DETERMINANTS OF ADOPTION OF AGRICULTURAL INNOVATIONS AND PROFITABILITY OF CEREALS AND LEGUMES IN THE SUDAN SAVANNA OF NIGERIA

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ABSTRACT

In order to facilitate a scientific assessment of the viability of the IAR4D concept, this paper analyzed the factors affecting adoption of agricultural technologies as well as determined the profitability of cereals and legumes in the Sudan savanna of Nigeria. Data were obtained from the baseline study conducted in 2008 as well as other official secondary data. Descriptive statistics, budgetary as well as logistic regression techniques were used to analyze the data. Results show that the respondent's age range vary between 40 and 55 years implying that they are relatively young elders with large family size of between 12 and 14 possibly providing family labour for farm work. The educational level is expectedly low with only about a third of them having up to six years of formal education. The regression results reveal that the location of the farmer, large family size and awareness encouraged adoption of new technologies across the various sites. The gross margin analysis reveals that among the cereal crops, maize gave the highest yield and revenue, while for legume crops, groundnut gave the highest yield and revenue figures in all sites with labour being the highest variable cost item on all sites. In conclusion, the study affirmed that farmers in the study area possess the potential to adopt agricultural innovations which could increase yields and enhanced income.

Keywords: Integrated Agricultural Research for Development, adoption, Innovation Platforms, gross margin

INTRODUCTION

The Sub Saharan Africa Challenge Programme (SSA CP) was initiated in 2004 following extensive consultations with numerous agricultural stakeholders (researchers, extension and development agents, policy makers, farmers and the private sectors) to diagnose the reasons behind the underperformance of agricultural research in Africa. (FARA 2008) The consultations established that besides inadequate funding, the main impediment to the contribution of Africans agricultural research to development lies in the way the research is organized and conducted. Research technology transfer and

technology use have been treated as independent activities whereby research derived knowledge consisting of large prescriptive technology packages flows linearly from researchers to farmers through extension agents (FARA 2008).

The consultations proposed an alternative approach that aims to appropriately embed agricultural research within a larger system of innovation whereby knowledge from numerous sources (comprising all various actors and stakeholders) is integrated and effectively put into use. This approach to agricultural research is termed Integrated Agricultural Research for Development (IAR4D) and has been adopted by the SSA CP (FARA 2008).

The SSA CP's research has been organized around four projects: One Meta- Analysis project and three Pilot Learning Sites (PLS) projects in three different regions of Sub Saharan Africa (i.e. Lake Kivu (LK) in Eastern and Southern Africa, Kano and Katsina in Nigeria, Maradi in Niger Republic (KKM) in West Africa, and Zimbabwe-Malawi-Mozambique (ZMM) in Southern Africa. Each PLS project comprise three sub-projects.

The three sub projects that constitute the KKM project are distinguished by the agro-ecological zones (AEZs) where their research is based and focused. The relevant AEZs are the Sahel, the Sudan Savanna, and the Northern Guinea Savanna. Each of the three sub projects aims to evaluate the effectiveness of the IAR4D concept in its respective AEZ by establishing Innovation Platform (IP) and conducting action research aimed at intensifying crop systems, improving access to markets and promoting sustainable management of the natural resource base.

The Sudan Savannah subproject is particularly concerned with agricultural intensification and integrated natural resource management to improve the rural livelihoods in the Sudan Savannah. The taskforce implementing the subproject is led by the International Institute of Tropical Agriculture (IITA).

Each of the three sub-projects that constitute the KKM PLS project has the same types of outputs but activities differ based on the entry points and the specific context of each AEZ. The specificity of each subproject comes from the actual content of the field research work planned based on the identified entry points. The taskforce responsible for implementing each sub-project comprises scientists, extension services, NGOs, private sector actors, policymakers (especially at the local level). This group constitutes the nucleus of the innovation platform (IP). The innovation platform is the key component of the IAR4D as it serves as the platform for diagnosing problems, exploring opportunities and investigating solutions by the participating farmers and stakeholders. Each sub-project will establish four innovation platforms that will deal with issues related to value chains that are most important for the given AEZ.

In order to undertake impact-oriented research of this new approach, there is need to examine the current adoption and use of the available technologies accessible to farmers, the level of productivity and profitability of cereals and legumes grown by farmers under different typologies in the study area. Therefore, the broad objective of this study is to determine the current level of adoption, productivity and profitability of cereals and legumes in Sudan Savanna of Nigeria. The specific objectives are to

(a) examine the socioeconomic characteristics of farmers under different typologies in the study area,
(b) analyze factors affecting adoption of agricultural technologies in the sudan

savanna, and

(c) determine the profitability of cereals and legumes grown by farmers in the study area.

METHODOLOGY

The study area

The Sudan Savanna subproject is led by the IITA (International Institute of Tropical Agriculture). Its areas of intervention include the Sudan Savanna zones of Katsina and Kano States in Nigeria.

This sub-project works on cereal and legume issues in the two States with special focus on the production to consumption value chains. The actual choice of cereal and legume depends on the comparative advantages of each of the regions due to rainfall in the north-south gradient.

