

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 regression. Result shows 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, with net income of ₦280,118.615 and the return per naira was 1.36, implying that for every naira spent in the enterprise the farmer expects a return of ₦1.36. The gross margin ratio estimate was 1.69, and this result implied that for every ₦1 realized from the sales of yam, maize and soybean the farmer had ₦1.69 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. 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: Profitability, Yam- maize-soybean, Resource poor farmers, Herbicide, Weed control.

Introduction

Effective weed control in crop production systems is a necessary requirement that will enable increased crop (Masthan *et al.*, 1989). According to Prasad *et al* (2008), manual weeding is labour intensive; and if done late sometimes may lead to severe yield losses (Rashid *et al.*, 2012). Manual weeding has been found to be unsustainable (Kamara, 2012) and cumbersome in terms of 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).

Different crops combinations can be grown simultaneously on a piece of land. For instance, (Obasi, Henri-Ukoha, Anosike, & Ibekwe, 2015) identified cassava based (cassava, maize, melon), yam based (yam, cassava, maize and melon) as well as other crops that could be in the mixture such as okra, groundnut, cocoyam, pepper, tomatoes and amaranths. This mixture helps

to make up for losses arising from the other crop enterprise. The uncertainty of yield due to changing climatic conditions, contributes to farmers choice of more crop combination, the choice of four different crop mixtures has an added advantage of resource (land) utilization and higher returns on investment (Chidiebere-Mark, *et.al.*, 2014). The herbicide may be selective herbicides or non-delective herbicide which could be pre-emergence or post emergence herbicides.

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 (Omorbude 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 to:

- (i) Describe the socio-economic characteristics of the yam-maize-soybean crop mixture farmers in the study area
- (ii) to determine the profitability of yam-maize-soybean enterprises;
- (iii) determine factors influencing the profitability of the mixture; and
- (iv) to identify the problems encountered by the farmers in the use of chemical weed control measures.

Materials and Methods

Study Area

The study was conducted in Bwari Local Area Council of Federal capital territory (FCT), Abuja. It lies at latitude range of 08° 00' and 09° 31' north and longitude 007° 22' and 07° 58' east. It

has a population of about 371,674 million people and a land mass of 914km² (National Population Commission, 2006). The mean annual temperature is 25.3°C, mean annual rainfall of 1387mm and relative humidity of 59 percent. 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.

Sampling Technique and Sample Size

The sampling frame where the sample was drawn came from the list of farmers across the communities of the Area Council. A Multi-stage sampling technique was employed in selecting the respondents. In the first stage, 10 communities were randomly selected from the communities in the study area. The selected communities include Baragoni, Gaba, Galuyi, Igu, Kawu, Kuchiku, Kuduru, Sherekoro, Kute and Sunape (though they were later aggregated into seven (7) sampling points) which include Bwari Central Market, Baragoni, Igu, Galuyi, Guto, Kawu and Zango in the study area (Figure A). In the second stage, 6 farmers that practiced cassava/maize/soyabean crop mixture were purposively selected. The reason for the purposive selection was to get the target respondents. This gave a total of 60 farmers.

Data were obtained through primary sources by the administration of a structured questionnaire.

Data Analysis

Objectives i and iv were analyzed using descriptive statistics such as mean, percentages, frequency counts; objective ii was analyzed using Net Return and Gross margin models while objective iii was analyzed using Ordinary Least Square and Multiple Regression models.

