CHOICE AND DEMAND FOR IMPROVED LEGUME SEEDS IN KANO STATE, NIGERIA

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Abstract. This study was conducted to assess the nature of demand for improved legume seeds among farmers in Kano State, Nigeria. Primary data were collected from 250 farmers from two Local Government Areas (LGAs) in the State using multistage sampling technique. Data were analysed using descriptive statistics, multivariate probit regression model and a censored Quadratic Almost Ideal Demand System (QUAIDS) model. The results showed that farm size, years of farming experience, access to credit, membership of cooperative association and visitation by extension agents influenced their choice of improved legume seeds. Also, the result showed that farmers were sensitive to changes in their incomes as well as to the prices of the different improved legume seeds. The results therefore recommended that improved legume seeds should be subsidized as this will encourage farmers to use the improved seeds.

Keywords: Choice, Demand, Varieties, Improved, Legume Seeds

INTRODUCTION

Seed, an important input in crop production is first and foremost, the source of most food, at least of plant origin, and therefore have the greatest socio-economic benefit to human welfare of any known biological device (Cavatassi *et al*., 2010; Zewdie, 2004). More significantly, quality seeds of any preferred variety are a basis for improved agricultural productivity since they respond to farmers' dual needs of increasing productivity and domestic legume consumption (Pelmer, 2005). Thus, quality seed provision is a prerequisite for increasing food production, improving farmers' income, alleviating poverty and food insecurity – which is of critical concern in most developing countries including Nigeria.

However, food crops rich in protein particularly legumes could effectively help solve the problem of malnutrition and food insecurity among the populace of the country (Tropilab Incorporated, 2005). This is because legumes such as cowpea, soybean and groundnut are regarded as the cheapest sources of protein to the poverty-ridden populace of Nigeria. In addition, considering the interest of international bodies in reducing hunger, poverty and malnutrition in developing countries including Nigeria, the significant importance of increasing legume productivity to tackle these challenges cannot be neglected (Coulibaly and Lowenberg-Debber, 2000). Furthermore in Nigeria, the production of legumes has increased over the last decade; production is yet to cover the rising demand for them due to the ever increasing population, hence, the continued importation of these legumes from other neighbouring countries (Rusike, 2011).

More so, the maximum contribution of these legumes to mankind has not been fully exploited by farmers in Nigeria. This is due to low productivity problems associated with farmers' production systems as well as the types of varieties cultivated, which do not sufficiently meet the challenges of the country's disproportionate increase in human population relative to production (Ondoma, 2006). As a result, a consortium of research institutes and organizations have all come together to address the challenges to legumes production with the primary goal of enhancing productivity and yield stability which will subsequently lead to increased food security, improved nutrition and increased income to resource-poor farmers (Balangaliza, 2014). These institutes and organizations have made progress in legume improvement with the most spectacular being the introduction of short-duration varieties (Ajeigbe *et al*., 2009).

Moreover, literature has shown that these improved varieties significantly have the potential to increase agricultural output and to improve farmers' income (Ajeigbe *et al*., 2009). However, the use and adoption of these new cultivars have been rather disappointing to most experts. This is because farmers are still mostly using traditional cultivars which though have most of the desired attributes but are by far, low yielding, late maturing and susceptible to diseases as compared to these improved varieties (Minde *et al*., 2008). Also, most farmers continue to recycle seeds that have become exhausted after generations of cultivation with the resultant effects of depending on these poor quality seeds have been poor yield, persistent food insecurity as well as low living standard of farmers (Zulu, 2004). It is in line with the foregoing that this study attempted to fill the gaps by identifying farmers' choice of improved legume seeds, factors that determine the choice among the improved legume seeds and analysed the responsiveness of improved legume seed demand to changes in their prices and income of the farmers in the study area.