The Data

The baseline data were obtained through a household survey conducted in the year 2008. The main instruments for data collection were well structured questionnaires administered on households by trained enumerators under the supervision of the IITA and the project task force. Altogether eight local government areas (lgas) were covered for the purpose of data collection. These were Bunkure, Shanono, Dawakin Tofa and Karaye lgas in Kano State and Safana, Musawa, Dan Musa and Ingawa lgas in Katsina State. Each IP covers 5 villages within a local government. 10 counterfactual villages (5 with no R&D and 5 with some R&D) have also been chosen for comparison purposes. Furthermore, for each IP, information sharing and technology uptake within the communities are assessed using a random sample of 10 farmers per village. The total sample size was therefore 600 households in all. This study employed multistage stratified random sampling within the selected local government areas (IAR4D and counterfactual) to select the villages where IAR4D were introduced, study village communities where conventional approaches are in operation, and study villages where no agricultural interventions have been carried out over the last 2-5 years.

Analytical technique

Data were analyzed with the aid of descriptive statistics, logistic regression model and budgetary techniques. Factors that influenced adoption of improved agricultural technologies such as improved crop varieties, improved maize and cowpea technologies were determined using logistic regression model. The model with dependent variable (Y) and the vector of independent variables are described and explained as follows.

Logistic regression is used to model the relationship between a categorical outcome variable, which is usually dichotomous, such as disease being present versus absent, and a set of predictor variables. Traditionally, logistic regression assumes that the observations are a random sample from a population (i.e., independently and identically distributed random variable), where the model is expressed as

$$yi = \pi(xi) + \varepsilon i. \qquad (1)$$

In this equation, yi represents the dichotomous dependent or outcome variable; π(xi) represents the conditional probability of experiencing the event given independent predictor variables, xi, or Pr(Yi = 1|xi); and εi represents the binomial random error term. More formally, the conditional probability, π(xi), as a function of the independent covariates, xi, is expressed as

$$\pi(X_i) = Pr(Y_i = 1 \mid X_i) = \frac{e^{X_i\beta}}{1 + e^{X_i\beta}} \qquad (2)$$

where $\boldsymbol{\beta} = (\beta 0, \beta 1, \ldots, \beta p)$ are the model parameters to be estimated and p + 1 is the number of independent terms in the model.

Pearson's chi-squared test is one such goodness-of-fit test that examines the sum of the squared differences between the observed and expected number of cases per covariate pattern divided by its standard error. In traditional logistic regression where n observations are independently sampled (i.e., there are no clusters), a covariate pattern is defined to be a unique set of the xi's, where i = 1, . . . , n, and mk will represent the number of subjects with the same covariate pattern where k = 1, . . . , K. Therefore, K represents the number of unique covariate patterns.

Our X – vector of independent variables in this model is stated in Table 1. The rationale for inclusion of these factors was based on a priori of agricultural technology adoption literature (Alene et al. 2000; Bamire et al. 2002; Akinola et al. 2009; Bamire and Mayong 2003).

In order to evaluate the profitability of farm production activities, budgetary analyses involving the computation of the gross margin (GM) and the benefit cost ratio (BCR) was used. These were carried out separately for crop production activities along the MLL IP and SLL IP. The monetized values of variable inputs and incidental production costs were subtracted from gross revenue (GR) to arrive at GM estimates for crop enterprises. The RPN was calculated by finding the ratio of the GM to the total variable cost (TVC) in each case. That is

$$GM = GR - TVC \quad (3)$$

$$\text{and} \quad BCR = GM/TVC \quad (4)$$

From the above, it was possible to carry out a sensitivity analysis by increasing the cost and decreasing the revenues by 10% and then recalculating the GM to see whether crop production still gave a positive GM in the face of changing cost and revenues scenarios, as used by (Alimi and Mayong 2000).

Table 1: Variables Used in the Logistic Model of Determinants of Adoption Of Improved Agricultural Technologies

VARIABLE	DESCRIPTION	A PRIORI SIGNS	VARIABLE	DESCRIPTION	A PRIORI SIGNS
Y	Adoption of improved technology: 1 adopted; 0=otherwise				
LGA	1=Intervention local government; 0=non-intervention local government	±	TOTALREV	total income of the farmers	+
GENDER	1=male; 0=female	±	COWAREA	area of cowpea planted	+
HEADAGE	age of household head in years	±	INSECTIC	Cost insecticide used on cowpea	-
HEADEDU	education of household head: 1=formal education; 0=no formal education	+	TPREPCOS	other variable cost	-
HHSIZE	household size	±	TLABCOST	total labour cost	
DURATION	farm experience in years	+	CREDIT	amount of credit in Naira	+
AWARENES	awareness of improved agricultural technologies(crop)	+	TOTALAND	total land area	+
INPUTMKT	distance to input market		AWARENE0	awareness of improved agricultural technologies(livestock)	+
OUTPUTMKT	distance to output market		NON_FMIN	non-farm income in Naira	+
BORROWED	access to credit: 1=yes; 0=no	+	FERTILIZ	quantity of fertilizer used in kg	+
AGRIEXT	visited by agric extension agent: 1=yes; 0=no	+	ANIMALMA	animal manure in kg	+
FEXTENSION	frequency of extension visits	+			

RESULTS

The results of the analysis of the data are presented on an IP basis for easier understanding.

Kano - Maize-Legume IP (MLL IP)

Household Socio Economic Characteristics of the maize-legume IP (MLL IP) are shown in Figure 2. Age has been found to determine how active and productive the household head would be as well as the rate of household adoption of innovations that in turn affect household productivity and livelihood improvement strategies. Figure 2 shows the distribution of household heads by their age ranges. The ages of household heads were fairly similar in Kano State. The mean ages of the household head in the IAR4D Sites in Bunkure, R&D sites in Karaye and clean sites in Karaye LGAs were 48, 46 and 45 respectively. The mean age of the households in all the locations was between 40 and 55, indicating that the farmers were in their young productive age.

