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Farmer preferences for groundnut traits and varieties in West Africa: Cases of Mali, Niger and Nigeria

J Ndjeunga, BR Ntare, A Abdoulaye, A Ibro, MA Zarafi, Y Cisse, A Moutari, O Kodio, CA Echekwu, SG Mohammed and I Micko

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International Crops Research Institute for the Semi-Arid Tropics

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Abstract

Participatory varietal selection trials were implemented in Mali, Niger and Nigeria and were used to assess farmers' preferences for plant and seed traits of selected groundnut varieties. Using a panel of farmers in every country, plant and seed traits were assessed and found to be statistically associated with the varieties tested. Ordered probit models were used to identify plant and seed traits liked by panelists. Color of the leaves, maturity (short cycle), number of pods, pod size, constriction, pod yield, pod filling and taste were the important attributes explaining farmers ranking for varieties in Mali. In Niger, the color of the leaves, the number of pods per plant, pod filling, pod beak, and pod yield were the most important traits sought by farmers. In Nigeria, plant vigor, plant maturity, plant type, number of pods per plant, pod size, haulm yield and pod yield were the preferred traits. These traits should be used to identify varieties (from large germplasm collections) most likely to be adopted by farmers. Varieties with traits sought by farmers should be promoted and used to build sustainable seed supply systems. Attributes such as color of leaves, pod reticulation and pod beak tend to be overlooked and should be included in future breeding programs.

Keywords: participatory variety selection, groundnut plant and seed trait, ordered probit model, value of traits.

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We are largely indebted to all the farmers in the TL II project sites in the three states of Nigeria mainly Katsina, Kano and Jigawa, the regions of Dosso in Niger and of Koulikoro and Kayes in Mali who tirelessly responded to our questions and enlightened us on the factors explaining their choice for variety traits and their ranking or preference for groundnut varieties.

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Acronyms and abbreviations

DNSI	Direction Nationale de la Statistique et de l'Informatique
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IER	Institut d'Economie Rurale
INRAN	Institut National de la Recherche Agronomique du Niger
IAR	Institute of Agricultural Research
FCFA	Franc de la Communauté Française Africaine
CFC	Common Fund for Commodities
GSP	Groundnut Seed Project
PVS	Participatory Varietal Selection
BUK	Bayero University of Kano
CSP	Cellule de Suivi et de Planification
LABOSEM	Laboratoire des Semences
NGO	Non-Governmental Organization
WCA	West and Central Africa
TLII	Tropical Legumes II

Summary

Participatory varietal selection (PVS) trials were implemented in the Tropical Legumes II (TL II) project sites in three countries in West Africa, namely Mali, Niger and Nigeria, using the mother and baby trial design. These trials were used to assess farmers' preferences for plant and seed traits of selected groundnut varieties. Preferences for traits were revealed using structured surveys administered to a panel of farmers in each site. Seventy-four (74) farmers were selected in Mali as part of the panel, as were 114 in Niger and 155 in Nigeria. Each farmer expressed his/her preference for traits by rating the attributes of each variety and by ranking each of the varieties.

Median scoring of varieties showed that farmers in Mali liked both ICGV 86124 and 47-10 (local variety) over JL 24, Fleur 11 and ICGV 86 015. In Niger, RRB, the local check (55-437) and J11 were equally preferred over Fleur 11 and TS32-1. Finally, in Nigeria, the variety ICIAR 19BT was largely preferred over the local checks (SAMNUT 21 and SAMNUT 23). ICIAR 6AT and ICIAR 7B were the least preferred in Nigeria. There are however differences based on location, region or village. In Mali, in the region of Kayes, farmers have expressed their preference equally for JL24, Fleur 11, ICGV 86124 and the local, whereas in Koulikoro, ICGV 86124 and the local were equally and largely preferred by farmers over ICGV 86015. In Doula, Niger farmers expressed their preference for 55-437 (the old variety) followed by J11 and ICG 9346, whereas in Tanda, farmers preferred RRB, followed by TS32-1 and Fleur11. In Nigeria, however, in all the three states the variety ICIAR 19BT was selected over the local checks (SAMNUT 21 and SAMNUT23). Two other new varieties (ICIAR 6AT and ICIAR 7B) performed poorly in the three states.

In all countries, farmers were able to discriminate most major plant and seed traits used in the typical card for the survey. In fact, plant and seed traits were found to be statistically associated with the varieties tested under the PVS. In Nigeria, for example, farmers found plant type, grain size, and resistance to diseases, color of the leaves, maturity, haulm yield, haulm quality, pod yield, grain color, foliar diseases, plant vigor, pod reticulation, pod filling, pod size, and number of pods as being largely associated with varieties tested. In Niger, plant type, resistance to diseases, color of the leaves, plant maturity, number of pods, pod yield, haulm quality, haulm yield and plant vigor as being strongly associated with varieties tested. In Mali, plant maturity, number of pods, pod size, pod filling, pod reticulation, pod beak, pod constriction, grain size, grain color, haulm quality, pod yield and taste were associated with the varieties.

Ordered probit models were used to identify plant and seed traits liked by panelists. Results showed that color of the leaves, maturity (short cycle), number of pods, pod size, constriction, pod yield, pod filling and taste were the important attributes explaining farmers ranking for varieties in Mali. In Niger, the color of the leaves, the number of pods, pod filling, pod beak, and pod yield were the most important traits sought by farmers. In Nigeria, plant vigor, plant maturity, plant type, number of pods, pod size, haulm yield and pod yield were the important traits.

For some traits, varieties selected for the PVS were similar/identical not allowing farmers to differentiate between varieties based on those characteristics. Varieties selected by farmers can be site-specific and finally, attributes such as color of leaves, pod reticulation and pod beak tend to be neglected. Lessons learned include (1) a better choice of varieties for PVS with different traits, and (2) the need for targeting varieties to recommendation domains.

1. Introduction

Over the last three decades, groundnut (*Arachis hypogaea* L.) production in West Africa has declined in importance as both food and a cash crop for households and national economies. Since 1984, West Africa has been losing its production and export shares. Higher world prices for groundnut products compared to substitutes and difficulties to meet the quality standards required by the international markets (ie, aflatoxin levels) have limited the competitiveness of West African groundnut in global trade. Prospects for regaining production and market shares lie in the adoption of improved varieties and crop management technologies that will significantly increase productivity and production and the improvement of quality standards.

In West Africa, groundnut production is estimated to about 5.87 million tons (2002-07) accounting for 67% of total groundnut production in Africa and about 16% in the World. In 1984-2008, the rate of growth in production is estimated to about 5.24% mainly due to increases in area cultivated. Mali, Niger and Nigeria are major groundnut producers with Nigeria accounting for about 40% of groundnut production in Africa. Yields are very low, estimated at 481 kg/ha in Niger and 1082 kg/ha in Nigeria, which are below world estimates or that of a leading country such as China with yield nearly 3000 kg/ha (2002-07 estimates) (FAOSTAT 2009). Despite the availability of high performing varieties developed by ICRISAT and NARS, adoption of modern varieties is low due largely to poor access to quality seed. ICRISAT and NARS have developed or tested a range of varieties that could significantly increase productivity. To alleviate this constraint, a project funded by the Common Fund for Commodities (CFC) called the Groundnut Seed Project (GSP) started to address the seed availability constraint from 2003 to 2007. In 2007, the Tropical Legumes II program implemented in West Africa addressed sustainable community-based seed systems issues in two steps: 1) PVS trials to promote improved varieties and selecting varieties to be produced by farmers or farmer associations or the private sector, and 2) building up the seed demand and seed supply systems.

Farmer Participatory varietal selection using the mother and baby trial approach has been used to increase farmers' exposure to contemporary groundnut varieties and assess farmers' preference for varieties. Demand for varieties is a function of plant, seed and processing traits preferred by farmers that are embodied in the varieties. The plant traits preferred by farmers in Niger have been investigated for groundnut (Baidu-Forson 1997). Plant types, pod and haulm yield, and leaf spot resistance were found to be significantly preferred by farmers. Most seed and processing traits were not included. Seed traits were included in other earlier studies but localized in countries such as in Niger (Ndjeunga et al. 2003). This study is unique in that it carries out the PVS in three countries in West Africa and includes both plant and seed traits.

