

Profitability of Yam-Maize-Soybean Enterprise Among Resource Poor Farmers Using Herbicide for Weed control in the Northern Guinea Savanna.

Abstract

This study examined the profitability of herbicide weed control in yam-maize-soybean enterprise, factors influencing it, as well as the problems encountered by the farmers using this weed control measures. The study was conducted in Bwari Area Council of the Federal Capital Territory (FCT) in the Northern Guinea Savanna agro-ecological zone of Nigeria, between August, 2015 and January, 2016. Data were collected from 60 randomly selected farmers using a structured questionnaire, and analyzed using descriptive statistics, net income, gross margin model and multiple regressions. Result showed that the enterprise was dominated by male farmers (97 %) with 88 % of them married and had an average household size of 13 persons. The respondents were educated with average farm size of 4 ha. The gross revenue was ₦1,062,696.075 per hectare, and the return per naira was 1.23, implying that for every naira spent in the enterprise the farmer expects a return of ₦1.23. The gross margin ratio estimate was 1.16, and this result implied that for every ₦1 realized from the sales of yam, maize and soybean the farmer had ₦1.16 kobo left over to cover basic variable costs as well as profit. Lack of credit facilities, high cost of labour, environmental effects and high cost of herbicide were the major problems encountered by the farmers. Level of education, farm size, household size, farming experience, use of herbicide were all positively related to profit and significant at 5% probability level. This study concluded that yam-maize-soybean enterprise in Northern Guinea Savanna area of Nigeria was profitable, when herbicides were used in weed control and farmers should be encouraged to use herbicide for weed control. Policies that would favour herbicide subsidies and credit facilities for farmers in this agro-ecology zone will be a strong incentive for increased productivity and profitability.

Key words: *Herbicide, yam, maize, soybean, profit*

Introduction

There is paucity of labour required for manual weeding, in order to attain high yield in developing countries (Zhang, 2003). Effective weed control in crop production systems is a necessary requirement that will enable increased crop (Masthan *et al.*, 1989). The use of herbicides for weed control may enhance the performance of other inputs such as fertilizer, thereby encouraging their use to improve on the yield (Manda, 2011; Hossain *et al.*, 2014a). According to Prasad *et al* (2008), manual weeding may only result to yield optimum It is labour

intensive, and the drudgery associated with it makes it inefficient method for effective weed control (Hossain, 2015), and if done late sometimes may lead to severe yield losses (Rashid *et al.*, 2012).. In Africa, a lot of land is left fallow due to unavailability of labour to provide manual weeding (Bishop-Sambrook, 2003). Manual weeding has been adjudged unsustainable according Kamara (2012), and cumbersome especially when considering economies of scale (Udensi *et al.*, 1999). The use of herbicide in weeding is a better option to hand weeding as it is cheaper, faster, and more effective with less drudgery (Chikoye *et al.*, 2002; 2004).

The use of herbicide for weed control is becoming popular due to increase in the opportunity cost of labour especially in developing countries (Pingali and Gerpacio, 1997), and this trend enables the practice of adoption of minimum-till and zero-till farming systems (Holm and Johnson, 2010). This may offer the advantages of saving the fragile and marginal soils of most African countries. The use of herbicides weed control may help to conserve moisture (Blackshaw, 2006), and also reduces the emission of greenhouse gases from the use of tractor (Ortiz-Monasterio *et al.*, 2010). Herbicide weeding uses less labour which implies reduced costs of farming operation, implying higher profit (Ogunghile *et al.*, 1982) as opposed to 50-70% of the total labor time spent by smallholder farmers in hand weeding (Chikoye *et al.*, 2007a). Manual weeding is commonly practiced in Nigeria (Chikoye *et al.*, 2002) and this cannot sustain the system with the ever increasing population that must be fed. For instance, in Nigeria, it was reported that weeding once led to yield loss of about 40 % when compared to farmlands where weeding was done thrice (Chikoye *et al.*, 2004). The use of herbicide for controlling weeds is an alternative to manual weeding although it is not commonly practiced by smallholder farmers (Overfield *et al.*, 2001; Mavudzi *et al.*, 2001). The reason may be because of unguided perception of its effect, high initial cost of its engagement, lack of knowledge of the application and lack farmers

encouragement by the way of input subsidies or credit facilities.. According to Beltran *et al.*, (2012); Adigun *et al.*, (1993) the use of herbicide is more profitable than hand weeding and is key to sustainable crop production (Hossain, 2015).