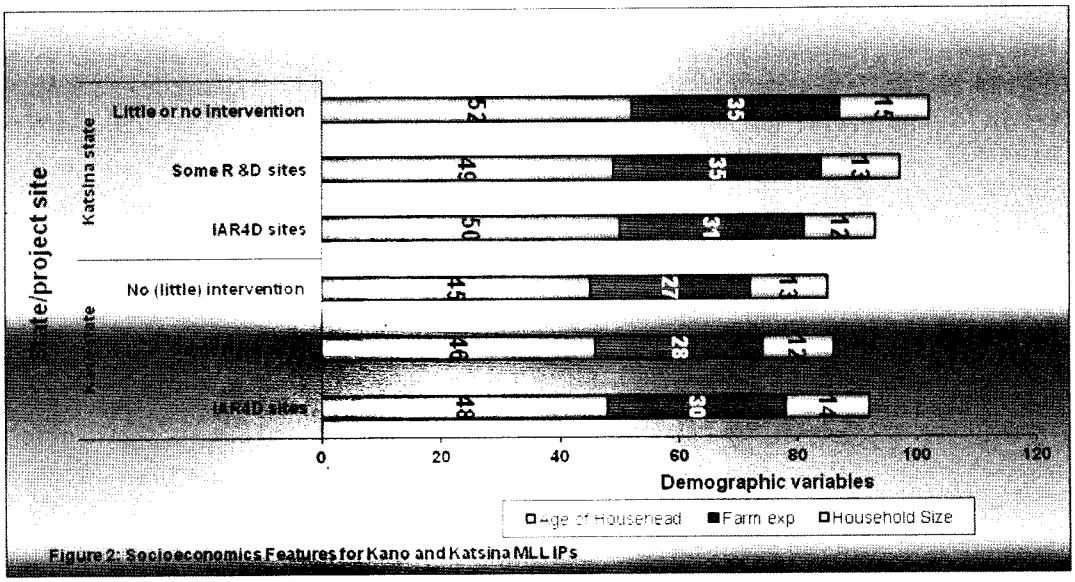

Figure 2: Socioeconomics Features for Kano and Katsina MLL IPs

Farming experience is an important factor that determines adoption of an innovation and productivity in farming, although the effect on productivity and production could be positive or negative, the effect on adoption is always expected to be positive. The farming experience of an average household head in all the sites in Kano was over 27 years implying that they have a reasonable number of years of experience in farming. The household size that indicates the availability of family labour for farming activity ranged from 12 to 14 in all the sites in the State suggesting a fairly large family size possibly for use on farm. However, the literacy level was generally low as the proportion of household heads that attended primary schools only range between 24 percent and 36 percent in the population. From the table, the proportion of farmers practicing polygamy in all the LGAs of maize-legume IP was high as expected, the highest being 62 percent since most farmers in the study area were Muslims. Most of the household were male headed (82-94 percent).

Katsina – Maize and Legume IP (MLL IP)

In this IP as in the Kano State MLL IP, the age of farmers was also fairly similar (Figure 2). The average ages in IAR4D site in Musawa,

Dan Musa [R&D sites] and in Dan Musa [clean sites] were 50, 49 and 52, respectively. This implies that the farmers were still in their young productive age. The average years of farming experience of more than 30 years obtained in Katsina State was indicative of the fact that the farmers in the State may be more experience than in Kano State. The average household size in the State was also similar to what obtained in Kano State (12-15) with no significant difference among the household size in all the sites, thus suggesting family labour availability. Literacy level was also low as less than 36 percent in IAR4D, R&D and clean sites had primary school education. Barely half of the households practiced polygamy and a significant proportion was male-headed (54-84 percent).

Kano – Sorghum and Legume IP (SLL IP)

Household socio economic characteristics of the farmers in the SLL IP are as shown in Figure 3. The result indicated that in Kano State, the average age of household heads in the clean site and the IAR4D was about 50, and 51 in the R&D sites. Most of the household head had farming experience of not less than 31 years in all the 3 sites with the household size ranging between 15 and 17. The literacy level in this IP was higher with the percentage that attended primary school ranging being 32 and 50 percent for clean and IAR4D sites, respectively. Polygamy was also not too rampant in the states as only 44 percent of the respondents were polygamous. Male headed household ranged between 78 and 98 percent.

Katsina – Sorghum and Legume IP (SLL IP)

In Katsina State, the average age of the household head was 47 each in IAR4D and R&D sites, while it was 51 in clean sites indicating that they are younger. While 44 percents of the households in R&D and clean sites had primary school education only 20 percent in IAR4D sites went to primary school. Polygamy ranged between 42 percent in R&D sites to 50 percent in clean sites.

