

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

Abstract

This study analysed the adoption of glyphosate herbicide for the control of spear grass in three local government areas (Ankpa, Olamaboro and Omala) of Kogi State. Some of the objectives were to describe the socioeconomic characteristics of the respondents, determine the adoption level and ascertain the socioeconomic factors influencing the adoption. A total of two hundred and sixteen (216) sets of questionnaire were distributed. The data collected were analyzed using descriptive statistics, logit regression analysis, mean scoring from 3-point likert scale, z-test and percentage scoring methods. The study revealed that the yam farmers were in various categories of adoption. Out of 216 farmers only (186) farmers (84.7%) adopted glyphosate herbicide technology, of (186) adopters, 33.3percent were low level adopters, while 41.9percent and 24.7 percent were medium and high level adopters respectively. The results of logit regression revealed that farm size, educational level and income do not significantly influence the adoption. However extension visits and knowledge of the use of glyphosate herbicide significantly influenced the adoption of glyphosate herbicide at 10%. The 3-point likert type rating scale used in knowing the level of seriousness of perceived constraints showed that high cost of herbicides, lack of capital, lack of access to credit and lack of technical know how with mean scores of 2.58, 2.57, 2.56 and 2.33 respectively were perceived to be very serious constraints while unavailability of herbicide and poor market information with mean scores of 1.82 and 1.88 respectively were seen to be less serious. Cultural constraint was not serious. This study recommends that there is a need for collaborative research with relevant bodies to bring about relatively cheaper herbicides for the farmers while effort should be made by extension agents to increase the knowledge of farmers on the use of the technology.

Introduction

Few decades ago, Nigeria was ranked as the top producer of yam, providing 36.72 million metric tons annually, Food and Agricultural Organization of the United Nations, FAO, (1997). Yams are excellent sources of carbohydrate and some minerals. About 85% of a tuber is edible which partly composed of 65–75% 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 Consultative Group on International Agricultural Research (CGIAR) (1996) Carbohydrates rich food like yam and cassava products make up to 60 – 90% of daily food intake in West Africa when compared to about 50% in developed countries. Yam has ritual, socio-cultural and economic influences on the lives of the people (Orkwor *et al.*, 1998).

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

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

47 The area affected by *Imperata* expands as fallow length becomes shorter. In many
48 farming systems recurrent fires are used to clear vegetation and continuous cropping is
49 replacing the traditional cropping/bush fallow due to increase in population and pressure on
50 land (Chikoye *et al.*, 2000; Garrity *et al.*, 1997). Small scale farmers suffer more from
51 *imperata* infestation because they do not have sufficient resources to purchase inputs to
52 control the weed in a sustainable manner (Chikoye, Ellis – Jones, Alum, Tarawali and
53 Avav, 2005).

54 Technologies developed to control *Imperata* have been used successfully in large
55 estates or commercial farms where there is an ample supply of labour, capital, and
56 herbicides. However, very few have been widely adopted by small – scale farmers (Terry *et*
57 *al.*, 1997). There are serious Concerns about the impact of weeds, particularly *imperata* and
58 *striga*, on agricultural production and productivity and the low adoption rate of the existing
59 *imperata* management technologies by small – scale farmers in Nigeria, especially in the
60 savanna zone. This development prompted the International Institute for the Tropical
61 Agriculture (IITA), Ibadan to request financial assistance from the Department for
62 International Development (DFID) to implement a 3 – year participatory project (2002–
63 2004) on *Imperata* and *Striga* control in Nigeria (Chikoye *et al.*, 2005).

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

69 The weed has been identified as the major natural problem affecting the production
70 of yam by many farmers in some rural communities in Kogi, Benue, Cross River State and
71 other parts of Nigeria (Chikoye *et al.*, 2005). Past research in West Africa has shown that
72 selected herbicides, mechanical, cultural, biological, chemical, alley cropping and cover
73 crops were used individually or as integrated programmes for effective combat of spear
74 grass. For example, Chikoye, *et al.*, (2002) showed that the use of herbicides such as
75 glyphosate or cover crops gave higher crop yield and net benefits in corn, cassava and yam
76 than hand weeding. Cover crops have the ability to shade spear grass and reduce it to non-

competitive levels within 2-5 years (Udensi *et al.*, 1999). The use of glyphosate, also, gave higher grain yields and crop value in soybeans, higher tuber yields and crops benefit in yam, higher tuber and stem yields in cassava than the farmers' control. The use of the herbicide gave significantly higher control of spear grass in soybeans when compared with traditional weeding with hoe (Avav and Okereke, 1997).