Knowledge of the range of plant, seed and processing traits are valuable for crop improvement programs and good market signals for processors. The demand for improved groundnut varieties is likely to increase if, among others, varieties are designed to include producers and consumers' preferred traits. Therefore, improving the performance of varieties accounting for all significant traits will likely contribute to the productivity, efficiency and profitability of groundnut production in West Africa. Market prices to food processors or its utility to consumers may be linked to traits embodied in the varieties that are preferred by consumers or food processors. There is no definite account of the value of each quality trait that is embodied in the varieties. In other words, market prices for those products or utility derived by consumers do not provide specific information (signals) on the marginal value of specific characteristics that are important to consumers or food

processors. Rather, price is a composite for a bundle of characteristics that defines the overall quality of the product (eg, oil, cakes or edible nuts). In order to better link economic decision criteria to improvement in genetic characteristics of groundnut, it is useful to have a measure of the marginal contribution of specific characteristics to quality.

This study uses PVS trials to systematically evaluate the farmers preferences based on plant and seed characteristics and overall preference for varieties. One primary question forms the basis for the preference evaluation: what are the values placed on specific characteristics of varieties? We here use the Ordered Probit model to identify factors driving the ranking of farmers on varieties, and measure the value of plant and seed characteristics.

2. Description of the study area – Infrastructure and production environment in Mali, Niger and Nigeria

This study was undertaken in the pilot sites of the TL II program in Mali, Niger and Nigeria. These pilot sites were selected from the drought-prone zones and are located in groundnut producing areas of the countries. The sites span a range of socioeconomic and demographic settings, and are representative of agro-ecologies suitable for groundnut production in West Africa.

Mali

Groundnut production is concentrated in the West, South and parts of the Center covering the regions of Kayes, Koulikoro, Sikasso and Segou. These regions account for 97% of area and 98% of groundnut production in Mali. Rainfall ranges from 400 to 800 mm per year. The Tropical Legumes II program sites are located in the regions of Koulikoro and Kayes. The region of Kayes is the major groundnut producing region accounting for 33% of area and 35% of groundnut production in Mali. The region of Koulikoro accounts for 21% of groundnut area and 24% of groundnut production in Mali (DNSI, 1996/97).

Kolokani is one of the largest groundnut-producing areas in the Koulikoro region. It has a history of experiencing repeated droughts one year out of three. Groundnut is the main source of rural livelihoods representing 37% of the total cultivated area. It is mostly planted as a sole crop and in rotation with cereals. Only about 8% of groundnut area is cultivated in association with cereals. Groundnut is cultivated on collective plots by all household members or individual plots owned by either men or women in the household (DNSI, 1996/97).

Yields are higher in Kita (1249 kg/ha) compared to 661 kg/ha in Bougouni and 760 kg/ha in Kolokani (CPS/IER, 1998). The low yields are partly due to the poor quality of seed used by farmers. Thirty-two percent reported poor quality seed to be a major constraint to groundnut production. Almost all farmers complain of low supply of seed of improved varieties. Farmers also use very little inorganic fertilizer.

Since 1996, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Institut d'Economie Rurale (IER) have been working in Kolokani area, developing a range of varieties tolerant or resistant to many foliar diseases.

In 2000, ICRISAT initiated a small-scale seed production scheme with farmers in the villages of Bambabougou, Kanekebougou, Tioribougou and Komokorobougou in the Kolokani region. Seed

was marketed using small-scale pack seed (Ndjeunga et al. 2003). Since 2003, the groundnut seed project (GSP) continued to promote a range of seed multiplication and delivery schemes in other regions of Mali.

Niger

The program pilot sites are located in the Dosso region in Niger. The sites were selected to represent the agro-ecological zones of the Dosso region. Dosso is located in southwest Niger and covers 33,844 sq km with a population density of 44-persons/sq km and population estimated at 1.5 million inhabitants accounting for 14% of the total population (République du Niger, 2005). The climate is the Sudano-Sahelian type, with rainfall levels ranging between 400 and 1200 mm.

Soils are mainly sandy accounting for two-thirds of the region, with clayey soils in less than 10% of the region. There are hydromorphic soils located in the low land area called dallol and river valley, very rich in organic matter (Danguiwa, 2000). Zarma, Maouri and Peulh are the main ethnic groups representing 48%, 34% and 12%, respectively. The main rainfed crops grown are millet, sorghum, “fonio”, rice, cowpea, groundnut and bambara nuts. Irrigated crops such as rice, vegetables or fruit trees, are grown in the river valley, silty and sandy-clay soils in the low ground and dallol. Major crop associations include millet-cowpea, followed by millet-sorghum-cowpea, millet-sorghum and millet-cowpea-sesame. The size of production units range between 7.3 ha in the Gaya area to 19.7 ha in the Loga area.

A number of projects have been implemented in the Dosso region. In 2001, PADEL a rural development project was involved in variety testing and dissemination in the region of Gaya. In 2002, eight individual farmers and 5 farmers associations were targeted to produce seed of farmers’ selected varieties

In 2003/04 with the inception of the GSP, a mother and baby trial approach was implemented in 3 villages of western Niger to assess household preferences for plant and seed traits of 5 groundnut varieties. Based on preferences recorded for 5 groundnut varieties, RRB, 55-437 and ICGV 9346 were the most preferred. This was followed up by the production of seed of selected varieties by farmers’ associations and individual farmers.

Nigeria

The Tropical legumes II program sites are located in the states of Jigawa, Katsina and Kano states that account for more than 50% of total groundnut production in Nigeria. These states are located in the Sudan savanna and Sahel ecological region where millets, sorghum, cotton, groundnut, cowpea, vegetables, maize, cassava, sugar cane and beniseed are the main crops grown under rainfed and irrigated conditions.

Each of the three states occupies between 20,400 km^2 and 22,600 km^2 with rainfall ranging between 600 to 900 mm. Farm sizes are relatively small and are estimated between 1.6 ha in Kano to 2.7 ha in Jigawa. Kano is the most densely populated, with an estimated 276 people/km^2, more than double that of Jigawa. Average household sizes range between 8 and 10 members with average income ranging between 3200 Naira in Jigawa to 4000 Naira in Kano. The major ethnic groups are Hausa and Fulani (Ogungbile et al. 1999).

Since 1990, ICRISAT and IAR developed and tested more than 44 groundnut varieties. These varieties were tested in multi-locational trials in partnership with Agricultural Development Programs (ADP) and Sasakawa Global 2000 in many states including Kaduna, Kano, Jigawa and Katsina. Following an on-farm testing program in 2001, 3 groundnut varieties (UGA 2 (SAMNUT 21); M 572.80I (SAMNUT 22) and ICGV-IS-96894 (SAMNUT 23)) were formally released.

In 2003, the groundnut seed project (GSP) started to promote a range of high yielding groundnut varieties resistant to rosette disease with market and farmers' preferred traits through PVS, seed multiplication and delivery systems. Four states were targeted, namely, Kaduna, Kano, Katsina and Jigawa.

On-farm trials with farmers' management were conducted under the supervision of ADPs, the extension services in Nigeria. Once farmers had selected the preferred varieties, the next task was to increase access to seed of modern varieties and evaluate the size of the seed market. Thus, scientists initiated the sale of small seed packs. Besides, seed was produced through the private sector with seed companies such as Alheri and Premier Seeds, and farmers' associations. Seed was also sold through private company outlets.

3. The Tropical Legumes II Program

The main purpose of the Tropical Legumes II program is to enhance the productivity of legumes in drought-prone areas of South Asia and sub-Saharan Africa. In West Africa, the program is implemented in Niger, Nigeria and Mali and focuses on targeting opportunities to enhance uptake of legume-based technologies for the poor in the drought prone areas, groundnut variety development and seed systems.

Targeting opportunities deal with the need to target crop breeding and delivery mechanisms to enhance the project's impacts on the livelihoods of the poor in West Africa.

The project's **variety development strategy** takes advantage of existing improved germplasm in the short term through participatory varietal selection. At the same time, new segregating populations are developed and selected for tolerance to drought and resistance to accompanying biotic constraints. This is complemented by a **seed delivery strategy** that will emphasize decentralized, pro-poor seed production and delivery systems.