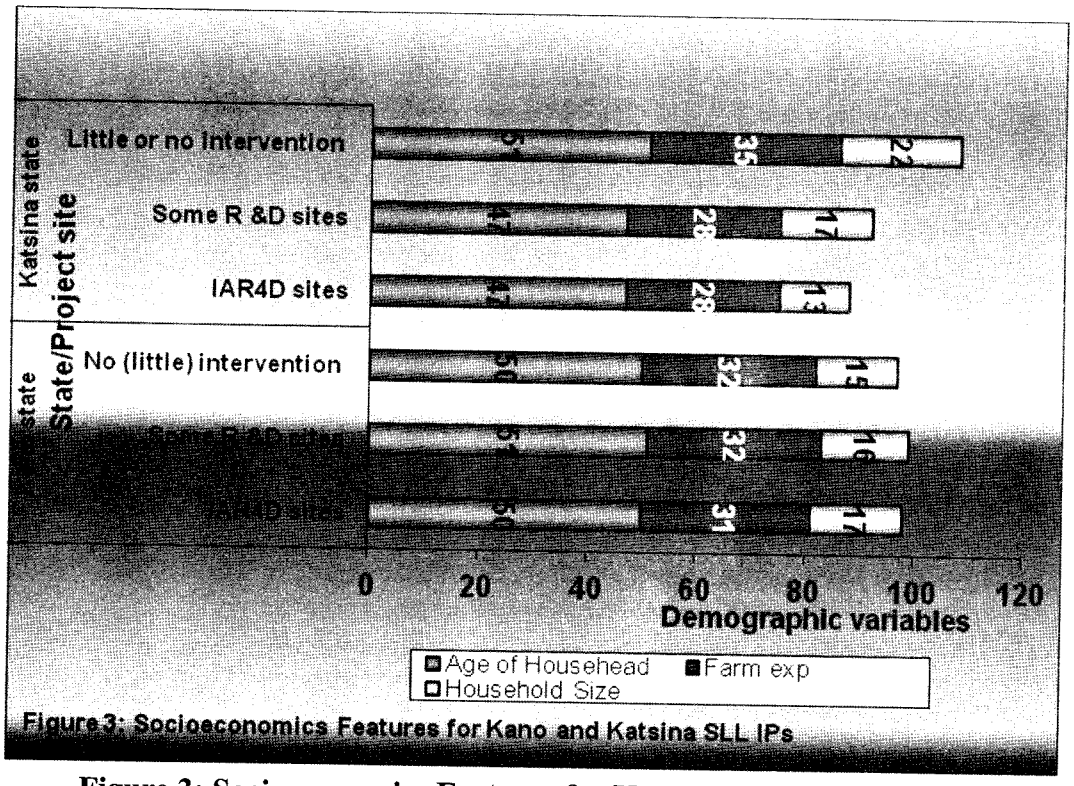

Figure 3: Socioeconomics Features for Kano and Katsina SLL IPs

The implication of the above results is that the basic household socio-economic characteristics of farmers in both the MLL IP and SLL IP are very similar with little statistically significant difference.

With the age range between 47 and 51 years, farming experience 28 to 35 years, household size ranging between 13 and 22 but with percent who had primary school education different at the different IPs: Kano MLL (24 - 36%); Kano SLL (32 -50%); Katsina MLL (36%) and Katsina SLL (20%). Polygamy, percentage of male headed households and housing properties were also similar among the IPs. This may be because the sample was chosen from the same agro ecological zone or socio cultural background.

Sources and Amount of Credit obtained for Farming.

Kano State - MLL IP

The availability of credit to farm household is vital to agricultural production and it is an important factor in the adoption process. The results of analysis of respondents by sources and amount of credit obtained showed that in all the IPs the farmers that borrowed did so mostly for agricultural purposes and obtained it mainly from informal sources, relatives and friends. The analysis showed (Table 2) that only 68 percent of the respondents that had access to credit in the IAR4D MLL IP borrowed an average amount of N25,000 whereas, in the R&D the 20 per cent households that had access to credit received about N 16,050 and 12 percent of the farmers that had access to credit received N85,000 in the average in the clean sites.

Table 2: Access to Credit Facilities (MLL IP)

Village	LGA	% that received credit	Average amount borrowed	Credit sources (major)	Purpose of borrowing (major)
Kano state					
7IAR4D sites	Bunkure	68(34)	25000(34)	Relative& friends	Agric
Some R &D sites	Karaye	20(10)	16050(10)	Relative& friends	Agric
No (little) intervention	Karaye	12(6)	85000(6)	Bank/relative & friends	Agric
Katsina state					
IAR4D sites	Musawa	64(32)	30188(50)	Relative& friends	Agric
Some R &D sites	Dan Musa	46(23)	28874(23)	Relative& friends	Agric
Clean	Dan Musa	40(20)	48275(20)	Relative& friends	Agric

Figures in brackets are number of respondents

Source: Field Survey 2008

Katsina State - MLL IP

In Katsina State of the MLL IP (Table 2), 64 percent of the farmers that had access to credit received about N30,188 on the average, 46 percent received about N28,894 in the R&D and 40 percent in the clean site received about N48,275 on the average.

Kano State - SLL IP

In the SLL IP of Kano State not all the households had access to credit (Table 3). Of all that had access to credit, amount received on the average varies. On the general note, those that had access to credit in Kano State under the SLL IP are more in number compared with their counterpart in the MLL IP, the amount received by an average household varies from about N31,000 in IAR4D; N61,000 in R&D to N103,000 in clean sites.

Katsina State - SLL IP

In Katsina State, fewer households had access to credit compared with their counterpart in the MLL IP (Table 3). Only 12 percent of the household that had access were able to receive an average of N8,500. In the R&D and clean sites in Katsina State, 36 percent and 38 percent of the household that had access received about N46,000 and N48,000 respectively.

In all, the results showed that more farmers in the MLL IP in Katsina State had access to credit, but farmers in the SLL IP in Kano State obtained higher amount of credit.

Access to and Use of Extension Services

Access to and use of extension services is vital to adoption of agricultural innovations. The results of access to and use of extension services are presented in Table 4.

