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Tobit Analysis of Improved Dual Purpose Cowpea in Damboa, Borno State, North-Eastern Nigeria

[1, 2]B.H. Gabdo and [3]P.S. Amaza
[1]Department of Agribusiness and Information System, University Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia
[2]Department of Agricultural Economics and Extension, Adamawa State University, P.M.B. 25, Mubi, Nigeria
[3]Department of Agricultural Economics and Extension, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria

Abstract: A recursive three equations simultaneous tobit was modelled to analyse and unravel adoption issues: the intensity of adoption and adoption determinants of Improved Dual Purpose Cowpea (IDPC) in four villages socio-economically stratified in to two domains: Low Population-Low Market (LPLM) and Low Population-High Market (LPHM) selected on the basis of human population density and accessibility to whole sale market in Damboa, Borno State, Nigeria. Data collection spanned between December, 2006 and February, 2007 conducted on 150 cowpea respondents. The study revealed that IDPC cultivation started in 2004 and mass cultivation of 65.3% adoption rate was recorded in 2006. Of the varieties grown, IT89KD-288, IT97K-499-35 and IT90K-277-2 were the most preferred in order of decreasing magnitude with seldom cases of intra-adoption movement but no case of inter-adoption movement recorded. The intensity of adoption ($\propto$) was estimated 0.3957 which infers about 40% of cowpea areas in the study sites were seeded with the IDPC varieties. Socio-economic domain, ownership of small ruminants, hired labour, number of cowpea varieties planted and group membership were factors significantly identified to influence farmers' decision to adopt IDPC varieties in the area. While fertilizer was observed as a necessary condition, insecticide spray was discerned as a sufficient condition for IDPC adoption. The study recommended targeting socio-economic domain, cowpea-livestock integration, formation of cowpea farmers' cooperative groups and revitalization of extension work as avenues for increased IDPC adoption.

Key words: Socio-economic domain, tobit, improved dual purpose cowpea, intensity, ownership, hired labour

INTRODUCTION

Cowpea is a global legume of African origin. Davies *et al*. (2005) and Jefferson (2005) attested that cowpea is an ancient crop whose cultivation began in Africa between 5000 and 6000 years ago. Today, the crop is widely grown across continents of the world. Langyintuo *et al*. (2005) ranked Nigeria as the world leading producer nation of cowpea with a production index of 1.69 million tones accounting for 56.3% of global output. Globally, Singh *et al*. (1997) asserted that cowpea is grown on 12.5 million ha with 3 million tones in volume of production.

The Improved Dual Purpose Cowpea (IDPC) technology was developed by International Institute of Tropical Agriculture (IITA), Ibadan-Nigeria and International Livestock Research Institute (ILRI), Kenya.

The concept of IDPC is premise on the simultaneity advantage of bigger grain size and huge fodder production. An improved cowpea variety is denoted dual purpose only on the fulfilment of the concurrent increase in grain size and fodder production otherwise, it remains an ordinary improved or local variety. IDPC technology is thus, an upgrade of the non-IDPC varieties by breaking its jinx of low grain and fodder yield, long gestation period, high incidence of pests and diseases among others.

Cowpea production in Nigeria has witnessed remarkable progress in terms of land size, production techniques and volume of production between 1961 and 1995 (Ortiz, 1998) with 0.68 ton ha^{-1} in the year 2005 (FAO, 2007). Despite this feat and numerous advances in other food crops, the world is yet to be spared of the ravaging effects of food insecurity particularly in Africa. The deficiency in dietary needs of the under developed and

Corresponding Author: B.H. Gabdo, Department of Agribusiness and Information System, University Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

developing economies is still very alarming, impelled substantially by population growth. FAO (2004) estimated that about 850 million people in the world are subjected to hunger and malnutrition and 73% of the world's 146 million underfed children are in ten African nations comprising Nigeria with 6 million underfed children (UNICEF, 2006). Thus, an inquiry assessing the intensity or extent of adopting a promising legume variety that is anchored on bumper production for the sustenance of global protein requirement is indeed very timely.