The profitability of herbicide use in crop production in the rainforest and forest savanna transition zones in Nigeria have been reported by various authors; each enumerating the benefits in comparison with hand weeding (Aluko *et al.*, 2017; Omovbude and Udensi, 2012; Koricocha *et al.*, 2011; Nezeer *et al.*, 2004; Adigun *et al.*, (1993) However, little or no attention has been given to the use of herbicides and its benefits in terms of productivity and profitability in arable crop mixture in the Northern Guinea Savanna agroecology of Nigeria. This shows a gap in research which this study intends to fill. The objectives of this study are: (a) to determine the profitability of yam-maize-soybean enterprises; (b) determine factors influencing the profitability of the mixture; and (c) to identify the problems encountered by the farmers in the use of chemical weed control measures.

Materials and Methods

Study site

The study was conducted in Bwari Local Area Council located at the Federal capital territory (FCT), Abuja; and lies at latitude range of 08°80' and 09°31' north and longitude 007°22' and 07°58' east. Potentially Bwari is in the Guinea Savanna (GS) agro ecology of Nigeria with a fertile soil that supports predominantly farming communities. The area is predominantly savannah with sparse forests in its southern parts. Major crops grown in the include millet, corn, sorghum, rice, yams, cassava, plantains, groundnuts and cowpeas. The commercial rearing of