Table 3: Access to Credit Facilities (SLL IP)

Village	LGA	% that received credit	Average amount borrowed	Credit sources	Purpose of borrowing
Kano state					
IAR4D sites	Shanono	86(43)	31279(43)	Relative& friends	Agric
Some R &D sites	Dawakin Tofa	48(24)	60958(24)	Relative& friends	Agric
No (little) intervention	Dawakin Tofa	52(26)	102538(26)	Relative& friends	Agric
Katsina state					
IAR4D sites	Safana	12(6)	8500(6)	Money lender(local one)	Food/Agric
Some R &D sites	Ingawa	36(18)	45722.22(18)	Relative& friends	Agric
Clean	Ingawa	38(19)	48315.79(19)	Relative& friends	Agric

Figures in brackets are number of respondents

Source: Field Survey 2008

Table 4: Access to and Use of Extension Services among the Farmers

Kano MLL IP	24	26	13	28	32	-
Katsina MLL IP	18	24	-	18	32	-
Kano SLL IP	28	30	18	17	24	16
Katsina SLL IP	16	04	04	16	13	04

Source: Data Analysis 2008

MLL IP-Kano and Katsina States

Farmers in the R&D sites of Kano and Katsina states seem to have more (26% and 24%) interactions with the extension agents though rather low when compared with their colleagues in the other villages. In terms of use also farmers in the R&D sites of Katsina State had better use of the interactions with 32% although the percentage is low.

SLL IP-Kano and Katsina States

In the SLL IP, farmers in R&D sites had more frequent interactions with the extension agents than the other groups. This is expected since the issue about extension has to do with the presence of government agents in the community.

Regression Results

Logistic regression on the determinants of adoption of improved crop technology.

Table 5 shows the result of logistic regression analysis on determinants of adoption of improved agricultural technologies. The chi square statistics as well as the log likelihood values indicate that the model is a good fit for the data. The regression was run for crops (generally) and for specific crops as maize and sorghum. The LGA was introduced into the regression model to account for the specific area where the IP is situated.

For crops, the variables that were significant are LGA, HHSIZE, INPUTMKT, OUTPUTMKT, FEXTENSION, NON FMIH and CREDIT. While the coefficient of LGA was negative suggesting that farmers in non-intervention will more likely adopt improved crop varieties than those in intervention sites. However, the other included variables had positive sign, suggesting that as household size and farmers awareness increased, tendency to adopt new varieties also increased. However the positive sign of the coefficient of distance to input and output markets does not conform to the a priori expectation, this may be because although the farmers knew that although both markets were far away their perceived need for improved propels them to cover the distance. In addition, the frequency of extension visit, non-farm income as well as amount of credit secured propels crops adoption.

For improved maize varieties adoption, only coefficients of LGA, HEADAGE and TPREPCOS were significant variables. In essence, farmers in intervention sites will more likely adopt new maize varieties than those non-intervention sites. Also, in line with a priori expectation, as farmers grew older, tendency to adopt new maize variety decline; however, increasing cost of production could

Table 5: Logistic regression on the determinants of adoption of improved crop varieties technology

VARIABLE	COEFF	VARIABLE	COEFF	VARIABLE	COEFF	VARIABLE	COEFF
CONSTANT	-2.59*	Constant	-1.18*	CONSTANT	-2.03*	CONSTANT	0.10
LGA	-1.79**	LGA	0.07***	LGA	-2.23**	LGA	-0.10**
GENDER	-0.40	GENDER	0.43	GENDER	0.18	GENDER	0.03
HEADAGE	0.001	HEADAGE	-0.004***	HEADAGE	0.22	HEADAGE	0.002
HEADEDU	0.12	HEADEDU	-0.287	HEADEDU	-0.12	HEADEDU	0.001
HHSIZE	0.00*	HHSIZE	0.000	HHSIZE	0.30	HHSIZE	0.001**
DURATION	0.001	DURATION	0.001	DURATION	-0.13**	TOTALAND	0.001**
TOTALAND	0.001	TOTALAND	0.0001	AWARENES	0.90***	AWARENE0	0.80*
AWARENES	4.50*	AWARENES	0.002	INPUTMKT	-0.90	INPUTMKT	0.001
INPUTMKT	0.001***	INPUTMKT	0.001	OUTPUTMKT	-0.68	BORROWED	0.02
OUTPUTMKT	0.0024***	OUTPUTMKT	0.002	BORROWED	0.78	AGRIEXT	-0.07
BORROWED	0.24	BORROWED	0.15	AGRIEXT	0.80***	FEXTENSION	0.003
AGRIEXT	-0.67	AGRIEXT	0.30	FEXTENSION	-0.21	NON_FMIN	0.001***
FEXTENSION	0.47***	FEXTENSION	0.03	TOTALREV	-0.45	TLABCOST	0.00***
NON_FMIN	0.002*	NON_FMIN	0.0001	COWAREA	0.47	CREDIT	0.002
FERTILIZ	0.001	TOTALREV	0.0001	INSECTIC	-0.35***		
ANIMALMA	0.003	FERTILIZ	0.0002	TPREPCOS	0.51		
TPREPCOS	0.002	TPREPCOS	0.0001***	TLABCOST	-0.67		
TLABCOST	0.001	TLABCOST	0.0003	CREDIT	-0.97		
CREDIT	0.001***	CREDIT	0.0002				
Test statistics		**Test statistics**		**Test statistics**		**Test statistics**	
Log likelihood function	-66.7	Log likelihood function	-332	Log likelihood function	-77.91	Log likelihood function	-42.5
Restricted log likelihood	-145	Restricted log likelihood	-342	Restricted log likelihood	-93.17	Restricted log likelihood	-131
Chi-squared	156.9	Chi-squared	18.45	Chi-squared	30.52	Chi-squared	178
Degrees of freedom	19	Degrees of freedom	20	Degrees of freedom	18.00	Degrees of freedom	14
Significance level	0.001	Significance level	0.558	Significance level	0.03	Significance level	0.001