4. Estimation technique and the econometric model

Maddala refers to the preference measured on a scale of 1 to 5 with 1 being intensely disliked and 5 being intensely liked as an ordered categorical variable. For discrete dependent variables, the linear probability model has a number of shortcomings. The error term is heteroscedastic and it produces inefficient estimates (Greene 1990; p. 663). Because of these difficulties, an ordered probit model consisting of *U* as an unobservable dependent variable, consisting of R_{γ} (where γ =0,1,2,3,… , *w*) as the choice alternative or observable dependent variable, and v and γ as the block of independent variables, and γ as the threshold variable can be formulated as follows:

$$U = \alpha + S\nu + \gamma b + e$$

where $e \sim N(0,1)$
R=0 if $U \leq 0$.
R=1 if $U \leq \gamma 1$
R=2 if $\gamma\ 1 \leq \leq \gamma\ 2$.
.
.
$\mathrm{R} = w \text{ if } \gamma_{w\text{-}2} \leq U$

where U is a j ×1 vector of unobservable utility, of, say, variety to a farmer, and $R\gamma$ is a vector of preference ratings. The γ's are threshold variables or cut-off points that provide the ratings of alternatives, S is a matrix of non-stochastic effect-coded variables of N attribute levels for the M products; μ is a matrix of marginal values of the gth characteristic levels for the jth variety; and μ is another matrix of non- stochastic interaction variables of M product and N individuals' characteristics. The interaction terms are effect coded (-1,0,1); b is the weight of the interaction term between the gth variety's attribute and ith farmer's characteristics; α is a column vector of constants or the intercept of the equation; and *e* is the stochastic error term[1].

The threshold concept is central to economic theory of consumer behavior (Doyle 1997). The theory asserts that a buyer responds (buys or rates alternatives) when utility exceeds a threshold or critical level of satisfaction. For example, variations in the independent variable would cause a switch into a farmer's preference ratings when utility reaches some levels. The cut-off points vary with individuals. Individuals with similar tastes and background have similar cut-off points.

5. Methodology and data

This section presents the mother and baby trial approach, the trial locations, the varieties used, the method used on the preference survey and varieties used in the PVS trials.

Mother and baby trial approach

The mother and baby trial approach was designed and implemented by Snapp (2002) to evaluate soil fertility best bet technologies options: mother trial and 10 or most satellite baby trials. The mother trial is a set of replicated trials with close monitoring by researcher. However the baby trials allow farmers to experience the technologies on their own. In this case, the mother trials were used as basis for assessing farmers' preference for groundnut varieties. The mother trials were located on central or visible locations and were implemented collectively by a group of selected farmers by village or farmer associations. Trials were set up in a randomized complete block of varieties depending on the number selected of varieties in the different countries[2]. Plot size was 10 m × 10 m.

1 This framework draws heavily from Sy HA, Merle D. Faminow, Gary V Johnson and Gary Crow. 1997. Estimating the Values of Cattle Characteristics Using an Ordered Probit Model. *Amer. J. Agr. Econ.* Vol. 79: 463-476 where details can be found.

2 Except in Nigeria where we had one plot per variety lined up in a row. Plots were larger by 10 m × 20 m.

The baby trials were implemented using incomplete block design. In each village, a number of farmers (based on the number of varieties) were selected and were given 1 kg each of one or two varieties to be compared to their local variety.

Trial locations

The trial locations in the three countries are represented in the map below (Figure 1).

In each of the countries, six villages were selected for the implementation of the PVS trials. The villages were selected based on agro-ecological zone and prior knowledge of key informants or links with other initiatives in these villages.

In Mali, the villages were Diagounte, Dialafara and Sadiola in the Kayes region and Marako, Diorila and Faladje in the Kolokani region.

In Niger, the six villages were in the Dosso region and included Doula, Guidan Gaba, Koma Beri, Tanda, Tounga and Wassangou.

In Nigeria, two villages from each of the three states were selected. These include Wurno and Zaburan in Jigawa state, Yarrutu and Ruwan Kanya in Kano state and Kuki and Tashar Nagulle in Katsina State.

Based on potential characteristics likely to explain choice for varieties, a discussion was held in each country with groundnut experts as well as groups of farmers in order to evaluate alternative question formats, contents and elicit general advice from consumers for different traits. The last stage in the process involved the development of the survey instrument. Only characteristics that were ranked high via the expert meeting and focus-group meetings were included in the questionnaire. Accordingly, 15 plant and seed characteristics were included. Growth habit, disease resistance, plant vigor, color of the leaves, plant maturity, number of pods, pod filling, pod beak, pod reticulation, pod constriction, pod and haulm yields, pod size, sees size and seed color were cited as important plant and seed characteristics for groundnut (Annex 1).

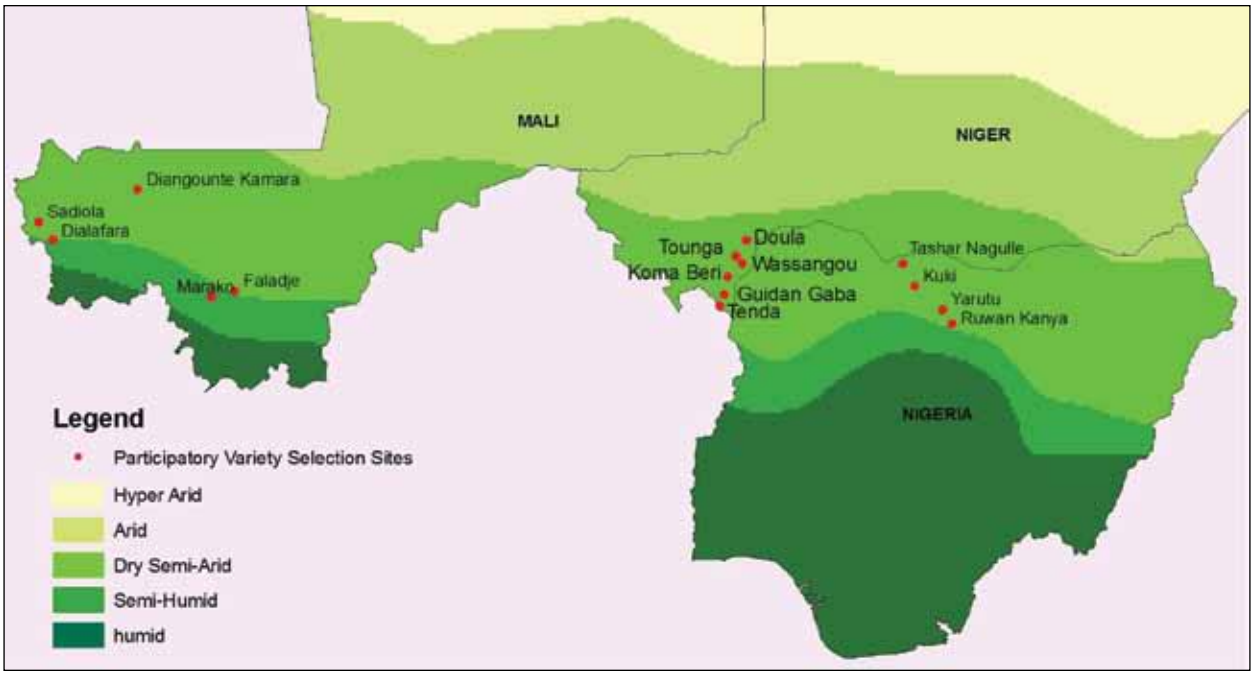

Figure 1. Participatory varietal selection trial locations in Mali, Niger and Nigeria.

Farmers-respondents evaluated the groundnut varieties using an N-point preference scale (N being the number of varieties. For 5 varieties for example, 0 was the least preferred and 4 was the most preferred). Similarly for each attribute, farmers – panelists ranked the attribute depending on the scale (eg, For color 0= does not like it, 1=indifferent, 2=liked it).

Preference assessment surveys were conducted in Mali using a total 74 panelists in the regions of Kayes and Koulikoro. In Niger, 114 panelists were identified in the five villages. In Nigeria, 155 panelists from the three project states (Jigawa, Kano and Katsina) participated in the survey.

At harvest, scientists asked farmers (panelists) for their preference for variety attributes and the overall ranking on varieties using structured survey instruments. On the first day, enumerators collected information on socio-demographic and economic profile and production technologies of households. On the second day, farmers familiarized themselves with the terminology used and the rating scales and were asked to rank the traits and varieties. Tests were carried out next to the PVS trials and panelists were asked to avoid communication between themselves during the test.