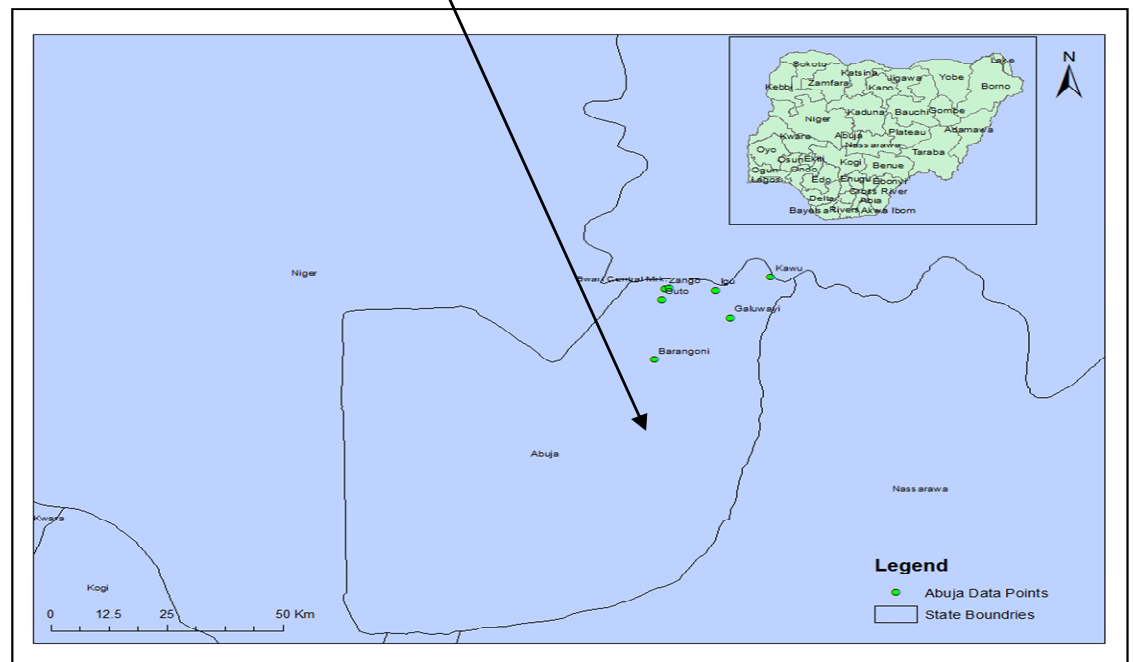
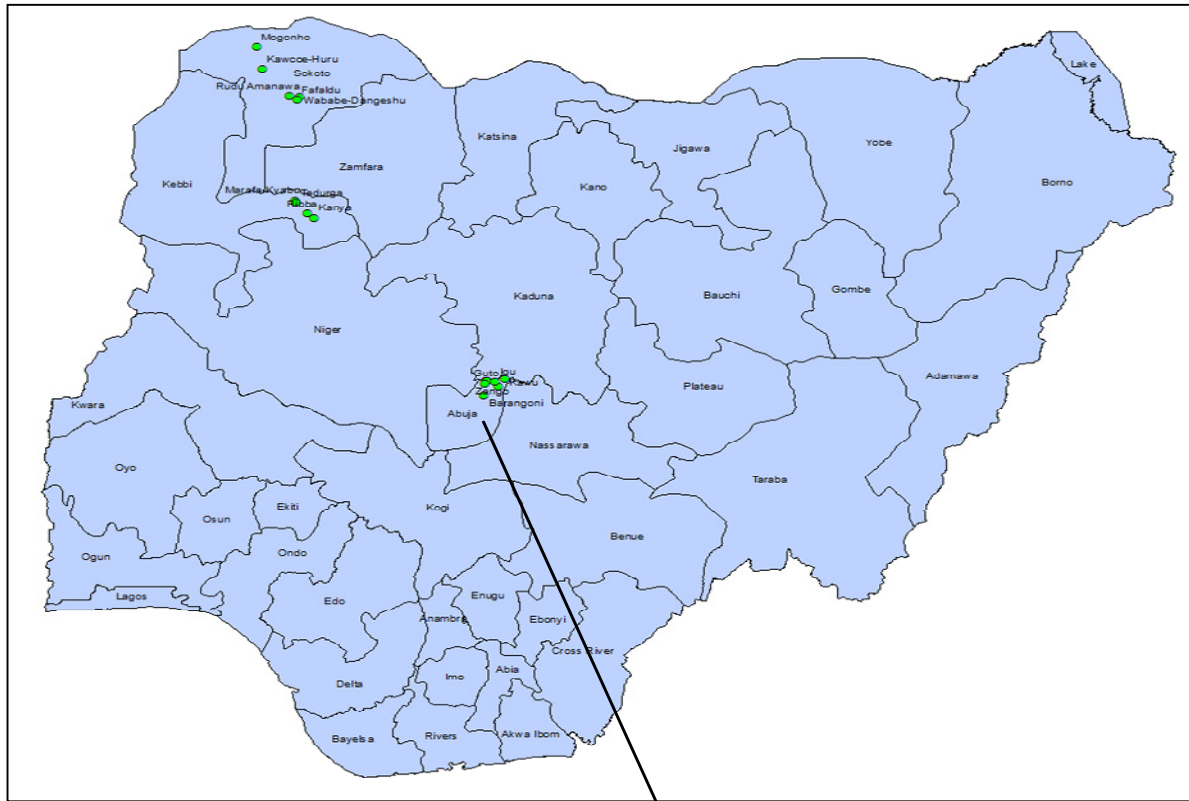
80 cattle, sheep, and goats is also an important economic activity ([http://nigeriazipcodes.com/wp-](http://nigeriazipcodes.com/wp-content/uploads/2012/07/FCT-Abuja-Postcode-Map.jpg)
81 [content/uploads/2012/07/FCT-Abuja-Postcode-Map.jpg](http://nigeriazipcodes.com/wp-content/uploads/2012/07/FCT-Abuja-Postcode-Map.jpg))

82 **Survey Method**

83 A structured questionnaire containing both closed and open-ended questions was designed to
84 elicit primary data for the study. The sampling frame where the sample was drawn came from
85 the list of farmers across the communities of the Area Council. A Multi-stage random sampling
86 technique was employed in selecting the samples from where the data were collected. This
87 procedure was used in selecting 60 farmers from 10 major communities (Baragoni, Gaba,
88 Galuyi, Igu, Kawu, Kuchiku, Kuduru, Sherekoro, Kute and Sunape) that were aggregated into
89 seven (7) sampling points (Bwari Central Market, Baragoni, Igu, Galuyi, Guto, Kawu and
90 Zango) in the study area (Figure A)

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92



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94 Figure A. Nigeria Map Showing Location of FCT and Bwari Area Council study site

95 **Data Analysis**

96 Data were analyzed using descriptive statistics, gross margin as well as Ordinary Least Square
97 and Multiple Regression models.