Source: Data Analysis 2008

not discourage adoption possibly because farmers considered maize production a necessity to the sustenance of their livelihood. The results obtained for improved cowpea shows that five variables viz: LGA, DURATION, AWARENES AGRIEXT and INSECTIC significantly determines farmers' adoption decisions. In other words, improved cowpea is more likely to be adopted by farmers in non-intervention sites and the long years of farming experience might not necessary encourage adoption. As expected, visits by extension agents (AGRIEXT) encouraged adoption of the crop, while the cost of insecticide (INSECTIC) discouraged the adoption of cowpea.

Gross margin analysis of priority Cereal crops
A results of the gross margin analysis carried out on cereals in the study is presented in (Tables 6 and 7).

Kano State - MLL IP

Results in table 6 shows that maize gave the highest yield (1108kg/ha) and revenue (about N89,000) in R&D site of Karaye LGA in Kano State. The lowest yield (631kg/ha) and revenue (about (N50,000) in millet production came from the same R&D sites. The variable costs of crops production did not

Table 6: Gross Margin Analysis of Priority Cereal Crops (MLL IP)

	IAR4D sites (Bunkure)			R &D sites (Karaye)			Clean (Karaye)		
Kano	maize	Sorghum	millet	Maize	Sorghum	Millet	maize	Sorghum	Millet
Yield(kg/ha)	1070	908	797	1108	847	631	915	896	878
Revenue(Naira/Ha)	85600	72640	63760	88640	67760	50480	73200	71680	51840
Total Variable Cost -TVC (Naira/Ha)	21043	21639	11541	42324	41332	40462	45422	29425	27335
Gross Margin GM(Naira/Ha)	64557	51001	52219	46316	26428	10018	27778	42228	24505
Benefit:Cost (GM/TVC)	3.1	2.4	4.5	1.1	0.6	0.2	0.6	1.4	0.9
Katsina	IAR4D sites (Musawa)			R &D sites (DanMusa)			Clean (DanMusa)		
Yield(kg/ha)	1310	916	878	1558	908	757	1134	872	683
Revenue(Naira/Ha)	104800	73280	70240	124640	72640	60560	90720	69760	54640
Total Variable Cost - TVC	19752	23186	19747	37423	37966	42838	41625	40629	12985
Gross Margin GM(Naira/Ha)	87217	50091	50493	49095	34674	17722	42581	29131	41655
Benefit:Cost (GM/TVC)	4.4	2.2	2.6	1.3	0.9	0.4	1.0	0.7	3.2

vary widely across different enterprises production. This was not surprising since most household could be expected to use similar variable inputs purchased at fairly similar prices and given that most parts of the project area practiced similar crop production system. The most important items of variable cost were labour and fertilizer. The clean site expended most on labour with (N25,425) for maize production while the IAR4D spent the lowest amount (N5,012) in Bunkure. The highest gross margin (N64,557) in maize production and benefit-cost ratio (4.5) were obtained in the IAR4D sites of the IP while the lowest gross margin (about N10,000) and benefit-cost ratio (0.2) in millet production came from R&D site of Karaye in the State.

Katsina State - MLL IP

The R&D sites of DanMusa LGA of Katsina State had the highest yield (1558kg/ha) and revenue (N124,640kg/ha) in maize production, while the clean sites gave the lowest yields and revenues. However, the lowest variable cost item (labour) was highest also in R&D sites and this had an effect of reducing the gross margin obtained. The highest gross margin (N87,217) and benefit-cost ratio (4.4) were obtained in maize production in IAR4D sites, while the R&D sites of the state gave the lowest gross margin (N17,722) and benefit-cost ratio (0.4).

Kano State - SLL IP

The gross margin analysis for cereal crops in the sorghum and legume IP is similar to the

Table 7: Gross Margin Analysis of Priority Cereal Crops (SLL IP)

	IAR4D sites (Shanono)			Some R &D sites (Dawakin Tofa)			Clean (Dawakin Tofa)		
Kano	Maize	Sorghum	Millet	Maize	Sorghum	Millet	maize	Sorghum	Millet
Yield(kg/ha)	948	852	822	1156	796	725	1216	780	646
Revenue(Naira/Ha)	75840	68160	65760	92480	63680	58000	97280	62400	51680
Total Variable Cost - TVC(Naira/Ha)	33259	32874	23529	34995	31845	20613	45995	39880	41189
Gross Margin GM(Naira/Ha)	57485	35286	42231	51285	31835	37387	43847	22520	10491
Benefit:Cost (GM/TVC)	2.3	2.1	2.8	2.6	2.0	2.8	2.1	1.6	1.3
Katsina	**IAR4D sites**			**Some R &D sites**			**Clean**		
	Safana			**Ingawa**			**Ingawa**		
Yield(kg/ha	957	1607	882	926	791	604	838	794	460
Revenue(Naira/Ha)	76560	128560	70560	74080	63280	48320	67040	63520	36800
Total Variable Cost(Naira/Ha)	32713	87679	28305	12108	12965	15233	31001	33177	19885
Gross Margin GM(Naira/Ha)	43847	40881	42255	61972	50315	33087	36039	30343	16915
Benefit:Cost (GM/TVC)	1.3	0.5	1.5	5.1	3.9	2.2	1.2	0.9	0.9

maize-legume IP in that maize gave the highest yield and revenue (Table 7). The highest yield (1216 kg/ha) and revenue (N97,280) were obtained from clean sites of Dawakin Tofa in Kano State. Labour was also the most important variable cost item (N46,000) in maize production of the clean site. The highest gross margin (N57,000) came from IAR4D site of Shanono but the highest benefit-cost ratio (2.8) came from millet in IAR4D and R&D sites in the State.