103 The gross margin model is expressed mathematically as:

104 $GM = Q_y P_y - \sum Q_{xi} P_{xi}$ equation 1

105 Where,

106 GM = Gross Margin (N/ha)

107 Q_y = Quantity of Output (Kg)

108 P_y = Output Price (N)

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

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

111 and,

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

113 equation 2

114 Multiple Regression Model

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

117 $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 \dots + U)$ equation 3

118 Where,

119 Y = Total Profit (Naira)

120 X_1 = Age (Years)

121 X_2 = Level of education (Years)

122 X_3 = Farm size (Hectare)

123 X_4 = Household size (Number)

124 X_5 = Farming experience (Years of farming)

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

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

127 X_8 =Planting materials (Kg)

128 X_9 = Herbicide treatment (liters)

129 U = Error Term

130 *A priori* that $X_2, X_3, X_4, X_5, X_6, X_7, X_9 > 0$; $X_1, X_8 < 0$

131 The relationship between the endogenous and each of the exogenous variables were tried using
 132 four functional forms such as linear, exponential, double log and semi log while the best fit
 133 functional form was selected based on econometric and statistical criteria.

134 Linear function

135 $Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8$ equation 4

136 Semi-log

137 $Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 +$
 138 $b_8 \log X_8 +$ equation 5

139 Double log

140 $\log Y = b_0 + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 +$
 141 $b_8 \log X_8 +$ equation 6

142

Exponential

$$Y = ae^{b_1x_1 + b_2x_2} \dots\dots\dots\text{equation 7}$$

Results and Discussion

Socioeconomic Characteristics of Respondents

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

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

Source: Field Survey Data, (2016).

Table 1 shows 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 can bear risk. This is in agreement made immediately after observation of Nwaru (2004) that the ability to bear risk and be innovative decreases with age, thus farmers in this study were in their youthful age. The average number of years in education was about 10 years, and this shows that farmers were reasonably educated. Although 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 are likely to be more receptive to improved farming practices than farmers with little or no education. The mean of farm size of 4.22 hectares

172 suggested that the farmers had small **farm sizes** and were categorized as small holder farmers.
 173 Small holder farmers cultivates on the average 0.1-5.99 hectares (Ogunbile and Olukosi, 1991).
 174 A mean household size of 7 persons is an indication of availability of farm hands. **This could be**
 175 **attributed the tradition which allows men**
 176 **to marry more than one wife** (Effiong, 2005; Idiong, 2005). This has **implication** for higher
 177 profit of the enterprise. A mean farming experience of 26.27 years shows that the farmers were
 178 well experienced in farming which did not indicate experience in the use of herbicide treatment
 179 in the study area. Though farmers had little or no experience in herbicide use but having good
 180 farming experience is an advantage as this will make farmers to be more or less averse to risk
 181 involved by using herbicide. Farming experience according to Udensi *et al.* (2012), is an
 182 important variable that reduces the risk that may be encountered by farmers in using a new
 183 technology.

184

185 **Costs and Return**

186 Table 2 shows the cost and returns analysis of yam-maize-soybean enterprise per hectare of
 187 farmland. The total revenue was ₦1,062,696.075 per hectare. The estimated variable costs was
 188 ₦627,498.46 was obtained with a gross margin of ₦435,197.615 and net farm income of
 189 ₦280,118.615. The returns per naira invested was estimated to be 1.36 which implied that for
 190 every ₦1 spent in the enterprise, the farmer made a return of ₦1.69 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	7210	115,360
Herbicide Application	Lump			87000
Land Preparation	MD	14	3500	4900
Planting	MD	8	1500	12000
Fertilizer application	MD	9	2000	18000
Weeding	MD	3	1500	4500
(Herbicide application)				
Harvesting	MD	6	8000	48000
Total Variable Costs (B)				627,498.46
Fixed Costs				
Depreciation expenses				7312
Rent on land				10247
Interest				137520
Total Fixed Costs (C)				155,079
Total Costs (B+C= D)				782,577.46
Net return(A-D=F)				280,118.615
Gross Margin				435,197.615
Benefit/ cost ratio(A/D)				1.36
Gross Margin ratio (A/B)				1.69

Source: Field Survey data (2016)

The gross margin ratio was estimated to be 1.69 which implied that for every ₦1 realized from the sales of yam, maize as well as soybean; the farmer had ₦1.69 kobo left over to cover basic variable costs and profit. This suggests that yam-maize-soybean production in the savanna is profitable.