Glyphosate technology has been introduced to farmers by IITA in the study area for over 7 years. The percentage of the farmers who adopted the integrated technologies that were introduced by IITA has not been 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?

95

96 **Objectives of the Study**

97 The specific objectives of this study are to:

- 98 i. ascertain the socio-economic factors influencing the adoption of glyphosate
99 herbicide technology.
- 100 ii. determine the level of adoption of glyphosate herbicide among the yam farmers in
101 Kogi State.
- 102 iii. Compare the output valued in Naira from yam between the contact and the non –
103 contact yam farmers.
- 104 iv. Identify the constraints to the adoption of the glyphosate herbicide technology.

105 **Methodology**

106 **The Study Area**

107 The study was conducted in Kogi State which is in Guinea Savanna Agricultural
108 Zone of Nigeria. The state is located in the middle belt region of Nigeria. It is known as
109 confluence state because the confluence of rivers Niger and Benue met at its capital Lokoja.
110 The state was created on the 27th August, 1991 from parts of Kwara and Benue states. The

111 state lies between latitude $7^{\circ}30'N$ and $7^{\circ}50'N$ and Longitude $6^{\circ}42'E$ and $6^{\circ}70'E$. The state is
 112 made up of 21 local government areas and divided into four agricultural zones namely:-
 113 Zone A, with Ayetoro-Gbede as headquarter, zone B with Anyigba as headquarter, zone C
 114 has Koto-Karfe as headquarter, while Zone D with Alloma as the headquarter. The state
 115 comprises of 3major ethnic tribes namely Igala, Ebira and Yoruba (Okun), other minor
 116 groups include Kankanda, Kupa, Ogori-Mangongo, Nupe, Bassa-Komo, Bassa-Nge, and
 117 Gwari (Koseeds, 2004).

118 Kogi State has total land mass of about 30,354.4km and is the fifteenth largest state
 119 in the country in terms of land mass. The state is bordered by nine other states and is the
 120 most centrally located state in the country (Koseeds, 2004). Based on the 2006 census Kogi
 121 State population stood at 3,278,487. Kogi State has an average maximum temperature of
 122 32.2c and average minimum of 28.8c. Lokoja, the State capital is generally warm
 123 throughout the year.

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

131

132 **Population and Sampling Technique**

133 Data collection was carried out in three stages. The first stage was through the use of
 134 purposive sampling to select three local government areas (Ankpa, Olamaboro and Omala)
 135 (table 1) where the adoption of the glyphosate technology was experimented by IITA. The
 136 second stage was by random sampling to pick three cells of ADP agricultural extension
 137 structure from each of the three local government areas. Each of the cells has 20 contact
 138 farmers. The last stage was the use of random sampling to pick 12 contact and 12 non-
 139 contact farmers of the technology from each cell. This translated to 36 respondents who
 140 adopted and 36 who did not in each of the three local government areas. In summary, 108
 141 contact and 108 non - contact farmers were randomly selected in the three LGAs to make a
 142 total of 216 respondents. The summary of the sampling procedure is given in Table 1.

143

144

148 **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

149
150 **Source:** Field survey, 2012

151
152 **Data Collection Methods**

153 Data for this study were gathered essentially from Primary source. The primary data
154 were collected by a structured questionnaire containing relevant questions for the study.
155 These were validated by experts in the Department of Agricultural Economics and
156 Extension, Kogi State University, Anyigba to reflect all the objectives of the study. The
157 questionnaire was divided into four sections and each section contained relevant questions
158 on the objectives.

159 In section A, respondents provided information on their socio-economic
160 characteristics. Section B focused information on the levels of adoption of glyphosate
161 herbicide technology among the yam farmers. Section C obtained information on the output
162 valued in naira from yam by contact glyphosate herbicide contact and non contact. Section
163 D contained information about the constraints to the adoption of glyphosate while Section E
164 provided information about the factors influencing the adoption of glyphosate herbicide
165 among farmers. The researcher collected the data with the assistance of ADP extension
166 workers who were trained and used as enumerators.

