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ANALYSIS OF ADOPTION OF THE USAID/IITA IMPROVED COWPEA PRODUCTION TECHNOLOGIES IN KATSINA STATE, NIGERIA

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ABSTRACT
The study analyzed the adoption of USAID/IITA improved cowpea production technologies in Katsina State, Nigeria. Multi-stage random sampling technique was employed for the selection of the respondents. A sample size of 135 cowpea farmers was randomly selected for the study. Primary data for the study were obtained through the use of structured interview schedule. The data collected were analyzed using descriptive statistics and regression analysis. The results revealed that cowpea farmers were predominantly male (98%), had a mean age of 44 years, mean years of farming experience of 23, more than half (58.5%) had formal education at various level, mean household size of 12 persons and a mean farm size of 2 hectares. The logistic regression showed that gender, membership of association, participation in USAID/IITA cowpea training, extension contact, and availability/use of credit positively and significantly at $P<0.01$, $P<0.05$ and $P<0.1$, respectively, influenced adoption of USAID/IITA improved cowpea production technologies. The estimated regression coefficient of gender was positive and significant at 5% for adoption of disease control. The estimated regression coefficient of membership of association was positive and significant at 10% for adoption of recommended planting date. The study concluded that technologies package were highly adopted by the respondents and all the constraints to adoption were perceived as severe except storage problems and poor access to major output markets that were reported as not constraints. It was therefore recommended that more efforts from all the cowpea stakeholders should be geared towards diffusing the technologies to all other parts of the study area; and the USAID/IITA needs to provide additional support/intervention to cowpea farmers so as to raise the adoption level higher

Keywords: Cowpea, Katsina State, Technology, Socio-economic Characteristics, Technology Adoption.

INTRODUCTION
Cowpea up-scaling project in West Africa was lunched on June 30, 2015 at Accra Ghana. The project is sponsored by the United State Agency for International Development (USAID) with the aim of improving the cowpea seed sector in the West Africa. It is a three-year project (2015-2017) focused on a series of best-bet cowpea production technologies, reflecting input from IITA and other key partners by Institute of Agricultural Research (IAR), Agricultural Development Projects (ADPs) in Katsina, Kano, and Sokoto States; and seed companies in Nigeria. The technologies to scale-up, as part of the project include: quality seed of improved cowpea varieties, integrated pest management, appropriate crop management practices, and improved postharvest and seed/grain storage as reported by Ghana Business News (2015); and Katsina State Agricultural and Rural Development Authority [KTARDA] (2015).

The actors to benefit from the project were farmers producing cowpea and fodder, seed producers (community based and small and medium enterprises), manufacturers and

distributors of bags for hermetic storage of cowpea seeds and grains. The rest are farmers and traders engaged in storage and selling of cowpea for planting or use as food, processors engaged in transformation of cowpea grains into flour, food vendors who prepare popular dishes and snacks from cowpea for sale, and transporters who link production site with markets. The improved varieties include: IT99K573-1-1 (brown eyed), IT99K573-2-1(black eyed) and UAM09-1046-6-1(brown seed coat). These varieties have the following characteristics: early maturity, drought tolerance, resistance to weeds and insect pest attack.

KTARDA participated in the project inception meeting held at Accra, Ghana which was followed by in country meeting in Kano where five (5) Local Government Areas (LGAs) were selected for the conduct of the project activities and in each LGA two extension staff, were selected. A State meeting was held between Desk Officer, extension agents and farmers' representatives on the project activities, the 10 participating communities were selected in each LGA. Also, in each community, two (2) Community Based Organizations (CBO) were formed each involving 25 members (500 members per LGA). Subsequently, training was conducted on the methodology of the trial establishment which was followed by seeds and fertilizer distribution to the participating farmers. A second training was conducted on cowpea insect pest control, safe handling of pesticides and maintenance of spraying equipment. This was followed by monitoring field visits of all the demonstration and seed production plots and on the spot distribution of the required insecticides for the demonstration and seed production plots. All this aim at solving the problem of farmers who often complained about low (350-400 kg/ha) productivity of cowpea grown in the study area, which is due to the use of poor quality seed, poor management practices, weeds attack, diseases and pest infestation (International Institute for Tropical Agriculture [IITA] (2015).

