of .0916096 was not statistically significant to the adoption. This implies that the size of the household does not affect family labour on the adoption of glyphosate herbicides. From the results, it shows that farming experience with coefficient of .0450444 was not statistically significant. However experience had some effect on adoption of the herbicide as experience is the best teacher- great lessons are learnt from experience. Past odds or negative experiences will be avoided or minimized to avoid a repeat of such occurrences which results on better

performances. Also the more experiences the better the practices and the farmers tendency to accept innovations or extension messages. The result showed that income had positive influence with coefficient of 8.8007 which was statistically not significant. The result revealed that extension visits with coefficient of .1381565 was statistically significant at 1% and had positive effect on adoption. This means that more extension visits will lead to more awareness of adoption of new technology which may translate to increased in yield and income of yam farmers. The result also shows that knowledge of application of glyphosate was positive with a coefficient of 3.274187 and was statistically significant at 1%. This means that acquisition of knowledge has a positive and significant influence on the adoption of glyphosate herbicide.

Level of Adoption of Glyphosate Herbicide

Table 3: The result of the level of adoption of glyphosate herbicide

	<i>Adoption</i>	<i>Frequency</i>	<i>% of farmers</i>	<i>% of adopters</i>
1	Low Adoption	62	28.7	33.3
2	Medium Adoption	78	36.1	41.9
3	High Adoption	46	21.4	24.7
4	Non-adoption	30	13.4	—
	Total	216	100	100

Source: Computed from field survey data 2012

Distribution of farmers by level of adoption of glyphosate herbicide

Table 3 shows the distribution of respondents according to levels of adoption. The result of this study indicated that the glyphosate technology adopted by yam farmers were in various categories of adoption. Out of 216 farmers only 186 farmers (84.7%) adopted glyphosate herbicide technology. Of 186 adopters, 33.3 percent were low level adopters while 41.9 percent and 24.7 were medium and high level adopters respectively.

This was similar to the findings of Chinaka *et al.* (2007)¹⁶ on adoption of improved agricultural technologies by farmers in Aba Agricultural zone, Abia State who stated that there was a gap between awareness and adoption of innovation.

Table 4: Comparison of the yam output valued in Naira of contact and non-contact farmers of glyphosate herbicide

Variables	Mean	Standard error of mean difference	Z-cal	Z-tal	DF
Contact (Sample A)	136628	20808.51	1.9348	1.960	
Non-contact (Sample B)	96366.67	20808.51			

Source: Field survey 2011

Comparison of the yam output valued in Naira of contact and non-contact farmers on glyphosate adoption

The z-test results showed that z-calculated was 1.935 while the z-tabulated was 1.960. Since the z-tab was higher than the z-cal it means there was no significant difference between the output valued in Naira of glyphosate contact and non-contact farmers. This could be due to the fact that most of the glyphosate

herbicides farmers were low and medium adopters as indicated in Table 4. This implies that even when some adopted, it was not properly adopted to significantly influence the output (valued in naira) of the adopted.

Table 5: A 3-Point Likert Rating Type of Scale on the Constraints to the Adoption of Glyphosate Herbicide Technology

Constraints	Very Serious 3	Serious 2	Not Serious 1	Total no of resp (N)	Total no of score ($\Sigma FiAi$)	Mean score	Proportion of resp in %
High cost of herbicides	138	65	13	216	557	2.58	86
Unavailability of herbicide	54	78	84	216	402	1.86	62
Lack of capital	148	108	14	216	553	2.57	85.8
Illiteracy	189	85	85	216	427	1.97	65.6
Lack of access to credit	152	45	19	216	565	2.62	87.3
Ecological pollution	15	70	131	216	316	1.46	48.66
Cultural belief	26	55	135	216	323	1.49	49.66
Lack of technical know-how	102	84	30	216	504	2.33	77.66
Poor market information	40	94	82	216	390	1.80	60
Lack of extension services	70	49	97	216	405	1.88	62.66