Determinants 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(X_1)	245.665 (-0.233)	79748.730 (-1.103)	-.004 (-1.279)	.099 (-1.120)
Education level(X_2)	3808.102 (1.551)	44165.746 (1.200)	.009 (2.598)**	.107 (2.722)**
Farm size(X_3)	37492.957 (2.880)**	84077.154 (1.617)	.091 (2.521)*	.177 (2.541)**
Hhold size(X_4)	7303.528 (-0.694)	58367.287 (-1.005)	.011 (-1.520)	.094 (-3.361)**
Farm Experien(X_5)	3643.350 (-1.399)	110359.399 (2.465)*	0.009 (1.520)	0.233 (2.649)**
Irrigation(X_6)	14642.964 (1.255)*	13739.487 (2.360)*	.060 (2.444)*	.057 (2.523)*
Gender(X_7)	46947.687 (0.733)	46919.492 (0.211)	.069 (1.518)	.069 (1.521)
Plant Material(X_8)	-0.0407 (-1.206)	-3389.556 (-1.738)	-9.474E-10 (-1.002)	0.020 (-3.109)**
Herbicide(X_9)	.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 indicates that the explanatory variables that were considered highly accounted for 86% of variations in the dependent variable as shown in Table 3. Variables such as 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%

266 probability level ($P < 0.05$), while use of irrigation (X_6) was statistically significant at 1%
 267 probability level ($P < 0.01$).

268 The significant variables accounted for 86% of the observed variation in the farmer's profit.

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

273 Level of education was positive and significant implying that the higher the level of education,
 274 the higher the profitability of yam/maize/soybean crop mixture for farmers who use herbicide
 275 treatment.

276 Farm size was positive and significant implying that the higher the farm size, the higher the
 277 profitability of yam/maize/soybean crop mixture for farmers who use herbicide treatment.

278 Farming experience was positive and significant implying that the higher the farming experience,
 279 the higher the profitability of yam/maize/soybean crop mixture for farmers who use herbicide
 280 treatment.

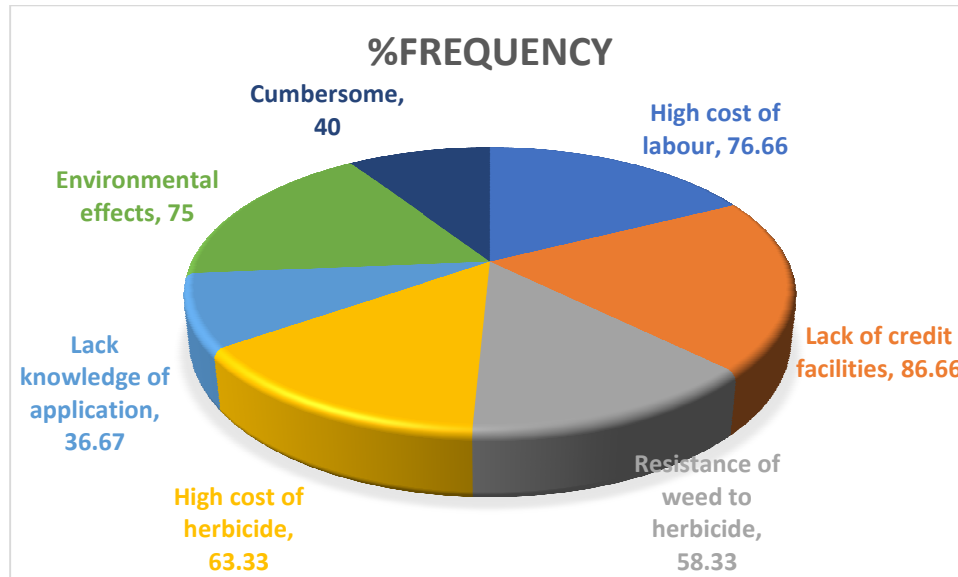
281 Use of irrigation was positive and significant implying that the higher the use of irrigation in
 282 their farmers, the higher the profitability of yam/maize/soybean crop mixture for farmers who
 283 use herbicide treatment.