In Mali, the panelists used in the experiment were adults whose average age was 42 years. About 30 percent were female farmers. About 2/3 came from the Malinke group followed by the Bambara (22 percent). Less than 50 percent were illiterate. Agriculture was the main activity for 93 percent of the farmers. About 88 percent own a cart, 9 percent a tractor and 84 percent a plough (Table 1).

Table 1. Characteristics of farmers surveyed in Mali.

		Region		
Variable		Kayes	Koulikoro	Sample overall
Sample size		37	37	74
Distribution of respondent by gender (percent)				
	Male	59.46	83.78	71.62
Age of distribution (years)		40.32	43.30	41.81
Average household size		19.94	37.14	28.78[a]
Level of education (percent)				
	Illiterate	52.78	37.84	45.21
Ethnic group (percent)				
	Bambara	5.41	37.84	21.62
	Malinké	75.68	59.46	67.57[a]
	Sarakolé	2.70	0.00	1.35
	Peulh	13.51	2.70	8.11
Agriculture as main activity (percent)		91.43	94.59	93.06
Average number of plots owned		2.35	3.89	3.12
Number of plots				
	Sole cropping	1.41	3.41	2.41
	Mixed cropping	0.95	0.49	0.72
Cart ownership		81.08	94.59	87.84[c]
Tractor ownership		10.81	8.11	9.46
Plough ownership		70.27	97.30	83.78[a]
Average value of equipment (FCFA)		351167.00	261030.00	306098.00
Average value of livestock (FCFA)		545034.00	828091.00	686563.00
Average value of draft animal (FCFA)		341216.00	485135.00	413176.00

[a]Difference is significant at 1%, [b]Difference is significant at 5% and [c]Difference is significant at 10%

In Niger, the panelists were adults of about 44 years old, were mainly male (76 percent). Less than 50 percent were illiterate and about 83 percent were from the Haoussa ethnic group. Agriculture was the main activity for 98 percent. About 63 percent of the panelists own a cart, less than 1 percent a tractor and about 50 percent own a plough (Annex 2).

In Nigeria, farmers surveyed were mainly men. Panelists were adults averaging about 43 years old. Few farmers were illiterate (about 3 percent). Agriculture is the main activity for about 71 percent of respondents. About 46 percent of farmers own a cart, 1 percent a tractor and 55 percent a plough (Annex 3).

Varieties used in the PVS trials

In each country, at least five varieties were selected. In Mali, JL24, Fleur 11, ICGV 86124 and ICGV 86 015 were chosen. While these varieties are resistant to drought and susceptible to foliar diseases, they are few differences based on color of the leaves and pod beak. They are however different based on plant type, plant maturity, pod reticulation, pod constriction, seed color and yields (Annex 4).

In Niger, six varieties were used in the PVS. These varieties are 55-437, TS32-1, ICG 9346, J11, JL 24 and RRB. Except for RRB and ICG 9346, these modern varieties were introduced to Niger some 30 years ago. All of them were of the erect type, early maturing (90 days), and susceptible to foliar diseases. Varieties differ slightly on the basis of drought (only one not tolerant to drought), with two seeds per pod except JL 24; with slight pod constriction except for RRB with none, with about the same color of the yellowish leaves, except for J11, which is off-white. Other attributes such as pod beak, pod reticulation, seed color and pod yield show some variability (Annex 4).

In Nigeria, five varieties were selected, namely, ICIAR 19BT, ICIAR 7B, ICIAR 6AT, SAMNUT21 and SAMNUT 23. These varieties are resistant to groundnut rosette and are of the erect type except for SAMNUT21 (semi-erect). They are also all early maturing except for SAMNUT21 (medium maturity), with the same number of seeds per pod except for SAMNUT21. Differences in varieties are found based on pod beak, pod reticulation, pod constriction, seed color and yields (Annex 4).

6. Results and discussions

Rating and attribute levels

Table 2, and Annexes 5 and 6 present results from two-way contingency tables of various variety attributes and the Pearson chi-square statistic of the hypothesis of statistical independence (Agresti 1990). The results showed that the panelists were able to discriminate between varieties for each of the attributes and their overall preference. In Mali, all attributes were perceived significantly different across varieties except for growth habit, resistance to diseases, color of the leaves, pod reticulation, and seed color. The lack of differentiation between attributes and varieties for those traits is consistent with the fact that those traits are the same for those varieties (Annex 4). In Niger, farmers were able to discriminate between varieties for most attributes except for pod filling, pod beak and seed color. Finally, in Nigeria, farmers were able to discriminate very well

Table 2. Comparison of 5 groundnut varieties for plant and seed rating by farmers in Mali.

Trait of variety	Variety					
	JL 24	Fleur 11	ICGV 86 124	ICGV 86 015	Local variety	
Sample	(47)	(52)	(48)	(48)	(48)	χ^2 Value
Growth habit (0=Does not like, 1=Indifferent, 3=Like)	0.51	0.56	0.56	0.5	0.56	0.06
Resistant to disease (0=Does not like, 1=Indifferent, 3=Like)	0.77	0.88	0.73	0.52	0.69	1.12
Color of leaves (0=Does not like, 1=Indifferent, 3=Like)	1.06	1.19	1.1	1.08	1.06	0.16
Plant maturity (0=Does not like, 1=Indifferent, 3=Like)	1.19	1.37	1.08	0.79	0.75	4.84*
Number of pods (0=Does not like, 1=Indifferent, 3=Like)	1.51	1.75	1.25	1.06	1.21	7.44*
Pod size (0=Does not like, 1=Indifferent, 3=Like)	1.11	1.75	1.31	0.9	1.19	10.23*
Pod filling (0=Does not like, 1=Indifferent, 3=Like)	1.55	1.6	1.27	0.98	1.15	6.04*
Pod reticulation (0=Does not like, 1=Indifferent, 3=Like)	0.68	0.79	0.67	0.56	0.67	1.36
Pod beak (0=Does not like, 1=Indifferent, 3=Like)	0.74	1.33	1.02	0.92	1.4	8.69*
Pod constriction (0=Does not like, 1=Indifferent, 3=Like)	1.38	1.23	1.04	0.9	0.94	4.65*
Seed color (0=Does not like, 1=Indifferent, 3=Like)	1.89	1.85	1.92	1.83	1.83	0.42
Seed size (0=Does not like, 1=Indifferent, 3=Like)	1.19	1.69	1.29	0.88	1.19	8.14*
Pod yield (0=Does not like, 1=Indifferent, 3=Like)	1.64	1.67	1.23	1.06	1	9.82*
Haulm quality (0=Does not like, 1=Indifferent, 3=Like)	1.15	1.31	0.98	0.67	1.38	7.92*
Haulm yield (0=Does not like, 1=Indifferent, 3=Like)	1.19	1.48	1.02	0.67	1.42	11.93*
Taste (0=Does not like, 1=Indifferent, 3=Like)	1.74	1.62	1.44	1.23	1.67	5.92*

*Significant at 1% probability level.

between varieties for each of the attributes. This is evidence that the survey instrument did identify attributes that farmers were able to distinguish.

One way ANOVA was used to assess differences in attributes rating based on socio-economic variables such as gender, ethnic group, level of education, household size, age groups, value of livestock owned and value of equipment owned. Farmers' rating for these traits did not differ based on each of these variables.

Table 3 presents the overall median ranking of varieties by panelists in the 3 countries. In Mali, median ranking showed that farmers preferred similarly ICGV 86124 and the local variety to ICGV

86015, Fleur11 and JL24. In Niger, median raking results indicate that 55-437, ICG 9346 and RRB are the most preferred variety by farmers. In Nigeria, ICIAT19BT was by far the most preferred variety followed by the local checks (SAMNUT21 and SAMNUT23). ICIAR 6AT and ICIAR 7B were least preferred.

The global ranking masks potential variety specific recommendations. Annexes 7, 8 and 9 present the mean and median ranking by state in Nigeria, by region in Mali and by village in Niger. In Jigawa state in Nigeria, ICIAR 19BT and SAMNUT 23 are the most preferred varieties by farmers. In Kano and Katsina, ICIAR 19BT and SAMNUT 21 are the most preferred varieties. This shows that varieties preferred by farmers are site specific and that variety recommendations should be targeted to specific domains where varieties are preferred by farmers (Annex 7).