Review of literature

According to Wen *et. al*., (2003), application of the theory of household demand requires a specific model. In general, econometric studies of demand include both single equations and systems of demand equations. The demand functions can be generalized for a consumer or household buying 'n' goods as:

$$q_i = q_i(p_i, p_2, \dots, p_n, Y) \qquad i = 1,2,\dots,n \qquad (1)$$

Where q_i = the quantity of commodities demanded

P = price

Y = income

These "n equations" can be estimated by single equations or by systems of equations. In this study, Equation 1 is estimated in a budget share form. Extending the demand function for individual consumers to that for a group of consumers in most empirical applications requires the inclusion of demographic variables besides prices and income.

Estimation of demand functions consistent with economic theory has been highly researched in the last four decades. Estimation of demand for goods and services has also attracted the attention of both theoreticians and empiricists, and a very dense literature is now available. Estimation of demand functions is very useful as it provides information on income and price elasticities. The measurement of income and price elasticities is required for the design of many different policies. For example, intelligent policy designs for indirect taxation and subsidies that require knowledge of these elasticities for taxable commodities and services (Deaton, 1988). The goal of demand analysis is to model households' expenditure patterns on a group of related items in order to obtain estimates of price and income elasticities and to estimate consumer welfare. The analysis of consumer behavior is indispensable since there are few aspects of economic policy that do not require some knowledge of household behavior. To be able to estimate demand function, many functional forms are available, economic theory does not answer the question of which specification is the best to choose in estimating it (Olorunfemi, 2013).

Different approaches for comparison have been proposed in the literature. These include the Linear Expenditure System (LES) of Stone (1954) which has been the pioneer in this area. However, LES has some limitations such as proportional income and price elasticities, and the ruling out of complementary relationships among goods. These limitations opened doors to the development of other models. Rotterdam model (Theil, 1965) and Translog model (Christensen, *et. al.*, 1975) can be listed among these more flexible models. However, Deaton and Muellbauer (1980) proposed an alternative modelling which they called Almost Ideal Demand System (AIDS).

MATERIAL AND METHODS

Study area. The study was carried out in Kano State based on the prevalence of legume production. The state lies in the semi-arid zone of Nigeria, around latitude 11°34'N and longitude 8°44'E. The ecology is characterized by a growing period of about 100 to 150 days. Annual rainfall of between 500 and 1000mm is erratic and restricted to four months. A multistage sampling procedure was used to select respondents for this study. Initially, two legume-producing LGAs were drawn purposively because of the prevalence of legume production. Thereafter, a simple random selection of five communities was made from each of the LGAs. Finally, 25 farmers were simple randomly selected from each of the ten communities. Thus, a total of 250 farming households were sampled for this study. Data collected for the study were analysed using descriptive statistics, multivariate probit regression model and a censored Quadratic Almost Ideal Demand Systems (QUAIDS) model.

Factors that influence choice of legume seeds: Multivariate probit regression model. In order to determine the factors that influence the farmers' choice of improved legume seeds and to correct for selection bias resulting from zero expenditure, a selection model was required. Thus for the purpose of this study, the estimation began with a probit model. The probit model was used because its likelihood function is well-behaved as it gives consistent Maximum Likelihood Estimate (MLE) coefficients (β) and standard error of the estimate(s) (Maddala, 1992). The probit model estimates the probability of choosing improved legume seeds for farming household level data and measures this likelihood after controlling the relevant variables used in the model. The dependent variable in the first step was defined as a dichotomous variable with the values 1 for those who prefer and 0 for those who do not prefer.

It should be noted that since the seed demand model that follows requires data for all the seeds, it is also important to estimate choice equations for all the seeds. The simplest and most straight forward estimation procedure would be to estimate each probit equation separately. However, it is important to note that the data for the different improved seeds were collected from one individual farmer at a given point in time. This may bring endogeneity within the data set that is, the error terms between the equations of different seeds might be correlated since data is being collected from the same individual whose decision on a particular seed choice may affect the probability of selecting another seed. As such, multivariate probit model was used to address this problem. Following Cappellari and

Jenkins, (2003) the multivariate probit model was structured as follows. Consider the M-equation multivariate probit model:

$$y_{im}^{*} = \beta_m{}' X_{im} + \epsilon_{im}, m = 1, \ldots, M$$
$$y_{im}^{*} = 1 \text{ if } y_{im}^{*} > 0 \; and \; 0 \; otherwise \quad (2)$$