284

285 However, household size (X_4) and cost of planting materials (X_7) were negative and statistically
 286 significant at 5% probability level, suggesting that the higher the values of these variables, the
 287 less the amount of profit made by the farmers who used herbicide treatment. This implied that
 288 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.

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



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Source: Field Survey, 2016

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Problems encountered by yam-maize-soybean farmers in the use of herbicide is presented in Figure 1. The major problem encountered by the farmers was lack of credit facilities as it ranked first (86.66%). This suggests that the farmers did not have good access to credit facilities which likely affected their ability to purchase herbicides for the control of weeds in their farmland. Credit is an important resource to farmers. This was followed by high cost of labour (76.66%). Another major problem is environmental factors (75%). Hossain (2015) observed that some important environmental factors are associated with the over use of herbicides. These include unintended damage occurring both on the sprayed site, and offsite. This corroborates the findings

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of Mamy, Gabrielle and Barriuso (2010) who observed that long-term fate of the herbicides has a negative effect on the environment through their breaking down of their products in the soil, air and groundwater.

High cost of herbicide (63.33%) and resistance of some weeds to certain herbicides (58.33%) ranked 4th and 5th respectively. International Survey of Herbicide Resistant Weeds (2015) and Prather *et al.* (2000) confirmed resistance of some weeds to herbicides. According to them, repeated use and application of any herbicide will expose weed populations to selection pressure 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 was ranked 6th and the farmers who believed that the practice is cumbersome (40%) ranked 7th.

Conclusion and Recommendations

The use of herbicide treatment in yam-maize-soybean enterprise in the Northern Guinea Savanna agroecology is profitable. The farmers were young, reasonably educated and experienced with large number of persons per household. They cultivated on small farm sizes. The study therefore concluded that yam/maize/soybean production in the savanna is a profitable enterprise.

Level of education, farm size, household size, farming experience, use of irrigation, cost of planting materials, use of herbicide are determinants of profitability in the use of herbicide treatment by farmers involved in yam-maize-soybean production in the Savanna.