MATERIALS AND METHODS

Damboa, a local government area of Borno State, North-Eastern Nigeria is located in the semi arid zone of the Sudan savannah with unpredictable rainfall usually between May and October. It is portrayed by scrubby vegetation interspersed with tall tree woodlands, a relative humidity of 49% and evaporation of 203 mm year^{-1} (Ayuba, 2005). The IDPC producing villages: Azir, Damboa, Kimba, Kuboa, Nzuda, Mungule and Sabongari were stratified based on human population density and access to wholesale market in to Low Population-Low Market (LPLM) and Low Population-High Market (LPHM) socio-economic domains. From the domains 4 villages (Azir, Damboa, Kuboa and Sabongari) were selected from which emerged 150 cowpea farmers as research respondents. The market stratification was based on the market tension approach used by Brunner *et al*. (1995) as economic distance to the nearest wholesale market expressed in terms of market indicator ranging between 1 and 10, the higher the indicator the smaller the distance and the cheaper the transport cost and conversely. Data collection spanned between December, 2006 and February, 2007.

A recursive three equation simultaneous tobit was modelled to estimate the intensity of adoption and determine the significant factors to IDPC adoption. These estimates were achieved at the second stage of the tobit analysis. Kristjanson *et al*. (2005) delineates intensity of IDPC adoption as the proportion of total cowpea area seeded with IDPC varieties and expressed the model as:

$$\propto + X_i\beta + \varepsilon_i$$

Blundell and Smith (1986) illustrated the possibility of extending the model to accommodate more endogenous variables. The model was decomposed as below to capture the two endogenous variables: fertilizer and insecticide spray used in this research:

$$\propto = X_i\beta + \varphi_2 y_2 + \varphi_3 y_3 + \varepsilon_1$$

$$y_2 = \eta_2 x_2 + \varepsilon_2$$

$$y_2 = \eta_2 x_3 + \varepsilon_3$$

Where:

$\propto$	=	Intensity of adoption (%)
X_i	=	Vector of explanatory variables β
β	=	Coefficient of explanatory variables X_i
y_2	=	Vector of endogenous variable (chemical fertilizer) (bags)
y_3	=	Vector of endogenous variable (insecticide spray) (litres)
φ_2	=	Coefficient of y_2
φ_3	=	Coefficient of y_3
x_2	=	Vector of instrumental variables of y_2
x_3	=	Vector of instrumental variables of y_2
η_2	=	Coefficient of
η_3	=	Coefficient of
ε_2..... ε_3	=	Error terms

Equation 3 and 4 were the first stage of the analysis and the first to be estimated using the Ordinary Least Squares (OLS) technique but its interpretation is not captured in this article. However, the outcome of one was incorporated with other variables in Eq. 2 to estimate using the full information Maximum Likelihood Estimate (MLE) technique in the second stage. In accordance with Kristjanson *et al*. (2005), the adoption variables used in the analysis were also categorized in to: endogenous (internal), Instrumental (endogenous predictors) and Exogenous (external) variables. Empirically, the model can be expressed:

$$y_{2(FERT)} = f\left\{\begin{matrix}\text{SEEDOM, EDUC, HSIZE,}\\ \text{MANURE, MISCOSTS, FNUM,}\\ \text{CVOL, VNUM, GROUP,}\\ \text{HDLBHA, EXTVST}\end{matrix}\right\}$$

$$y_{3(SPRAY)} = f\left\{\begin{matrix}\text{SEDOM, EDUC, DPCAREA,}\\ \text{FDIST, TTLB, CVOL,}\\ \text{VNUM, GROUP, HDLBHA,}\\ \text{EXTVST}\end{matrix}\right\}$$

$$\propto_{(DPPROP)} = f\left\{\begin{matrix}\text{SEDOM, FDIST, HAHSIZE,}\\ \text{SRUM, LRUM, HDLBHA,}\\ \text{MISCOSTS, CVOL, VNUM,}\\ \text{GROUP, PFERT, RFERT,}\\ \text{PSPRAY, RSPRAY}\end{matrix}\right\}$$

SEDOM	=	Socio-economic domain of the villages
EDUC	=	Educational status of the farmers
HSIZE	=	Number of people in farmers household