98 The gross margin model is expressed mathematically as:

99 $GM = Q_y P_y - \sum Q_{xi} P_{xi}$ equation 1

100 Where,

101 GM = Gross Margin (N/ha)

102 Q_y = Quantity of Output (Kg)

103 P_y = Output Price (N)

104 Q_{xi} = Quantity of the i th unit of input (Kg)

105 P_{xi} = Price of the i th unit of input (N)

106 and,

107 Benefit cost Ratio = $\frac{\text{Total Benefit}}{\text{Total Cost}}$

108 equation 2

109 **Multiple Regression Model**

110 Multiple regression analysis was used to establish the relationship between key factors that may
111 likely predict the direction and magnitude of the production enterprise and it is expressed as:

112 $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 \dots + U)$ equation 3

113 Where,

114 Y = Total Profit (/ha)

115 X_1 = Age (Years)

116 X_2 = Level of education (Liters)

117 X_3 = Farm size (Hectare)

118 X_4 = Household size (Number)

119 X_5 = Farming experience (Years of farming)

120 X_6 = Irrigation (Dummy: 1 if farmer practices irrigation, 0 if otherwise).

121 X_7 = Gender (Dummy: 1= Male; 0 = Female)

122 X_8 =Planting materials (Naira)

123 X_9 = Herbicide treatment (liters)

124 U = Error Term

125 It is expected *a priori* that $X_2, X_3, X_4, X_5, X_6, X_7, X_9 > 0$; $X_1, X_8 < 0$

126 The relationship between the endogenous and each of the exogenous variables were tried using

127 four functional forms such as linear, exponential, double log and semi log while the best fit

128 functional form was selected based on econometric and statistical criteria.

129 Results and Discussion

130

131 Socioeconomic Characteristics of Respondents

132 **Table 1:** Distribution of respondents according to their socio-economic characteristics

133 Variable	Mean	Standard Deviation	Range
134 Age (years)	52.67	6.831	28-62
135 Level of Education (years)	10.13	5.258	0-17
136 Farm Size	4.22	0.927	0-6.5
137 Household size (persons)	7.28	1.250	2-12
138 Farming experience (years)	26.27	7.180	1-38

139 **Source: Field Survey Data, (2016).**

140

Table 1 show that the average age of the farmers who use herbicide for weed control was 52.67 years with a standard deviation of 6.83 years. This indicates a high degree of variability in the ages of the farmers; nevertheless, they are still within the active and productive age to provide optimal performance in any form of productive labour in the farm. The result also suggests that the farmers were within the age bracket that enabled them to bear risk and therefore were able to use herbicide. This is in agreement with the observations of Nwaru (2004) that the ability to bear risk and be innovative decreases with age, thus farmers in this study were within the youthful age. The average number of years in education was about 10 years, and this shows that farmers were reasonably educated though there was a wide variability in the years they spent in formal education (5.24years). This literacy level is advantageous and has implications for exposure and adoption of innovation as evident in the use of herbicide in place of manual weeding. According to Okoye et al. (2004) and Udensi *et al* (2012), educated farmers were likely to be more receptive to improved farming practices than farmers with little or no education. The mean farm size of 4.22 hectares suggested that the farmers had small farms and were categorized as small holder farmers. Small holder farmers cultivate on the average 0.1-5.99 hectares (Ogungbile and Olukosi, 1991). A mean household size of 7 persons is an indication of availability of farm hands. This high figure could be attributed to the tradition in the study area which allowed men to marry more than one wife, and this may enhance the availability of (Effiong, 2005; Idiong, 2005). This has implications for higher profit of the enterprise. A mean farming experience of 26.27 years shows that the farmers were well experienced in farming which did not indicate experience in the use of herbicide treatment in the study area. Though farmers had little or no experience in herbicide use but having good farming experience is an advantage as this will make farmers to be more or less averse to risk involved by using herbicide. Farming experience

164 according to Udensi *et al.* (2012), is an important variable that reduces the risk that may be
165 encountered by farmers in using a new technology.

166

167 **Cost and return of yam-maize-soybean enterprise**

168 Table 2 shows the cost and returns analysis of yam-maize-soybean enterprise per hectare of
169 farmland. The total revenue was ₦1,062,696.075 per hectare. The estimated variable cost was
170 ₦918856 was obtained with a gross margin of ₦143,840.075 and net farm income of
171 ₦112,529.10. The returns per naira invested was estimated to be 1.23 which implied that for
172 every ₦1 spent in the enterprise, the farmer made a return of ₦1.23 kobo.