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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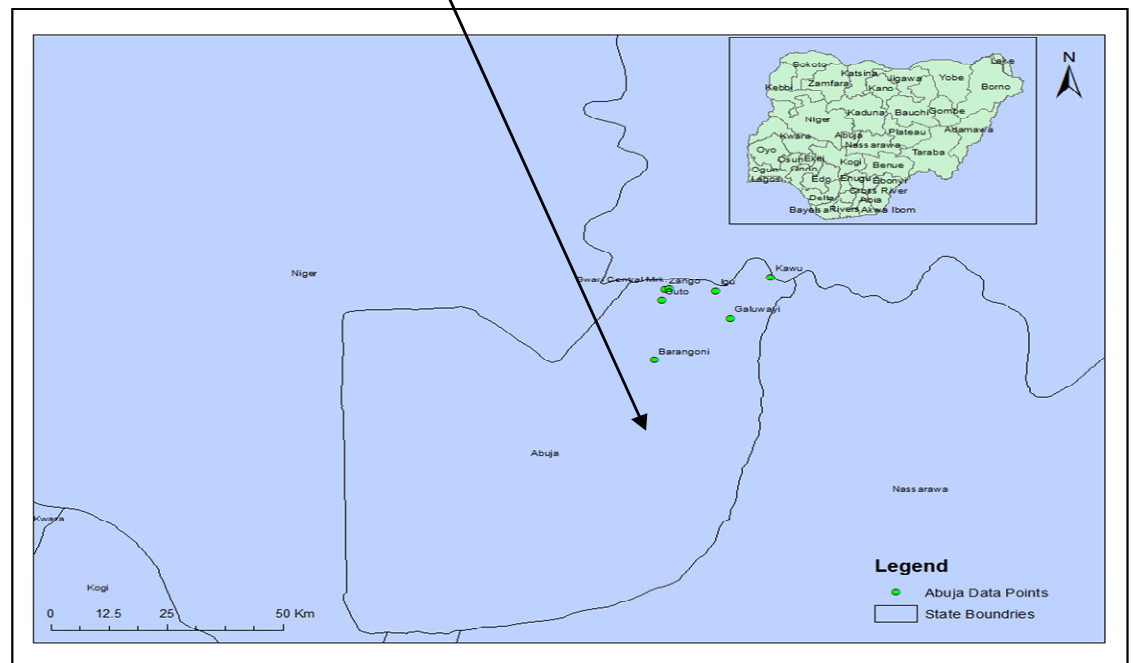
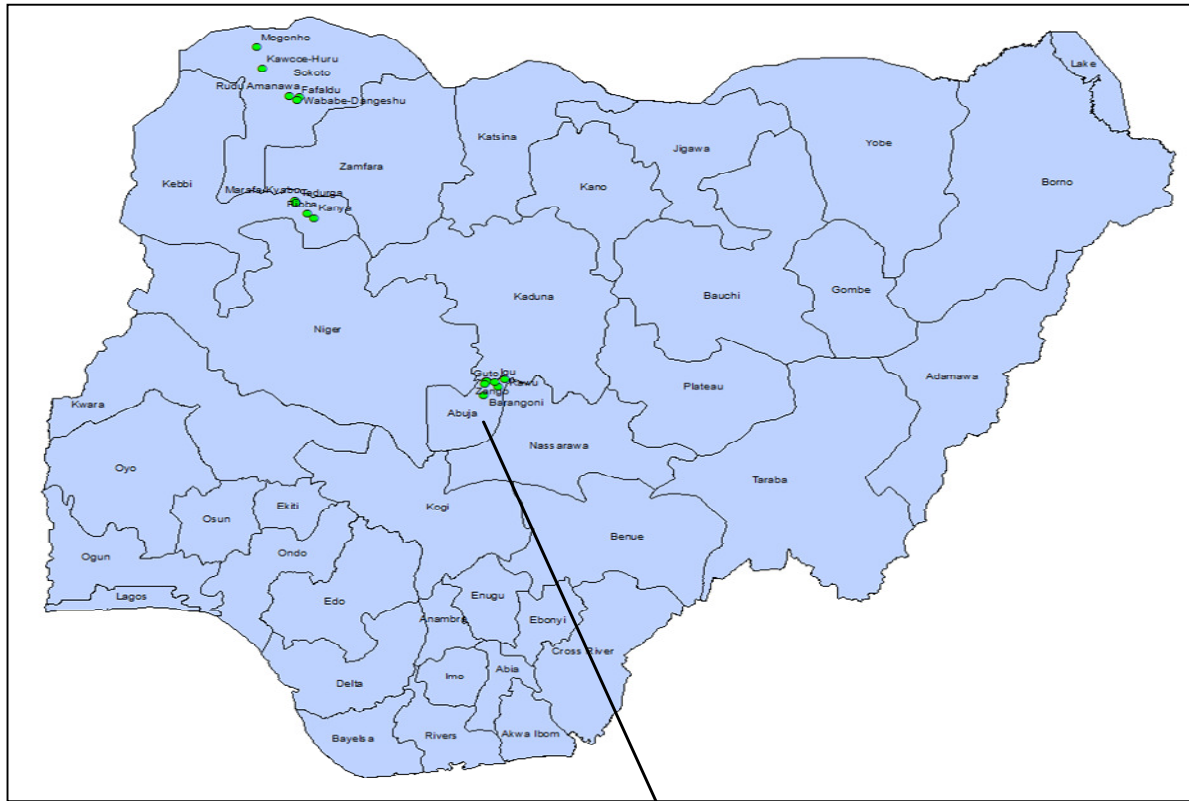


Figure A. Nigeria Map Showing Location of FCT and Bwari Area Council study site