Low extension contact, limited access to credit, low farm-gate prices, high cost and low quality of farm inputs and poor access to major output markets are the serious constraints to intensification of farming systems (KTARDA, 2015). These problems warranted the study to be carried out in order to understand the current situation considering the technology available. Also, cowpea producers in Katsina State were faced with so many problems among which include: unavailability of inputs at all the time of peak production season, lack of knowledge about improved technology, low yield potential of prevailing varieties, lack of appropriate agronomic practices, lack of cooperative marketing system, vulnerability to insect attack, storage problems, low extension contact, limited access to credit, inadequate funds, poor access to major output markets and low farm-gate price.

In addition, the high cost of protein sourced from animals, had made it economically imperative that improved cowpea production technologies should be promoted. Its economic and nutritive values should be developed further in Nigeria and Africa at large. In an attempt to thereby increase cowpea production in Nigeria, USAID/IITA has been promoting its production using improved technologies in Katsina State. USAID/IITA Technology is a package consisting of three (3) improved cowpea varieties developed by IITA/IAR alongside the following good/recommended agricultural practices: planting of improved cowpea varieties, land clearance using herbicides, planting date (mid-July), planting distance (75cm × 25cm), fertilizer application (Single Super Phosphate at 100 kg/ha before planting), chemical weed control, disease control and integrated pest management. These recommended practices were disseminated to the cowpea farmers in the study area through both mass media (TV, Radio, Pamphlets, and Newspaper) right from the first phase of the project in the year 2015. The problems identified have given rise to the study.

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From the foregoing, the study was carried out to achieve the following objectives: described the socio-economic characteristics of the cowpea farmers; determined the influence of socio-economic characteristics of cowpea farmers on the adoption of improved cowpea production technologies; describe the extent of adoption of improved cowpea production technologies by farmers and ascertain the constraints faced by the farmers in the adoption of improved cowpea production technologies in the study area.

MATERIALS AND METHODS

The Study Area

The study was carried out in Katsina State which was created in 1987 from the old Kaduna State and has 34 Local Government Areas (LGAs) with a population of 5,801,584 and an annual population growth rate of 3.5% (National Population Commission [NPC], 2006 and Katsina State Government [KTSG], 2016). It lies within latitude $12^0$59' North and Longitude $7^0$35' East (Google Maps, 2016). The State is bounded in the East by Kano and Jigawa States, to the West by Zamfara State, in the North by Niger Republic and in the South by Kaduna State. It covers a total land area of 24,192KM^2. Its Savannah vegetation favours the cultivation of cowpea, guinea corn, millet, maize, ground nut and cotton in addition to the rearing of livestock (KTSG, 2016).

Katsina State has a tropical continental climate with high mean annual temperature slightly above 27^0C. It is situated in the Sahel Savannah with a rainy season that starts from June and ends in October, while the hamattan season runs from November to February. The weather is dry from January to April before the arrival of the rainy season. The relief is made up of land between 399-600 meters above sea level (KTSG, 2016).

Sampling Procedure

The study employs multi-stage random sampling technique in the selection of the respondents. In the first stage, three (3) making 60% LGAs of the five (5) project LGAs were randomly selected using 'hat-drawn method without replacement'. By which Danmusa, Dutsinma and Kankara appeared as sampled LGAs. The second stage also involves random sampling technique using 'hat-drawn method without replacement' to select 5(50%) of the 10 project communities in each of the three (3) selected LGAs to get a total of 15 communities. The five (5) communities selected from each LGA were drawn from a bowl containing the name of ten (10) communities each folded in a piece of paper after thorough shaking of the bowl content. The names of the communities chosen are in Table 1. In the third stage, 135 farmers were randomly selected for the interview using the formula $\{n = \frac{N}{1+N(\propto)^2}\}$ adopted from Miller and Brewer (2003); where; n = required sample size; N = population size (750 project beneficiaries from the three [3] selected LGAs); and α = margin error (8%), in which 9 respondents were captured in each community and a total of 45 farmers were interviewed from each LGA (45 farmers X 3 LGA = 135 farmers).