$\epsilon_{im}, m = 1, \ldots, M$ are error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix V, where V has value of 1 on the leading diagonal and correlations $\rho_{jk} = \rho_{kj}$ as off diagonal elements. The multivariate probit model has a structure like the Seemingly Unrelated Regression (SUR), except that the dependent variables are binary indicators. The y_{im} might represent outcomes for M different choices at the same point in time, for example, whether a farmer chooses M type of seeds. The X_{im} is a vector of explanatory variables and β_m are unknown parameters to be estimated. The probability function of the probit model is usually the standard normal density which provides predicted values within the range (0, 1). Therefore, a multivariate model allowing for the possible contemporaneous correlation in the decisions to choose the different seeds can be specified as follows:

$$y_{ij} = x_{ij}^{I} \beta_j + \varepsilon_{ij} \quad (3)$$

Where

i = observation of farming household;

j = the number of improved seeds (j = 1, ... ,4);

ε_{ij} = unobserved error term;

y_i = improved legume seeds chosen by farming households;

Prob (y_i = j) = probability of choosing any of the selected improved legume seeds;

$$y_1^{*} = \alpha_1 + X\beta_1 + \varepsilon_1$$
$$y_2^{*} = \alpha_2 + X\beta_2 + \varepsilon_2$$
$$y_3^{*} = \alpha_3 + X\beta_3 + \varepsilon_3$$
$$y_4^{*} = \alpha_4 + X\beta_4 + \varepsilon_4$$

With y_1^{*}, y_2^{*}, y_3^{*}, and y_4^{*} a set of n-latent variables underlying each of the improved legume seed choice decision such that $y_j = 1$ if $y_j^{*} > 0$; 0 otherwise.

β = the coefficients' vector;

X_i = vector of farming household characteristics,

where:

X_1 = age of farmer (years);

X_2 = household size (number);

X_3 = sex of farmer (dummy 1 = male and 0 = female);

X_4 = marital status (dummy 1 = married and 0 = otherwise);

X_5 = number of years spent in education (Years);

X_6 = Price of improved cowpea seed (natural logarithm);

X_7 = Price of improved groundnut seed (natural logarithm);

X_8 = Price of improved soybean seed (natural logarithm);

X_9 = Price of other improved legume seeds (natural logarithm);

X_{11} = household monthly expenditure (proxy for income) (natural logarithm).

Demand for improved legume seeds: Censored QUAIDS model

A censored QUAIDS model was used to determine farming households' demand for improved legume seeds. For this, an Inverse Mills Ratio (IMR) was computed from the multivariate probit regression and estimates of the IMR were included as independent variables in the QUAIDS model so as to account and correct for any bias created by zero observations or expenditure on any improved legume seed. The QUAIDS model was used to estimate the effect of household's income (proxied by total expenditure), the prices of different improved legume seeds and other covariates on the demand for the different improved legume seeds. Thus in the model, farming household's budget share on the different improved legume seeds served as the dependent variables. The QUAIDS model was expressed as follows:

According to Poi (2012), the household's expenditure share for good i, ω_i is defined as

$$\omega_i = \frac{p_i q_i}{y} \tag{4}$$

where ω_i is the budget share for the improved legume seed i, p_i is the price paid for different improved legume seed i, q_i is the quantity of improved legume seed i purchased, and y is the total expenditure on all improved legume seed in the demand system. With this definition of y,

$$\sum_{i=1}^{k} \omega_i = 1 \tag{5}$$

where K is the total number of improved legume seed in the demand system. The assumption of equation (5) stipulates that budget share of an individual farming household on improved legume seed must sum to 1.

The fact that $\sum_i \omega_i = 1$ is often called the adding up condition and this condition is satisfied if the following hold, that is if:

$$\sum_{i=1}^{k} \propto_i = 1 \quad \sum_{i=1}^{k} \beta_i = 0 \quad \sum_{i=1}^{k} \lambda_i = 0 \; and \; \sum_{i=1}^{k} \gamma_{ii} = 0 \; \forall i$$

The adding-up restrictions are not testable, and are imposed by dropping one of the share equations and estimating the remaining equations.