In the Kayes region in Mali, farmers have expressed their preference for all varieties except for ICG 86015. Whereas in the Koulikoro region, farmers expressed their strong preference for ICGV 86124 and the local variety over ICGV 86015. Fleur 11 and JL24 were ranked very low (Annex 8). In Doula, Niger, farmers have ranked 55-437 very high followed by J11 and ICG 9346. Other varieties were ranked very low. In Wassangou, farmers expressed their preferences for RRB

Table 3. Median and mean scoring of varieties in Mali, Niger and Nigeria.

	Scoring			
Country/variety	Mean	Median	Minimum	Maximum
Mali				
JL 24	1.574468	1	0	4
Fleur 11	1.730769	1	0	4
ICGV 86 124	2.791667	3	0	4
ICGV 86 015	1.6875	2	0	4
Local variety	2.270833	3	0	4
Total	2.00823	2	0	4
Niger				
55-437	2.807339	3	0	5
Fleur 11	2.06422	2	0	5
ICG9346	2.618182	3	0	5
J11	2.427273	2	0	5
RRB	2.827273	3	0	5
TS32-1	2.3	2	0	5
Total	2.507599	3	0	5
Nigeria				
ICIAR 19BT	3.167742	4	0	4
ICIAR 6AT	1.006452	1	0	4
ICIAR 7B	1.16129	1	0	4
SAMNUT 21	2.432258	3	0	4
SAMNUT 23	2.451613	3	0	4
Total	2.043871	2	0	4

and ICG 9346 and in Koma beri, J11 and ICG9346 were equally preferred. Other varieties were ranked low (Annex 9). The results above indicate the needs for varieties to suit the needs of farmers who are also the consumers.

Ordered probit model results: Determinants of the farmers' ranking for varieties

Table 4 and Annexes 10 and 11 present the results of ordered probit models, major statistical properties and specification tests for Mali, Niger and Nigeria, respectively. All variables are continuous and entered as effect-coded variables (for example -1,0,1 rather than 0,1,2). The use of coded variables instead of dummy leads to marginal effect coefficient equal to partworths (Sy et al. 1997).

According to Maddala (1993), the threshold coefficients should exhibit the following relationship, $\gamma_1 \leq \gamma_2 \leq \ldots\ldots\ldots \leq \gamma_{w-2}$ and must be positive. Failure to exhibit these conditions would imply specification errors of the models. All threshold coefficients are positive and statistically significant at 95% confidence level implying that there are no specification errors.

Another test was performed to look at the overall significance of the independent variables (levels of variety attributes and consumer profile) in explaining the variation in the consumer dependent variable rankings. A log-likelihood distributed as $\chi_{356,5}$ with a critical value of 9.06 indicated the strong rejection of the null hypothesis of the test $\nu = b = 0$ at the 95% confidence interval for the three countries. The p-values are 0 to 3 or more significant digits in all the three countries meaning that the product attributes and consumer profile variables are relevant in explaining variation in consumer preferences.

The estimated coefficients listed in Table 4, Annexes 10 and 11 were tested using a t-test. In Mali for example, plant maturity, number of pods per plant, pod size, pod constriction, pod yield, pod filling and taste were significant at least at the 10% level.

In Niger, disease resistance, number of pods per plant, pod filling, pod beak, seed color, and pod yield,

Table 4. Effects of variety traits and socio-economic and demographic characteristics on rankings in Mali.

Rank	Coefficient
Plant and seed characteristic	
Growth type	-0.1225567
Disease resistance	0.1124069
Color of leaves	0.0784758
Maturity	0.2201687[b]
Number of pods	0.3547637[a]
Size of pods	0.3344323[a]
Pod filling	-0.1213194
Pod beak	-0.181958
Pod reticulation	0.041961
Pod constriction	0.1858802[c]
Seed color	0.2691313
Pod yield	0.2146629[c]
Pod filling	0.8662914[a]
Haulm quality	-0.0276555
Haulm yield	-0.028681
Taste	0.3804388[b]
Socio-economic characteristics	
Age	0.0053832
Sex	-0.0497244
Marital status	-0.2557715
Formal education	0.0238058
Major occupation	0.0800745
ln (value of equipment)	-0.0053388
ln (value of livestock)	0.0062251
Koulikoro region	0.5008335
γ_1	2.894903
γ_2	3.810336
γ_3	4.644078
γ_4	5.539898
Ordered probit regression	
Number of obs	354
LR chi2(24)	259.74
Prob > chi2	0
Pseudo R2	0.2279
Log likelihood	-439.86438

[a]significant at 1%, [b]significant at 5% and [c]significant at 10%.

were significant at least at 10% level (Annex 10). In Nigeria, plant vigor, plant maturity, growth habit, number of pods per plant, pod yield and haulm quality were significant at least at 10% level.

Partworth estimates

Table 4 and Annexes 10 and 11 contain the main effect coefficient of variety attributes that represent the marginal values or partworths that each farmer, irrespective of the background, places on variety attributes in Mali, Niger and Nigeria, respectively. For illustration, in Mali, pod filling has a marginal value of 0.87 to an average consumer. Similarly, variety taste has a marginal value of 0.38 to an average consumer. Pod yield, number of pods per plant, and the size of the pods have average values of 0.21, 0.35 and 0.33, respectively to an average consumer. (Table 4). In Niger, the number of pods per plant had the highest marginal value to an average farmer, followed by pod yield, pod beak, seed color, disease resistance and pod filling. Negative partworth was observed for pod beak signaling that farmers would decrease their preference for a variety if pod beak is less pronounced. In Nigeria, plant vigor and the number of pods per plant had the highest marginal values estimated to 0.39 and 0.37 respectively. Pod yield, plant maturity, growth habit, and pod size, had positive marginal values of 0.30, 0.26, 0.22 and 0.15 respectively to the average consumer. Haulm quality had a negative partworth of 0.21 meaning that farmers preference decrease as the haulm quality increases. This result is counter-intuitive because of the importance of livestock in the livelihood of smallholder farmers in the Sahel.

Relative importance of variety traits

Table 5 presents the relative value of the trait preferred by farmers in the three countries. Findings from this study showed that in Mali, pod filling, taste, number of pods per plant, pod size, plant maturity, pod yield and pod constriction are the most important attributes preferred by farmers, in the order of decreasing importance. While most of the traits are largely related to yield or productivity, pod constriction is mostly a trait important in processing. Varieties with high constriction can easily break during decortication. In Niger, number of pods, pod yield, pod beak, seed color, disease resistance, and pod filling were the most preferred traits by order of importance. Most of these are

Table 5. Relative importance of variety attributes in Mali, Niger and Nigeria.

Country	Trait	Relative value
Mali	Plant maturity	9
	Number of pods	14
	Size of pods	13
	Pod constriction	7
	Pod yield	8
	Pod filling	34
	Taste	15
	Total	100
Niger	Disease resistance	11
	Number of pods	28
	Pod filling	9
	Pod beak	16
	Seed color	13
	Pod yield	23
	Total	100
Nigeria	Plant vigor	20
	Plant maturity	13
	Plant type	11
	Number of pods	19
	Pod size	7
	Pod yield	15
	Haulm quality	10
	Haulm yield	5
	Total	100

productivity traits signaling the importance of increased yields. Essentially, farmers liked varieties with a large number of pods per plant, high yielding, and disease resistant with good pod filling. Seed color was found difficult to interpret. However, the most preferred variety in Niger is dark red signaling that red color may be preferred by farmers. In Nigeria, in order of decreasing importance, plant vigor, number of pods, pod yield, plant maturity, growth habit, haulm quality, pod size and haulm yield were the most important variety traits preferred by farmers. As for Mali and Niger, most of the traits are related to yield. Essentially, farmers like high yielding varieties for groundnut. They also prefer the erect type variety probably because they mostly use agricultural equipment, for example for weeding, where the erect type makes it easier to work with.