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Table 1: Summary of Sample Frame and Size of the Cowpea Farmers

LGAs	Communities Covered by the Project	Selected Communities	Beneficiaries (50%) Population Size	Sample
Danmusa	Dafa, D. Takori A, Farfara, D. Takori B, K/Arewa, Tashar B. T/Icce, T/Maialewa, Aidun Gado, Aidun Mangoro.	Dafa,	50	8.6≈9
		D. Takori A	50	8.6≈9
		D. Takori B	50	8.6≈9
		Aidun Gado	50	8.6≈9
		Aidun Mangoro	50	8.6≈9
Dutsinma	Badole, Faguwa, Gago, Garhi, Gizawa, Kagara, Rowan Dorawa, Sabon Garin Safana, Takatsaba, Wakaji	Faguwa	50	8.6≈9
		Wakaji	50	8.6≈9
		Takatsaba	50	8.6≈9
		Gago	50	8.6≈9
		Gizawa	50	8.6≈9
Kankara	Dandashere, Gidan Soda, Hurumi, Ketare, A and B, Ketare C, Kukarsheka, Santar Bailu, U/Shehu, Unguwar Umaru	Dandashere	50	8.6≈9
		Santar Bailu	50	8.6≈9
		Gidan Soda	50	8.6≈9
		Ketare A	50	8.6≈9
		Ketare C	50	8.6≈9
Total	30	15	750	129≈135

Source: IITA, 2015

Method of Data Collection

Primary data was employed in this study; it was sourced from project beneficiaries in the study area through a face to face interview using structured interview schedule administered with the assistance of trained enumerators.

Analytical Technique

The data collected were analyzed using descriptive statistics (mean, percentage, and frequency count) and binary logit regression analysis was equally used. The model is implicitly stated as:

$$\text{Prob. } (y^{*}=1) = 1\text{-}F^{*}(\square x_i\beta_j) = \frac{e^{\square Xi\beta j}}{1+e^{\square Xi\beta j}} \quad \ldots (1)$$

$$\text{Prob. } (y^{*}=0) = F^{*}(\square x_i\beta_j) = \frac{e^{\square Xi\beta j}}{1+e^{\square Xi\beta j}} \quad \ldots (2)$$

where;
Y = adoption of improved cowpea production technologies;
F = the cumulative distribution function for μi; and
e = exponential function.

The explicit logistic model is expressed as:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + \mu \quad \ldots (3)$$

where;
Y = adoption of improved cowpea production technologies;
a = the intercept;
b_i = the coefficient of x_i;
x_1 = age of household (years);
x_2 = gender (male = 1, female = 0);
x_3 = farming experience (years);
x_4 = years of formal education (years);
x_5 = household size (number);

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x_6 = farm size (hectare);
x_7 = membership of association (member = 1, 0 otherwise);
x_8 = participation in USAID/IITA cowpea training (participated = 1, 0 otherwise);
x_9 = extension contact in 2017 cropping season (number);
x_{10} = availability/use of credit (used = 1, 0 otherwise); and
μ = error term.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the farmers

Result in Table 2 revealed that the average age of the respondents is 44 years implying that the highly strong and energetic farmers adopt more than the very old or young farmers. This is in line with the findings of Agwu (2004) who reported 45 years as the average age of the cowpea farmers. It is also in line with the findings of Brown (1972) and Akintola (1986) who reported that older and younger farmers are less flexible in changing their cultural perception than the middle aged farmers who are restless and ready to explore an experiment in anticipation of breakthrough.