The QUAIDS model was specified by applying Roy's Identity and the demographics (household characteristics) were incorporated as suggested in Poi (2012) using the scaling technique introduced by Ray (1983) as follows.

$$\omega_i = \propto_i + \sum_{j=1}^{k} \gamma_{ij} \ln p_j + (\beta_i + \eta_j{}'\mathbf{z}) \ln\left\{\frac{y}{\overline{y_0}(\mathbf{z})\, a(\mathbf{p})}\right\} + \frac{\lambda_i}{b(\mathbf{p}) c(\mathbf{p},\mathbf{z})} \left[\ln\left\{\frac{y}{\overline{y_0}(\mathbf{z})\, a(\mathbf{p})}\right\}\right]^2 \tag{6}$$

When $\lambda_i = 0$ for all i, the quadratic term in each expenditure share equation drops out, the model thus resembles the Deaton and Muellbauer's (1980) original AIDS model. Including the IMR, the QUAIDS model then becomes:

$$w_i = \widehat{\Phi}\left[\alpha_i + \sum_{i=1}^{J} \gamma_{\mathrm{ij}}\, lnp_j + \beta_i \ln\left[\frac{x}{a(p)}\right] + \frac{\lambda_i}{b(p)}\left\{ln\left[\frac{x}{a(p)}\right]\right\}^2\right] + \delta\widehat{\emptyset} + \varepsilon_{ih} \tag{7}$$

Where, w_i is expenditure share for improved legume seed i, p_j is the price of improved legume seed j, x is the household expenditure, α_i, γ_{ij}, β_i and λ_i are parameters to be estimated, a(p) is a transcendental logarithm price index, $\widehat{\Phi}$ and $\widehat{\emptyset}$ are cumulative distribution and probability density functions respectively and ε_{ih} is a residual assumed to be multivariate normally distributed with zero mean and a finite variance-covariance matrix. The demand theory requires that the above system to be estimated under restrictions of adding up, homogeneity and symmetry. The adding-up is satisfied if $\sum_{i=1}^{J} \omega_{\mathrm{i}} = 1$ for all x and p which requires:

Adding-up $\sum_{i=1}^{J} \alpha_i = 1$, $\sum_{i=1}^{J} \beta_i = 0$, $\sum_{i=1}^{J} \gamma_{ij} = 0$, $\sum_{i=1}^{J} \lambda_i = 0$

Homogeneity in prices $\sum_{i=1}^{J} \gamma_{ij} = 0$

Slutsky Symmetry $\gamma_{ij} = \gamma_{ji}$

These conditions were satisfied by dropping one of the *n* demand equations from the system and recovering parameters of the omitted equations from the estimated equations using non-linear combination (nlcm) STATA command.

RESULTS AND DISCUSSION

The results on Table 1 showed that the average age of legume seeds farmers was approximately 42 years and that majority (97.6%) of the farmers are male, indicating that an average farmer in the study area is active and that legume farming is male dominated. The result also showed that the average years of farming experience was approximately 25 years and that the average farm size was approximately 4 hectares thus implying that legume farming is practiced on a small-scale basis. In addition, the result showed that only few (21.2%) of the farmers had access to credit facilities, 80.8% of the farmers were visited by extension agents while 53.6% are members of a cooperative society. Finally, the result showed that majority (96.8%) of the farmers used improved cowpea seeds, 73.6% used improved groundnut seeds, 60.8% of the farmers used improved soybean seeds while only few (12.0%) of the farmers interviewed used other improved legume seeds.