Table 2: Distribution of costs and return per hectare of yam/maize/soybean in the study area.

Item	Unit	Quantity	Price	Value (₦)
Revenue				
Yam	Kg	2636.35	236.20	622705.87
Maize	Kg	2512.2	92.13	231,448.986
Soybean		1262.35	165.2	208,540.22
Total Revenue (A)				1,062,696.075
Variable Cost				
Tubers	Kg	10000	28.13	281,300
Maize Seeds	Kg	32	152.4	4,876.80
Soybean seeds	Kg	46	162.21	7461.66
Fertilizer	50kg/bag	16	8644.36	432,218
Herbicide Application	Lump			87000
Land Preparation	MD	5	3500	17500
Planting	MD	8	1500	12000
Fertilizer application	MD	12	2000	24000
Weeding	MD	3	1500	4500
(Herbicide application)				
Harvesting	MD	6	8000	48000
Total Variable Costs (B)				918856
Fixed Costs				
Depreciation expenses				7312
Rent on land				10247
Interest				13752
Total Fixed Costs(C)				31311
Total Costs (B+C= D)				950167
Net return(A-D=F)				112,529.1
Gross Margin				143,840.075
Benefit/ cost ratio(A/D)				1.12
Gross Margin ratio (A/B)				1.16

Source: Field Survey data (2016)

The gross margin ratio was estimated to be 1.16 which implied that for every ₦1 realized from the sales of yam, maize and soybean, the farmer had ₦1.16 kobo left over to cover basic variable costs and profit. This suggested that yam-maize-soybean production in the savanna is profitable.

Determinant of the profitability of yam-maize-soybean production enterprise

The profitability of the yam-maize-soybean production with herbicide treatment was estimated using the multiple regression analysis (Table 3); four functional forms were estimated. The semi-

log functional form was the lead equation as it has the highest coefficient of multiple determination (R^2), number of t-values as well as conformity with *a priori* expectations.

Table 3: Regression analysis of the yam-maize-soybean enterprise with herbicide treatment.

Variables	Linear	Exponential	Double log	Semi-log
Constant	448004.570	177619.642	13.110	12.142
Age(X1)	245.665 (-0.233)	79748.730 (-1.103)	-.004 (-1.279)	.099 (-1.120)
Education level(X2)	3808.102 (1.551)	44165.746 (1.200)	.009 (2.598)**	.107 (2.722)**
Farm size(X3)	37492.957 (2.880)**	84077.154 (1.617)	.091 (2.521)*	.177 (2.541)**
Hhold size(X4)	7303.528 (-0.694)	58367.287 (-1.005)	.011 (-1.520)	.094 (-3.361)**
Farm Experien(X5)	3643.350 (-1.399)	110359.399 (2.465)*	0.009 (1.520)	0.233 (2.649)**
Irrigation(X6)	14642.964 (1.255)*	13739.487 (2.360)*	.060 (2.444)*	.057 (2.523)*
Gender(X7)	46947.687 (0.733)	46919.492 (0.211)	.069 (1.518)	.069 (1.521)
Plant Material(X8)	-0.0407 (-1.206)	-3389.556 (-1.738)	-9.474E-10 (-1.002)	0.020 (-3.109)**
Herbicide(X9)	.100 (2.039)*	16104.504 (2.502)*	1.567E-6 (2.837)**	.110 (3.234)**
R ²	.067	0.76	0.81	.086
N	60	60	60	60
F-Value	12.26	18.94	22.74	27.85

** = Significant at 5%, * = Significant at 1% ** F-value significant at 5%, figure in are t-ratio
Source: Field Survey, 2016

The R^2 value of (0.86) indicated that the explanatory variables that were considered highly accounted for 86% of variations in the dependent variable as shown in Table 3. The F-value of 27.85 was significant leading to the rejection of the null hypothesis that there is no significant difference between profitability of the yam/maize/soybean crop mixture and the socioeconomic characteristics of the farmers.