Source: Field survey 2012

Constraint to the Adoption of glyphosate herbicide Technology

Table 5 shows the 3-point likert scale on level of severity of constraints to glyphosate yam farmers. The concept of real limit of 2–2 and 2–3 was used to interpret the mean response of each constraint. Any constraint with a mean score of 2 and above is considered as a very serious constraint. The result revealed that the yam farmers with mean score of 2.58 (about 86%) agreed with the fact that high cost of herbicide was a serious constraint to the yam production in this area. Furthermore, the mean score of 2.62 (about 87.3%) said lack of access to credit was a very serious problem. This finding is in line with report of Mbah (2008)¹⁷ that capital was still a major obstacle to increased rural production in Owerri Imo State, Nigeria. The implication is that credit is needed to buy farm inputs and improved techniques. Yam farmers in the study area might have found it difficult to access loan from banks in order to increase their production. Also 85.6% with a mean score of 2.57 agreed with the statement that lack of capital was a very serious constraint. Among very serious constrained is lack of technical know-how with mean score of 2.33 about 77.66%.

While unavailability of herbicides, illiteracy, poor market information, and lack of extension services with mean score of 1.82, 1.97, 1.80 and 1.88 with 62%, 65%, 60%, and 62% respectively were listed as serious constraints while cultural belief, ecological pollution with 49.66%, and 48.66% with score of 1.46 and 1.49 were listed not serious in the constraints. This means scores that were below 2 can be interpreted to mean that poor market, herbicide unavailability among others were no serious problems.

Conclusion

From the findings one can draw a conclusion that glyphosate adoption has not been properly adopted as recommended. Inadequate knowledge of use of the technology, high cost and inaccessibility to fund were the major draw backs to the adoption. Aggressive and sustainable training and visit on glyphosate adoption should be put in place by both public and private extension outfits who advocate glyphosate usage for the control of this stubborn, energy shaping weed. Cooperative society can also be embraced by yam farmers to

306 jointly share the cost of purchasing a large bulk of glyphosate herbicide which will partly reduce cost and
307 enhance a greater access to the use of the technology. However, farmers and extension workers must exercise
308 restraint to the over use of the herbicide because of its detrimental effect on soil and the crop planted.

309

310 **Competing Interest**

311 Herbicides use often requires additional land to increase the size of farm and justify the huge financial outlay.
312 However, land tenure which is held onto tenaciously by the traditional farmers always hinders the possibility
313 of increasing the land size for yam production.

314

315 **Authors Contributions to Knowledge**

316 This study has provided information on the social economic characteristics of yam farmers that influence the
317 adoption of glyphosate herbicides. The study also ascertained that the use of the herbicides positively
318 influenced the yam output. It also provided information on the constraints to the adoption of the herbicides and
319 the various levels of adoption. These contributions to knowledge should help the agricultural extension agents,
320 researchers and glyphosate manufacturers to adjust their approaches to the methods of information
321 dissemination and use which should enhance the adoption of the herbicides.

322

323 **Recommendations**

324 This study therefore recommends that;

- 325 1. Extension agents should step up their visits on glyphosate adoption education in rural areas on how to
326 use the technology as recommended.
- 327 2. Workshops should be organized by Ministry of Agriculture and private organizations to educate
328 farmers and update extension workers on knowledge of glyphosate usage.
- 329 3. More collaborative research with relevant bodies to bring about a less, costly but effective herbicides
330 for control of spear grass.
- 331 4. Groups have been found to be important information sharing and in creating a spread, diffusion or
332 multiply effect with relevant improved technologies adoption. Therefore farmers should be encouraged
333 by extension agents to join cooperative societies so as to benefit from the groups which may reduce cost
334 of purchase of glyphosate and enhance availability and successful adoption of the technology.
- 335 5. Adequate supply of herbicides in agro-service centers in rural communities should be put in place and
336 within reach of farmers.
- 337 6. Provision of credit facilities to farmers without given much collateral at low interest rate and also cut
338 down bureaucratic bottlenecks so as to enable the farmers access agricultural loans.
- 339 7. Provisions of herbicides to farmers at subsidized rate, so that the less privileged can have access to
340 them.

341

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