MANURE	=	Availability of livestock manure
OTHCOSTS	=	Expenditure on inputs other than labour, fertilizer and insecticide
CVOL	=	Credit available to farmers
VNUM	=	Number of cowpea varieties planted
GROUP	=	Participation of farmers in cooperative societies
HDLBHA	=	Amount of hired labour
EXTVST	=	Number of visits by extension agents
DPCAREA	=	Area planted to IDPC
FDIST	=	Distance of farms from household
TTLB	=	Total household labour available
HAHSIZE	=	Cultivated farm size per household member
SRUM	=	Total (small) livestock unit per household
LRUM	=	Total (large) livestock unit per household
PFERT	=	Predicted value of fertilizer
RFERT	=	Residuals of fertilizer
PSPRAY	=	Predicted value of spray
RSPRAY	=	Residuals of spray

Pathway coefficient was also used to measure the contributory power or impact of each variable on adoption of IDPC. Jirico (2006) expressed the pathway coefficient as:

$$R.1 = \frac{*\beta i}{\Sigma *\beta ij} \times 100$$

Where:

R.1 = Relative Impact

$\Sigma * \beta_i$ = A given significant coefficient

$\Sigma * \beta_{ij}$ = Summation of all significant variables

RESULTS AND DISCUSSION

Information flow for the existence of IDPC varieties to the farmers started in 2004 with the introduction by IITA of the IDPC varieties. The source of initial information dissemination over the years to the farmers, as indicated in Table 1 were chiefly promoted by IITA/Research institutes (45.3%), other farmers in the village (28.0%) and extension agents (20.0%). These information sources attracted the confidence of the farmers via practical demonstration of the productive abilities of the IDPC varieties and their ability to disseminate pure IDPC seeds to the respondent, evident from the 80% of farmers who acquired IDPC seeds from IITA.

Since, inception in 2004, majority (83.3%) of the farmers became informed in 2005. This translates to the mass cultivation of the IDPC varieties in 2006, evident from the 65.3% of farmers who cultivated the varieties.

Table 1: Summary of adoption variables (N = 150) of cowpea farmers in Damboa, Borno State, North-Eastern Nigeria

Variables	Farmers	Percentage
Source of information on IDPC		
None	8	5.3
Extension agents	30	20.0
Other farmers in the village	42	28.0
Other farmers in other villages	2	1.3
IITA/Research institutes	68	45.3
Year of first information		
2004	12	8.0
2005	125	83.3
2006	5	3.3
Yet to be informed	8	5.3
Year of first planting		
2004	1	0.7
2005	21	14.0
2006	98	65.3
Yet to plant	30	20.0
Origin of IDPC seeds		
IITA/Research institutes	120	80.0
Yet to plant	30	20.0
Adoption category		
Adopters	120	80.0
Non-adopters	30	20.0
Abandon varieties		
IT89KD-288	1	0.7
IT90K-277-2	26	17.3
Yet to abandon	93	62.0
Yet to plant IDPC	30	20.0
Reasons for abandoning		
Non-availability of IDPC seeds	1	3.7
Low fodder yield	10	37.0
Shattering of grains	16	59.3
Preferred varieties		
IT89KD-288	81	54.0
IT90K-277-2	9	6.0
IT97K-499-35	14	9.3
Yet to plant/no preference	46	30.7
Reasons for preference		
High grain yield	38	25.3
High fodder yield	7	4.7
Early maturity/food security/cash	12	8.0
Higher cereal yield the next year	1	0.7
All of the above	46	30.7
Yet to plant/no preference	46	30.7

Field survey (2007)

IT89KD-288, IT97K-499-35 and IT90K-277-2 were identified as the most preferred varieties in descending order of magnitude by 54.0, 9.3 and 6.0% adoption rate, respectively. Motives advanced for their preference were also captured; individual and combined effects of higher yield and fodder yield, early maturity-food security/cash and higher grain yield the following year.