The years of farming experiences indicated 23 years on average. This shows that the farmers have considerable years of experience in cowpea production. This is in line with the finding of Yanguba (2004) who reported 24 years as the average years of farming experience in Katsina State, Nigeria.

The household size of the cowpea farmers was found to be about 12 persons per household. This indicates that majority of the respondents have above the National Average of 5 person per household as reported by National Bureau of Statistics [NBS] (2010). This is a large size and could adversely affect adoption of innovation by the farmers.

The average farm size of the respondents is found to be 2 hectares. This finding differ from the findings of a study carried out in southeastern Nigeria (Agwu and Anyanwu, 1996) were the average number of hectares cultivated per farmer was found to be about 1.5 hectares. This implies that farmers in the North West cultivate relatively larger hectares than their counterparts in southeastern Nigeria. This is an advantage for adoption of innovative practices.

Table 2: Socio-Economic Characteristics of the Respondents

Variables	Minimum	Maximum	Mean	Std. Deviation
Age	20	70	44	10.74
Years of farming experience	3	55	23	11.03
Household size	2	35	12	6.29
Farm Size (Ha)	0.5	5	2	1.07

Factors that Influenced Cowpea farmers' Adoption of Improved Production Technologies

The adoption of USAID/IITA improved cowpea production technologies were influenced by a number of socio-economic factors. This is why the study attempted to estimate the factors influencing the adoption of USAID/IITA improved cowpea production technologies in Katsina State, Nigeria using logistic regression (Table 3).

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Table 3: Logistic Regression Result

Technologies	**Planting of improve cowpea varities**		**Land clearance using herbicide**		**Planting date**		**Planting distance**	
Variables	**Coeff.**	**Signif.**	**Coeff.**	**Signif.**	**Coeff.**	**Signif.**	**Coeff.**	**Signif.**
Age	0.108	0.253	0.042	0.330	-0.008	0.926	-0.727	0.634
Gender	-18.89	0.999	-0.020	0.989	-18.56	0.999	-19.48	0.999
Farming experience	-0.109	0.258	-0.037	0.381	-0.061	0.456	0.203	0.453
Year of formal educ.	0.158	0.171	0.041	0.357	0.117	0.261	-0.128	0.725
Household size	0.028	0.736	-0.036	0.391	0.096	0.178	-0.224	0.700
Farm size	0.079	0.870	-0.212	0.389	-0.173	0.687	-0.086	0.885
Membership of association	-17.60	0.999	0.982	0.346	2.871	0.078*	2.253	0.303
Participation in training.	-1.602	0.076*	0.759	0.061*	0.435	0.551	2.249	0.037**
Extension contact	0.419	0.142	0.176	0.189	-0.098	0.696	1.096	0.042**
Availability of credit	18.130	0.998	0.551	0.337	19.396	0.998	20.096	0.998
2Log likelihood ratio test	57.547		170.174		64.070		56.737	
Cox and snell R^2	0.097		0.100		0.118		0.164	
Nagelkerke R^2	0.236		0.135		0.261		0.364	
Percentage prediction	93.3		63.0		91.9		93.3	

Note: ***P<0.01, **P<0.05 and *P<0.1

The dependent variables were USAID/IITA improved cowpea production technologies, viz. planting of improved cowpea varieties, land clearing using herbicide, planting date (mid-July), planting distance (75cm X 25cm), fertilizer application (SSP 100 kg/ha BP), Chemical weed control, Disease control and Chemical pest control while the independent variables include age of the farmer, gender, farming experience, formal education, household size, farm size, membership of association, participation in USAID/IITA cowpea training, contact with extension agent and lastly availability/ access to credit.

The significant variables that are positively related to adoption of USAID/IITA improved cowpea production technologies include gender, membership of association, participation in USAID/IITA cowpea training, contact with extension agent and availability/use of credit. The estimated regression coefficient of gender was positive and significant at 5% for adoption of disease control. The estimated regression coefficient of membership of association was positive and significant at 10% for adoption of recommended planting date. The estimated regression coefficient of participation in USAID/IITA cowpea training was positive and significant at 10% for planting of improved cowpea varieties. This is invariably saying that participation in cowpea training results in the adoption of planting improved cowpea varieties.