Katsina State - SLL IP

In contrast to what obtained in other IP, the highest yield (1607 kg/ha) and revenue (N128,560) came from sorghum in IAR4D site of Safana LGA with labour as the most important cost item as in the other IPs. However, the highest gross margin (N61,972/ha) was obtained in the R&D sites of Ingawa LGA of the State. In all, the results show a lot of similarity in the enterprise gross margin for all the sites.

Gross margin analysis of priority legume crops

Tables 8 and 9 present the result of the gross margin analysis of the priority legume crops in the study sites.

Kano State - MLL IP

Results in Table 8 shows that Groundnut produced the highest yield (752kg/ha) and revenue (N90,240/ha) in R&D site while the lowest yield (394kg/ha) and revenue (N39,400) were obtained in IAR4D site of Bunkure LGA. Labour (the most important variable cost item) was highest in groundnut production of R&D site. However, the highest gross margin (about N65,000/ha) and benefit-cost ratio (3.5) came from groundnut production in the IAR4D site.

Katsina State - MLL IP

For these IPs, groundnut also had the highest yield [730kg/ha] and revenue [about N88,000/ha]. The largest cost item (labour)

Table 8: Gross Margin Analysis of Priority Legume Crops (MLL IP)

	IAR4D sites (Bunkure)		Some R &D sites (Karaye)		Clean (Karaye)	
Kano	**Cowpea**	**Gnut**	**Cowpea**	**Gnut**	**Cowpea**	**Gnut**
Yield(kg/ha)	394	698	561	752	397	670
Revenue(Naira/Ha)	39400	83760	56100	90240	39700	80400
Total Variable Cost - TVC(Naira/Ha)	16532	18747	42124	51234	31605	40620
Gross Margin GM(Naira/Ha)	22868	65013	13976	39006	8095	39780
Benefit:Cost (GM/TVC)	1.4	3.5	0.3	0.8	0.3	1.0
Katsina	**IAR4D sites**		**Some R &D sites**		**Clean**	
	Musawa		**DanMusa**		**DanMusa**	
Yield(kg/ha)	683	730	394	678	352	663
Revenue(Naira/Ha)	68300	87600	39400	81360	35200	79560
Total Variable Cost(Naira/Ha)	13500	20360	10525	42048	21833	46021
Gross Margin GM(Naira/Ha)	54800	67240	28875	39312	13367	33539
Benefit:Cost (GM/TVC)	4.1	3.3	2.7	0.9	0.6	0.7

Table 9: Gross Margin Analysis of Priority Legume Crops (SLL IP)

	IAR4D sites (Shanono)		Some R &D sites (Dawakin Tofa)		Clean (Dawakin Tofa)	
	Cowpea	Gnut	Cowpea	Gnut	Cowpea	Gnut
Yield(kg/ha)	422	760	356	698	368	691
Revenue(Naira/Ha)	42200	91200	35600	83760	36800	82920
Total Variable Cost(Naira/Ha)	18448	22460	18100	31648	21660	38295
Gross Margin GM(Naira/Ha)	23752	68740	17500	52112	15140	44625
Benefit:Cost (GM/TVC)	1.3	3.1	1.0	1.6	0.7	1.2
Katsina	**IAR4D sites (Safana)**		**Some R &D sites (Ingawa)**		**Clean (Ingawa)**	
Yield(kg/ha)	423	732	363	689	310	673
Revenue(Naira/Ha)	42300	87840	36300	82680	31000	80760
Total Variable Cost(Naira/Ha)	15536	26310	12900	15700	11700	30150
Gross Margin GM(Naira/Ha)	26764	61530	23400	66980	19300	50610
Benefit:Cost (GM/TVC)	1.7	2.3	1.8	4.3	1.6	1.7

Source: Data Analysis 2008

had the highest value (about N32,000) in clean site of Karaye LGA. Although, the highest gross margin (N67,240) was obtained from groundnut however, the highest benefit-cost ratio (4.1) came from cowpea production in the IAR4D site of the State.

Kano State - SLL IP

In the SLL IPs, the results of the gross margin analysis (Table 9) shows that groundnut had the highest yield (760kg/ha) and revenue (about N91,200) in the IAR4D sites of Shanono LGA. The highest variable cost item (labour) with a value of (about N24,000) in groundnut production was obtained in the clean site of Dawakin Tofa LGA. The highest gross margin (about N69,000) and benefit-cost ratio (3.1) was obtained in the IAR4D site producing groundnut in Shanono LGA in the IP.

Katsina State - SLL IP

As obtained in Kano State of the SLL IP, the highest yield (732kg/ha) and revenue (about N88,000) were obtained in groundnut production in IAR4D site of Safana LGA. The highest cost (labour) was recorded also in groundnut production in clean site of Ingawa LGA. However, the highest gross margin (about N67,000) and benefit-cost ratio (4.3) were obtained in R&D site of Ingawa LGA.