7. Conclusions and implications

Farmers' preference for varieties is based on traits embedded into the varieties. Breeders would have to select for those desirable traits. This study used a simple ordered probit model with coding effect that produces marginal value of variety attributes following Sy et al. 1997. Results from this study indicate that in the three countries yield related traits are very important in varieties preferred by farmers. Pod yield, number of pods, pod filling, pod size were preferred by farmers in at least two countries. Processing traits such as pod constriction and pod beak were also found to be important. Haulm yield and quality were found as important traits in Nigeria only. This was counter-intuitive in environments like the Sahel where crop production and livestock rearing are the major sources of livelihood.

Lessons drawn from this study include (a) limited variability in some traits among tested varieties, (b) the need for site specific recommendations for varieties and (c) the need to include other traits in the breeding programs. In fact, some characteristics such as growth habit and resistance / tolerance to drought,though important, could not catch farmers' preference. Farmers' preference may vary according to sites and blanket recommendations could mask the preference choices in locations. This calls for the need for better targeting of sites. Processing traits such as pod beak and pod constriction should also be given priority in the selection of groundnut varieties.

Research is needed to assess preference along the value chain for each set of actors including farmers, processors, retailers and wholesalers. Failure to complete this may hinder other important processing traits targeting different products made from groundnut such as paste, cakes and oil.

References

Agresti A. 1990. Categorical Data Analysis. Wiley, New York.

Baidu-Forson J, Ntare BR and **Waliyar F.** 1997. Utilizing conjoint analysis to design modern varieties: empirical example for groundnut varieties in Niger. Agricultural Economics 16:219-226.

Baidu-Forson J, Waliyar F and **Ntare BR.** 1997. Farmers Preferences for Socioeconomic and Technical Interventions in Groundnut Production System in Niger: Conjoint and Ordered Probit Analyses. Agricultural Systems. 54(4):463-476.

CPS/IER. 1998. Diagnostic de la filière arachide au Mali. Rapport Final. Ministre du développement Rurale et de l'Eau. République du Mali.

Danguiwa A. 2000. Etude Agro-socio-économique et amenagements des terroirs dans le Departement de Dosso. Projet d'Appui au Développement Rural du Departement de Dosso. Republique du Niger.

Doyle P. 1977. The Application of Probit, Logit, and Tobit in Marketing: Review. *J. Bus. Res.* 5:235-48.

DNSI. 1997. Recensement général de l'agriculture. Cellule de Planification et de Statistique. Ministère de l'Agriculture du Mali. DNSI 1996/97.

FAOSTAT. 2009. FAO Statistics Division.

Greene WH. 1990. Econometric Analysis. McMillan Publishing Company, New York.

Sy HA, Merle D, Faminow, Gary V Johnson and **Gary Crow**. 1997. Estimating the Values of Cattle Characteristics Using an Ordered Probit Model. Amer. J. Agr. Econ. 79: 463-476.

INRAN. 1984 Catalogue des varietés développées au Niger. Institut de la Recherche Agronomique du Niger. Ministère de l'Agriculture et de l'Elevage.

Louviere JJ. 1990. Analysing Decision Making Metric Conjoint Analysis. Series: Quantitative Applications in Social Sciences. University Paper 67. Beverly Hills CA: Sage Publications.

Maddala GS. 1993. Limited-Dependent and Qualitative Variables in Econometrics}. Cambridge: Cambridge. University Press.

Melton BE, Arden Colette W and **Willham RL**. 1994. Imputing Input Characteristic Values From Optimal Commercial Breed or Variety Choice decisions. Amer. J. Agr. Econ. 76:478-491.

Moore WL. 1980. Levels of Aggregation in Conjoint Analysis: An Empirical Comparison. J. Mktg. Res. 17:516-23.

Morris WMM. 1982. Consumer Preferences and the Adoption of New Cultivars in Sahelian West Africa. Pages 365-367 *in* Proceeding of an International Symposium on Sorghum Grain Quality. 28-31 October, 1982. ICRISAT Center, Patancheru, India.

Ndjeunga J, Ntare B, Waliyar F, Ondio Kodio J and **Traore A.** 2003. Assessing the Diffusion of Groundnut Varieties in Mali. Pages 33-35 *in* International Arachis Newsletter No 23. Patancheru 502 324, Andhra Pradesh, India: ICRISAT.

Ogungbile AO, Tabo R and **van Duivenbooden N.** 1999. Multi-scale characterization of production systems to prioritize research and development in the Sudan Savanna Zone of Nigeria. Information Bulletin no. 56. Patancheru 502 324, Andhra Pradesh, India: International Crops Research institute for the Semi-Arid Tropics. 112 pp.

Ratchford BT. 1975. The New Economic Theory of Consumer Behavior: An Interpretive Essay. J. Consumer Res. 2:65-75.

République du Niger. 2005. Note de Presentation des Resultats Definitifs du RGP/H-2001. Bureau Central du Recensement – BCR. Ministère de l'Economie et des Finances. Secrétariat General.

Snapp S. 2002. Quantifying Farmer Evaluation of Technologies: The Mother and Baby Trial Design. *In* Quantitative Analysis of Data from Participatory Methods in Plant Breeding (Bellon MR and Reeves J, eds.). Mexico, DF: CIMMYT.

Train K. 1986. Qualitative Choice Analysis: Theory, Econometrics, and an Application to Automobile Demand. Cambridge MA: The MIT Press.

Varian HR. 1978. Microeconomic Analysis. W.W. Norton and Company, New York, NY.

Annexes

Annex 1. Typical card for plant and seed traits from the preference survey.					
	Variety				
Characteristic	*Var 1*	*Var 2*	*Var 3*	*Var 4*	*Var 5*
Vigor of plant (ability to stand, uprightness, plant height) (0=bad, 1=average, 2=good)					
Color of leaves (0=do not like it, 1=indifferent, 2=like it)					
Resistance to diseases and pests (0=poor, 1=average, 2=high)					
Resistance/tolerance to drought (0=poor, 1=average, 2=good)					
Growth habit (0=does not like it, 1=indifferent, 2=like it)					
Plant maturity (0=late, 1=medium, 2= early)					
Number of pods per plant? (0=low, 1=average, 2=high)					
Pod size (0=small, 1=average, 2=big)					
Pod filling (0=bad, 1=average, 2=good)					
Pod reticulation (0=disliked, 1=liked)					
Pod constriction (0=disliked, 1=liked)					
Grain color? (0=disliked, 1=indifferent, 2=liked)					
Seed size (0=small, 1=medium, 2=large)					
Pod yield (0=low, 1=average, 2=high)					
Haulm quality (0=poor, 1=average, 2=good)					
Haulm yield (0=low , 1=average, 2=high)					
Preference ranking (What is your general assessment of the variety (**1-5** with **1** being the least preferred and **5** the most preferred)					

Annex 2. Characteristics of farmers surveyed in Niger.

Variable	Village					Sample overall
	Doula	Guidan Gaba	Koma Béri	Tanda	Wassangou	
Sample size	22	22	29	10	31	114
Gender (percent)						
Male	86.36	22.73	86.21	100	90.32	76.32
Female	13.64	77.27	13.79	0	9.68	23.68
Age (years)	46.68	41.59	42.17	45.9	43.26	43.55
Household size	11.59	11.73	10.77	11.1	12.73	11.69
Level of education (percent)						
Illiterate	68.18	86.36	20.69	0	41.94	46.49
Ethnic group (percent)						
Zarma	9.09	13.64	10.34	80.00	0.00	14.04
Haoussa	90.91	86.36	89.66	10.00	93.55	83.33
Peulh	0.00	0.00	0.00	0.00	6.45	1.75
Touareg	0.00	0.00	0.00	10.00	0.00	0.88
Agriculture as main activity (percent)	100	100	93.1	100	100	98.25
Land size owned (ha)	14.07	6.23	6.17	5.45	7.24	7.93[a]
Area of groundnut (ha)	2.5	1.47	0.79	1.65	1.15	1.42
Average number of plots owned	1.19	1.5	1.04	1.8	1.9	1.47
Average number of plots under cropping systems						
Sole cropping	0.33	0.59	0.08	1.2	0.43	0.43
Mixed cropping	0.86	0.91	0.96	0.6	1.47	1.04
Ownership of cart	72.73	59.09	55.17	50	70.97	63.16
Ownership of tractor	0	0	0	10	0	0.94
Ownership of plough	31.82	50	48.28	80	58.06	50.88
Value of equipment (FCFA)	165268	75093	105141	473895	151684	155949[b]
Value of livestock (FCFA)	208193	217516	144666	182889	355198	230247
Value of draft animal (FCFA)	241591	237667	152621	477000	542400	324038

[a]Difference is significant at 1%, [b]difference is significant at 5%.