This finding corroborates Horizon (2003) who in their adoption and impact studies in Kano, North-Western Nigeria also identified IT89KD-288 and IT90K-277-2 as the most preferred. Adoption in this study was categorized in to adopters and non-adopters with the former constituting 80% of the respondents. The research has remarkably identified that the adopters exhibits intra-adoption movement; production transformation from one IDPC variety to another without necessarily exiting the adopters category. There was no report of inter-adoption movement (change in the cultivation of IDPC for improved or local varieties) by the farmers recorded. Justifications for their intra-adoption movement or abandoning one IDPC variety for another within the adoption category were also captured. Non-availability of pure IDPC seeds was the only reason for the farmer who abandoned IT89KD-288 for other IDPC varieties.

The 17.3% of farmers who abandoned IT90K-277-2 for other IDPC varieties reasoned that the variety shatters on maturity prior to harvest and comparatively produce lower fodder than other IDPC varieties. This shows that farmers are very reluctant in abandoning the IDPC varieties due to the perceived contentment they have with the varieties. Table 2 showed the maximum likelihood estimates of the variables incorporated in the second stage of the tobit model. The result shows the dependent variable (β) which is the proportion of total cowpea area planted with IDPC varieties shows an intensity of adoption of 0.396%. This infers that 40% of the total cowpea area under cultivation was planted with IDPC. Thus, in cowpea cultivation in the area, IDPC varieties had substituted non-IDPC varieties by 40% which indeed was quite remarkable in terms of rapid substitution considering its diffusion in 2004.

Kristjanson *et al.* (2005) estimated 0.29% as the proportion of IDPC in total cowpea area in their adoption and impact analyses in kano, North-Western Nigeria. The result also indicates the statistically significant determinants of IDPC adoption with anticipated signs to include socio-economic domain, ownership of small ruminants, hired labour, number of cowpea varieties planted, group membership and other costs expended on inputs other than cost of labour, fertilizer and insecticides.

Farmers can be influenced by any or a combination of these factors in deciding their adoption status. The two elements of socio-economic domain: access market and human population plays a vital role in the significance of socio-economic domain on adoption at 1%. Availability of input supply.

IDPC seeds, insecticides and fertilizer are a product of market access which can inspire farmers to adopt IDPC and conversely. Similarly, demand for grain and fodder yield can be adequate in a more populated domain with accessed market and inversely. Availability of small ruminants in a community will also influence IDPC adoption positively since the huge fodder produced are palatable diets to small ruminants. Group membership as a factor may be attributed to the fact that farmers who associates in group tend to interact and be inspired better than farmers who operate in isolation.

The lack of ownership of sprayers by farmers which compels them to contract out the spraying of the cowpea explains the significance (1%) level of hired labour on adoption. The larger the farm size, the more cost of hired labour, the more farmers' un-affordability and the higher the tendency of non-adaptability of the IDPC and conversely. The result also shows that spraying of insecticide is more yield encouraging than fertilizer application judging from the significance and the non-significance of the predicted value of spray and predicted value of fertilizer, respectively. While the fertilizer application emerged as a necessary condition, insecticide spraying was observed to be more of a sufficient condition for IDPC adoption.

The result of the pathway coefficient of the relative impact of the significant variables on IDPC adoption portrayed in Table 3 shows socio-economic domain as the most vital factor under consideration for farmers' decision to adopt IDPC varieties. This suggests that farmers' decisions on these varieties are 51% dominated or influenced by socio-economic domain. Recall, socio-economic domains is function of proximity anddense human population further explained in terms of demand for inputs and supply of the outputs of the crop.

Table 2: Maximum Likelihood Estimate (MLE) of the coefficients of Tobit model adoption intensity and factors affecting IDPC adoption in Damboa, Borno State, North-Eastern Nigeria