Table 1

Socio-economic characteristics of improved legume seeds farmers

Socio-economic characteristics	Frequency	Percentage
Age		
21 – 30	47	18.8
31 – 40	85	34.0
41 – 50	60	24.0
51 – 60	42	16.8
61 – 70	13	5.2
71 – 80	3	1.2
Mean (Standard Deviation)	**42.42 (11.91)**	
Gender		
Male	244	97.6
Female	6	2.4
Years of farming experience		
1 – 10	35	14.0
11 – 20	80	32.0
21 – 30	79	31.6
31 – 40	33	13.2
41 – 50	16	6.4
> 50	7	2.8
Mean (Standard Deviation)	**24.58 (12.38)**	
Farm size		
≤ 5	197	78.8
6 – 10	50	20.0
> 10	3	1.2
Mean (Standard Deviation)	**3.97 (2.42)**	
Access to credit		
Yes	53	21.2
No	197	78.8

Extension agents' visitation		
Yes	202	80.8
No	48	19.2
Membership of cooperative		
Yes	134	53.6
No	116	46.4
Choices of improved seeds cultivated†		
Cowpea	242	96.8
Soybean	152	60.8
Groundnut	184	73.6
Other improved legume seeds	30	12.0

Source: Data Analysis, 2020. † indicates multiple response

Factors influencing decision to participate in improved seeds varieties

The result on Table 2 revealed that the log-likelihood function was -408.298, the Wald chi^2 was 38.30 and that the Prob>chi^2 was 0.0081 indicating that the entire model was significant at the 1% level of significance. These diagnostic variables and the significance level reveal the fitness of the entire model.

The result revealed that the coefficient of years of farming experience was significant for all improved legume seeds. The result further revealed that whilst the coefficient of years of farming experience was positively significant for improved cowpea seeds and improved groundnut seeds, it was however negatively significant for improved soybean seeds and other improved legume seeds. The result showed that an increase in the years of farming experience would increase the likelihood of farmers to use improved cowpea and groundnut seeds. However, the result showed that an increase in the years of farming experience would decrease the likelihood of farmers to use improved soybean seeds and other improved legume seeds. Moreover, the result showed that the coefficient of access to extension agents was negative and significant for all improved legume seeds except improved cowpea seeds. This implies that an increase in extension agents' visitation would decrease the likelihood of farmers to use improved soybean seeds, improved groundnut seeds and other improved legume seeds.

The result further showed that the coefficient of farm size was positive and significant for improved groundnut seeds at 5% level of significance. This implies that as the size of farm increases, the likelihood of farmers using improved groundnut seeds would increase. The farm size, according to Akinola *et al*. (2010), is significant to influence farmers' decision in using improved technologies. In addition, the result showed that the coefficient of access to credit was negatively significant at 5% level of significant, which shows that the likelihood of farmers using improved groundnut seeds would increase with a decrease in farmers' access to credit facilities. This could be due to the fact that access might not translate to use and as such not all the farmers having access to credit facilities would use the facilities. This result is however contrary to Akinola *et al*. (2010) who found out that access to credit was significant in affecting the use of an innovation.

Finally, the result showed that the coefficient of membership of cooperative was significant for all improved seeds except for improved groundnut seeds. The result showed that whilst an increase in farmers' membership of cooperative societies would increase the likelihood of them using improved soybean seeds and other improved legume seeds, an increase in membership of cooperative society would decrease the likelihood of farmers using improved cowpea seeds. The positive relationship between membership of cooperative association and use of improved soybean seeds is consistent with Akinola *et al*. (2010) and Oseni *et al*. (2015) who submitted that farmers who belong to cooperatives will be better informed on the use of resources and implement better farming techniques, which enables them to utilize resources more efficiently.

The expected multivariate interdependence of use of the different improved seeds varieties were accounted for employing the multivariate probit simulation of the four cultivars. The null hypothesis that the correlations are jointly zero and the four decisions to use are independent was rejected at the 1% significance level. The results revealed that improved cowpea seeds enhanced the use of improved groundnut seeds. This could be due to its ability to contribute to the fertility of the soil (rho31). Also, the result showed positive interdependence of other improved legume seeds and improved soybean seeds (rho42). The positive interdependence indicates that the use of one improved seed variety gives the farmer the avenue to use another improved seed. Therefore, the positive interdependence showed that farmers' decision to use an improved seed does not affect or alter the decision to use another improved seed. Furthermore, the positive interaction showed that the activities done to promote one improved seed would also promote another improved seed.