Annex 3. Characteristics of farmers surveyed in Nigeria.

Variable	State			Overall sample
	Jigawa	Kano	Katsina	
Sample size	61	52	42	155
Gender (percent)				
Male	100.00	100.00	95.24	98.71
Age (years)	45.30	42.73	39.95	42.99
Average household size	10.38	11.50	10.41	10.77
Level of education (percent)				
Illiterate	1.64	5.77	2.5	3.27
Agriculture as main activity (percent)	44.26	82.69	95	70.59
Average land size owned (ha)	7.81	11.61	9.26	9.48
Average area of groundnut (ha)	2.17	2.95	3.6	2.82
Average number of plots owned	2.02	2.06	2.59	2.18
Average number of plots				
Sole cropping	1.68	1.59	2.57	1.88[b]
Mixed cropping	0.33	0.5	0.03	0.31[a]
Ownership of cart	69.49	25.58	32.50	45.77[a]
Ownership of tractor	1.69	0.00	2.50	1.41
Ownership of plough	72.88	30.23	55.00	54.93[a]
Average value of equipment (FCFA)				

[a]Difference significant at 1%, [b]difference significant at 5% and [c]difference significant at 10%.

Annex 4. Plant and trait characteristics of varieties used in the PVS trials.

Country/ variety	Plant and seed characteristics																
	Growth habit	Resistance to drought	Leaf color	Maturity	Number of seed/pods	100 Pod weight	Pod beak	Pod reticulation	Pod constriction	Resistance to foliar diseases	Seed color	Seed size	Pod yield	Haulm yield-t/ha	Year of development	Year of introduction	Institution
Mali																	
JL 24	Erect	Tolerant	3	90	2	70-75	3	5	3	Suspt	11	45	2.0	5	1966	1982	India
55-437	Erect	Tolerant	3	90	1	50-55	2	5	1	Suspt	8	34	2.0	5	1955	1960	ISRA
Fleur 11	Erect	Tolerant	3	90	1	130-140	3	7	3	Suspt	7	50	3	7	1990	1993	ISRA
ICGV86124	S-Erect	Tolerant	4	110	2	60-65	3	7	3	Suspt	10	40	3.0		1986	1989	ICRISAT
ICGV86015	S-Erect	Tolerant	3	110	2	55-60	2	5	5	Suspt	8	38	3.5	6.5	1986	1989	ICRISAT
Niger																	
55-437	Erect	Tolerant	3	90	1	50-55	2	5	1	Suspt	8	34	2.0	5.5			
TS 32-1	Erect	Tolerant	3	90	1	70-75	3	7	2	Suspt	8	40	3.5	7			
ICG 9346	Erect	Tolerant	3	90	1	90-100	3	7	2	Suspt	10	40	3.5	6	1966	1983	BF.INERA/IRHO
J11	Erect	Tolerant	2	90	1	95-100	2	5	2	Suspt	8	44	3.0	6	Landrace	1990	ICRISAT
JL 24	Erect	Tolerant	3	90	2	70-75	3	5	3	Suspt	11	45	2.0	5.5	1965	1983	India
RRB	Erect	N.Tolerant	3	90	1	80-90	3	5	3	Suspt	14	35	3.0	5.5			
Nigeria	Erect														1988	1989	Nigeria
ICIAR 19BT	Erect	Resistant	3	87	1	70-72	2	5	2	Suspt	10	44	3.0	6.5			
ICIAR 6AT	Erect	Resistant	3	86	1	60-70	2	5	3	Resistant	6	38	2.5	6			
ICIAR 7B	Erect	Resistant	3	87	1	70-75	2	7	2	Resistant	8	44	2.5	6.5		1988	Nigeria
Samnut 21 (UGA 2)	S-Erect	Resistant	4	110	2	130-140	4	7	3	Resistant	20	61	2	6		1988	Nigeria
Samnut 23 (ICGV-IS 96894)	Erect	Resistant	4	90	1	70-75	4	9	3	Resistant	14	50	2.5	6.5		1988	Nigeria

Pod beak: 2 Average, 3=pronounced; **Color of the leaves :** 2 green, 3: light green, 4 : dark green
Number of seed per pod: 1: predominance of two seeds with occasional 1 seed; 2: predominance of 2 seeds with occasional 3 seeds and rarely 1 seed
Pod reticulation: 5 Average, 7 pronounced; 9 very pronounced ; Seed color: 6: light, 7: tan, 8: dark tan, 10: pink, 11: salmon, 14:n dark red, 20: blotched

Annex 5. Comparison of six groundnut varieties for attribute ratings in Niger.

Attribute	Variety						Total	X2
	55-437	Fleur 11	ICG9346	J11	RRB	TS32-1		
Sample	109	109	110	110	110	110	658	
Growth habit (0=Does not like, 1=Indifferent, 3=Like)	1.85	1.48	1.68	1.75	1.36	1.8	1.65	96.065*
Resistant to disease (0=Does not like, 1=Indifferent, 3=Like)	1.76	1.41	1.63	1.75	0.95	1.73	1.54	103.0814*
Leaf Color (0=Does not like, 1=Indifferent, 3=Like)	1.45	1.39	1.24	1.45	1.54	1.48	1.42	28.347*
Plant maturity (0=Does not like, 1=Indifferent, 3=Like)	1.8	1.59	1.85	1.77	1.42	1.62	1.67	58.1466*
Number of pods per plant (0=Does not like, 1=Indifferent, 3=Like)	1.72	1.29	1.65	1.66	1.69	1.54	1.59	70.8443*
Pod size (0=Does not like, 1=Indifferent, 3=Like)	1.37	1.62	1.76	1.53	1.85	1.65	1.63	70.9605*
Pod filling (0=Does not like, 1=Indifferent, 3=Like)	1.76	1.62	1.77	1.66	1.65	1.73	1.7	13.8605
Pod beak (0=Does not like, 1=Indifferent, 3=Like)	1	0.94	1	1	1.03	1.07	1.01	10.3235
Pod constriction (1=Disliked, 2=Liked)	1.78	1.77	1.71	1.79	1.73	1.72	1.75	11.0488
Seed color (0=Does not like, 1=Indifferent, 3=Like)	1.74	1.71	1.81	1.72	1.8	1.73	1.75	5.6881
Seed size (0=Does not like, 1=Indifferent, 3=Like)	1.55	1.68	1.83	1.77	1.83	1.75	1.74	34.9517*
Pod yield (0=Does not like, 1=Indifferent, 3=Like)	1.72	1.33	1.65	1.56	1.65	1.61	1.59	33.6974*
Haulm quality (0=Does not like, 1=Indifferent, 3=Like)	1.61	1.6	1.53	1.58	1.86	1.65	1.64	37.446*
Haulm yield (0=Does not like, 1=Indifferent, 3=Like)	1.62	1.46	1.43	1.55	1.65	1.62	1.55	18.1532*
Pod Reticulation (1=Disliked , 2=Liked)	0.74	0.71	0.74	0.76	0.73	0.7	0.73	5.0006*
Plant vigor (0=Does not like, 1=Indifferent, 3=Like)	1.72	1.44	1.66	1.65	1.4	1.71	1.6	41.8187*

*Significant at 1% probability level.

Annex 6. Comparison of five groundnut varieties for attribute ratings in Nigeria.