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Table 3: Logistic Regression Result. **Cont'd.**

Technologies	**Fertilizer application**		**Chemical weed control**		**Disease control**		**Chemical pest control**	
Variables	**Coeff.**	**Signif.**	**Coeff.**	**Signif.**	**Coeff.**	**Signif.**	**Coeff.**	**Signif.**
Age	0.059	0.225	0.061	0.189	0.094	0.319	-0.056	0.559
Gender	22.369	0.999	22.241	0.999	4.402	0.016**	1.756	0.332
Farming experience	-0.051	0.287	-0.035	0.431	-0.094	0.306	0.142	0.202
Year of formal educ.	-0.004	0.930	0.163	0.191	0.107	0.289	0.171	0.264
Household size	0.019	0.674	0.000	0.992	-0.023	0.780	-0.072	0.504
Farm size	-0.052	0.851	-0.307	0.235	-0.089	0.855	-0.276	0.673
Membership of association.	0.701	0.524	1.680	0.172	1.658	0.272	-16.91	0.999
Participation in training.	1.481	0.001***	1.336	0.002***	-0.082	0.919	0.571	0.594
Extension contact	-0.026	0.862	-0.008	0.953	-0.205	0.458	-0.507	0.247
Availability of credit	1.129	0.084*	0.447	0.460	0.999	0.487	17.097	0.998
2Log likelihood ratio test	144.385		155.856		58.890		38.574	
Cox and snell R^2	0.200		0.179		0.088		0.075	
Nagelkerke R^2	0.276		0.242		0.214		0.246	
Percentage prediction	73.3		68.1		93.3		95.6	

Note: ***P<0.01, **P<0.05 and *P<0.1

The estimated regression coefficient of participation in USAID/IITA cowpea training was positive and statistically significant at 10% for land clearance using herbicides – this shows that the more the farmer is involved in the USAID/IITA cowpea training the better the tendency for him to adopt land clearance using herbicides. It also has positive coefficient which is significant at 5% for planting distance. This indicates that participation in cowpea training stimulates the farmer to adopt the recommended planting distance. The estimated regression coefficient of participation in USAID/IITA cowpea training was positive and high statistically significant at 1% for fertilizer application. This implies that participation in cowpea training will result in adoption of fertilizer application at recommended rate and time. The estimated regression coefficient of participation in USAID/IITA cowpea training was positive and statistically significant at 1% for adoption of chemical weed control. This indicates that participation in cowpea training will positively influence the adoption of chemical weed control.

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The estimated coefficient of availability/use of credit is positive and statistically significant at 10% for adoption of fertilizer application at recommended dose and time. This implies that availability/use of credit has positive influence on the adoption of fertilizer application.

Extent of Adoption of Improved Cowpea Production Technologies

The extent to which the farmers adopt the improved cowpea production technologies was measured using five steps of adoption; viz.; awareness, interest, evaluation, trial and adoption and scored 1, 2, 3, 4 and 5, respectively. The percentage of farmers at each step for each technology was worked out, mean adoption score and grand mean adoption score was also evaluated in Table 4.

Table 4: Cowpea Farmers' Extent of Adoption of Improved Cowpea Production Technologies

Variables/ Stages	**Improved Cowpea Production Technologies**							
	Planting	**Land clearance**	**Planting date**	**Planting distance**	**Fertilizer application**	**Chemical weed control**	**Disease control**	**Chemical pest control**
Awareness	100	80.0	100	100	100	100	100	99.3
Interest	99.3	81.5	97.8	97.8	96.3	97.0	98.5	97.8
Evaluation	99.3	58.5	95.6	95.6	76.3	75.6	94.8	96.3
Trial	96.3	60.7	91.9	94.1	74.1	73.3	94.1	95.6
Adoption	92.6	57.0	91.1	91.1	65.2	59.3	92.6	95.6
Total	487.5	337.7	476.4	478.6	411.9	405.2	480.0	484.6
Mean adoption score	0.98	0.68	0.95	0.96	0.82	0.81	0.96	0.97
Grand mean adoption score	0.89							