Table 2

Factors influencing the decision to use improved legume seeds

Variable	Cowpea	Soybean	Groundnut	Other improved legume seeds
Farm experience	0.657*** (3.98)	-0.330** (-2.16)	0.182** (2.13)	-0.451*** (-4.13)
Farm size	0.130 (0.48)	0.179 (1.29)	0.354** (2.33)	0.256 (1.36)
Access to credit	-0.202 (-0.50)	-0.245 (-1.19)	-0.530** (-2.50)	-0.118 (-0.44)
Access to extension agent	0.454 (1.18)	-0.580*** (-2.60)	-0.366* (-1.65)	-0.509** (-2.14)
Membership of cooperative	-0.846** (-1.99)	0.382** (2.24)	0.195 (1.07)	0.540** (2.31)
Constant	1.187 (1.37)	1.442 (2.81)	-0.069 (-0.13)	-0.820 (-1.32)
Rho21	-0.048 (-0.34)			
Rho31	0.390** (2.52)			
Rho41	-0.003 (-0.01)			
Rho32	0.143 (1.35)			
Rho42	0.317** (2.48)			
Rho43	0.147 (1.07)			
Log likelihood	-408.298			
Wald chi^2	38.30			
Prob>chi^2	0.0081			

Likelihood ratio test of the correlation coefficients of the improved seeds rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: $chi^2(6) = 13.3962$; Prob > $chi^2 = 0.0372$

Demand for improved legume seeds

Table 3 indicate that none of the coefficients of the inverse mills ratios in the equation were significant, implying that there is no evidence of selection bias. The result on Table 3 showed that the coefficient of the price of improved cowpea seeds was contrary to a priori expectations and as such it was positive and statistically significant at 5%. This shows that as the price of improved cowpea seeds increases, the share of the budget that farmers would devote to improved cowpea seeds would also increase. The positive relationship between the price of improved cowpea seed and the budget share allocated to it could be due to its importance in the diets of farmers and the entire populace alike as well as its significance to ensuring food security and soil nutrition. However, the price of improved groundnut seeds was negative and statistically significant at 5%, which implies that an increase in the price of improved groundnut seeds would reduce the budget share allocated to improved cowpea seeds. The negative relationship between the price of improved groundnut seeds and the budget share allocated to improved cowpea seeds could be due to the fact that farmers in the study area mostly have strong cultural attraction for groundnut as a legume seed. This is evident because Kano State is known for her historical “groundnut pyramid” and also because groundnut is known for its industrial usefulness as well as an agricultural product for export.

In addition, the result showed that the coefficient of the price of improved soybean seeds was contrary to a priori expectation. This indicates that an increase in the price of improved soybean seeds would make farmers increase the budget share allocated to it. However, the price of improved groundnut seeds was negatively significant at 5%, indicating that farmers would allocate less of the budget share to improved soybean seeds if the price of improved groundnut seeds increase. Finally, the price of improved groundnut seed was contrary to a priori expectation and as such was positively significant at 1%. This shows that an increase in the price of improved groundnut seeds would make farmers increase the budget share allocated to improved groundnut seeds.

Table 3

Factors influencing demand for improved legume seeds

Variable	**Budget shares of improved seeds**			
	Cowpea	**Soybean**	**Groundnut**	**Other improved legume seeds**
Price of cowpea	0.431** (2.41)	-	-	-
Price of soybean	-0.102 (-0.84)	0.340** (2.37)	-	-
Price of groundnut	-0.350** (-2.49)	-0.277** (-2.38)	0.698*** (4.17)	-
Price of other improved legume seeds	0.021 (0.34)	0.039 (0.63)	-0.071 (-1.22)	0.011 (0.19)
Total household expenditure	0.003 (0.05)	-0.010 (-0.23)	0.019 (0.35)	-0.012 (-0.58)
Inverse Mill’s Ratio	-0.014 (-0.16)	0.035 (0.51)	-0.047 (-0.57)	0.026 (0.86)
Constant	0.485 (8.54)	0.127 (2.73)	0.382 (7.04)	0.007 (0.25)