Trait of variety	Variety					X2 value
	ICIAR 19BT	ICIAR 6AT	ICIAR 7B	Samnut 21	Samnut 23	
Sample	155	155	155	155	155	
Growth habit (0=Does not like, 1=Indifferent, 3=Like)	1.63	1.1	1.14	1.5	1.55	78.7896*
Resistant to disease (0=Does not like, 1=Indifferent, 3=Like)	1.43	1.08	1.14	1.55	1.23	67.9819*
Leaf color (0=Does not like, 1=Indifferent, 3=Like)	1.43	1.25	1.28	1.85	1.57	102.2023*
Plant maturity (0=Does not like, 1=Indifferent, 3=Like)	2.55	1.86	1.82	2.05	2.29	106.8041*
Number of pods (0=Does not like, 1=Indifferent, 3=Like)	1.79	0.94	1.07	1.43	1.68	176.0752*
Pod size (0=Does not like, 1=Indifferent, 3=Like)	1.48	1.07	1.03	1.56	1.85	165.5034*
Pod filling (0=Does not like, 1=Indifferent, 3=Like)	1.7	1.21	1.3	1.5	1.69	68.1079*
Pod reticulation (0=Disliked, 1= Liked)	1.04	0.79	0.77	1.01	1.09	58.7847*
Plant vigor (0=Does not like, 1=Indifferent, 3=Like)	1.63	1.15	1.14	1.55	1.48	96.9593*
Flowering (0=Does not like, 1=Indifferent, 3=Like)	1.47	1.13	1.24	1.59	1.34	62.7933*
Seed color (0=Does not like, 1=Indifferent, 3=Like)	1.82	1.24	1.34	1.64	1.72	85.1387*
Seed size (0=Does not like, 1=Indifferent, 3=Like)	1.62	1.14	1.23	1.55	1.79	110.6562*
Pod yield (0=Does not like, 1=Indifferent, 3=Like)	1.72	0.98	1.1	1.48	1.69	143.3008*
Haulm quality (0=Does not like, 1=Indifferent, 3=Like)	1.41	1.41	1.31	1.8	1.59	70.9253*
Haulm yield (0=Does not like, 1=Indifferent, 3=Like)	1.4	1.37	1.33	1.77	1.51	76.4963*

*Significant at 1% probability level.

Annex 7. Mean and Median Scoring of varieties by State in Nigeria.

State/Variety	Mean	Stdev	Median	Min	Max
Jigawa					
ICIAR 19BT	3.04918	1.039651	3	0	4
ICIAR 6AT	1.409836	1.101167	1	0	4
ICIAR 7B	1.262295	1.093948	1	0	4
Samnut 21	1.540984	1.638839	1	0	4
Samnut 23	2.639344	1.169513	3	0	4
Total	1.980328	1.418721	2	0	4
Kano					
ICIAR 19BT	3.115385	1.078377	3.5	0	4
ICIAR 6AT	0.480769	0.779401	0	0	3
ICIAR 7B	1.307692	1.057901	1	0	3
Samnut 21	3.019231	1.019234	3	1	4
Samnut 23	2.365385	1.103095	2	0	4
Total	2.057692	1.433378	2	0	4
Katsina					
ICIAR 19BT	3.404762	1.105629	4	0	4
ICIAR 6AT	1.071429	1.197413	1	0	4
ICIAR 7B	0.833333	1.057301	0.5	0	4
Samnut 21	3	1.059222	3	0	4
Samnut 23	2.285714	1.110608	2	0	4
Total	2.119048	1.499639	2	0	4

Annex 8. Mean and Median scoring of varieties by region in Mali.

Region/Variety	Mean	SD	Median	Min	Max
Kayes					
JL 24	2.083333	1.1645	2	0	4
Fleur 11	1.9375	1.526161	2	0	4
ICGV 86 124	2.083333	1.505042	2	0	4
ICGV 86 015	1.666667	1.370689	1.5	0	4
Local	2.25	1.712255	2	0	4
Total	2	1.436486	2	0	4
Koulikoro					
JL 24	1.4	1.168206	1	0	4
Fleur 11	1.638889	0.899294	1	0	4
ICGV 86 124	3.027778	0.999603	3	0	4
ICGV 86 015	1.694444	1.687254	2	0	4
Variété locale	2.277778	1.560423	3	0	4
Total	2.011173	1.414169	2	0	4

Annex 9. Mean and Median scoring of varieties by region in Niger.

Village/Variety	Mean	St Devd	Median	Min	Max
Doula					
55-437	4.555556	0.704792	5	3	5
Fleur 11	1.666667	1.57181	1	0	5
ICG9346	2.777778	1.114374	3	0	5
J11	3.111111	1.323493	3.5	1	5
RRB	1.055556	1.513555	0.5	0	5
TS32-1	1.888889	1.367217	2	0	5
Total	2.509259	1.710306	2.5	0	5
Guidan gaba					
55-437	3.217391	1.475759	4	0	5
Fleur 11	2.045455	1.703701	2	0	5
ICG9346	2.086957	1.755848	2	0	5
J11	1.913043	1.592969	2	0	5
RRB	2.75	1.775436	3	0	5
TS32-1	3.130435	1.659801	3	0	5
Total	2.528986	1.718054	3	0	5
Komaberi					
55-437	2.344828	1.446075	2	0	5
Fleur 11	1.862069	1.826866	1	0	5
ICG9346	2.793103	1.698304	3	0	5
J11	2.931034	1.688851	3	0	5
RRB	2.827586	1.891125	2	0	5
TS32-1	2.241379	1.573331	2	0	5
Total	2.5	1.712754	2.5	0	5
Tanda					
55-437	1.777778	1.563472	2	0	4
Fleur 11	3.1	1.595131	3.5	0	5
ICG9346	1.4	2.01108	0.5	0	5
J11	1.8	1.549193	1.5	0	5
RRB	4.222222	1.641476	5	0	5
TS32-1	3.1	1.911951	3.5	0	5
Total	2.551724	1.921005	3	0	5
Wassangou					
55-437	2.2	1.270352	2	0	5
Fleur 11	2.166667	1.966676	2	0	5
ICG9346	3.166667	1.341212	3	0	5
J11	2.133333	1.6344	2	0	5
RRB	3.533333	1.870521	4	0	5
TS32-1	1.7	1.368362	1.5	0	5
Total	2.483333	1.702693	2	0	5

Annex 10. Effects of variety traits and socio-economic and demographic characteristics on rankings in Niger.

Rank	Coefficient
Plant and seed characteristics	
Growth habit	-0.0772302
Disease resistance	0.1997059[c]
Plant vigor	-0.0406331
Leaf Color	0.1199268
Plant maturity	0.003147
Number of pods	0.5128627[a]
Pod filling	0.1686394[c]
Pod beak	-0.2982916[b]
Pod reticulation	-0.1026316
Pod constriction	0.0756434
Seed color	0.2419987[c]
Seed size	-0.0933111
Pod yield	0.4228103[a]
Haulm quality	0.0329328
haulm yield	-0.0010921
Socio-economic characteristics	
Age	-0.0049743
Sex	0.0677956
Marital status	0.1125172
Level of education	0.0059717
Ethnic group	0.001273
Social status	-0.0044237
Main occupation	0.0225143
Ln(value of equipment)	0.0248193
Ln(value of livestock)	-0.045274[a]
Village	
Guidan Gaba	-0.1508404
Koma Beri	-0.3418285
Tanda	-0.0821621
Wassangou	-0.1841017
γ_1	0.0642506[a]
γ_2	0.1595013[b]
γ_3	0.2283531[a]
γ_4	0.7067815[a]
γ_5	1.275423[a]
Number of observations	580
LR chi2(28)	113.24
Prob > chi2	0
Pseudo R2	0.0545
Log likelihood	-982.524

[a]denotes significance at 1%, [b]at 5% and [c]at 10%

Annex 11 . Effects of variety traits and socio-economic and demographic characteristics on rankings in Nigeria.

Rank	Coefficient
Seed and plant characteristics	
Plant vigor	0.389139[a]
leaf Color	-0.08395
Plant maturity	0.25996[a]
Plant type	0.219089[a]
Pest resistance	0.138193
Foliar diseases	0.007544
Number of pods	0.371693[a]
Pod size	0.148016[c]
Pod filling	0.075931
Pod reticulation	-0.02477
Seed color	-0.05592
Seed size	0.061084
Pod yield	0.295392[a]
Haulm quality	-0.20752[b]
Haulm yield	0.09965
Socio-economic characteristics	
Age	-0.00395
Marital status	-0.01474
Level of education	0.017175
Main occupation	-0.03612
Ln(value equipment)	-0.0191
Ln(value livestock)	0.026767
Region	
Kano state	0.088454
Katsina state	-0.37202
γ_1	0.2073[a]
γ_2	0.354549[a]
γ_3	0.715398[a]
γ_4	1.48219[a]
Number of observations	705
LR chi2(23)	378.89
Prob > chi2	0
Pseudo R2	0.1672
Log likelihood	-943.712

[a]denotes significance at 1%, [b]at 5% and [c]at 10%

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