DISCUSSION OF FINDINGS

The summary of socio economic characteristics of the respondents in the various IPs shows an age range of between 40 and 55 years suggesting that they are fairly young with a predominantly large family size of between 12 and 14 possibly to raise family labour for farm work. The educational level is expectedly low with only about a third of them having up to six years of formal education.

Altogether, the farm families are mainly male headed. Credit was accessed by relatively few of the respondents, mainly for agricultural purposes from informal sources, while the access to and use of extension shows those respondents in the R&D sites having more access to extension services though not statistically significant.

The regression results show that what determines adoption of agricultural technologies for crops and varies widely across the sites. Indeed, location was generally significant for all the models thus suggesting that the area where the farmer resides may have an influence on his reception to adoption of improved methods possibly due to persistence and reduced costs of acquisition. Although the result obtained for location was not consistent in the models. Large family size encouraged adoption of new technologies across the various sites, this is plausible given the fact that most farm operations are labour intensive which warrants the availability of family labour. Awareness of the technology encouraged adoption of both crop technologies.

The Gross margin analysis reveals that for the MLL IP maize yields the highest yield and revenue, while labour was the highest variable cost item on all sites. Although the yield figures for maize in Katsina State was higher than that of Kano State the figure was not statistically significant. As per legume crops, groundnut gave the highest yield and revenue figures in all sites.

CONCLUSION

A firm conclusion that we obtain from this study was that farmers in the study area have a good potential to adopt agricultural innovations which could result in increased yields and enhanced income, though the levels of adoption differ across states and agricultural domains. The factors that influence adoption of agricultural innovations in the study area include among others: large family size and awareness of the technology. These are the issues to watch out for as regards dissemination of the improved technologies especially as it relates to the IAR4D in the study area. Finally, both maize as a cereal and groundnut as legumes are profitable agricultural ventures worthy of promoting in the study area.

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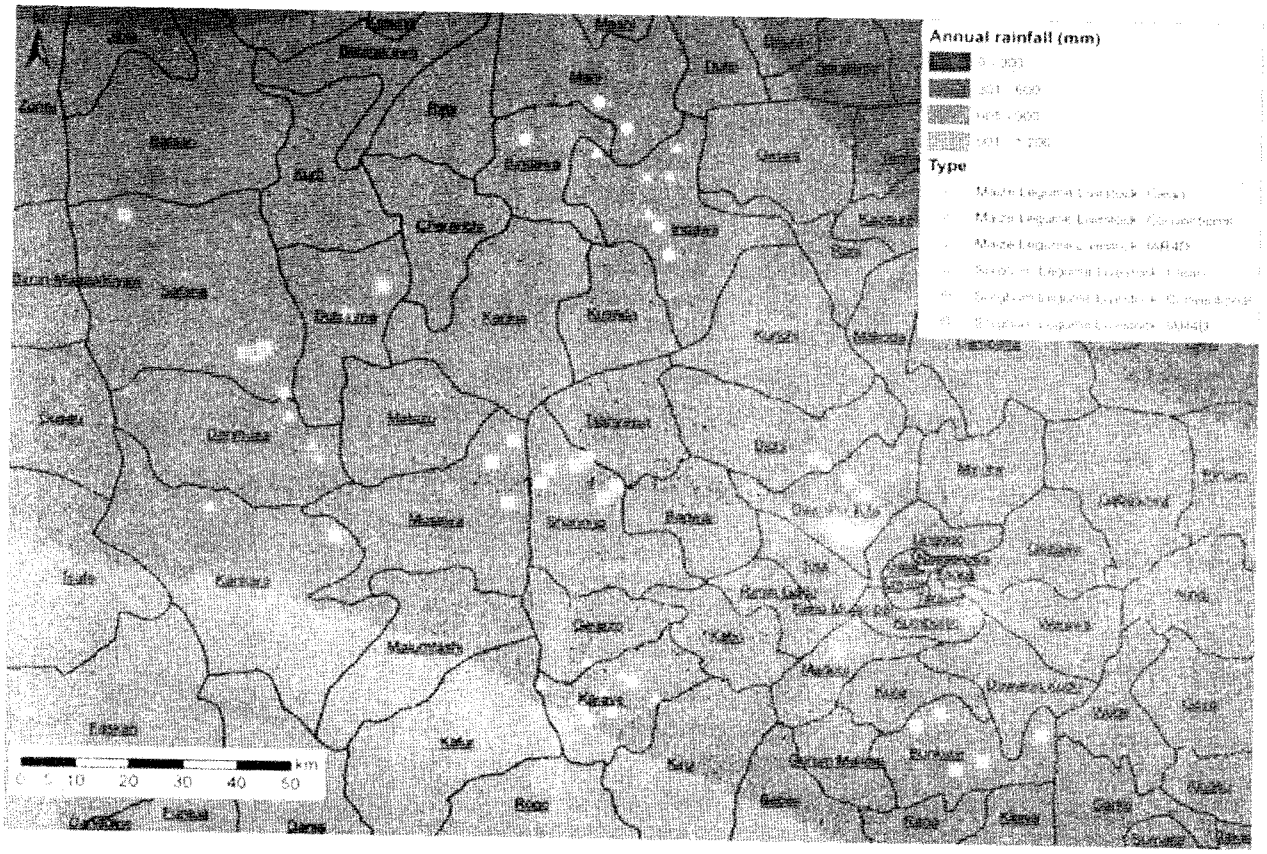

Figure 1: Map of Sudan Savanna TF (Ayanwale et al. 2011)