Source: Data Analysis, 2020

Estimation of price and expenditure elasticities

The result on Table 4 showed the price and expenditure elasticities. The result showed that only the own-price elasticity of improved groundnut seeds was significant. The own-price elasticity for improved groundnut seeds was positive though inelastic (0.920), which implies that the quantity demanded for this seed increased less than proportionately to the increase in its price. Contrary to a priori expectation, the result revealed that farmers would be willing to buy more improved groundnut seeds in spite of upward change in the seeds' price. This may be due to its nutrient contribution to the soil and it may also be as a result of the increase in their demand by the populace. Hence, farmers have no option than to use them in production despite the increase in its price.

Table 4

Own, Cross and Expenditure elasticities

Improved seed	Cowpea	Soybean	Groundnut	Other improved legume seeds
Cowpea	0.437 (0.426)	-0.032 (0.288)	-0.480 (0.334)	0.076 (0.144)
Soybean	-0.068 (0.613)	0.880 (0.724)	-1.030* (0.588)	0.218 (0.312)
Groundnut	-0.568 (0.394)	-0.571 (0.326)	1.313*** (0.471)	-0.174 (0.165)
Other improved legume seeds	1.287 (2.412)	1.711 (2.462)	-2.470 (2.340)	-0.528 (2.392)
Uncompensated elasticity				
Cowpea	-0.045 (0.427)	-0.259 (0.289)	-0.887*** (0.335)	0.047 (0.143)
Soybean	-0.311 (0.616)	0.765 (0.725)	-1.235** (0.589)	0.204 (0.312)
Groundnut	-1.033*** (0.396)	-0.789** (0.327)	0.920* (0.471)	-0.202 (0.165)
Other improved legume seeds	1.095 (2.418)	1.621 (2.465)	-2.633 (2.343)	-0.540 (2.392)
Expenditure elasticity	1.143*** (0.087)	0.577*** (0.146)	1.104*** (0.098)	0.456 (0.507)

Source: Data Analysis, 2020

Considering the cross-price elasticity, the result revealed that the improved legume seeds exhibited complementary relationships since they all have negative signs. The complementary relationship between improved cowpea seeds and improved groundnut seeds as well as improved soybean seeds and improved groundnut seeds imply that a decrease in the price of one of the improved seeds would lead to an increase in the demand for the other and vice-versa. On the other hand, the result showed that if farmers increase their demand for one of the improved seeds, their demand for the other would also increase. This may be a risk-mitigation effort and an act against crop failure. This may also be true because individual improved legume seeds have distinct potentials which are believed by farmers to promote soil fertility and livestock sustainability.

The result of the expenditure elasticities showed that all the improved legume seeds were elastic. The result further showed that improved cowpea seeds (1.143) and improved groundnut seeds (1.104) were luxuries while improved soybean seeds is a necessity (0.577). The positive expenditure elasticity showed that as income increased, the expenditure for improved legume seeds would also increase. This could be due to the output of these products per hectare and consequently to the returns received by the farmers at the end of each sale.

The results showed that farmers were sensitive to changes in income and prices of improved legume seeds. The implication of this is that any intervention to improve farmers' seed purchases should take into account efforts to increase farmers' purchasing power. Approaches such as subsidizing the improved seeds may be a way to achieve this.

CONCLUSIONS

This study was conducted to assess the nature of demand for improved legume seeds among farmers in Kano State, Nigeria. The study addressed the factors that influenced farmers' choice of improved legume seeds as well as the responsiveness of these seeds to changes in their prices and farmers' income. The results showed that farm size, years of farming experience, access to credit, membership of cooperative association and visitation by extension agents influenced their choice of improved legume seeds. Also, the result showed that farmers were sensitive to changes in their incomes as well as to the prices of the different improved legume seeds. The results therefore recommended that farmers should be sensitized on the benefits and importance of belonging to a cooperative organization. Adequate farming land should be provided to legume farmers as this has been shown to increase their use of improved legume seeds. Also, improved legume seeds should be subsidized as this will encourage farmers to use the improved seeds.

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