The study shows the distribution of cowpea farmers according to their step of adoption of eight USAID/IITA improved cowpea production technologies investigated. The highest adoption score was 0.98 for the planting of improved cowpea varieties introduced; IT99K573-1-1 (brown eyed), IT99K573-2-1 (black eyed) and UAM09-1046-6-1 (brown seed coat). The least adoption score was 0.68 for land clearance using herbicide because herbicide is very expensive and farmers lack the skills to handle and apply herbicide according to the level or direction of use. The grand mean adoption score was 0.89, that is about 89% of the entire USAID/IITA improve cowpea production technology package was adopted by the cowpea farmers in the study area. Hence the technology package was highly adopted by the farmers. This is higher than the findings of Orebiyi (1981) who reported that about 61% of the entire eight (8) IITA cassava production technology package were adopted by the ADP contact farmers in Imo State. The high mean adoption score was due to the inputs and training intervention given to all the participating farmers (respondents).

Constraints to Adoption of USAID/IITA Improve Cowpea Production Technologies

The constraints encountered by the farmers in adoption of new production technologies (Table 5) were examined by the respondents and indicated their position with respect to how they perceived the constraints as either severe, mild or not a constraint**.** The mean scores were used to categorize constraints on 3 scales as: 1 = not a constraint, 2 = mild constraint and 3 = severe. Table 5 revealed that all the constraints were perceived as severe constraints to adoption

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of improved cowpea production technologies by respondents except for storage problems and poor access to major output markets were perceived as not constraints. Storage was not perceived as a constraint because the farmers were trained on cowpea storage using Purdue Improve Cowpea Storage (PICS) bags and also the villages were connected to the major output markets by good roads network which facilitate easy movement of people and their goods, that is why access to major output markets were not perceived as constraints by the respondents. The findings are in accordance with the findings of Chaturvedi (2000), Singh and Waris (2002), Shinde *et al.* (2003), Khan and Chauhan (2005), Agarwal (2008) and Banker (2008).

Table 5: Constraints to Adoption of USAID/IITA Improved Cowpea Production Technologies

Constraints	Mean score	Rating
Unavailability of input at all the time of peak production season	2.98	Severe
Lack of knowledge on improved technologies (seeds, weedicide and plant protection measure)	2.99	Severe
Impurity of seeds and chemical	2.90	Severe
Inputs are costly	2.98	Severe
Weed control (herbicides) is technically complex phenomenon	2.88	Severe
Low yield potential of prevailing varieties	2.94	Severe
Lack of appropriate agronomic practices	2.90	Severe
Lack of cooperative marketing system	2.53	Severe
Vulnerability to insect attack	2.97	Severe
Storage problems	1.42	Not a constraint
Low extension contact	2.89	Severe
Limited access to credit	2.54	Severe
In adequate funds	2.90	Severe
Poor access to major output markets	1.35	Not a constraint
Low farm-gate price	2.96	Severe

CONCLUSION AND RECOMMENDATIONS

The findings of the study revealed a significant positive relationship between adoption of 8 improved cowpea production technologies and the five (5) variables; e.g., gender, membership of agricultural association, participation in USAID/IITA cowpea training, number of extension contact in 2017 cropping season and availability/use of credit. The technologies package were highly adopted by the respondents and all the constraints to adoption were perceived as severe except storage problems and poor access to major output markets that were reported as not constraints. The study therefore, made the following recommendation:

1. More efforts from all the cowpea stakeholders should be geared towards diffusing the technologies to all other parts of the study area;
2. The USAID/IITA needs to provide additional support/intervention to cowpea farmers so as to raise the adoption level higher.
3. Both public and private extension organizations should recruit/hire more extension personnel and posted them to rural areas in order to disseminate information to farming families within the study area.

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