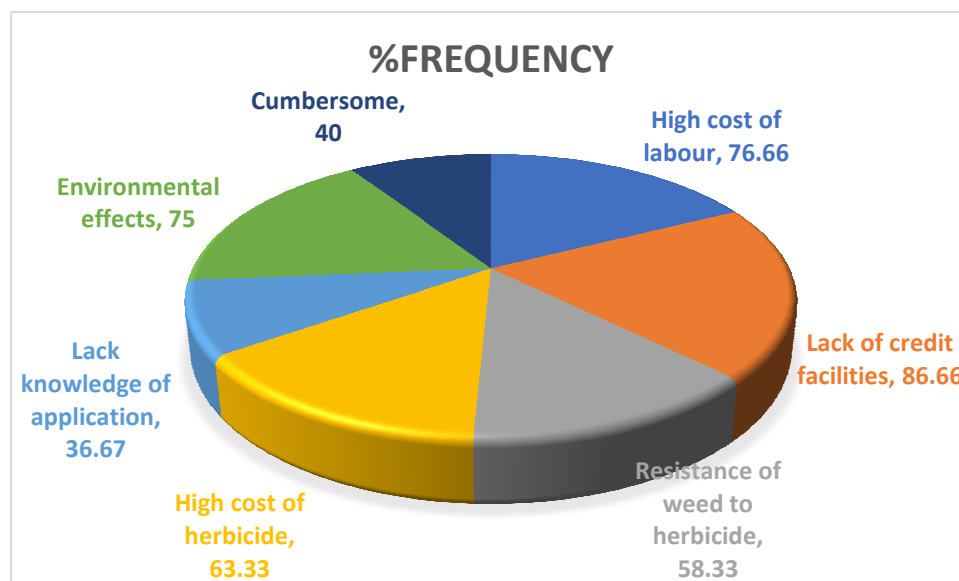
The level of education (X_2), farm size(X_3), household size (X_4), farming experience (X_5), cost of planting materials (X_7), use of herbicide (X_8) were statistically significant at 5% probability level

($P < 0.05$), while use of irrigation (X_6) was statistically significant at 1% probability level ($P < 0.01$). The significant variables accounted for 86% of the observed variation in the farmer's profit.

Level of education (X_2), farm size(X_3), farming experience (X_5), use of irrigation (X_6) and use of herbicide (X_8) were positive and statistically significant. This was in conformity with *a priori* expectation. This indicated that as farmers increase the usage of these inputs, more profit would be obtained with herbicide treatment.

However, household size (X_4) and cost of planting materials (X_7) were negative and statistically significant at 5% probability level, suggesting that the higher they were, the less the volume of profit made by the farmers who used herbicide treatment. This implied that level of education (X_2), farm size(X_3), household size (X_4), farming experience (X_5), use of irrigation (X_6), cost of planting materials (X_7), use of herbicide (X_8) are determinants of profitability in the use of herbicide treatment by farmers involved in yam-maize-soybean production in the Savanna.

272
273 **Fig 1:** Distribution of yam-maize-soybean farmers according to problems encountered in the use
274 of herbicide treatment.



275
276 Source: Field Survey, 2016

277
278 Problems encountered by yam-maize-soybean farmers in the use of herbicide is presented in
279 Figure 1. The major problem encountered by the farmers was lack of credit facilities as it ranked
280 first (86.66%). This was followed by high cost of labour (76.66%), and followed by
281 environmental factors (75%). Hossain (2015) observed that some important environmental
282 factors are associated with the over use of herbicides. These include unintended damage
283 occurring both on the sprayed site, and offsite. High cost of herbicide (63.33%) and resistance of
284 some weeds to certain herbicides (58.33%) ranked 4th and 5th respectively. ISHRW (2015) and
285 Prather et al. (2000) confirmed resistance of some weeds to herbicides. According to them,
286 repeated use and application of any herbicide will expose weed populations to selection pressure
287 that may lead to an increase in the number of surviving species, and of resistant individuals in the

population. The least problem encountered by the farmers was lack of knowledge of application (36.67%) which ranked 6th and the farmers who believed that the practice is cumbersome (40%) ranked 7th. This low response could be attributed to the fact that majority of the respondents were reasonably educated which had the capacity of exposing them to innovations as well as skills required in the use of herbicide treatment in the yam-maize-soybean enterprise.

Conclusion and Recommendations

The use of herbicide treatment in yam-maize-soybean enterprise in the Northern Guinea Savanna agroecology is profitable. The study therefore concluded that yam/maize/soybean production in the savanna is a profitable enterprise. Farmers in the savanna region should be encouraged to use herbicides in weeding their farms. Consistent government policies that would favour herbicide subsidization and credit facilities should be made available and implemented.

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