Variables	Across all domian (N = 150)	IPLM domain (N = 100)	LPHM domain (N = 50)
Constant	-0.326271	0.013261	0.07263
SEDOM	0.518103	N/A	N/A
FDIST	-0.014032*	-0.087251	-0.00005**
HSIZE	-0.003273	-0.000073	0.0013699
SRUM	0.1235021***	0.00654***	0.0013721
LRUM	0.0007145	0.012573	-0.0045511
HDLBHA	0.068547***	0.006194*	0.531272
TTLB	0.105119	0.0113246	0.0038831
OTHCOSTS	0.019561**	0.0012889	0.0000014
CVOL	-0.0000062	0.0033621	0.013369
VNUM	0.0000392**	0.2613481	0.0032154
GROUP	0.2914327***	0.06532**	0.00000141**
PFERT	-1.205795	0.003841	0.078346**
PSPRAY	0.0006003**	0.004100	0.0000921
RFERT	0.0000174***	0.0057780	0.0000171
RSPRAY	0.002866***	0.036766	
model			
Statistics log likelihood	64.88519	93.78553	52.30694
DPPRDP (∝)	0.3957	0.3342	0.3822

Table 3: Pathway coefficient result of relative impact of positive significant variables on IDPC adoption in Damboa, Borno State, North-Eastern Nigeria

Variables	Coefficient	Adoption impact (%)
Socio-economic domain	0.518103***	50.740
Small ruminant	0.1235021***	12.090
Hired labour	0.068547***	6.710
Other costs	0.019561**	1.920
Variety	0.0000392**	0.004
Group	0.2914327***	28.540

Computed from field survey data (2007)

Farmers' decisions to adopt can also be impacted significantly by farmers' ability to associate in group (29%) and availability of small ruminants (12%). The impact factor for farmers' group is substantiated by the creation of awareness, inspiration from farmer colleagues and possible subsidy of inputs as a result joining the group while availability of small ruminants as a result of preference for fodder aid in their adoption decision hence the 12% impact.

REFERENCES

Ayuba, H.K., 2005. Environmental Sciences. Loud Books Publishers, Ibadan, Nigeria, pp: 49-53.

Brunner, J., N. Heinninger and U. Deichmann, 1995. West African Long Term Perspective Study (WALTPS), Database and Users' Guide. World Resources Institute, Washington DC.

Davies, D.W., E.A. Oelke, E.S. Oplinger, J.D. Doll, C.V. Hanson and D.H. Putman, 2005. Cowpea: Alternative Field Crop Manual. Centre for Alternative Plant and Animal Product, Minnesota Extension Services, University of Minnesota and Cooperative Extension Services, University of Wisconsin-Madison.

FAO, 2004. Livestock and Global change. Food and Agriculture Organisation, Rome, Italy.

FAO, 2007. Statistics. Food and Agriculture Organisation, Rome, Italy.

Horizon, 2003. Agriculture: Adoption and impact of dry-season dual purpose cowpea in Nigerian semiarid regions. http://www.solutions-site.org/artman/publish/article_9.shtml.

Jefferson, T., 2005. Cowpea: A Versatile Crop for Hot Dry Conditions. Thomas Jefferson Agricultural Institute, West Nifong Boulevard, Colombia.

Jirico, R.K.K., 2006. Socio-economic factors affecting the performance of women in food production. Proceedings of 11th Annual National Conference on Changing Perspectives in Extension Innovation System in Nigeria, Agricultural Extension Society of Nigeria.

Kristjanson, P., I. Okike, S. Tarawali, B.B. Singh and V.M. Manyong, 2005. Farmers perceptions of benefits and factors affecting the adoption of improved dual purpose cowpea in dry savannas of Nigeria. J. Agric. Econ., 32: 195-210.

Langyintuo, A.S., J. Lowenberg De Boar, M. Faye, D. Lambert and G. Ibro *et al.*, 2005. Cowpea Demand and Supply in West and Central Africa. Department of Agricultural Economics, Purdue University, West Lafayette, Indiana, USA.

Ortiz, R., 1998. Cowpeas from Nigeria: A small food revolution. Outlook Agric., 27: 125-128.

Singh, B.B., O.L. Chambliss and B. Sharma, 1997. Recent Advances in Cowpea Breeding. In: Advances in Cowpea Research, Singh, B.B., D.R. Mohan Raj, K.E. Dashiell and L.E.N. Jackai (Eds.). IITA and JIRCAS, Hong Kong, pp: 30-50.

UNICEF, 2006. Progress for children: A report card on nutrition, gamma irradiation and food security. Weekly Trust Newspaper, Abuja-Nigeria. July, 22-28.