167
168

169 **Method of Data Analysis**

170 **Objective 1**

171 To find out the socio-economic factors influencing the adoption of glyphosate
172 herbicide. Logit regression was used to achieve this. The model is specified as follows:

$$173 \quad \text{Ln}y = \text{Ln} (p/1 - p) \text{_____}$$

$$174 \quad \text{Ln} (p/i_p) = b_0 + b_1 x_1 + b_2 x_2 + \text{_____} b_8 + e$$

175 Where;

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

177 P = probability of the use of glyphosate.

178 Ln = Natural logarithm function.

179 Bo = Constant.

180 B₁ - B₈ = Logistic regression coefficients.

181 X₁ = Age of the farmer (in years).

182 X₂ = Level of education (in years).

183 X₃ = Household size (number of persons).

184 X₄ = Farm size (in hectares)

185 X₅ = Farming experience (in years)

186 X₆ = Yam output valued (in Naira)

187 X₇ = Extension contact (No of visits in the year)

188 X₈ = Ability to apply agro- chemicals (Yes = 1, No = 0).

189

190 **Objective 2**

191 To determine level of adoption of glyphosate herbicide among the yam farmers in
192 Kogi State, adoption level was measured by using likert scale in which scores were given to
193 each adoption stage as used by Iwueke (1990). Values were assigned for each stage of the
194 adoption process, the values assigned were 0 for unawareness, 1 for awareness, 2 for
195 interest, 3 for evaluation, 4 for trial, 5 for adoption, and 0 for rejection and 4 for
196 discontinuance. Using Iwueke methodology of measuring adoption level, the integrated
197 package of yam production technology was used, the integrated package has the following
198 steps; step 1 direct application of glyphosate at 4 and 8 weeks after planting + 1 hoe
199 weeding at 12weeks after planting, step 2 involved the use of fusillade post emergence at
200 3weeks after planting + 2 hoe weeding, 8 and 12 weeks after planting, step 3 involved pre-
201 tillage application of glyphosate followed by mucuna at 6 weeks after planting + 2 hoe
202 weeding at 8 and 12 weeks after planting. A farmer who adopted these 3 steps will score a

203 maximum point of 15. Based on the above criteria, a farmer was considered as a low
204 adopter if he recorded a score between 1-7 while a score between 8-11 implied that such
205 farmer was medium adopter while score between 12-15 was considered high adopter and a
206 score of 0 was for non-adopters.

207

208 **Objective 3**

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

212

$$213 \quad Z = \frac{\overline{X}_A - \overline{X}_B}{\overline{Sd}}$$

215

216 Where $\overline{X}_A$ = Mean of sample A (Contact farmers)

217 $\overline{X}_B$ = Mean of sample B (Non contact farmers)

218 $\overline{Sd}$ = Standard error of the difference between means obtained

219

$$220 \quad \overline{Sd} = \overline{SX}_A - \overline{SX}_B = \sqrt{\frac{S^2_A}{N_A} + \frac{S^2_B}{N_B}}$$

223

224 **Objective 4:**

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

232

233

Results and Discussion

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

Variables	Coefficients	Std Error	Z	P>[z]
Age	-.0939357	.0353428	2.66	0.008*
Education	.0190617	.046789	0.41	0.684
Household size	.0916096	.0756999	1.21	0.206
Farm size	.0922627	.0756651	1.22	0.223
Farm experience	.0450444	.030775	1.46	0.143
Income.	8.80e-07	3.60e-06	0.24	0.80
Extension Visit	.1381565	.082071	1.68	0.092*
Knowledge of application of glyphosate	3.274187	.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 perior ratio of 68.65 was significant at 1% and 10% meaning that the model was significant in its entirety. 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 if yam farmers receive adequate knowledge of how to use the glyphosate herbicides, they should be able to increase their production level that will in turn affect the income of the farmers.

273

274 **Level of Adoption of Glyphosate Herbicide**

275 **Table 3: Shows 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

276 **Source:** Computed from field survey data 2012

277

278 **Distribution of farmers by level of adoption of glyphosate herbicide**

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

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

287

288

289 **Table 4: Comparison of the yam output valued in Naira of contact and non-contact**
 290 **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			

291 **Source:** Field survey 2011

292 Diff = mean (contact) – mean (non-contact) t = 1.9348

293 Ho: diff = 0 degrees of freedom = 214

294 Ha: diff < 0 Ha: diff! = 0 Ha: diff > 0

295 Pr (T < t) = 0.9728 Pr (/T/ > /t/ = 0.0543 Pr (T > t) = 0.0272

296

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

299 The z-test results showed that z-calculated was 1.935 while the z-tabulated was
 300 1.960. Since the z-tab was higher than the z-cal it means there was no significant difference
 301 between the output valued in Naira of glyphosate contact and non-contact farmers. This
 302 could be due to the fact that most of the glyphosate herbicides farmers were low and
 303 medium adopters as indicated in table 4. This implies that even when some adopted, it was
 304 not properly adopted to significantly influence the output (valued in naira) of the adopted.

305

306 **Table 5: A 3-point likert rating type of scale on the Constraints to the adoption of**
 307 **glyphosate herbicide technology**

Constraints	Very Serious 3	Serious 2	Not Serious 1	Total no of resp (N)	Total no of score (ΣFiAi)	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

308 **Source:** Field survey 2012

309

310 **Constraint to the Adoption of glyphosate herbicide Technology**

311 Table 5 shows the 3-point likert scale on level of severity of constraints to glyphosate yam
 312 farmers. The concept of real limit of 2–2 and 2–3 was used to interpret the mean response of
 313 each constraint. Any constraint with a mean score of 2 and above is considered as a very
 314 serious constraint. The result revealed that the yam farmers with mean score of 2.58 (about
 315 86%) agreed with the fact that high cost of herbicide was a serious constraint to the yam
 316 production in this area. Furthermore, the mean score of 2.62 (about 87.3%) said lack of
 317 access to credit was a very serious problem. This finding is in line with report of Mbah
 318 (2008) that capital was still a major obstacle to increased rural production in Owerri Imo
 319 State, Nigeria. The implication is that credit is needed to buy farm inputs and improved
 320 techniques. Yam farmers in the study area might have found it difficult to access loan from
 321 banks in order to increase their production. Also 85.6% with a mean score of 2.57 agreed
 322 with the statement that lack of capital was a very serious constraint. Among very serious
 323 constrained is lack of technical know-how with mean score of 2.33 about 77.66%.

324 While unavailability of herbicides, illiteracy, poor market information, and lack of
 325 extension services with mean score of 1.82, 1.97, 1.80 and 1.88 with 62%, 65%, 60%, and
 326 62% respectively were listed as serious constraints while cultural belief, ecological
 327 pollution with 49.66%, and 48.66% with score of 1.46 and 1.49 were listed not serious in
 328 the constraints. This means scores that were below 2 can be interpreted to mean that poor
 329 market, herbicide unavailability among others were no serious problems.

330

331 **Conclusion**

332 From the findings one can draw a conclusion that glyphosate adoption has not been
 333 properly adopted as recommended. Inadequate knowledge of use of the technology, high
 334 cost and inaccessibility to fund were the major draw backs to the adoption. Aggressive and
 335 sustainable training and visit on glyphosate adoption should be put in place by both public
 336 and private extension outfits who advocate glyphosate usage for the control of this stubborn,
 337 energy shaping weed. Cooperative society can also be embraced by yam farmers to jointly
 338 share the cost of purchasing a large interest of glyphosate herbicide which will partly reduce
 339 cost and enhance a greater access to the use of the technology.

340

341

342 **Recommendations**

343 This study therefore recommends that;

- 344 1. Extension agents should step up their visits on glyphosate adoption education in rural
345 areas on how to use the technology as recommended.
- 346 2. Workshops should be organized by ministry of Agric and private organizations to
347 educate farmers and update extension workers on knowledge of glyphosate usage.
- 348 3. More collaborative research with relevant bodies to bring about a less, costly but
349 effective herbicides for control of spear grass.
- 350 4. Groups have been found to be important information sharing and in creating a spread,
351 diffusion or multiply effect with relevant improved technologies adoption. Therefore
352 farmers should be encouraged by extension agents to join cooperative societies so as
353 to benefit from the groups which may reduce cost of purchase of glyphosate and
354 enhance availability and successful adoption of the technology.
- 355 5. Adequate supply of herbicides in agro-service centers in rural communities should be
356 put in place and within reach of farmers.
- 357 6. Provision of credit facilities to farmers without given much collateral at low interest
358 rate and also cut down bureaucratic bottlenecks so as to enable the farmers access
359 agricultural loans.
- 360 7. Provisions of herbicides to farmers at subsidized rate, so that the less privileged can
361 have access to them.

362

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